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Abstract

We examine possible impacts of demographics on outcomes of capital tax competition in political economy. For this purpose, we develop an overlapping generations model wherein public good provision financed by capital tax is determined by majority voting. When a population is growing, younger people represent the majority, whereas when a population is decreasing, older people represent the majority. We show that the race to the bottom is likely to emerge in the population growing economy whereas the race to the top might emerge in the population decreasing economy.

JEL Classification: H20, J11,
Keywords: tax competition, majority voter, fiscal externality, political externality

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1 Introduction

This paper investigates the possible impacts of demographics on the results of capital tax competition in political economy. Given the drastic increases in capital flows across countries and regions, many scholars have analyzed the effects of globalization in the capital market over the past few decades. One of the most important strands in this field is the theory of capital tax competition, which has a long history dating back at least to Zodrow and Mieszkowski (1986) and Wilson (1986).[1] Researchers in this strand investigated the role of governments in attracting capital to their jurisdictions. In standard tax competition models, governments are benevolent and maximize the representative resident's welfare. Nonetheless, they set inefficiently low capital tax rates because capital taxation causes capital flight, which increases the tax base in other countries and causes positive fiscal externalities. This result is known as the *race to the bottom* and has attracted much attention (see e.g., OECD, 1998).

Around the same time, we observe large differences in demographic structure among countries and drastic demographic changes in many of them. In fact, if we consider at the old-age dependency ratio, which is the ratio of people older than 65 years of age to the working-age population, we find large differences among countries. For example, the 2014 ratios were 9.6 in Mexico, 11.1 in Turkey, 21.6 in the United States, 27.7 in Spain, 34.4 in Italy, and 41.9 in Japan.[2] Similarly, the median ages in 2010 were 26.6 in Mexico, 28.3 in Turkey, 36.9 in the United States, 40.1 in Spain, 46.4 in Italy, and 47.8 in Japan.[3] Moreover, we also observe drastic changes in these figures: the old-age dependency ratios and median ages of OECD countries rose from 13.7 to 24.2 between 1960 and 2014 and from 28.9 to 45.4 between 1950 and 2010, respectively. These facts imply that in political economy, decisive voters are younger generations in countries such as Mexico and Turkey, whereas they are older generations in countries such as Italy and Japan. Moreover, they are getting older in OECD countries. Put plainly, decisive voters and hence, the objectives of governments might change over time and place. This would, in turn, affect the outcomes of capital tax competition.

To analyze the effects of demographics on capital tax competition, we develop a capital tax competition model involving the overlapping generations structure wherein policies are determined by majority voting. In our model, all individuals live for two periods, young and old, and the population grows with an exogenous constant growth rate. If the population growth rate is positive, then the young individuals represent the majority because their population size is larger than that of old individuals. In contrast, if the population growth rate is negative, then the old individuals represent the majority. We consider multiple countries and each country's government supplies public goods and finances them with capital tax. A government chooses the level of public good provision and capital tax rate to maximize the utility of the individuals representing the majority.

In our model, young individuals supply labor to firms, which produce private consumption goods with labor and capital. The wage income of young individuals increases with the capital inputs in the country, whereas the savings income of old individuals increases with the rate of return on savings. Young individuals consume private and public goods and save the wage income for old-age consumption. Old individuals consume private and

[1] For surveys on this strand, see Wilson (1999), Wilson and Wildasin (2004) and Zodrow (2003) among others.

[2] World Bank, http://data.worldbank.org/indicator/SP.POP.DPND.OL

[3] OECD, http://www.oecd-ilibrary.org/education/trends-shaping-education-2013/median-age-going-up-into-the-next-century_trends_edu-2013-graph43-en

public goods. Governments at a certain period cannot commit to future policies when maximizing the majority's utility. This brings about a discrepancy between the government's objective and the life-time utility of individuals. Hence, capital taxation causes inter-generational externalities, which we call the *political externality*. Such an externality is positive when the individual's preference for public good consumption is strong and negative when it is weak in both population growing and decreasing economies.

Moreover, because we assume free mobility of capital between countries, capital taxation causes a positive externality, which we call the *fiscal externality*, as is standard in models of capital tax competition. Moreover, because young individuals' wage income increases with capital inputs in the country whereas old individuals savings income does not depend on them, young individuals prefer a lower capital tax rate than old individuals. Therefore, a government has a stronger incentive to offer tax-cuts on capital and this results in a stronger fiscal externality in a population growing economy than in a population decreasing economy.

The relative significance of political and fiscal externalities characterizes the (in)efficiency of the equilibrium capital tax rate. When individuals strongly prefer public good consumption, the political externality becomes positive. Combined with positive fiscal externality, it yields an inefficiently low capital tax rate, i.e., we observe the *race to the bottom*. When individuals do not strongly prefer public good consumption, the political externality becomes negative, yielding the possibility of an inefficiently high capital tax rate, which we call the *race to the top*. Furthermore, because the fiscal externality is weaker in a population decreasing economy than in a population growing economy, we can show that the former is more likely to exhibit the race to the top than the latter.

We also consider asymmetric countries. When the population is growing or decreasing in all countries, we can obtain qualitatively similar results with the case of symmetric countries. When the population is growing in some countries and decreasing in other countries, we show a possibility that capital tax rates are inefficiently low in population growing countries and inefficiently high in population decreasing countries.

Several existing papers have investigated capital tax competition in political economy models. Persson and Tabellini (1992), Borck (2003), Lockwood and Makris (2006), Grazzini and van Ypersele (2003), Fuest and Huber (2001), and Ihori and Yang (2009) assumed that individuals have different endowments of labor and capital, and that capital tax rates are determined by the political economy process. These papers commonly showed that if the decisive voter 's capital endowment is smaller than the average, then the equilibrium capital tax rate tends to be high. This political economy effect sometimes overwhelms the tax competition effect, which implies that the equilibrium capital tax rates become inefficiently high. Our paper also studies the tax competition in a political economy model. However, in our model, individuals are not heterogeneous with respect to endowments. Alternatively, we consider a difference between generations by using an overlapping generations model. Put differently, we focus on inter-generational political conflict, whereas existing studies focus on political conflicts among individuals with heterogeneous endowments.

We also refer to existing studies that used overlapping generations models in political economy to investigate a macro economy. Alesina and Rodrik (1994) and Persson and Tabellini (1994a, b) constructed overlapping generation models wherein individuals have heterogeneous endowments of labor and capital, and a median voter chooses the capital income tax rate. In these models, when the median voter has more capital endowments, the equilibrium capital tax rate becomes lower, which raises the equilibrium growth rate.

These papers analyzed the closed economy models and focused on the effects of income distribution on growth rates. Our paper also constructs an overlapping generation model in political economy. However, we consider an open economy wherein capital is mobile among countries and focus on the effects of demographics on the results of capital tax competition.

Moreover, our analysis regarding asymmetric countries relates to studies of asymmetric tax competition, which have considered differences in many aspects between regions and countries. In particular, whereas previous studies focused on regional characteristics and disparities in population size, technology, preferences, labor market, and initial endowment, we add a new and significant view to asymmetric tax competition by considering international differences in demographic structure.[4]

This paper is structured as follows. Section 2 presents the baseline framework. Section 3 provides the various efficiency properties of our model. Section 4 extends the baseline framework by considering asymmetric countries. Section 5 concludes.

2 Baseline framework

Consider an overlapping generations model wherein time is discrete and each individual lives for two periods. At the first (young) period, an individual works to earn wage income, consumes, and saves, whereas at the second (old) period, she/he does not work and spends her/his savings to consume. At the end of the old period, she/he exits the economy. We call a cohort of individuals who are young at time t as generation t. This economy has M countries, and each country i $(i = 1, ..M)$ has a population of size $\overline{L}_{it} + \overline{L}_{it-1}$, where $\overline{L}_{it}$ represents the population size of generation t. We assume that the population growth rate, n, is exogenous, and in the baseline model, we assume symmetric countries so that n is common to all countries. Hence, we have $\overline{L}_{it+1} = (1+n)\overline{L}_{it}$.

2.1 Individuals

Individuals obtain utility from private good consumption, c, and public good consumption, g. We specify the utility function as follows:

$$U_{it} = u_{iyt} + \beta u_{iot+1}, \tag{1}$$

where β $(\in (0,1))$ is the time discount rate. The subscripts y and o represent the young and old periods, respectively. u_{iy} is the utility from consumption at the young period in country i and u_{io} is that from consumption at the old period in country i. We assume that u_{ij} $(j = y, o)$ is given by

$$u_{ijt} = \ln c_{ijt} + \alpha \ln g_{it}. \tag{2}$$

α is a positive constant that represents the preference for public good consumption. Budget constraints are given by

$$w_{it} = c_{iyt} + s_{it}, \qquad (1 + r_{it+1})s_{it} = c_{iot+1},$$

where w_{it}, s_{it}, and r are the wage income, savings, and rate of return on savings, respectively. We assume that individuals are price-takers. At period t, an individual in

[4]See Ogawa et al (2016) for a brief survey of the existing studies on asymmetric tax competition.

generation t inelastically supplies her/his labor endowments, which are normalized to one, to earn w_{it}, and chooses c_{iyt} and s_{it} given all prices. At period $t+1$, she/he receives $(1+r_{it+1})s_{it}$ and chooses c_{iot+1} given all prices. We assume perfect foresight regarding individual's expectation on r_{it+1}. Standard life-time utility maximization yields

$$c_{iyt} = \frac{w_{it}}{1+\beta}, \qquad s_{it} = \frac{\beta w_{it}}{1+\beta}, \qquad c_{iot+1} = \frac{\beta}{1+\beta}(1+r_{it+1})w_{it}. \tag{3}$$

2.2 Firms

Firms produce the numéraire using labor and capital under constant returns to scale. We assume perfectly competitive goods, labor, and capital markets. We employ a Cobb-Douglas production function:

$$y_{it} = L_{it}^{\gamma} K_{it}^{1-\gamma},$$

where y is the output level, γ ($\in (0,1)$) is a positive constant representing the labor share in production, and L and K are labor and capital inputs, respectively. Letting k denote the capital per capita (capital-labor ratio, $= K/L$), profit maximization yields

$$w_{it} = \gamma k_{it}^{1-\gamma}, \qquad k_{it} = \left(\frac{1-\gamma}{r_{it}+\tau_{it}}\right)^{1/\gamma}, \tag{4}$$

where τ represents the capital tax rate. As is standard in capital tax competition models, capital taxation decreases the capital per capita ($\partial k_{it}/\partial \tau_{it} < 0$).

