Endogenous timing in tax competition with asymmetric governments' objectives

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Abstract

This study examines a timing game in capital income tax competition between the government as a benevolent maximizer of social welfare and a tax revenue maximizing Leviathan. When both governments' objectives are revenue-maximizing, two sequential-move outcomes are SPNEs. This is true even if there is no absentee capital ownership. When one government is the Leviathan, outcomes of SPNEs are determined by whether the benevolent government is a capital importer or a capital exporter. In this model, the asymmetry in production function is represented by different vertical intercepts of capital demand. In the case of symmetric objectives, leadership by the large country is Pareto-dominant equilibrium. However, under the same structure of production function, if the governments' objectives are asymmetric, the leadership by the small country is Pareto-dominant.

Keywords: Tax competition; Endogenous timing

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1 Introduction

The recent studies in the tax competition relax the assumption that the competing governments choose their strategic variables simultaneously. In this context, the source of heterogeneity between countries or regions is the one of important factors. A typical example is the market power in the capital market.Indeed, Kempf and Rota-Graziosi (2010) focus on the gradient of demand for capital, while Hindriks and Nishimura (2015, 2017) consider the vertical intercept of the demand for capital. This paper mainly focuses on the other characteristic, objective functions of the country. Many previous studies assume that governments are benevolent and maximize social welfare, which is a weighted sum of individuals' utility functions. In the contrast, Edwards and Keen (1996) and Wilson (2005) consider a case where the governments maximize their net tax revenues to increase the government size, in order words, the government acts as a Leviathan. They may place a low weight on a total surplus, when the governments face severe revenue shortfall. According OECD (2015), between 2009 and 2014, the ratio of tax revenues to GDP falls in OECD countries, for example, Spain, Norway, Czech Republic, Luxembourg, and Turkey, while the ratio rises in countries, for example, Greece, Denmark, Iceland, Estonia, New Zealand. [1] Difference in objectives of the governments may appears among these countries. Theoretically, Pal and Sharma (2013) construct the model of interregional competition for mobile capital with the stage that the governments chooses their objective functions. They show that, in the case of sequential move competition, the leader chooses to be benevolent, while the follower chooses to be a Leviathan (See their Proposition 5). These mean that not only the market power but also the governments' objectives can be seen as heterogeneity between countries.

In this paper, we construct the model that not only size of country but also governments' objectives vary between countries. The goal of government in a country is to maximize social welfare, while that of the government in another country is tax revenue. When both governments' objectives are revenue-maximizing, two sequential-move outcomes are SPNEs. This is true even if there is no absentee capital ownership. This is because both governments care about the only their tax revenue, and then their payoff do not depend on the price of capital. When either government is the Leviathan, outcomes of SPNEs are determined by whether the benevolent government is a capital importer or a capital exporter. Moreover, we consider a coordination issue. In this model, the asymmetry in market power is represented by different vertical intercepts of capital demand such as Hindriks and Nishimura (2015, 2017) and Ogawa (2013). In the case of symmetric objectives, leadership by the large country is Pareto-dominant equilibrium. This is because the reaction functions differ among countries only by the vertical intercepts. But, fixed the structure of production function, if the governments'

[1] Indeed, cooperate tax revenues have been falling across OECD countries. Average revenues from cooperate incomes and gains fall from 3.6 % to 2.8 % over from 2007 to 2014.

objectives are asymmetric, leadership by the small country is Pareto-dominant. This is because the reaction functions differ by not only the vertical intercepts but also gradients. These can be pointed out by interactions between asymmetry of governments' objectives and market power.

The rest of this paper is organized as follows. Section 2 presents a setup of model. Section 3 analyzes the equilibrium and discusses results. Section 4 consider a coordination issue. Section 5 concludes.

