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Optimal Policy for Social and National Security

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Abstract

In this study, we discuss the optimal policy when the government controls both tax to finance social and national security and allocation of public funds between them, by introducing national risk into our model. We present the optimal tax and optimal allocation rates when the probability of national risk is equal to or more than 50% and the interest factor is more than the population growth rate. As both optimal rates depend on the probability of national risk, we reveal that a higher probability increases the optimal tax rate and decreases the optimal allocation rate from national to social security.

Key Words: Life Risk; Social Security; National Risk; National Security; Optimal Policy.

JEL Classification: E61, E66, H21, H55, H56.

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1 Introduction

In our life, we always face two types of risks. One is life risk, which may prevent us from living safely, free of illness, accidents, and other unpleasant experiences. Especially in recent times, when longevity has increased leading to an aging society, there are concerns on how to hedge these risks and lead a safe life after retirement. We can try mitigating life risk using savings and private insurance. However, when these cannot mitigate life risk, governments provide social security to mitigate such risks. The second type of risk is national risk, which includes risks due to natural disasters (e.g., earthquakes, tornadoes, typhoons, and other climate changes) and national defense. Since we cannot safeguard ourselves against national risks, which are an act of god and the force majeure, as governments are not immune to them, governments need to create national policies to mitigate such national risks.

We need to secure ourselves from these risks. However, it is difficult for private agents to provide security against such risks. As pointed out in Musgrave [12], as a part of their obligations under public finance, governments must assess and mitigate these risks. Governments have a policy of public fund allocation between social and national security. Aging populations require social security payments from governments while international conflicts and protection from acts of terrorism require considerably more expenditure for national defense. Sanz and Velázquez[15] show that, in countries of the

Organization for Economic Co-operation and Development (OECD), from 1970 to 1997, government spending increased for functions that were particularly in demand by the elderly populations, such as social welfare and health, and for national defense. Although aging is one of the driving forces for increasing government spending, governments expend much more on national security. Therefore, the question arises, which aspects of social and national security need to be emphasized in society?

Many studies in the past have examined social security after retirement. The contributions of Diamond[5], Feldstein[6], Becker and Barro[2], and others indicate that social security affects capital accumulation. Especially, incorporating an uncertain lifetime into the overlapping-generations model, Yakita[19] shows that increased life expectancy lowers fertility, and that pay-as-you-go social security does not reverse fertility. However, in the literature, there are few discussions that include both social and national security. There is room for examining the relationship between social and national security.

For the discussion on natural disasters and national defense as national security in the literature, we have applied the economic wisdom of public goods and/or public services [1]. Especially in the context of the discussion on national defense, Murphy and Topel[11] suggest that national security has the following three characteristics[2]. First, national security investments pro-

[1] For example, a government builds a sea embankment in anticipation of flooding after a tsunami. Such an embankment is a public good.

[2] Smith[17] provides an analytical survey of military expenditure using an empirical econometric model. Sandler[14] explains collective action failures that plague targeted countries in their efforts to respond to global terrorism.

vide societal insurance against widespread harm. Second, national security is useful in various circumstances such as military preparedness and/or protection of important resources such as oil. Third, potential national security threats are uncertain in terms of their occurrence and magnitude.

However, controversial issues persist on how governments mitigate national risk. For natural disasters, governments adopt policies to mitigate damage caused by the disasters considering the probability of such disasters recurring. By assuming such a public policy in a simple overlapping-generations model economy, Naito and Omori[13] discuss the effects of natural disaster prevention behavior of households among the populations distributed in certain areas, and on fertility. On the other hand, for national defense, governments formulate and execute policies to deter enemies and mitigate damage caused to national interests by the enemy[3]. In the literature on national defense, there are few theoretical models based on the premise that governments mitigate damage caused by the enemy. In this paper, we assume that national security mitigates the damage generated by a national risk such as natural disasters, international disputes, and other eventualities. Therefore, when consumers cannot secure life risk and national risk, governments must secure these risks by adopting social security and national security. For these discussions, in this paper, we develop a

[3]In many developed countries, military power presents a deterrent to other countries and lowers the probability of outbreak of hostilities. However, in Japan, the constitutional law prohibits the Japanese from having military capabilities. The law, however, approves the right to defense. Japanese self-defense forces only intercept and interdict enemies.

model that includes social security and national security.