2.3 Market clearing conditions

In this paper, we assume that individuals are immobile between countries, implying that the labor market is local, whereas capital is freely mobile, implying that the capital market is global. Hence, the labor market clearing condition in country i is given by

$$L_{it} = \overline{L}_{it}.$$

The global capital market clearing condition is given by

$$\sum_{i=1}^{M} K_{it} = \sum_{i=1}^{M} s_{it-1}\overline{L}_{it-1}.$$

Because capital is assumed to be freely mobile among countries, the interest rate becomes common to all countries ($r_{it} = r_t$, $\forall i$). Then, the capital market clearing condition can be written as

$$\sum_{i=1}^{M}\left(\frac{1-\gamma}{r_t+\tau_{it}}\right)^{1/\gamma}\overline{L}_{it} = \frac{\beta\gamma}{1+\beta}\sum_{i=1}^{M}\left(\frac{1-\gamma}{r_{t-1}+\tau_{it-1}}\right)^{(1-\gamma)/\gamma}\overline{L}_{it-1}. \tag{5}$$

2.4 Governments

In each country, the government uses capital tax revenues to finance public good provision. We assume that policies are determined by majority voting: the capital tax rate, τ_{it}, and the level of public good provision, g_{it}, are determined so that they maximize the utility of the majority at period t.[5] Hence, when the population size of generation t is larger than that of generation $t-1$ ($\overline{L}_{it} > \overline{L}_{it-1}$), the government at period t chooses τ_{it} and g_{it} that maximize U_{it}. When the opposite holds true ($\overline{L}_{it} < \overline{L}_{it-1}$), it chooses τ_{it} and g_{it} that maximize u_{iot}.[6] When deciding on τ_{it} and g_{it}, governments regard past variables (w_{it-1}), other countries' policies (τ_{jt} and g_{jt}), prices determined in the global market (r_t and r_{t+1}), and own future policy (g_{it+1}) as given.[7] We make the last assumption because governments make decisions at each period, which implies that they cannot commit to future decisions. We assume perfect foresight regarding government's expectations on g_{it+1}, and r_{t+1}. The following figure summarizes the structure of the model.

[Figure 1 around here]

2.4.1 Economy with a growing population

We start from the case of $n > 0$, which implies the population is increasing. In this case, because $\overline{L}_{it} > \overline{L}_{it-1}$, the young individuals represent the majority of the population and the government maximizes U_{it}. Plugging (2), (3) and the government budget constraint $g_{it} = \tau_{it} K_{it}$ into (1), we obtain

$$\begin{aligned} U_t = \alpha \ln \tau_{it} - \frac{\alpha + (1+\beta)(1-\gamma)}{\gamma} \ln(r_t + \tau_{it}) \\ + \beta \ln(1 + r_{t+1}) + \alpha\beta \ln g_{it+1} + \alpha \ln \overline{L}_{it} + \Upsilon \end{aligned} \tag{6}$$

where Υ is defined as

$$\Upsilon \equiv \beta \ln \beta - (1+\beta)\ln(1+\beta) + \alpha \ln(1-\gamma)^{1/\gamma} + (1+\beta)\ln \gamma(1-\gamma)^{(1-\gamma)/\gamma}.$$

The first-order condition regarding τ yields

$$\tau_{it} = \frac{\alpha\gamma}{(1+\alpha+\beta)(1-\gamma)} r_t. \tag{7}$$

2.4.2 Economy with a decreasing population

Next, we consider the case of $n < 0$, which implies that the population is decreasing and aging. In this case, because $\overline{L}_{it} < \overline{L}_{it+1}$, old individuals represent the majority and the government maximizes u_{iot}. Plugging (3) and $g_{it} = \tau_{it} K_{it}$ into (2), we obtain

$$u_{iot} = \alpha \ln \tau_{it} - \frac{\alpha}{\gamma} \ln(r_t + \tau_{it}) + \ln(1 + r_t) + \alpha \ln \overline{L}_{it} + \ln w_{it-1} + \Psi, \tag{8}$$

[5] In our setting wherein only two types of individuals exist, this corresponds to maximize the utility of the median voter.

[6] When $\overline{L}_{it} = \overline{L}_{it-1}$, we assume that the government chooses to maximize U_{it} or u_{iot} with equal probability. If it chooses to maximize U_{it}, then the results are the same as those in the case of $\overline{L}_{it} > \overline{L}_{it-1}$; if it chooses to maximize u_{iot}, then the results are the same as those in the case of $\overline{L}_{it} < \overline{L}_{it-1}$. For the sake of expositional simplicity, we omit the case of $\overline{L}_{it} = \overline{L}_{it-1}$.

[7] We assume that a government regards global prices as given for analytical simplicity. Such an assumption would be appropriate when many countries exist. Even if we do not assume this, the government's incentive to tax capital is different between population growing and decreasing economies. Hence, the economy would have equilibrium inefficiencies that depend on demographics as will be shown in this paper.

where Ψ is defined as

$$\Psi \equiv \alpha \ln \left(\frac{\beta}{1+\beta} \right) + \alpha \ln(1-\gamma)^{1/\gamma}.$$

The first-order condition regarding τ gives

$$\tau_{it} = \frac{\gamma}{1-\gamma} r_t. \tag{9}$$

Equations (7) and (9) imply that for a given rate of return on savings, an economy with a decreasing population has a higher capital tax rate than an economy with a growing population. Because the government regards the global price, r_t, as given, capital taxation affects the utility through changes in capital tax revenues, $\tau_{it} K_{it}$, and changes in wage rate, w_{it}. The former effect appears in both U_{it} and u_{iot} whereas the latter appears only in U_{it}. Moreover, as shown in (4), capital taxation, by decreasing capital per capita, k_{it}, lowers w_{it} and U_{it} because capital and labor are complementary in production. Hence, the government has a weaker incentive to tax capital in a population growing economy than in a population decreasing economy.[8]

2.5 Transitional dynamics

In the baseline model, we assume symmetric countries, which implies that all countries have the same capital holdings at period 0, the same population size, and the same population growth rate, implying that $\overline{L}_{it} = \overline{L}_{jt}$ $(i \neq j)$ for all t. From the capital demand (4), and the capital market clearing condition (5), the sequence of capital per capita, k, can be written as

$$k_t = \frac{\beta\gamma}{(1+\beta)(1+n)} k_{t-1}^{1-\gamma}, \tag{10}$$

regardless of population growth rate. Note here that k_t is common to all countries. Moreover, (3) and (4) result in common consumption levels, i.e., $c_{iyt} = c_{yt}$ and $c_{iot} = c_{ot}$, $\forall i$.

2.6 Steady-state

We focus on steady-state equilibrium, wherein the level of individual's consumption, c, and capital per capita, k, are constant over time ($c_{yt} = c_{yt+1} = c_y^*$, $c_{ot} = c_{ot+1} = c_o^*$, and $k_t = k_{t+1} = k^*$).[9] Then, from (4), we readily know that $r_t + \tau_t = r_{t+1} + \tau_{t+1}$. Using this and (4), (10) can be rewritten as

$$r_t + \tau_t = \frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma}. \tag{11}$$

The higher the population growth rate, the smaller the capital per capita becomes, which results in higher marginal productivity of capital(i.e., higher gross rate of return on

[8] This result is similar to the results shown in the existing studies of tax competition with the median voter principle cited in the Introduction, wherein the incentive of governments to impose tax on capital increases with the decrease in the capital endowment of the median voter. In our framework, the median voter is young individuals in the population growing economy and old individuals in the population decreasing economy. Because young individuals have no capital, the government has a weaker incentive to tax capital in the population growing economy than in the population decreasing economy.

[9] Note here that (10) has a unique steady state. Combined with (3) and (4), this implies that there exists a unique consumption level.

capital). We can solve (7) and (11) to derive equilibrium τ and r in a population growing economy whereas we can use (9) and (11) to obtain equilibrium τ and r in a population decreasing economy.

2.7 Possible externalities

Here, we summarize the possible externalities emerging in our framework. The optimal tax rate maximizes the life-time utility given by (6), implying that it is identical to the government's objective function in a population growing economy. However, in the optimal, the effects of capital taxation, τ_t, on the global price, r_t, must be considered in determining τ_t, whereas in the equilibrium, the government treats r_t as given. Such a difference causes a distortion.[10] More specifically, capital flight caused by capital taxation enlarges the tax base in other countries, resulting in a positive externality. This is standard in tax competition models and we call it the *fiscal externality.* Note that r_t appears in the term $-\{[\alpha + (1+\beta)(1-\gamma)]/\gamma\} \ln(r_t + \tau_{it})$ of the government's objective function (6) in a population growing economy and in the term $-(\alpha/\gamma)\ln(r_t + \tau_{it})$ of the government's objective function in a population decreasing economy. From this, we know that a given over-evaluation regarding changes in $r+\tau$ by the government causes smaller changes in the objective function, i.e., the fiscal externality is weaker in a population decreasing economy than in a population growing economy.

Our framework of political economy yields additional externalities. A government chooses its current policies to maximize the majority's utility and cannot commit to future policies. This implies that the government in a population growing economy does not recognize the effects of the capital taxation on future variables i.e., terms $\beta \ln(1 + r_{t+1}) + \alpha\beta \ln g_{it+1}$ in (6), whereas such effects must be internalized in the optimal. Ignoring the effects on these terms implies that the government ignores the effects on old individual's utility. Put differently, capital taxation causes an inter-generational externality, which we call the *political externality* in a population growing economy. Note here that capital taxation decreases r and increases g. Hence, when α is sufficiently small, the former effect on the old individual's utility dominates the latter effect and the political externality becomes a negative externality, and when α is sufficiently large, the opposite holds true and it becomes a positive externality.