2 Model

There are two countries denoted by $i = 1$ and $i = 2$. The production sector in both countries utilizes capital and labor, and its technology exhibits constant return to scale. The production per capita in country i is the following quadratic production function: $f^i = (A_i - k_i)k_i$ where k_i denotes the capital per capita in country i and A_i denotes the parameter for production efficiency in country i. It is assumed $\Delta \equiv A_1 - A_2 > 0$, in words, the country 1 is more productive than the country 2. Here, we consider that the more (less) productive country corresponds to the larger (smaller) one. The profit of firm is given by $\pi_i = f^i(k_i) - rk_i - T_ik_i - \omega_i$ where r denotes the market price of capital, T_i the unit tax rate on capital, and ω_i the wage rate. We define the net tax revenue TR_i as follows:

$$TR_i = T_ik_i, \quad i = 1, 2 \tag{1}$$

The total amount of capital in the economy is $2\bar{k}$. Following Ogawa (2013), a consumer in country i has an initial endowment of capital, $\theta\bar{k}$ where $\theta \in [0, 1]$ denotes the parameter indicated consumer's capital ownership. We consider that the capital market is perfectly competitive. The preference of consumer in the country i is represented by $u(c^i) = c^i$ where c^i denotes his/her consumption level. The net income of the consumer consists of labor income, capital income, and the income transfer from the government in his/her country. The labor and capital income of the consumer in the country i is $IR_i = k_i^2 + r\theta\bar{k}$. The income transfer is financed by the tax revenue TR_i. Thus, the social welfare of the country i SW_i is given by the sum of incomes of consumer IR_i and tax revenue TR_i:

$$SW_i = IR_i + TR_i \quad i = 1, 2 \tag{2}$$

The government in each country imposes a unit tax on capital located in its country. Following Edwards and Keen (1996), the objective function is defined as follows:

$$W_i = \alpha_i SW_i + (1 - \alpha_i)TR_i \quad i = 1, 2 \tag{3}$$

where $\alpha_i \in [0, 1]$ denotes the parameter for motivation of the policymakers. When $\alpha_i = 1$, the government maximizes consumer's utility. However, $\alpha_i = 0$ corresponds to a policymaker as revenue-maximizing Leviathans. The market clearing conditions are

$$2\bar{k} = k_1 + k_2, \quad \text{and} \quad r = f_k^1(k_1) - T_1 = f_k^2(k_2) - T_2$$

Under these conditions, the level of capital in each country and the price of capital are

$$k_1 = \bar{k} + \frac{\Delta}{4} + \frac{T_2 - T_1}{4} \tag{4}$$

$$k_2 = \bar{k} - \frac{\Delta}{4} + \frac{T_1 - T_2}{4} \tag{5}$$

$$r = \frac{\Omega}{2} - \frac{4\bar{k} + T_1 + T_2}{2} \tag{6}$$

where $\Omega \equiv A_1 + A_2$.

We propose a two stage game with the following timing. In the first stage, the government decides whether to set its tax rate at the first period or at the second period. Therefore, this is the timing game of Hamilton and Slutsky (1990). If both governments choose their tax rates in the same period, then these governments take decisions simultaneously. If one government sets its tax rate at the first period and the other at the second period, then tax rates are chosen sequentially. These mean that, in the second stage, the government decides its tax rate simultaneously or sequentially. To obtain a subgame perfect Nash equilibrium (hereafter, SPNE), we apply the concept of backward induction to solve the game.

3 Characterizing the tax competition

3.1 Symmetric objectives

As a benchmark case, we consider the case where both governments are revenue-maximizing Leviathans, that is, $\alpha_1 = \alpha_2 = 0$. We denote the case in which governments set these tax rates simultaneously by superscript N. On the other hand, when the governments set their tax rates sequentially. The superscript L (F) means that the government is a leader (follower).