By securing these risks, if a government adopts social security and national security simultaneously, an important issue arises regarding the allocation of public funds between national and social security as fundamental functions of the government. However, in the past literature discussing security related to national risk and life risk as functions of the government, it is difficult to find models that include both social and national security[4]. In this paper, we discuss an optimal security policy for both life risk and national risk to maximize social welfare. Moreover, since we assume that the government has tax and allocation policies for social and national security and adopts these policies simultaneously, the tax policy is affected by the allocation policy, and vice versa. Based on these discussions, we present the optimal wage income tax and the optimal allocation rates. The question addressed in this paper is as follows: When there are both life risks and national risks in the economy, what are the optimal tax policies for them as well as the optimal policy for allocating public funds between them? These optimal rates would tell us how governments play a role in the economy.

The remainder of this paper is organized as follows. Section 2 presents the

[4]On the allocation of public funds between social security and public education, Kaganovich and Zilcha[10] discuss the government's allocation between public investment in education and social security benefits to the older generation. Glomm and Kaganovich [8] discuss how the relationship between economic growth and inequality depends on public education and social security and show that an increase in government spending on social security reduces income inequality and produces a non-monotonic effect on growth. However, these studies do not address national security. There is, thus, some room to examine social and national security simultaneously.

model. Section 3 presents the optimal tax rate under the optimal allocation rate. Section 4, with calibration, examines the effects of the probability of national risk on the optimal tax rate. The final section presents concluding remarks.

2 The model

Based on Diamond[4], we develop the overlapping-generations model with national and social security in a small open economy. Production technology is assumed to be governed by a standard neoclassical constant-returns-to-scale production function. However, because we assume a small open economy, the capital labor ratio and wage rate are constant.

2.1 Consumers

We presume that identical consumers might survive during three periods, namely, the period of youth, the working period, and the retirement period. However, in this paper, we assume an uncertain lifetime economy. To introduce longevity into the model, we also assume that not all consumers necessarily survive these three periods. Consumers can survive through the retirement period with probability p_s. The probability that they will die before the retirement period is $1 - p_s$. In this model, similar to Chakraborty[3] who developed the model including the probability of survival, we assume that the probability of survival, p_s, is the same for all consumers.

Consumers who are in the working generation at period t inelastically supply their labor to firms. They divide their after-tax income among current consumption and saving for consumption after retirement. Consumers in the final period of their lives, the retirement generation, consume their social security benefits and their accumulated savings.

When consumers die before the final period, their savings would become an accidental bequest. To avoid such bequests, we introduce a private annuity market into the model, and the return in that market at period t is the interest rate, $1+r$, which is divided by p_s $\left(i.e., \frac{1+r}{p_s}\right)$. In this model, we have two types of annuity: private annuity and social security benefits. As discussed in the introduction, consumers try mitigating life risk by using savings and private annuity. However, when they cannot do so, the government provides social security for them.

Next, we discuss how to introduce national risk into the model. Following Naito and Omori [13] who developed a simple overlapping-generations model by including natural disaster prevention behavior, we assume that the utility function includes damage caused by a national risk at the probability of p_D, which is denoted by D_i in period i. Consumers deal with that damage as given and cannot control this variable because we assume that the national risk is a ?public bad? and generates negative external effects on the economy. p_D is assumed to be the same for all consumers because the national risk occurs at the same probability for all consumers in the economy. The probability of consumers surviving the retirement period is p_s, and the probability of national risk, p_D. In the retirement period of a representative consumer of generation t, he or she derives negative utility from the damage caused by national risk at a probability of $p_s \times p_D$.