In a population decreasing economy, the government's objective is to maximize the old individual's utility, (8). Hence, the government ignores its taxation effects on the terms $\alpha \ln \tau_{it} - \{[\alpha + (1+\beta)(1-\gamma)]/\gamma\} \ln(r_t + \tau_{it})$ in the young individual's utility, (6). Thus, we again observe an inter-generational externality, which is the political externality in a population decreasing economy. Capital taxation in a particular country, i, can cause a positive externality by increasing $\ln \tau_{it}$ for young individuals within country i and a negative externality by increasing $r_t + \tau_{jt}$ $(j \neq i)$ for young individuals in the other countries.[11] When α is sufficiently large, the former effect dominates the latter effect, and the political externality in a population decreasing economy becomes a positive externality. When α is small, the opposite holds true and the political externality becomes a negative externality.

[10] Even if a government does not regard r as given, it considers the effects of τ on its own country's welfare. In the optimal, one needs to consider the effects of τ, through changes in r, on the other countries' welfare and policies as well. Hence, even in this case, we observe a distortion caused by capital taxation.

[11] Because a change in τ_{it} does not affect $r_t + \tau_{it}$, the negative externality is not relevant for young individuals within country i.

3 Equilibrium and its efficiency

3.1 Preliminary analysis: closed economy

Before proceeding to the analysis of capital tax competition, we present the political economy outcomes in the absence of capital mobility. For this purpose, temporarily suppose that capital is immobile among countries. Then, all variables become local variables and the government takes taxation effects on the rate of return on capital, r_t, into consideration in addition to other local variables. Moreover, because $r_t + \tau_t$ is determined by past variables, the government now considers that any increases in τ are exactly offset by decreases in r ($\partial r_t/\partial \tau_t = -1$).

In a population growing economy, U_{it} given by (6) is an increasing function of τ_t ($\partial U_{it}/\partial \tau_t = \alpha/\tau_t > 0$) under consideration of $\partial r_t/\partial \tau_t = -1$. Therefore, the government sets its capital tax rate as high as possible (as long as $r_t \geq 0$), which, combined with (11), results in[12]

$$\tau_y^{im} = \frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma}. \tag{12}$$

The superscript im represents the case of capital immobility. In a population decreasing economy, the first-order condition for the maximization of u_{iot} with respect to τ_t ($\partial u_{iot}/\partial \tau_t = \alpha/\tau_t - 1/(1+r_t) = 0$) yields

$$\tau_o^{im} = \alpha(1 + r_o^{im}). \tag{13}$$

Comparing $\partial U_{it}/\partial \tau_t$ with $\partial u_{iot}/\partial \tau_t$, we know that the government in a population decreasing economy sets a lower tax rate than in a population growing economy, if capital is immobile between countries. Because changes in rate of return on savings absorb the capital tax effects ($\partial r_t/\partial \tau_t = -1$), capital taxation does not affect capital per capita, k_{it}, and hence, the wage rate, w_{it}. The government considers such a relationship, implying that a government in a population growing economy cares only about the level of public good provision in maximizing U_{it} whereas a government in a population decreasing economy considers decreases in returns from savings when maximizing u_{iot} as well. Thus, a government in a population decreasing economy is more tentative in taxing capital than a government in a population growing economy if capital is immobile.[13]

With tax rates in hand, we can examine the efficiency properties of these tax rates by looking at the effects of a coordinated increase in τ over time. Such effects can be derived by plugging $\tau_t = \tau_{t+1} = \tau$ into the individual's life time utility (6), taking its derivative with respect to τ, and evaluating it at τ_y^{im} or at τ_o^{im}. Plugging $\tau_t = \tau_{t+1} = \tau$ into (11), we can see that the return on savings does not depend on time: $r_t = r_{t+1} = r$. Equation (6)

[12] We obtain (11) from (5) by setting $M = 1$.

[13] Mateos-Planas (2010) analyzed the effects of demographics on the mix of tax rates on households' labor and capital income by using a median voter model, and showed that when the decisive voter changes from old individuals to young individuals, the capital tax rate increases. He confirmed the quantitative relevance of this result by calibrating his model to United States data. Our result on capital tax rate in the capital immobile case is consistent with this. However, he showed that when the proportion of old individuals decreases while keeping the decisive voter type unaltered, the capital tax decreases, which is not consistent with our result wherein a higher n and hence, a lower proportion of old individuals implies a higher capital tax rate. Such a departure would come from the fact we endogenize governments' expenditure and ignore labor income tax whereas Mateos-Planas (2010) fixed governments' expenditure and introduced labor income tax.

then becomes

$$U_t = \alpha(1+\beta)\ln\tau - \frac{(1+\beta)(1+\alpha-\gamma)}{\gamma}\ln(r+\tau) + \beta\ln(1+r)$$
$$+\alpha(1+\beta)\ln\overline{L}_t + \alpha\beta\ln(1+n) + \Upsilon + (1+\beta)\ln(1-\gamma)^{1/\gamma}.$$

Differentiating U with respect to τ, we obtain

$$\frac{\partial U_t}{\partial\tau} = \frac{\alpha(1+\beta)}{\tau} - \frac{\beta}{1+r}. \tag{14}$$

By evaluating (14) at $\tau = \tau_y^{im}$, we obtain

$$\left.\frac{\partial U_t}{\partial\tau}\right|_{\tau=\tau_y^{im}} = \beta\left[\frac{\alpha\gamma}{(1+n)(1-\gamma)} - 1\right].$$

Because τ cannot be higher than τ_y^{im} because of the non-negative constraint of r, we know that in a population growing economy, the equilibrium tax rate is optimal if the preference for public good consumption is sufficiently large (i.e., $\alpha \geq (1+n)(1-\gamma)/\gamma$), and inefficiently high otherwise (i.e., $\alpha < (1+n)(1-\gamma)/\gamma$). By evaluating (14) at $\tau = \tau_o^{im}$, we obtain

$$\left.\frac{\partial U_t}{\partial\tau}\right|_{\tau=\tau_o^{im}} = \frac{\alpha(1+\beta)}{\alpha(1+r_o^{im})} - \frac{\beta}{1+r_o^{im}}$$
$$= \frac{1}{1+r_o^{im}} > 0.$$

Hence, we observe an inefficiently low capital tax rate in a population decreasing economy.

Proposition 1 *Suppose immobility of capital between countries. Then, the capital tax rate is optimal or inefficiently high in a population growing economy whereas it is inefficiently low in a population decreasing economy.*

When capital is immobile between countries, no fiscal externality exists and therefore only the political externality is relevant. In a population growing economy, the political externality is positive when the preference for public good consumption, α, is large and negative when α is small. However, when α is large, both the optimal and equilibrium requires the capital tax rate to be the maximum possible rate, implying that the resulting equilibrium tax rate becomes identical to the optimal one. When α is small, the political externality is negative, yielding an inefficiently high capital tax rate in equilibrium. In a population decreasing economy, only the positive political externality is relevant, making the equilibrium tax rate inefficiently low.

3.2 Economy with a growing population

Now we return to the baseline model wherein capital is mobile between countries, and move to the efficiency analysis of capital tax competition in political economy. Start from a population growing economy. From (7) and (11), we obtain the equilibrium capital tax rate as follows:

$$\tau_y^* = \frac{\alpha(1+n)(1+\beta)(1-\gamma)}{\beta\left[\alpha+(1+\beta)(1-\gamma)\right]}. \tag{15}$$

The rate of return on savings becomes

$$r_y^* = \frac{(1+n)(1+\beta)(1-\gamma)^2(1+\alpha+\beta)}{\beta\gamma\left[\alpha+(1+\beta)(1-\gamma)\right]}. \tag{16}$$

Similarly to the previous section, we examine the equilibrium efficiency properties by looking at the effects of a coordinated increase in τ among countries and over time. Such effects can be derived by plugging $\tau_t = \tau_{t+1} = \tau$ into (6), taking its derivative with respect to τ, and evaluating it at τ_y^*. Plugging $\tau_t = \tau_{t+1} = \tau$ into (11), we can see that $r_t = r_{t+1} = r$ and $\partial r/\partial\tau = -1$. Differentiating U with respect to τ, we again obtain (14). By evaluating (14) at $\tau = \tau_y^*$ (see also (11)), we know that

$$\left.\frac{\partial U_t}{\partial \tau}\right|_{\tau=\tau_y^*} = \frac{\alpha(1+\beta)}{\tau_y^*(1+r_y^*)}\frac{\Phi}{\beta\gamma\left[\alpha+(1+\beta)(1-\gamma)\right]}, \tag{17}$$

where

$$\Phi \equiv (1-\gamma)\left[(1+\beta)^2(1+n) - \gamma(1+n+2\beta) - \beta\gamma n(3+\beta) + \alpha\Omega\right],$$
$$\Omega \equiv (1+n)(1-\gamma) + \beta\left[\frac{1}{1-\gamma} + n(1-\gamma) - \gamma\right] > 0.$$

Hence, we can see that

$$\mathsf{sgn}\left[\left.\frac{\partial U_t}{\partial \tau}\right|_{\tau=\tau_y^*}\right] = \mathsf{sgn}\left[\Phi\right].$$

Because we readily know that

$$\frac{\partial \Phi}{\partial \alpha} = (1-\gamma)\Omega > 0,$$

implying that Φ is linearly increasing in α. Therefore, we have a unique $\widetilde{\alpha}$ that satisfies $\Phi = 0$, and $\Phi > 0$ (resp. $\Phi < 0$) for $\alpha > \widetilde{\alpha}$ (resp. $\alpha < \widetilde{\alpha}$). Such $\widetilde{\alpha}$ is given by

$$\widetilde{\alpha} \equiv \frac{\gamma(1+n+2\beta) + \beta\gamma n(3+\beta) - (1+\beta)^2(1+n)}{\Omega}. \tag{18}$$

Therefore, (17) is positive if and only if

$$\alpha > \widetilde{\alpha}.$$

Proposition 2 *Capital tax competition in a population growing economy results in an inefficiently low (resp. high) capital tax rate if and only if the preference for public good consumption, α, is larger than $\widetilde{\alpha}$ (resp. smaller than $\widetilde{\alpha}$).*

In a population growing economy, we have the positive fiscal externality and positive (resp. negative) political externality when α is large (resp. small). If α is sufficiently large to satisfy $\alpha > \widetilde{\alpha}$, then the overall externality becomes positive, and capital tax competition yields an inefficiently low capital tax rate, i.e., we observe the *race to the bottom*. In contrast, when the opposite holds true ($\alpha < \widetilde{\alpha}$), the negative political externality makes the capital tax rate inefficiently high, and this externality dominate the fiscal externality, resulting in an inefficiently high capital tax rate, which we call the *race to the top*.