First, we solve the case when tax rates are set simultaneously. To insure interior solutions, we assume

Assumption 1.

$$\bar{k} - \frac{\Delta}{12} > 0$$

Each government chooses the level of tax rate to maximize equation (1) subject to equation (3) to (5). Solving these yields the following reaction functions:

$$T_1 = \frac{1}{2}T_2 + 8\bar{k} + 2\Delta \tag{7}$$

$$T_2 = \frac{1}{2}T_1 + 8\bar{k} - 2\Delta \tag{8}$$

From equations (7) and (8), the following is obtained:

$$\begin{aligned} T_1^N &= \frac{\Delta + 12\bar{k}}{3}, \quad T_2^N = \frac{-\Delta + 12\bar{k}}{3} \\ W_1^N &= \frac{(\Delta + 12\bar{k})^2}{36}, \quad W_2^N = \frac{(-\Delta + 12\bar{k})^2}{36} \end{aligned}$$

Next, we consider the case in which the governments decide their tax rates sequentially. When the government in the large country acts as a leader, it chooses the tax rate to maximize (1) taking into account (7). Solving it, we obtain:

$$\begin{aligned} T_1^L &= \frac{\Delta + 12\bar{k}}{2}, \quad T_2^F = \frac{-\Delta + 20\bar{k}}{4} \\ W_1^L &= \frac{(\Delta + 12\bar{k})^2}{32}, \quad W_2^F = \frac{(-\Delta + 20\bar{k})^2}{64} \end{aligned}$$

Similarly, when the small country is a leader, we have:

$$\begin{aligned} T_1^F &= \frac{\Delta + 20\bar{k}}{4}, \quad T_2^L = \frac{-\Delta + 12\bar{k}}{2} \\ W_1^F &= \frac{(\Delta + 20\bar{k})^2}{64}, \quad W_2^L = \frac{(-\Delta + 12\bar{k})^2}{32} \end{aligned}$$

It is well known that endogenous timing outcomes depend on crucially the slope of the reaction functions and the signs of the payoff externalities. From equations (7) and (8), it is easy to show that tax rates are strategic complement (i.e., these reaction functions functions are upward-sloping). We can also show the existence of positive externalities:

$$\frac{\partial W_1}{\partial T_2}(T_1^N, T_2^N) = \bar{k} + \frac{\Delta}{12} > 0, \quad \frac{\partial W_2}{\partial T_1}(T_1^N, T_2^N) = \bar{k} - \frac{\Delta}{12} > 0$$

The reason is straightforward. When the government in a country raises its tax rate, the tax revenue in another country increases, that is, $\frac{\partial TR_i}{\partial T_j} > 0$ for $i \neq j$. Therefore, the SPNEs of the timing game are two sequential-move outcomes.

Kempf and Rota-Graziosi (2010) and Hindriks and Nishimura (2015) show that the SPNEs of timing game are also two sequential-move outcomes when there is absentee capital ownership ($\theta = 0$) and all governments are benevolent ($\alpha_1 = \alpha_2 = 1$). Under the setting of their model, the social welfare SW_i can be rewritten as $SW_i = f(k_i) - rk_i$. When the government in a country raises its tax rate, the price of capital decreases, that is, $\frac{\partial r}{\partial T_i} < 0$ for $i = 1, 2$. The tax externality is positive for the governments in both countries, and then the equilibria are also two sequential-move outcomes. The point that their model and our model have in common is that objective functions exclude the parameter about capital ownership, θ.

3.2 Asymmetric objectives

When we allow the case of asymmetric objectives, that is, $\alpha_1 \neq \alpha_2$, we have two cases. First, the government in the large country is the Leviathan, that is, $\alpha_1 = 0$ and $\alpha_2 = 1$. Second, the opposite case where the government in the small country is the Leviathan, that is, $\alpha_1 = 1$ and $\alpha_2 = 0$.