The utility function of a representative consumer of generation t is as follows:

$$U_t = \ln c_t^t + p_s \ln c_{t+1}^t - p_D \ln D_t - p_s p_D \ln D_{t+1}, \tag{1}$$

where c_t and c_{t+1} respectively denote consumption in periods t and $t+1$. In addition, p_D is the probability of national risk, and we assume that $0 < p_D < 1$[5].

Budget constraint for consumers of the working generation and retirement generation are given as

$$(1-\tau)w = c_t^t + s_t, \tag{2}$$

and

$$\frac{(1+r)s_t}{p_s} + T_{t+1} = c_{t+1}^t, \tag{3}$$

where $\tau,\ w_t,\ s_t,\ r,$, and T_{t+1} respectively denote income tax, wage at period t, saving at period t, interest rate, and social security benefits. Let N_t be the total population of working generation at period t and n be the number of children (population growth rate). Then, we have $N_{t+1} = nN_t$.

[5] p_D in the utility function denotes the subjective provability of national risk rather than the occurrence probability of national risk. We assume that the marginal disutility of damage decreases in our model. In fact, Fennema and Van Assen[7] and Slovic et al.[18] use empirical analysis to show that marginal disutility decreases with respect to damage. Therefore, the utility function in our model reflects their empirical results. However, the behaviors of economic agents may affect the provability of national risk. In this paper, for simplicity, we do not assume such a case and the discussions in the model including the effects of agents' behavior on probability of national risk are left for future research.

Consumers maximize (1) subject to (2) and (3). Solving the maximization problem of consumers, we can derive the following solutions:

$$c_t^t = \frac{1}{1+p_s}\left\{(1-\tau)w + \left(\frac{p_s}{1+r}\right)T_{t+1}\right\}, \tag{4}$$

and

$$c_{t+1}^t = \frac{1}{1+p_s}\left\{(1+r)(1-\tau)w + p_s T_{t+1}\right\}. \tag{5}$$

2.2 National security

In this subsection, we consider the damage caused by national risk. Utility of the representative consumer of generation t is affected by damage of two types. One is damage D_t, which affects utility at period t. The other is damage D_{t+1}, which affects it at period $t+1$. Since these damages show national risk, consumers deal with them as given. Therefore, consumers cannot determine the level of this damage. However, as discussed in the introduction, we presume that the government can mitigate the impact of the damage by expending tax revenue for national security policy. Then, we assume the damage function because of national security as follows:

$$D_t = \frac{a}{G_t}, \tag{6}$$

and

$$D_{t+1} = \frac{a}{G_{t+1}}, \tag{7}$$

where a stands for the positive primary damage, G_t signifies public expenditure for national security at period t, and G_{t+1} is public expenditure for national security at period $t+1$. Based on (6) and (7), the damage to national security is a decreasing function of expenditure for national security[6].

2.3 The government

The government imposes a wage income tax on consumers of the working generation and allocates tax revenue to national and social security benefits.

The government's budget constraint in period t is

$$\tau w N_t = G_t N_t + G_t p_s N_{t-1} + T_t p_s N_{t-1}. \tag{8}$$

The left-hand-side of (8) shows the income tax revenue at period t. However, the first and second terms on the right-hand-side in (8) denote public expenditure for national security at period t. The third term on the right-hand-side in (8) represents social security benefits at period t. We assume that each consumer in the working generation has n children. Therefore, n is equal to N_t/N_{t-1}. Let θ represent the allocation rate of tax revenue for social security, where $0 < \theta < 1$. Then, we can show national and social security as

$$T_t = \frac{n}{p_s}\theta\tau w, \tag{9}$$

and

$$G_t = \frac{n}{n+p_s}(1-\theta)\tau w. \tag{10}$$

Substituting (9) and (10) into (4) and (5), respectively, consumers' opti-

[6]We assume that the government always expends funds for national risk as a government function.

mal plans in the state of equilibrium are shown as

$$c_t^t = \frac{w}{(1+p_s)(1+r)} \left[(1+r)(1-\tau) + n\theta\tau \right], \tag{11}$$

and

$$c_{t+1}^t = \frac{w}{1+p_s} \left[(1+r)(1-\tau) + n\theta\tau \right]. \tag{12}$$

It is noteworthy that the optimal plans of both consumers are independent of the probability of national risk.