We can state Proposition 3.2 in a different way by focusing on the labor share in production, γ. The definition of $\widetilde{\alpha}$ shows that $\widetilde{\alpha} \leq 0$ holds true if $\gamma \leq \widetilde{\gamma}$, where $\widetilde{\gamma}$ is defined as

$$\widetilde{\gamma} \equiv \frac{(1+\beta)^2(1+n)}{1+n+\beta\left[2+n(3+\beta)\right]}.$$

Corollary 1 *Capital tax competition in a population growing economy results in an inefficiently low capital tax rate, if* $\gamma \leq \widetilde{\gamma}$.

A sufficiently small γ implies higher significance of capital in production. This implies that the fiscal externality is prominent and the tax competition is likely to result in an inefficiently low capital tax rate.

3.3 Economy with a decreasing population

Next, consider a population decreasing economy. From (9) and (11), we obtain the equilibrium capital tax rate and rate of return on savings as follows:

$$\begin{aligned} \tau_o^* &= \frac{(1+n)(1+\beta)(1-\gamma)}{\beta}, \\ r_o^* &= \frac{(1+n)(1+\beta)(1-\gamma)^2}{\beta\gamma}. \end{aligned} \tag{19}$$

To examine the efficiency of equilibrium, we evaluate (14) at $\tau = \tau_o^*$ (see also (11)), resulting in

$$\left.\frac{\partial U_t}{\partial \tau}\right|_{\tau=\tau_o^*} = \frac{\beta\left[\alpha\Omega - \beta\left(1+n\right)\gamma\right]}{\left(1-\gamma\right)\left(1+n\right)\Omega}.$$

This is positive if and only if

$$\alpha > \widehat{\alpha},$$

where $\widehat{\alpha}$ is defined as

$$\widehat{\alpha} \equiv \frac{\beta\left(1+n\right)\gamma}{\Omega}. \tag{20}$$

Proposition 3 *Capital tax competition in a population decreasing economy results in an inefficiently low (resp. high) capital tax rate if and only if the preference for public good consumption,* α, *is larger than* $\widehat{\alpha}$ *(resp. smaller than* $\widehat{\alpha}$*).*

In a closed economy, the equilibrium capital tax rate becomes inefficiently low. However, when capital is mobile, we have the negative political externality. When α is sufficiently small, its effect becomes prominent, yielding the possibility of the race to the top.[14]

3.4 Possibility of the race to the top

Next, we question when an inefficiently high capital tax rate, that is, the race to the top, is likely to emerge. Let us start from a population growing economy. Simply differentiating $\widetilde{\alpha}$, which is the threshold value in this economy and given by (18), with respect to n, we readily know that $\partial\widetilde{\alpha}/\partial n > 0$ if and only if $\gamma \geq \overline{\gamma}$, where we define $\overline{\gamma}$ as

$$\overline{\gamma} \equiv \frac{\beta^2+\beta+1}{(1+\beta)^2}.$$

[14] We can observe that $\widehat{\alpha} > 0$ if and only if $n > -1$, which always holds true. Hence, in a population decreasing economy, we always have the possibility of an inefficiently high capital tax rate.

Thus, when the labor share is large (i.e., $\gamma \geq \overline{\gamma}$), a larger population growth rate increases the threshold value, $\widetilde{\alpha}$, and when the labor share is small (i.e., $\gamma < \overline{\gamma}$), it decreases $\widetilde{\alpha}$. Moreover, because we can verify that $\widetilde{\alpha}|_{n=0} < 0$, we observe $\widetilde{\alpha} < 0$ and hence the race to the bottom whenever $\gamma < \overline{\gamma}$. Even in the case of $\gamma \geq \overline{\gamma}$, $\widetilde{\alpha} < 0$ holds true if $\gamma \leq \widetilde{\gamma}$ (see Corollary 1). Such a possibility can emerge because we can show that $\overline{\gamma} < \widetilde{\gamma}$.[15]

In addition, we can readily see that $\partial\overline{\gamma}/\partial\beta < 0$ and $\overline{\gamma}|_{\beta=1} = 0.75$, implying that $\widetilde{\gamma} > \overline{\gamma} \geq 0.75$. Karabarbounis and Neiman (2014) estimated the global labor share and showed that it has exhibited a relatively steady downward trend from 0.64 to 0.59 during the past several decades. Their paper also presented the labor share for OECD and non-OECD countries, which showed that the labor share has been under 0.7 in most cases. Thus, it is reasonable to say that the labor share, γ, is smaller than 0.75, implying that in the real world, we observe that $\widetilde{\alpha} < 0$ i.e., the fiscal externality is large and capital tax competition always results in the race to the bottom in a population growing economy.

Let us move to a population decreasing economy. By differentiating $\widehat{\alpha}$, which is the threshold value in this economy and given by (20), with respect to n, we can see that $\partial\widehat{\alpha}/\partial n > 0$ always holds true. In a population decreasing economy, as the population growth rate rises, a high capital tax rate causes larger welfare losses of young individuals. Therefore, the higher the population growth rate, the more likely it is that the capital tax rate is inefficiently high. In addition, we can see that $\widehat{\alpha} > 0$ always holds true because $n > -1$, i.e., there always exists a case wherein the capital tax rate is inefficiently high in a population decreasing economy.

If we compare a population growing economy with a population decreasing economy, we observe a possibility that a government in a population growing economy sets an inefficiently low tax rate whereas a government in a population decreasing economy might set an inefficiently high tax rate. This can be shown in relation to Corollary 1: when $\gamma < \widetilde{\gamma}$, we know that $\widetilde{\alpha} < 0$ holds true and we observe the race to the bottom in a population growing economy. However, because $\widetilde{\gamma}$, and hence $\widehat{\alpha}$ do not depend on α, a government in a population decreasing economy imposes an inefficiently high tax rate on capital if and only if $\alpha < \widehat{\alpha}$.[16]

Proposition 4 *Suppose that $\gamma < \widetilde{\gamma}$. Then, capital tax competition always yields an inefficiently low tax rate in a population growing economy. However, it results in an inefficiently high tax rate in a population decreasing economy if and only if $\alpha < \widehat{\alpha}$.*

As shown in Section 2.4.2, when capital is mobile, the government's incentive to tax capital is stronger in a population decreasing economy than in a population growing economy because of a weaker fiscal externality. This generates a higher possibility of the race to the top in a population decreasing economy than in a population growing economy, which comes to the surface when γ and α are sufficiently small.

Figure 2 summarizes the results of Proposition 4. Figure 2 (a) represents the case wherein we always observe the race to the bottom in a population growing economy (i.e., when $n > 0$) whereas the race to the top might emerge in a population decreasing

[15] Because $\partial\widetilde{\gamma}/\partial n < 0$, we know that $\widetilde{\gamma} > \lim_{n\to\infty}\widetilde{\gamma}$. Noticing that

$$\lim_{n\to\infty}\widetilde{\gamma} = \frac{(1+\beta)^2}{1+\beta(3+\beta)},$$

simple comparisons yield that $\overline{\gamma} < \lim_{n\to\infty}\widetilde{\gamma} < \widetilde{\gamma}$.

[16] Note that in deriving $\widetilde{\gamma}$, we need to use n in a population growing economy, whereas we need to use n in a population decreasing economy in deriving $\widehat{\alpha}$ for a given γ.

economy (i.e., $n < 0$). Figure 2 (b) depicts the case wherein we have both possibilities in both population growing and decreasing economies.

[Figure 2 around here]

Figure 2 (a) describes the case wherein $\gamma < \widetilde{\gamma}$. When γ is small, the elasticity of the wage rate to the capital tax rate is large, and the fiscal externality is large. In such a case, the government always sets an inefficiently low tax rate. In Figure 2 (b), we have $\gamma \geq \widetilde{\gamma}$ and $\partial\widetilde{\alpha}/\partial n > 0$. Hence, $\widetilde{\alpha}$ becomes positive when n is sufficiently large. In this case, the elasticity of wage to the capital tax rate is small and the fiscal externality is small. Therefore, we might observe the race to the top in a population growing economy.

When $\gamma < \widetilde{\gamma}$, we know that $\partial\widetilde{\alpha}/\partial n < 0$ holds true, i.e., capital tax competition in a population growing economy always results in the race to the bottom and a higher population growth rate makes the tax rate less likely to be inefficiently high. In contrast, we know that $\partial\widetilde{\alpha}/\partial n > 0$ holds true in a population decreasing economy. Therefore, when the labor share, γ, is sufficiently small, if we increase the population growth rate, n, from a negative to a positive value, then the possibility of the race to the top first increases then drops to zero when n reaches zero as described in Figure 2 (a).