3.2.1 The case where the large country is the Leviathan

We first solve the case in which tax rates are set simultaneously. The assumption to insure interior solutions are modified as follows:

Assumption 2.

$$-\Delta + 2\bar{k}(6 + \theta) > 0$$

The large country chooses the level of T_1 that maximizes equation (1), but the small country chooses the level of T_2 that maximizes equation (2). Solving these problems, we obtain the reaction functions in tax rates:

$$T_1 = \frac{1}{2}T_2 + \frac{1}{2}\Delta + 2\bar{k} \tag{9}$$

$$T_2 = \frac{1}{3}T_1 - \frac{1}{3}\Delta + \frac{4(1-\theta)\bar{k}}{3} \tag{10}$$

From equations (9) and (10), the following is obtained:

$$T_1^N = \frac{2\{\Delta + 2\bar{k}(4-\theta)\}}{5}, \quad T_2^N = \frac{-\Delta + 4\bar{k}(3-2\theta)}{5}$$

$$W_1^N = \frac{(\Delta + 2\bar{k}(4-\theta))^2}{25}, \quad W_2^N = \frac{3(-\Delta + 12\bar{k})^2 + 4\bar{k}\theta(12A_1 + 13A_2 - 144\bar{k}) + 92\bar{k}^2\theta^2}{100}$$

Next, we consider the case in which governments decide their tax rates sequentially, and the Leviathan decides its tax rate first. It chooses the tax rate that maximizes (1) taking into account equation (10). Solving it yields

$$T_1^L = \frac{\Delta + 2\bar{k}(4-\theta)}{2}, \quad T_2^F = \frac{-\Delta + 2\bar{k}(8-5\theta)}{6}$$

$$W_1^L = \frac{(\Delta + 2\bar{k}(4-\theta))^2}{24}, \quad W_2^F = \frac{(-\Delta + 16\bar{k})^2 + 4\bar{k}\theta(5A_1 + 7A_2 - 80\bar{k}) + 52\bar{k}^2\theta^2}{48}$$

We turn to the case in which the government in the small country chooses the tax rate that maximize (2) taking into account equation (9). Solving it yields:

$$T_1^F = \frac{2\{\Delta + 2\bar{k}(8-3\theta)\}}{7}, \quad T_2^L = \frac{3\{-\Delta + 4\bar{k}(3-2\theta)\}}{7}$$

$$W_1^F = \frac{(\Delta + 2\bar{k}(8-3\theta))^2}{49}, \quad W_2^L = \frac{(-\Delta + 12\bar{k})^2 + 4\bar{k}\theta(4A_1 + 3A_2 - 48\bar{k}) + 36\bar{k}^2\theta^2}{28}$$

Evaluated at the simultaneous-move outcome, the external effects are

$$\frac{\partial W_1}{\partial T_2}(T_1^N, T_2^N) = \frac{\Delta + 2\bar{k}(4-\theta)}{10} > 0 \tag{11}$$

$$\frac{\partial W_2}{\partial T_1}(T_1^N, T_2^N) = \frac{-\Delta + 4\bar{k}(3-2\theta)}{10} \gtrless 0 \Longleftrightarrow \frac{\Delta}{\bar{k}} \lessgtr 4(3-2\theta) \tag{12}$$

Equation (11) means that the large country in the asymmetric objectives receives the same external effect as in the symmetric objectives. However, the small country suffers from negative external effect, if the small country is a capital exporter (i.e., $k_2^N - \theta\bar{k} < 0$). This is because its payoff, SW_2 can be rewritten as follows: $SW_2 = f(k_2) + r(\theta\bar{k} - k_2)$. The first term can be seen as the immobile factor, and the second term is the mobile factor. If the country is capital exporter, the amount of mobile factor is negative. Thus, it has the incentive to increase the price of capital. This is because from equation (6), the price of capital is lowered (raised) when the tax rates in a country is raised (lowered).