3 Optimal policies

In this study, we assume that the government has two policy instruments: tax to finance social and national security as well as allocation of public funds to them. However, since the government needs to adopt one optimal policy with the optimization of the other, one policy change can influence the other policy. Tax policy and allocation policy are in an interdependent relationship. In other words, if the tax policy to maximize social welfare is changed, such a tax policy change affects the allocation policy under the optimal tax policy and the optimal allocation policy would change. Similarly, when the optimal allocation policy is changed, the optimal tax policy also changes. Therefore, the tax policy and allocation policy are interdependent. To discuss the optimal policy in this model, we should consider this interdependence.

Before discussing the optimal policies, we assume the social welfare function in this small open economy. Substituting (10), (11), and (12) into (1), we derive the indirect utility function in equilibrium as

$$\begin{aligned} U_t &= (1+p_s)\ln\left[\frac{w}{1+p_s}\right] + \ln\frac{1}{(1+r)} + (1+p_s)\ln\left[(1-\tau)(1+r)+n\theta\tau\right] \\ &- (1+p_s)p_D\ln a + (1+p_s)p_D\ln\frac{n}{n+p_s}(1-\theta)\tau w. \end{aligned} \tag{13}$$

Based on this social welfare function, to show how social welfare depends on the tax rate and allocation rate, Figure 1 illustrates the case of $p_s = 0.8$, $p_D = 0.7$, $n = 1$, $w = 5$, $r = 0.04$, and $a = 10$. Figure 1 shows that these policies are interdependent, but there may be optimal tax and allocation rates to maximize social welfare. Therefore, in this section, we discuss the optimal policies when the government controls both tax and allocation policies.

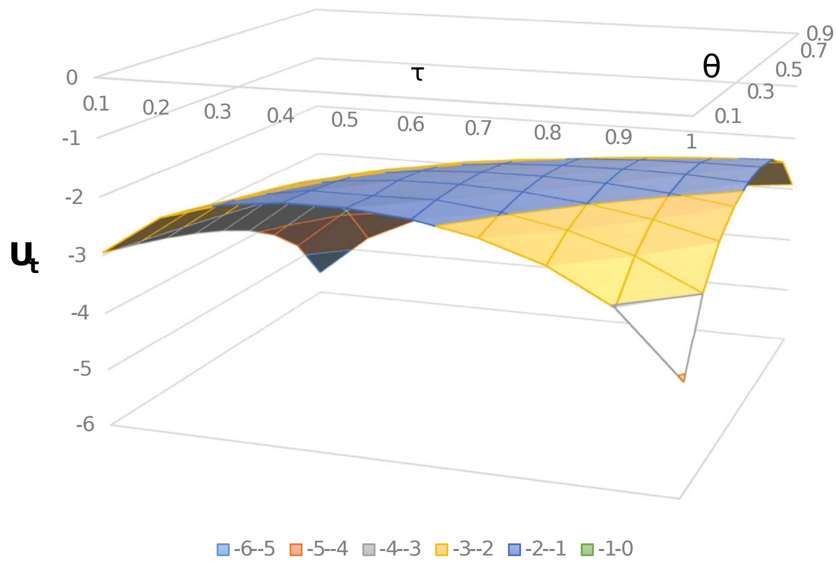

Figure 1: Effects of tax and allocation policies on social welfare

3.1 Tax policy

Given the allocation rate, differentiating (13) with respect to τ, the effect of tax on social welfare is shown as

$$\frac{dU_t}{d\tau} = -\frac{(1+p_s)((1+r)-\theta n)}{(1+r)(1-\tau)+n\theta\tau} + \frac{(1+p_s)p_D}{\tau}. \tag{14}$$