Such discontinuity in the relationship between the population growth rate and the possibility of the race to the top reflects the discontinuity in the relationship between the population growth rate and the equilibrium tax rate. As we can see from (15) and (19), the equilibrium tax rates, τ_y^* and τ_o^*, rise with the population growth rate, n. Note that when $n < 0$, we observe τ_o^* whereas when $n > 0$, we observe τ_y^*. Hence, as n decreases from a positive value to a negative value, we have a discontinuous change from τ_y^* to τ_o^* at $n = 0$. Moreover, if α is sufficiently small, then $\tau_o^*|_{n=0} > \tau_y^*\big|_{n=0}$ holds true, implying that the equilibrium tax rate discontinuously increases at $n = 0$. Hence, if we compare a population growing economy with a population decreasing economy, the latter is more likely to exhibit the race to the top than the former.

4 Asymmetric countries

In this section, we extend the baseline framework by considering asymmetric countries. Consider two groups of countries (groups h and l), where group h has M_h countries and group l has M_l countries. We assume that countries in each group have the same population growth rate. Let n_k denote the population growth rate of group k countries ($k = h, l$). Without loss of generality, we assume that $n_h > n_l$. Noticing that $r_{kt} + \tau_{kt} = r_{kt-1} + \tau_{kt-1}$ holds true in the steady state and that the assumption of global capital market yields $r_{ht} = r_{lt} = r_t$, we obtain the capital market clearing condition as

$$\begin{aligned}&\left(\frac{1-\gamma}{r_t+\tau_{ht}}\right)^{1/\gamma}\overline{L}_{ht}+\left(\frac{1-\gamma}{r_t+\tau_{lt}}\right)^{1/\gamma}\overline{L}_{lt} \\ &=\frac{\beta\gamma}{1+\beta}\left[\left(\frac{1-\gamma}{r_t+\tau_{ht}}\right)^{(1-\gamma)/\gamma}\frac{\overline{L}_{ht}}{1+n_h}+\left(\frac{1-\gamma}{r_t+\tau_{lt}}\right)^{(1-\gamma)/\gamma}\frac{\overline{L}_{lt}}{1+n_l}\right],\end{aligned} \tag{21}$$

where $\overline{L}_{ht}$ and $\overline{L}_{lt}$ are total population sizes in each group of countries and defined as $\overline{L}_{ht} \equiv \sum_{i=1}^{M_h} \overline{L}_{it}$ and $\overline{L}_{lt} \equiv \sum_{j=1}^{M_l} \overline{L}_{jt}$.

In this extended setting, we have the following three cases: (i) all countries have a growing populations (i.e., $n_h > n_l > 0$), (ii) all countries experience population decreases (i.e., $0 > n_h > n_l$), and (iii) group h countries have a growing population whereas group l countries have a decreasing population (i.e., $n_h > 0 > n_l$). In case (i) (resp. case (ii)), young (resp. old) individuals represent the majority in both groups of countries. In case (iii), young individuals represents the majority in group h countries whereas old individuals do so in group l countries.

4.1 Equilibrium and its welfare properties

Case (i): economy with a growing population

In this case, each government maximizes the young individual's utility, U_{it}, and the first-order condition yields (7) for all countries, implying that $\tau_{ht} = \tau_{lt} = \tau_t$. We substitute this into (21) to obtain

$$r_t + \tau_t = \frac{(1+n_w)(1+\beta)(1-\gamma)}{\beta\gamma}, \tag{22}$$

where n_w describes the world population growth rate and is defined as

$$n_w \equiv \frac{\overline{L}_{ht} + \overline{L}_{lt}}{\overline{L}_{ht}/(1+n_h) + \overline{L}_{lt}/(1+n_l)} - 1.$$

Note that we obtain (22) if we replace n with n_w in (11). Therefore, we obtain the equilibrium tax rate and rate of return on savings very similar to those shown in the baseline framework. More specifically, (7) and (22) yield

$$\begin{aligned} \tau^{(i)*} &= \frac{\alpha(1+n_w)(1+\beta)\,(1-\gamma)}{\beta\,[\alpha+(1+\beta)(1-\gamma)]}, \\ r^{(i)*} &= \frac{(1+n_w)(1+\beta)\,(1-\gamma)^2\,(1+\alpha+\beta)}{\beta\gamma\,[\alpha+(1+\beta)(1-\gamma)]}. \end{aligned} \tag{23}$$

The superscript (i) represents case (i). We can obtain (23) by replacing n with n_w in τ_y^* and r_y^* (given by (15) and (16)) in the baseline framework. Hence, welfare properties in this case are similar to those in the symmetric case. In fact, replace n in $\widetilde{\alpha}$ with n_w and denote it by $\widetilde{\alpha}^{(i)}$. Then, we can see that (17) evaluated at $\tau = \tau^{(i)*}$ is positive if and only if $\alpha > \widetilde{\alpha}^{(i)}$.

Proposition 5 *Suppose all countries have growing population but with different rates. Then, capital tax competition results in an inefficiently low (resp. high) capital tax rate if and only if the preference for public good consumption, α, is larger than $\widetilde{\alpha}^{(i)}$ (resp. smaller than $\widetilde{\alpha}^{(i)}$).*

Case (ii): economy with a decreasing population

When all countries have decreasing population, each government maximizes the old individual's utility, u_{iot}, and the first-order condition yields (9), implying that $\tau_{ht} = \tau_{lt} = \tau_t$. From (9) and (21), we obtain the equilibrium tax rate and rate of return on savings as

$$\begin{aligned} \tau^{(ii)*} &= \frac{(1+n_w)(1+\beta)(1-\gamma)}{\beta}, \\ r^{(ii)*} &= \frac{(1+n_w)(1+\beta)(1-\gamma)^2}{\beta\gamma}. \end{aligned} \tag{24}$$

The superscript (ii) represents case (ii). Again, we can obtain (24) by replacing n with n_w in τ_o^* and r_o^* (given by (19)) in the baseline framework. Hence, welfare properties become similar to those obtained in the baseline framework: (14) evaluated at $\tau = \tau^{(ii)*}$ is positive if and only if $\alpha > \widehat{\alpha}^{(ii)}$, where we replace n with n_w in $\widehat{\alpha}$ and denote it by $\widehat{\alpha}^{(ii)}$.

Proposition 6 *Suppose all countries have decreasing populations but with different rates. Then, capital tax competition results in an inefficiently low (resp. high) capital tax rate if and only if the preference for public good consumption, α, is larger than $\widehat{\alpha}^{(ii)}$ (resp. smaller than $\widehat{\alpha}^{(ii)}$).*

Case (iii): population growing countries v.s. population decreasing countries

In this case, young individuals represent the majority in population growing (group h) countries whereas old individuals do so in population deceasing (group l) countries. Then, the equilibrium tax rates become

$$\begin{aligned} \tau_{ht} &= \frac{\alpha\gamma}{(1+\alpha+\beta)(1-\gamma)} r_t, \\ \tau_{lt} &= \frac{\gamma}{1-\gamma} r_t. \end{aligned} \tag{25}$$

Comparing the two tax rates, we know that the equilibrium tax rate is lower in group h countries than in group l countries. From (25), we can derive

$$\begin{aligned} r_t + \tau_{ht} &= \frac{\alpha + (1+\beta)(1-\gamma)}{(1+\alpha+\beta)(1-\gamma)} r_t, \\ r_t + \tau_{lt} &= \frac{1}{1-\gamma} r_t, \end{aligned} \tag{26}$$

implying that

$$r_t + \tau_{ht} = \frac{\alpha + (1+\beta)(1-\gamma)}{1+\alpha+\beta} \left(r_t + \tau_{lt} \right).$$

We substitute this into (21) to rewrite the capital market equilibrium condition as

$$\begin{aligned} &\left[\frac{(1-\gamma)\Lambda}{r_t + \tau_{lt}} \right]^{1/\gamma} \overline{L}_{ht} + \left(\frac{1-\gamma}{r_t+\tau_{lt}} \right)^{1/\gamma} \overline{L}_{lt} \\ &= \frac{\beta\gamma}{1+\beta} \left\{ \left[\frac{(1-\gamma)\Lambda}{r_{t-1}+\tau_{lt-1}} \right]^{(1-\gamma)/\gamma} \frac{\overline{L}_{ht}}{1+n_h} + \left(\frac{1-\gamma}{r_{t-1}+\tau_{lt-1}} \right)^{(1-\gamma)/\gamma} \frac{\overline{L}_{lt}}{1+n_l} \right\}, \end{aligned}$$

where Λ is defined as $\Lambda \equiv (1+\alpha+\beta) / [\alpha + (1+\beta)(1-\gamma)]$. Furthermore, if we define z_t and H_t as

$$\begin{aligned} z_t &\equiv r_t + \tau_{lt}, \\ H_t &\equiv \frac{\beta\gamma}{(1+\beta)(1-\gamma)} \frac{\Lambda^{(1-\gamma)/\gamma} + \overline{L}_{lt}/\overline{L}_{ht}}{\Lambda^{1/\gamma}(1+n_{h)} + (1+n_l)\overline{L}_{lt}/\overline{L}_{ht}}, \end{aligned}$$

this becomes

$$z_{t+1} = H_t^{1-\gamma} z_t^{1-\gamma}. \tag{27}$$

In the long run, the total population size of group h countries expands whereas that of group l countries shrinks, implying that $\lim_{t\to\infty} \overline{L}_{lt}/\overline{L}_{ht} = 0$. Hence, the steady state value of H_t becomes

$$H^* = \lim_{t\to\infty} H_t = \frac{\beta\gamma}{\Lambda\left(1+\beta\right)\left(1-\gamma\right)\left(1+n_h\right)}.$$

Combined with (27), this yields the steady state value of z^* as

$$z^* = H^{*(1-\gamma)/\gamma}.$$

Plugging this into (26), we obtain the steady state values of the rate of return on savings and tax rates as follows:

$$\begin{aligned} r_t^* &= (1-\gamma)H^{*(1-\gamma)/\gamma}, \\ \tau_h^{(iii)*} &= \frac{\alpha\gamma}{1+\alpha+\beta}H^{*(1-\gamma)/\gamma}, \\ \tau_l^{(iii)*} &= \gamma H^{*(1-\gamma)/\gamma}. \end{aligned} \tag{28}$$