To characterize the SPNE, we define the first-mover incentive (second-mover incentive): a country has a first-mover incentive (second-mover incentive), if its indirect utility function in the sequential move game in which it leads (follows) is higher than in the simultaneous-move game. In Appendix A, we show that

$$W_i^L - W_i^N > 0, \quad i = 1, 2 \tag{13}$$

$$W_1^F - W_1^N \gtreqless 0 \Longleftrightarrow \frac{\Delta}{\bar{k}} \lesseqgtr 4(3-2\theta) \tag{14}$$

$$W_2^F - W_2^N \gtreqless 0 \Longleftrightarrow \frac{\Delta}{\bar{k}} \lesseqgtr \frac{2}{11}(76-49\theta) \tag{15}$$

These are summarized as the following proposition:

Proposition 1. *If the government in the large country is the Leviathan, we can derive three kinds of equilibria:*

1. *When $\frac{\Delta}{\bar{k}} > \frac{2}{11}(76-49\theta)$, a simultaneous-move outcome where both governments get their tax rate at the first period, is SPNE.*

2. *When $4(3-2\theta) < \frac{\Delta}{\bar{k}} < \frac{2}{11}(76-49\theta)$, a sequential-move outcome where the Leviathan sets its tax rate at he first period but the benevolent government sets its tax rate at the second period, is SPNE.*

3. *When $\frac{\Delta}{\bar{k}} < 4(3-2\theta)$, two sequential-move outcomes are SPNEs.*

When $\frac{\Delta}{\bar{k}} > \frac{2}{11}(76-49\theta)$, the Leviathan sets a higher tax rate than the benevolent government in all cases, that is, $T_1^L > T_2^F$, $T_1^F > T_2^L$, and $T_1^N > T_2^N$. This is due to the fact that the benevolent government is a capital exporter and its social welfare involves the mobile factor. By setting a lower tax rate, it raises the level of social welfare. In other words, it seeks to facilitate the "downward pressure" feature in the tax competition. However, the Leviathan wants to mitigate the "downward pressure" feature for higher tax revenue. When the Leviathan (the benevolent government) is leader, it raises (lowers) its tax rate in comparison to the simultaneous case since it knows that the benevolent (the Leviathan) also raises (lowers) its tax rate, because tax rates are strategic complements. These mean that tax rates are ordered as follows: $T_1^L > T_1^N > T_1^F$ and $T_2^F > T_2^N > T_2^L$. Therefore, choosing tax rates at the first period is dominant strategies for governments in both countries. This outcome is related to Bárcena-Ruiz (2007), which shows that in a mixed duopoly under the price competition, the private firm and the public firm set their prices at the first period is the only SPNE. The pubic firm concerns about the consumer surplus, and then wants to increase the market competition, while the private firm seeks to reduce the market competition. These imply that the public firm prefers a lower price than the simultaneous case, but the private firm prefers a higher price than the simultaneous case. As a result, both types of firms commit to choose their prices in the first period at the SPNE.

Proposition 1 is consistent with results in Hindriks and Nishimura (2017). Their proposition 1 shows the level of capital ownership switching from the Stackelberg to the simultaneous-move outcomes, under the symmetry in governments' objectives ($\alpha_1 =$

$\alpha_2 = 1$) and the asymmetry in the market powers ($\Delta > 0$). Indeed, the left-hand side of equation (14) and (15) can be rewritten as

$$W_1^F - W_1^N \gtrless 0 \Longleftrightarrow \theta \lessgtr \frac{3}{2} - \frac{\Delta}{8\bar{k}}, \; W_2^F - W_2^N \gtrless 0 \Longleftrightarrow \theta \lessgtr \frac{76}{49} - \frac{11\Delta}{98\bar{k}}$$

These can be seen as the switching points in which the countries have a second-mover incentives proposed in Hindriks and Nishimura (2017).[2]

3.2.2 The case where the small country is the Leviathan

We solve the case in which tax rates are set simultaneously. The assumption to insure interior solutions are modified as follows:

Assumption 3.