The first term on the right-hand side of (14) denotes the negative effect of income tax on consumption in periods t and $t+1$. The second term on the right hand side of (14) shows the positive effect of public expenditure through increasing income tax on national security. Although the first term in (14) is negative, the sign on the second term is positive. The effects of wage income tax on welfare are not determined. Presuming that the government enhances the wage income tax τ, consumers decrease consumption in periods t and $t+1$ because of the decrease in disposable income. However, it is noteworthy that there is an incentive to decrease their savings, because they receive more social security benefits in their retirement period. The increase in tax revenues causes an increase in the expenditure on national security and mitigates the damage associated with national risk.

At a constant allocation rate, from (14), the optimal tax rate, τ^T, can be shown as

$$\tau^T = \frac{p_D(1+r)}{(1+p_D)(1+r-n\theta)}. \tag{15}$$

For a positive tax rate, since we assume that $1+r-n\theta$ is positive, this assumption creates a dynamic efficient economy. In contrast, if $1+r-n\theta$ is negative, the tax rate is negative. When we consider national and social security, the economy in our model should be a dynamic efficient economy. As shown by Abel et al.[1], the United States and other OECD countries are indeed dynamically efficient. Following Abel et al.[1], this optimal tax rate should hold in the economy.

This optimal wage income tax rate, (15) depends not on the probability of surviving the retirement period, p_s but on the probability of national risk, p_D, interest rate, r, and population rate, n. Consumers can secure themselves for life risks, but the government must secure them when consumers cannot do so. Optimal plans of the representative consumer in equilibrium, (11) and (12), are affected by the probability of surviving, p_s because we assume the annuity market to avoid accidental bequests, and this assumption clears the life-risk problems that occur in $1 - p_s$. On the other hand, as discussed earlier, because consumers cannot secure for national risks and that only the government must secure them for these, this optimal tax rate, (15) shows that the government should care about national risk and not about life risk. In other words, because p_D is positive for a positive optimal tax rate and provision of social security benefits, social security can insure the retirement generation against national risk and the optimal tax rate does not depend on p_s

In addition, this optimal wage income tax rate depends on the allocation rate. If the government changes the allocation rate, the optimal tax rate should also be changed. This effect can be shown as follows:

$$\frac{d\tau^T}{d\theta} = \frac{np_D(1+r)}{\left[(1+p_D)(1+r-\theta n)\right]^2} > 0. \tag{16}$$

Increasing social security benefits for the older generation makes consumers less motivated to save their income. To fund such a benefit, the government increases the wage income tax.

3.2 Allocation policy

Next, we discuss the allocation policy that changes the allocation rate of public funds to maximize social welfare at a constant wage income tax rate. Given τ, differentiating (13) with respect to θ, the optimal allocation rate to social security, θ^*, is derived. That is,

$$\frac{dU_t}{d\theta} = \frac{(1+p_s)n\tau}{(1+r)(1-\tau)+n\theta\tau} - \frac{(1+p_s)\,p_D}{1-\theta}. \tag{17}$$

In fact, the second-order condition, $\frac{d^2U_t}{d\theta^2}$, is negative.

From (17), when the government adopts the optimal allocation policy for the maximization of social welfare, the optimal allocation rate, θ^A, is derived as

$$\theta^A = \frac{n\tau - p_D\,(1+r)\,(1-\tau)}{n\tau\,(1+p_D)}. \tag{18}$$

From (18), to maximize social welfare by controlling the allocation of public funds, the tax rate, τ^A, is rewritten as

$$\tau^A = \frac{p_D\,(1+r)}{n+p_D\,(1+r)-n\,(1-p_D)\,\theta}. \tag{19}$$

When the denominator of (19), $n + p_D(1+r) - n(1-p_D)\theta$, is positive, the optimal allocation rate τ^A is positive.