We substitute (28) into (14) to obtain

$$\begin{aligned} \left.\frac{\partial U}{\partial \tau}\right|_{\tau=\tau_h^{(iii)*}} &= \frac{(1+\beta)(1+\alpha+\beta)}{\gamma H^{*\frac{1-\gamma}{\gamma}}} - \frac{\beta}{1+(1-\gamma)H^{*\frac{1-\gamma}{\gamma}}}, \\ \left.\frac{\partial U}{\partial \tau}\right|_{\tau=\tau_l^{(iii)*}} &= \frac{\alpha}{\gamma H^{*\frac{1-\gamma}{\gamma}}} - \frac{\beta}{1+(1-\gamma)H^{*\frac{1-\gamma}{\gamma}}}. \end{aligned}$$

From this, we know that $\partial U/\partial\tau|_{\tau=\tau_h^{(iii)*}} > \partial U/\partial\tau|_{\tau=\tau_l^{(iii)*}}$, resulting in the following proposition.[17]

Proposition 7 *If group l countries set an inefficiently low capital tax rate, then so do group h countries ($\partial U/\partial\tau|_{\tau=\tau_h^{(iii)*}} > \partial U/\partial\tau|_{\tau=\tau_l^{(iii)*}} > 0$). If group h countries set an inefficiently high capital tax rate, then so do group l countries ($0 > \partial U/\partial\tau|_{\tau=\tau_h^{(iii)*}} > \partial U/\partial\tau|_{\tau=\tau_l^{(iii)*}}$ v). Additionally, there is a possibility that group h countries set an inefficiently low capital tax rate whereas group l countries set an inefficiently high capital tax rate ($\partial U/\partial\tau|_{\tau=\tau_h^{(iii)*}} > 0 > \partial U/\partial\tau|_{\tau=\tau_l^{(iii)*}}$).*

This result is consistent with that shown in Proposition 4. Put differently, we again find that population decreasing countries are more likely to exhibit the race to the top.

4.2 Welfare difference between asymmetric countries

We finally determine the group of countries that gain from tax competition in political economy. In so doing, we assume that countries in each group have the same population

[17] In fact, we have the second case when γ is large. When γ is sufficiently small, we have the first and the last cases. In fact, if we set $\gamma = 1/2$, the first case holds true when α is sufficiently large and the last case holds true when α is sufficiently small.

size (i.e., $\overline{L}_{it} = \widehat{L}_{kt} \equiv \overline{L}_{kt}/M_k$). The indirect utility of an individual in a group k country is written as

$$\begin{aligned} U_{kt} &= \alpha(1+\beta)\ln\tau_{kt} - \frac{(1+\beta)(1+\alpha-\gamma)}{\gamma}\ln(r_t+\tau_{kt}) + \beta\ln(1+r_t) \\ &\quad + \alpha(1+\beta)\ln\widehat{L}_{kt} + \alpha\beta\ln(1+n_k) + \alpha(1+\beta)\ln(1-\gamma)^{1/\gamma} \\ &\quad + (1+\beta)\ln\gamma(1-\gamma)^{(1-\gamma)/\gamma} - \ln(1+\beta) + \beta\ln\left(\frac{\beta}{1+\beta}\right). \end{aligned}$$

In cases (i) and (ii), we know that $\tau_{ht} = \tau_{lt}$, implying that

$$U_{ht} - U_{lt} = \alpha(1+\beta)\left(\ln\widehat{L}_{ht} - \ln\widehat{L}_{lt}\right) + \alpha\beta\left(\ln(1+n_h) - \ln(1+n_l)\right). \tag{29}$$

Thus, in these cases, we can decompose the welfare difference into two terms: the first term represents the population size effect and the second term represents the population growth effect. The larger the population size, the more the country attracts capital because of the complementarity between capital and labor in production, resulting in a larger tax base. Hence, individuals in a larger country can consume a larger amount of public goods than those in a smaller country, which makes the welfare of the larger country higher than that of the smaller country. Moreover, in a similar vein, a higher population growth rate increases the individual's public good consumption at the old period because it implies a larger population size of the next generation. This makes the welfare of group h countries higher than that of group l countries.

In case (iii), the welfare difference between countries becomes

$$\begin{aligned} U_{ht} - U_{lt} &= \alpha(1+\beta)\left(\ln\tau_{ht} - \ln\tau_{lt}\right) + \frac{(1+\beta)(1+\alpha-\gamma)}{\gamma}\left[\ln(r_t+\tau_{lt}) - \ln(r_t+\tau_{ht})\right] \\ &\quad + \alpha(1+\beta)\left(\ln\widehat{L}_{ht} - \ln\widehat{L}_{lt}\right) + \alpha\beta\left(\ln(1+n_h) - \ln(1+n_l)\right). \end{aligned}$$

Thus, in addition to the population size and growth effects, we have two other effects. The first-term of the right-hand side of the above equation represents the tax effect. A higher tax rate increases the tax revenues and individuals' public good consumption, resulting in a higher welfare. As we know from (25) that $\tau_{ht} < \tau_{lt}$, the first term is negative. The second term represents the capital cost effect. A higher capital tax rate implies a higher capital cost, reducing capital input per capita. This results in a lower wage rate and lower welfare. As we know that $\tau_{ht} < \tau_{lt}$, the second term becomes positive.

5 Summary and discussions

In this paper, we developed an overlapping generations model wherein public good provision financed by capital tax is determined by majority voting. When population is growing (resp. decreasing), young (resp. old) individuals represent the majority, implying that the government's decision depends on the demographic structure. We showed that young individuals suffer more from capital flight than old individuals, and that the race to the bottom is more likely to emerge when the population is growing than when it is decreasing. It is even possible to observe the race to the bottom when the population is growing whereas the race to the top might emerge when the population is decreasing. Such dependence on the outcomes of capital tax competition on demographics provide us a new viewpoint in policy debates regarding competition for capital. Particularly, because we observe drastic aging in many developed countries, our results indicate an increasing relevance of the race to the top.

We briefly discuss the robustness of our results against two alternative extensions.[18] First, suppose that in addition to capital taxation, the government has another instrument to finance its expenditure. As an example, we consider labor income tax on households. Then, the government in a population growing economy would finance its expenditure solely by labor income tax to prevent capital flight, whereas the government in a population decreasing economy would impose a positive tax on capital while trying to set income tax as high as possible because it cares only about tax revenues. Moreover, we can show that the equilibrium capital tax rate is inefficiently low in a population growing economy whereas it is so in a population decreasing economy if and only if the preference for public good consumption is sufficiently large, implying the possibility of the race to the top. In this sense, the introduction of income tax does not alter our main results qualitatively.

Second, in our framework, governments provide public goods. Alternatively, we can assume that governments provides public inputs that affect productivity of firms. In such a case, the positive externality associated to capital taxation is further strengthened because public inputs and capital are complementary in production. Consequently, we always observe the race to the bottom in a population growing economy. Moreover, since each government regards the rate of return on savings as given, it considers that the capital tax rate does not affect the old individual's welfare. This induces each government to set the capital tax rate to maximize the young individual's welfare even in a population decreasing economy. Hence, we observe an inefficiently low tax rate in this case as well. Hence, the introduction of public inputs would make the race to the bottom more likely to emerge.

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Online appendices (not for publication)

Appendix A: income tax

Suppose now that governments can impose tax on households in addition to capital tax. As an example, we introduce labor income tax, $\sigma_{it} \in [0,1]$, into the baseline model developed in Section 2. Such tax modifies the individual's demand (3) as

$$c_{iyt} = \frac{(1-\sigma_{it})w_{it}}{1+\beta}, \qquad s_{it} = \frac{\beta(1-\sigma_{it})w_{it}}{1+\beta}, \qquad c_{iot+1} = \frac{\beta}{1+\beta}(1+r_{it+1})(1-\sigma_{it})w_{it}. \tag{A1}$$

The budget constraint of the government becomes $g_{it} = \sigma_{it} w_{it} \overline{L}_{it} + \tau_{it} K_{it} = [\sigma_{it} w_{it} + \tau_{it} k_{it}] \overline{L}_{it}$, which, from (4), can be written as

$$\begin{aligned} g_{it} &= \left[\sigma_{it}\gamma \left(\frac{1-\gamma}{r_{it}+\tau_{it}} \right)^{(1-\gamma)/\gamma} + \tau_{it} \left(\frac{1-\gamma}{r_{it}+\tau_{it}} \right)^{1/\gamma} \right] \overline{L}_{it} \\ &= \frac{(1-\gamma)^{(1-\gamma)/\gamma} \overline{L}_{it} \left[\sigma_{it}\gamma(r_{it}+\tau_{it}) + (1-\gamma)\tau_{it} \right]}{(r_t+\tau_{it})^{1/\gamma}}. \end{aligned} \tag{A2}$$

Substituting (4), (A1), and (A2) into (6), we obtain

$$\begin{aligned} U_{it} &= \alpha \ln \left[\sigma_{it}\gamma\left(r_t+\tau_{it}\right) + (1-\gamma)\tau_{it} \right] - \frac{\alpha+(1+\beta)(1-\gamma)}{\gamma} \ln(r_t+\tau_{it}) + (1+\beta)\ln(1-\sigma_{it}) \\ &\quad + \alpha \ln(1-\gamma)^{(1-\gamma)/\gamma}\overline{L}_{it} + (1+\beta)\ln\gamma(1-\gamma)^{(1-\gamma)/\gamma} - \ln(1+\beta) \\ &\quad + \beta \ln\left(\frac{\beta}{1+\beta} \right)(1+r_{t+1}) + \alpha\beta \ln g_{it+1}. \end{aligned} \tag{A3}$$

Economy with a growing population

In the economy with growing population, the country i's government at period t chooses τ_{it} and σ_{it} to maximize (A3) while regarding r_t and future variables as given. The first-order conditions yield

$$\tau'_{yit} = 0 \qquad \text{and} \qquad \sigma'_{yit} = \frac{\alpha}{1+\alpha+\beta} > 0.$$