$$-\Delta + 2\bar{k}(4-\theta) > 0$$

The large country chooses the level of T_1 that maximizes equation (2), but the small country chooses the level of T_2 that maximizes equation (1). Solving these problems, we obtain the reaction functions in tax rates:

$$T_1 = \frac{1}{3}T_2 + \frac{\Delta + 4\bar{k}(1-\theta)}{3} \tag{16}$$

$$T_2 = \frac{1}{2}T_1 - \frac{1}{2}\Delta + 2\bar{k} \tag{17}$$

From equations (16) and (17), the following is obtained:

$$T_1^N = \frac{\Delta + 4\bar{k}(3-2\theta)}{5}, \quad T_2^N = \frac{-2\{\Delta + 2\bar{k}(-4+\theta)\}}{5}$$

$$W_1^N = \frac{3(-\Delta + 12\bar{k})^2 + 4\bar{k}\theta(13A_1 + 12A_2 - 144\bar{k}) + 92\bar{k}^2\theta^2}{100}, \quad W_2^N = \frac{(\Delta - 2\bar{k}(4-\theta))^2}{25}$$

Next, we consider the case in which governments decide their tax rates sequentially, and the benevolent government decides its tax rate first. It chooses the tax rate that maximizes (2) taking into account equation (17). Solving it yields:

$$T_1^L = \frac{3\{\Delta + 4\bar{k}(3-2\theta)\}}{7}, \quad T_2^F = \frac{-2\{\Delta + 2\bar{k}(-8+3\theta)\}}{7}$$

[2] By notations used in Hindriks and Nishimura (2017), these correspond to θ^N and θ^2, respectively.

$$W_1^L = \frac{(\Delta + 12\bar{k})^2 + 4\bar{k}\theta(3A_1 + 4A_2 - 48\bar{k}) + 36\bar{k}^2\theta^2}{28}, \quad W_2^F = \frac{(\Delta - 2\bar{k}(8 - 3\theta))^2}{49}$$

We turn to the case in which the Leviathan decides its tax rate first. The government in the small country chooses the tax rate that maximizes (1) taking into account equation (16). Solving it, we have

$$T_1^F = \frac{\Delta + 2\bar{k}(8 - 5\theta)}{6}, \quad T_2^L = \frac{-\Delta + 2\bar{k}(4 - \theta)}{2}$$

$$W_2^L = \frac{(\Delta + 16\bar{k})^2 + 4\bar{k}\theta(7A_1 + 5A_2 - 80\bar{k}) + 52\bar{k}^2\theta^2}{48}, \quad W_2^L = \frac{(\Delta - 2\bar{k}(4 - \theta))^2}{24}$$

Evaluated at the simultaneous-move outcome, the external effects are

$$\frac{\partial W_1}{\partial T_2}(T_1^N, T_2^N) = \frac{\Delta + 4\bar{k}(3 - 2\theta)}{10} > 0, \frac{\partial W_2}{\partial T_1}(T_1^N, T_2^N) = \frac{-\Delta + 2\bar{k}(4 - \theta)}{10} > 0 \qquad (18)$$

When the small country is the Leviathan, it receives a positive spillover. This is the same as in the case of symmetric objectives. As for the large country, is is the capital importer ($k_1^N - \theta\bar{k} > 0$) for any parameter values. Because of the same reason mentioned above, there is a positive spillover. Therefore, equations (18) for $i = 1, 2$ are positive. These are summarized as the following proposition:

Proposition 2. *If the government in the small country is the Leviathan, we can derive two sequential-move outcomes are SPNEs.*

Proposition 1 and 2 mean that when either government is the Leviathan, outcomes of SPNEs are related to the mobile factor in the benevolent government's objective function, that is, the country whose government is benevolent is a capital importer or a capital exporter.