This tax rate also depends on the allocation rate. Differentiating (19) with respect to θ, the effects of changing allocation rate on tax rate can be shown by

$$\frac{d\tau^A}{d\theta} = \frac{p_D(1+r)\,n(1-p_D)}{[n + p_D(1+r) - n(1-p_D)\theta]^2} > 0. \tag{20}$$

As increasing social security benefits needs more tax revenue, this sign is positive. On the lines of the discussion related to the optimal wage income tax rate, the tax rate under the optimal allocation rate is also independent of the probability of surviving, p_s.

3.3 Optimal policy

As discussed above, since the government has two types of policies, which are interdependent, the tax rate, (15), is equal to the rate (19) at social optimum. Therefore, we simultaneously solve the equations of (15) and (19) to derive the optimal tax rate, τ^*, and optimal allocation rate, θ^*. They can be shown by the following proposition.

Proposition 1

When the probability of national risk is equal to or more than 50% and the interest factor is more than the population growth rate ($1+r > n$)*, the optimal tax rate and optimal allocation rate are shown by*

$$\tau^* = \frac{2p_D^2(1+r)}{(1+p_D)[(2p_D-1)(1+r)+n]}, \tag{21}$$

and

$$\theta^* = \frac{(1+r)-n}{2p_D n}. \tag{22}$$

These optimal rates depend on the probability of national risk, p_D, interest rate, r, and rate of population growth, n. For the positive rates, we assume that the probability of national risk is equal to or more than 50% ($p_D \geq \frac{1}{2}$) on (21), and the interest factor is more than the population growth rate ($1 + r > n$) on (22)[7].

The occurrence of national risk is uncertain. It is difficult to specify the probability of national risk. In this model, as in Naito and Omori[13], we assume that this probability is the subjective probability of national risk. Nevertheless, we can discuss whether the probability of national risk, $p_D \geq 50\%$ is realistic or not based on $Proposition 1$. In this paper, we consider the probability of national risk for national disaster and international disputes. Regarding national disasters, there have been typhoons in Japan and hurricanes in the United States every year. The Great earthquakes ($Magnitude \geq 8$) repeatedly occur along the subduction zones around Japan. According to Satake[16], around the Nankai Trough of Japan, which is probably the best-known subduction zone in the world in terms of recurrence of large earthquakes, the 30-year estimated probabilities for Tonankai earthquake (Magnitude 8.1) and Nankai Trough earthquake (Magnitude 8.4) were, as of 2012,

[7]Focusing on the denominator of (21), $(2p_D - 1)(1 + r) + n$ should be positive for a positive tax rate, and $p_D \geq \frac{1}{2}$ is assumed. When we assume this condition, a positive rate is seen regardless of the values of r and n. However, if p_D is less than 50%, there might not be an optimal positive tax rate.

60% and 70%, respectively. For national security, the Institute for Economics and Peace[9] reports that a total of 77 countries recorded at least one death due to acts of terrorism, and this has seen an increase in 65 countries in 2015. The number of deaths due to terrorism continues to increase with its probability also apparently increasing. Based on these facts on national risk, as a probability of 50% is acceptable for the economy, it is realistic to assume that the probability of national risk is equal to or more than 50% as per the proposition.

Based on these assumptions, as the probability of national risk is realized as a small probability for the government, the government need not adopt both policies simultaneously. We also note that the government does not need to consider the probability of survival of consumers, p_s. Our discussions of the government's role in this model imply that the government needs to consider only the national security risks.