Hence, governments have no incentive to tax on mobile capital. Still, we can show that such zero-tax rate on capital is excessively low and a coordinated increase in capital tax rate can improve welfare. To see this, substitute $\tau_{it} = \tau_{it+1} = \tau$ and $\sigma_{it} = \sigma_{it+1} = \sigma$ into (A3) to obtain

$$\begin{aligned} U_{it} &= \alpha(1+\beta)\ln\left[\sigma\left(r+\tau\right)+\tau\right] - \frac{\alpha+(1+\beta)(1-\gamma)}{\gamma}\ln(r+\tau) + (1+\beta)\ln(1-\sigma) \\ &\quad + \alpha\ln(1-\gamma)^{(1-\gamma)/\gamma}\overline{L}_{it} + (1+\beta)\ln\gamma(1-\gamma)^{(1-\gamma)/\gamma} - \ln(1+\beta) + \beta\ln\left(\frac{\beta}{1+\beta}\right)(1+r). \end{aligned} \tag{A4}$$

where r is given by (11). By keeping σ as fixed, a coordinated increase in τ affects (A3) if evaluated at $\tau = 0$ and $\sigma = \sigma'_{yit}$ as follows:

$$\left.\frac{\partial U_{it}}{\partial \tau}\right|_{\tau=0 \text{ and } \sigma=\sigma'_{yit}} = \frac{(1+\alpha+\beta)\beta}{(1+\beta)(1+n)} - \Xi,$$

where Ξ is defined as $\Xi \equiv \beta^2\gamma / [(n-1)(1+\beta)(1-\gamma)-\gamma]$. We readily know that $\partial\Xi/\partial\gamma > 0$ and $\Xi|_{\gamma=1} = -\beta^2$, implying that[19]

$$\left.\frac{\partial U_{it}}{\partial \tau}\right|_{\tau=0 \text{ and } \sigma=\sigma'_{yit}} = \frac{(1+\alpha+\beta)\beta}{(1+\beta)(1+n)} - \Xi > \frac{(1+\alpha+\beta)\beta}{(1+\beta)(1+n)} + \beta^2 > 0.$$

Economy with a decreasing population

In the economy with decreasing population, a government chooses τ_{it} and σ_{it} to maximize u_{iot} while regarding r_t and past variables as given. Substituting (4), (A1), and (A2) into u_{iot}, we obtain

$$\begin{aligned}
u_{iot} &= \ln\left(\frac{\beta}{1+\beta}\right)(1+r_{it})(1-\sigma_{it-1})\, w_{it-1} + \alpha \ln \frac{(1-\gamma)^{(1-\gamma)/\gamma}\overline{L}_{it}\left[\sigma_{it}\gamma(r_{it}+\tau_{it}) + (1-\gamma)\tau_{it}\right]}{(r_t+\tau_{it})^{1/\gamma}} \\
&= \ln\left(\frac{\beta}{1+\beta}\right)(1+r_{it})(1-\sigma_{it-1})\, w_{it-1} + \alpha \ln\left[\sigma_{it}\gamma(r_{it}+\tau_{it}) + (1-\gamma)\tau_{it}\right] \\
&\quad - \alpha \ln (r_t+\tau_{it})^{1/\gamma} + \alpha \ln (1-\gamma)^{(1-\gamma)/\gamma}\overline{L}_{it}.
\end{aligned}$$

Here, we know that u_{iot} is monotonously increasing in σ_{it}. To avoid the non-existence of equilibrium rate of return on savings, we assume the upper-bound of labor income tax $\overline{\sigma} \in (0,1)$.[20] The government determines tax rates as

$$\tau'_{oit} = \frac{r\gamma(1-\sigma)}{1-\gamma(1-\sigma)} \qquad \text{and} \qquad \sigma'_{oit} = \overline{\sigma}.$$

By keeping σ as fixed, a coordinated increase in τ, evaluated at $\tau = \tau'_{oit}$ and $\sigma = \overline{\sigma}$, results in[21]

$$\begin{aligned}
\left.\frac{\partial U_{it}}{\partial \tau}\right|_{\tau=\tau'_{oit} \text{ and } \sigma=\overline{\sigma}} = \beta\gamma \Bigg[&-\frac{\beta^2\gamma}{(1+\beta)(1+\gamma) - (1+n+\beta n+\beta\tau'_{oit})\gamma} \\
&+ \frac{\alpha\beta}{\beta\tau'_{oit}\gamma + (1+\beta)(1+n)(1-\gamma)\overline{\sigma}} \Bigg].
\end{aligned}$$

Hence, we readily know this is positive if and only if

$$\alpha > \widetilde{\alpha}',$$

where $\widetilde{\alpha}$ is defined as

$$\widetilde{\alpha}' \equiv \frac{\beta\left[\tau'_{oit} + (1+n)(1+\beta\overline{\sigma})\right]}{(1+\beta)(1+n) - (1+n+\beta n+\beta\tau'_{oit})\gamma} > 0.$$

Therefore, if governments can impose tax on households, capital tax competition under population growth results in an inefficiently low capital tax rate, and capital tax competition under decreasing population results in an inefficiently high (resp. low) capital tax rate if the household's preference for public good consumption is sufficiently small i.e., $\alpha < \widetilde{\alpha}'$ (resp. large, i.e., $\alpha > \widetilde{\alpha}$).

[19] Note here that (11) implies that $\partial r/\partial\tau = -1$.

[20] When $\sigma = 1$, the equilibrium rate of return on savings diverges to infinity.

[21] Note again that (11) implies that $\partial r/\partial\tau = -1$.

Appendix B: public inputs

Suppose that individuals obtain utility only from private good consumption, c. We specify the utility function as follows:

$$U_{it} = \ln c_{iyt} + \beta \ln c_{iot+1}, \tag{B1}$$

where β ($\in (0,1)$) is the time discount rate. From utility maximization, we can obtain the following equations:

$$c_{iyt} = \frac{w_{it}}{1+\beta}, \qquad s_{it} = \frac{\beta w_{it}}{1+\beta}, \qquad c_{iot+1} = \frac{\beta}{1+\beta}(1+r_{it+1})w_{it}.$$

Firms produce the numéraire by using labor and capital under constant returns to scale. Here, we assume that public inputs raise productivity of firms. We employ a Cobb-Douglas production function:

$$y_{it} = g_{it}^{\epsilon} L_{it}^{\gamma} K_{it}^{1-\gamma},$$

where ϵ is a positive constant. We assume that $\gamma > \epsilon$. Profit maximization yields

$$w_{it} = \gamma g_{it}^{\epsilon} k_{it}^{1-\gamma}, \qquad k_{it} = \left[\frac{g_t^{\epsilon}(1-\gamma)}{r_{it}+\tau_{it}}\right]^{1/\gamma}, \tag{B2}$$

where τ represents the capital tax rate. We substitute $g_{it} = \tau_{it} K_{it}$ into (B2) to get

$$g_{it} = \tau_{it}^{\gamma/(\gamma-\epsilon)} \left(\frac{1-\gamma}{r_{it}+\tau_{it}}\right)^{1/(\gamma-\epsilon)} \overline{L}_{it}^{\gamma/(\gamma-\epsilon)}. \tag{B3}$$

Economy with a growing population

We start with the case of $n > 0$, which implies that the population is increasing. In this case, because $\overline{L}_{it} > \overline{L}_{it+1}$, young individuals represent the majority and the government maximizes U_{it}. Plugging (3), (B2), and the government budget constraint (B3) into (B1), we obtain

$$\begin{aligned} U_{it} = {} & (1+\beta)\frac{\epsilon}{\gamma-\epsilon}\ln\tau_{it} - (1+\beta)\frac{1-\gamma+\epsilon}{\gamma-\epsilon}\ln(r_{it}+\tau_{it}) + \beta\ln(1+r_{it+1}) \\ & + \beta\ln\left(\frac{\beta}{1+\beta}\right) + \ln\left(\frac{1}{1+\beta}\right) + (1+\beta)\ln\left[(1-\gamma)^{(1-\gamma)/\gamma}\,\overline{L}_{it}^{\varepsilon/(\gamma-\varepsilon)}\right]. \end{aligned}$$

The first-order condition regarding τ yields

$$\tau_{it} = \frac{\epsilon}{1-\gamma} r_t. \tag{B4}$$

Economy with a decreasing population

Next, we consider the case of $n < 0$, which implies that the population is decreasing. In this case, because $\overline{L}_{it} < \overline{L}_{it+1}$, old individuals represent the majority and the government maximizes u_{iot}. Plugging (3) and $g_{it} = \tau_{it} K_{it}$ into (2), we obtain

$$u_{iot} = \ln\left(\frac{\beta}{1+\beta}\right) + \ln(1+r_{it}) + \ln w_{it-1}.$$

In this case, the utility of the old individual does not depend on τ_{it}, implying that old agents are indifferent to any tax rate. Therefore, policies that maximize U_{it} are supported by the majority, and the first-order condition of the maximization again yields (B4).