4 A coordination issue

To rank the two SPEs, we apply a criterion: the Pareto-dominance. We introduce the concept of a first-mover advantage (a second-mover advantage): the government has a first-mover advantage (a second-mover advantage), if its indirect utility in the sequential-move outcome in which it chooses a tax rate in the first period is higher (lower) than the indirect utility that it chooses a tax rate in the second period. All derivations of this section are shown in Appendix B.

Under the case of symmetric objectives, we show that

$$W_1^L - W_1^F \gtrless 0 \Longleftrightarrow \frac{\Delta}{\bar{k}} \gtrless \delta_1 \qquad (19)$$

$$W_2^L - W_2^F < 0 \tag{20}$$

From Assumption 1, we discuss the equilibrium selection for $0 < \frac{\Delta}{\bar{k}} < 12$.

Lemma 1. *Consider the case of symmetric objectives.*

1. *For $0 < \frac{\Delta}{\bar{k}} < \delta_1$, both governments have the second-mover advantage.*

2. *For $\delta_1 < \frac{\Delta}{\bar{k}} < 12$, the large country has the first-mover advantage but the small country has the second-mover advantage.*

We turn to the case of asymmetric objectives. In the case in which the government in the large country is the Leviathan, from equation (12), we discuss the equilibrium selection for $0 < \frac{\Delta}{\bar{k}} < 4(3-2\theta)$. We obtain

$$W_1^L - W_1^F < 0 \tag{21}$$

$$W_2^L - W_2^F > 0 \Longleftrightarrow 0 < \frac{\Delta}{\bar{k}} < \delta_2 \text{ or } \delta_3 < \frac{\Delta}{\bar{k}} < 4(3-2\theta) \tag{22}$$

These give

Lemma 2. *Consider the case where the government in the large country is a Leviathan.*

1. *For $0 < \frac{\Delta}{\bar{k}} < \delta_2$ or $\delta_3 < \frac{\Delta}{\bar{k}} < 4(3-2\theta)$, the large country has the second-mover advantage but the small country has the first-mover advantage.*

2. *For $\delta_2 < \frac{\Delta}{\bar{k}} < \delta_3$, both governments have the second-mover advantage.*

In the case in which the small country is the Leviathan, we obtain

$$W_1^L - W_1^F \lesseqgtr 0 \Longleftrightarrow \frac{\Delta}{\bar{k}} \lesseqgtr \delta_4 \tag{23}$$

$$W_2^L - W_2^F > 0 \tag{24}$$

From Assumption 3, we discuss the equilibrium selection for $0 < \frac{\Delta}{\bar{k}} < 2(4-\theta)$.

Lemma 3. *Consider the case where the small country is a Leviathan.*

1. *For $0 < \frac{\Delta}{\bar{k}} < \delta_4$, the large country has the second-mover advantage but the small country has the first-mover advantage.*

2. *For $\delta_4 < \frac{\Delta}{\bar{k}} < 2(4-\theta)$, both governments have the first-mover advantage.*

These lemma allows us to find the Pareto-dominant equilibrium.

Proposition 3. *Suppose that the asymmetry in the market power is represented by different vertical intercepts. We have*

1. *In the case of symmetric objectives, that is, $\alpha_1 = \alpha_2 = 0$, the leadership by the large country is Pareto-dominant, if the asymmetry of productivity is sufficient large.*

2. *In the case of asymmetric objectives, that is, $\alpha_1 \neq \alpha_2$, the leadership by the small country is Pareto-dominant, if the asymmetry of productivity is sufficient small or large.*