4 Effects of the probability of national risk on the optimal policies

In this section, we examine the effects of the probability of national risk on optimal policies while using calibration. Differentiating (21) with respect to p_D, we can show the effects as follows:

$$\frac{d\tau^*}{dp_D} = (1 + 2p_D)\, n - 4\,(1 + 2p_D)^2\,(1 + r)\,. \tag{23}$$

The sign of this differentiation is ambiguous. We calibrate the effects under

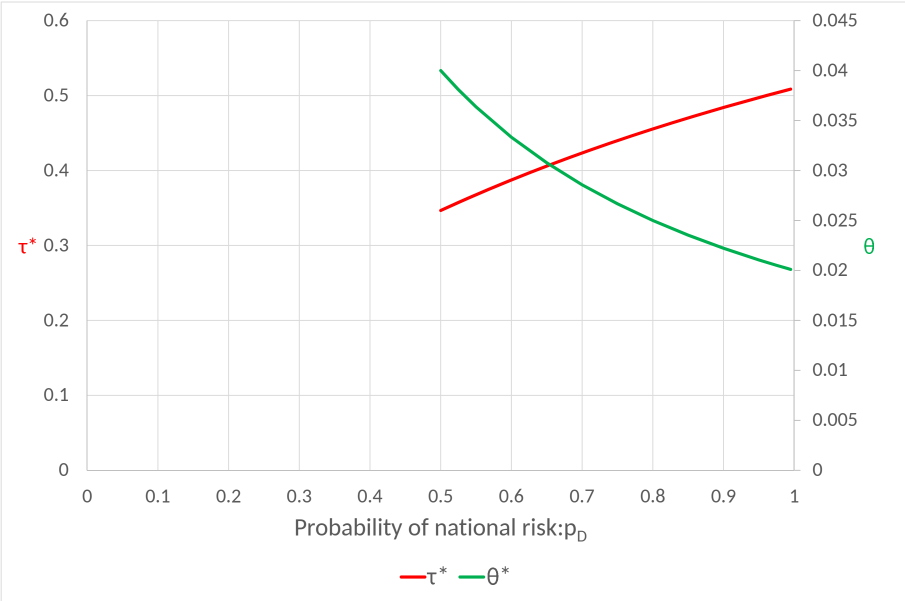

Figure 2: Effects of the probability of national risk on optimal policies

the settings of $r = 0.04$ and $n = 1$. We draw such effects in $Figure2$ in the case of $0.5 \leq p_D \leq 0.995$ because of the optimal tax rate as shown in $Proposition1$. $Figure2$ shows that, as p_D goes up, the optimal tax rate increases because the government needs more revenue for national security.

To discuss the effects of national risk on optimal allocation between social and national security, we differentiate (22) with respect to p_D. From $Proposition1$,

$$\frac{d\theta^*}{dp_D} = -\frac{(1+r)-n}{2p_D^2 n} < 0. \tag{24}$$

As p_D increases, the government must expend more on national security. Showing the conventional wisdom of public goods, the role of providing national security is the government?s and not that of any private agent. To confirm this effect, we calibrate in the case of $0.5 < p_D < 0.995$ under the settings of $r = 0.04$ and $n = 1$. This calibration is also shown in $Figure 2$.

Although the increasing tax rate decreases disposable income, decreases consumers' savings for life risk, and makes consumers need social security benefits in the retirement period, as p_D increases further, the government must further secure national risk, and such a policy should have priority over social security.

5 Concluding remarks

In this study, we introduced national risk into the overlapping-generations model with social security and revealed the optimal tax rate for social and national security as well as the optimal allocation rate between them. Since these policies are interdependent, the government should adopt one policy to maximize social welfare by the optimization of the other policy. We presented the optimal tax rate and optimal allocation rate when the probability of national risk is equal to or more than 50% and the interest rate is also more than the population growth rate. Furthermore, we proved that as the probability of national risk goes up, the optimal tax rate increases and optimal allocation rate decreases.

Our results demonstrate that when the government requires tax revenues for social and national security and allocates them to the economy, the optimal wage tax rate and optimal allocation depend not on life risk but on national risk. In an economy with an aging population, although the government faces a dilemma on how public funds should be allocated between national and social security, the government should make policies while considering national security for national risk rather than social security for life risk.

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