Steady-state

We assumed symmetric countries, which implies that all countries have the same capital holdings at period 0, the same population size, and the same population growth rate, implying that $\overline{L}_{it} = \overline{L}_{jt}$ $(i \neq j)$ for all t. From $\overline{L}_{it} = \overline{L}_{jt}$ $(i \neq j)$, we obtain $c_{it} = c_{jt} = c_t$ and $k_{it} = k_{jt} = k_t$. We focus on the steady-state equilibrium, wherein the level of individual's consumption, c_t, and capital per capita, k_t, are constant over time ($c_t = c_{t+1} = c^*$ and $k_t = k_{t+1} = k^*$). Then, from (4), we readily know that $r_t + \tau_t = r_{t+1} + \tau_{t+1}$. Using this, the capital market clearing condition (5) can be rewritten as

$$\left[\frac{g^{\epsilon}(1-\gamma)}{r_t+\tau_t}\right]^{1/\gamma} \sum_{j=1}^{M} \overline{L}_{it} = \frac{\beta\gamma}{1+\beta} g^{\epsilon} \left[\frac{g^{\epsilon}(1-\gamma)}{r_t+\tau_t}\right]^{(1-\gamma)/\gamma} \sum_{j=1}^{M} \overline{L}_{it-1}.$$

From $\overline{L}_{it+1} = (1+n)\overline{L}_{it}$ for all countries, we obtain

$$r_t + \tau_t = \frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma}. \tag{B5}$$

Equilibrium and its efficiency

From (B4) and (B5), we obtain the equilibrium capital tax rate in both economies as follows:

$$\tau_{y2}^* = \frac{\epsilon(1+n)(1+\beta)(1-\gamma)}{\beta\gamma(1-\gamma+\epsilon)}.$$

Plugging $\tau_t = \tau_{t+1} = \tau$, the indirect utility of an agent becomes as

$$\begin{aligned} U_{it} = {} & \frac{\epsilon(1+\beta)}{\gamma-\epsilon}\ln\tau - \frac{(1+\beta)\left[1-\gamma+\epsilon\right]}{\gamma-\epsilon}\ln\left[\frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma}\right] \\ & + \beta\ln\left[1+\frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma}-\tau\right] + \beta\ln\left(\frac{\beta}{1+\beta}\right) \\ & - \ln(1+\beta) + (1+\beta)\ln\left[(1-\gamma)^{(1-\gamma)/\gamma}\,\overline{L}_{it}^{\varepsilon/(\gamma-\varepsilon)}\right]. \end{aligned} \tag{30}$$

We differentiate (30) with τ to obtain

$$\frac{\partial U_{it}}{\partial\tau} = \frac{(1+\beta)\,\epsilon}{(\gamma-\epsilon)\,\tau} - \frac{1}{1+r},$$

where r is given by

$$r = \frac{(1+n)(1+\beta)(1-\gamma)}{\beta\gamma} - \tau.$$

From this, we know that the welfare monotonically increases with the capital tax rates. Hence, τ_{y2}^* is lower than the optimum tax rate.

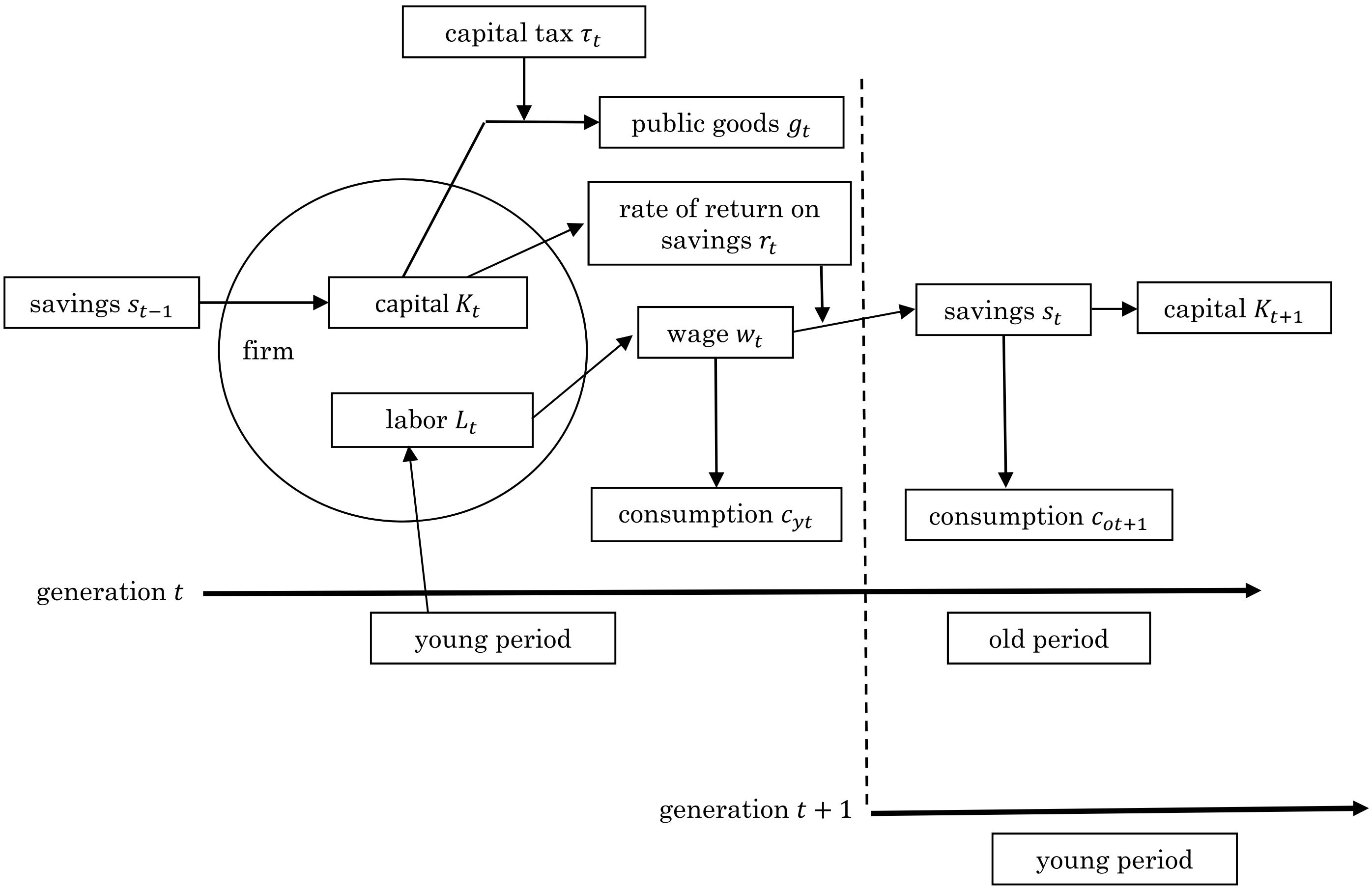
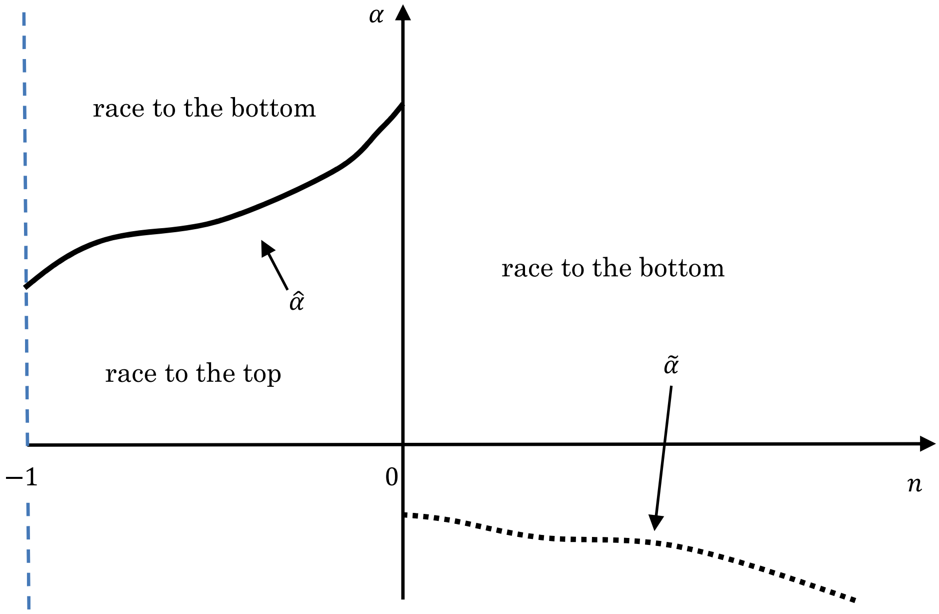
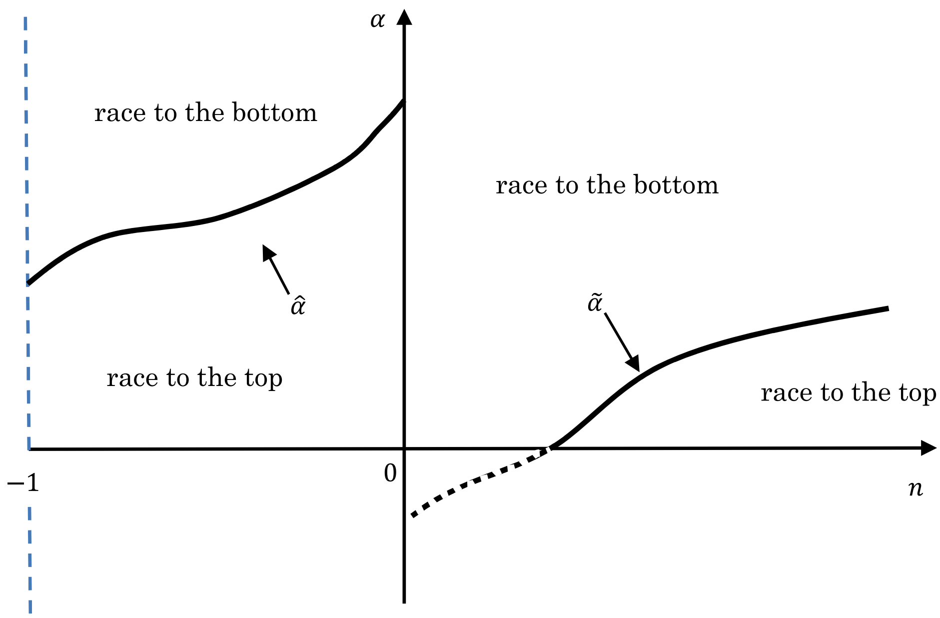


Figure 1： OLG structure of the model



(a) Case of $\gamma < \tilde{\gamma}$



(b) Case of $\gamma \geq \tilde{\gamma}$

Figure 2: Possibility of the race to the top