Under the production function in this model, $f(k_i) = (A_i - k_i)k_i$, the country with higher productivity, that is, the large country has greater market power. Mathematically, it is represented by the vertical intercepts of capital demand. Hindriks and Nishimura (2015) show that SPNE where such a country move first is Pareto-dominant if the asymmetry in market power is sufficient. The first argument in Proposition 3 is consistent with the outcome. In this model, the reaction functions (equations (7) and (8)) have the same gradients but differ the vertical intercepts. Because of the higher intercept for the large country, the country benefits from higher taxes and thus has a first-mover advantage. Fixed on the production function, the asymmetry of governments' objectives translates to the difference in the gradients (see equations (9), (10), (16), and (17)). In the case in which the large country is the Leviathan, the country is more sensitive to the tax rate of the small country, that is, $\frac{\partial T_1}{\partial T_2} = \frac{1}{2} > \frac{\partial T_2}{\partial T_1} = \frac{1}{3}$. The leadership by the small country is preferable to facilitate a greater positive reaction in the tax rate of the large country. This leads the small country to move in the first period. We turn to the case in which the small country is the Leviathan. From the slope of reaction functions, the small country is more sensitive to the tax rate of the large country. In contrast, for $0 < \frac{\Delta}{\bar{k}} < \delta_4$, the vertical intercept of the small country's reaction function is higher than that of the large country's reaction function. For the range of parameters, the small country benefits from setting a higher tax rate, and then the leadership by the small country is preferable to the leadership by the large country.

5 Conclusion

This paper introduces the difference of governments' objectives into the endogenous timing of tax competition. The government in a country is the revenue-maximizing Leviathan, but the government in another country is benevolent maximizer of social welfare. When both governments' objectives are revenue-maximizing, two sequential-move outcomes are SPNEs. This is true even if there is no absentee capital ownership. This is because both governments care about the only their tax revenue, and then their payoff do not depend on the price of capital. When either government is the Leviathan, outcomes of SPNEs are determined by whether the benevolent government is a capital importer or a capital exporter. In this model, the asymmetry in production function is represented by different vertical intercepts of capital demand. In the case of symmetric objectives, leadership by the large country is Pareto-dominant equilibrium. However, under the same structure of production function, if the governments' objectives are asymmetric, the leadership by the small country is Pareto-dominant.

Appendix A

To derive the SPNEs of the timing game, we compare the indirect utility functions of the governments in both countries. We have

$$W_1^L - W_1^N = \frac{(-\Delta + 2\bar{k}(4-\theta))^2}{600} \tag{A.1}$$

$$W_2^L - W_2^N = \frac{(\Delta - 4\bar{k}(3-2\theta)^2}{175} \tag{A.2}$$

$$W_1^F - W_1^N = -\frac{8}{1225}(3\Delta + \bar{k}(34-11\theta))(\Delta - 4\bar{k}(3-2\theta)) \tag{A.3}$$

$$W_2^F - W_2^N = -\frac{1}{1200}(\Delta + 2\bar{k}(4-\theta))(11\Delta - 2\bar{k}(76-49\theta)) \tag{A.4}$$

It is easy to show that equations (A.1) and (A.2) are positive. This means that equation (13) is strictly positive. The sign of equation (A.3) depends on the direction of spillover (equation (12)). Then, we get equation (14). According to equation (A.4), under the Assumption 2, the third bracket is negative. Then, we get equation (15). □

Appendix B

To determine the first-mover advantage (the second-mover advantage), we compare the indirect utility function of the governments in both countries. When $\alpha_1 = \alpha_2 = 0$, we obtain

$$W_1^L - W_2^F = \frac{1}{64}(\frac{\Delta}{\bar{k}} + 4(1+2\sqrt{2}))(\frac{\Delta}{\bar{k}} - \delta_1) \tag{B.1}$$

$$W_2^L - W_2^F = \frac{1}{64}(\frac{\Delta}{\bar{k}} - 4(1-2\sqrt{2}))(\frac{\Delta}{\bar{k}} - 4(1+2\sqrt{2})) \tag{B.2}$$

where $\delta_1 \equiv 4(-1+2\sqrt{2})$. The sign of equation (B.1) depends on the second bracket. Then, we get equation (19). Under Assumption 1, the first bracket of equation (B.2) is positive, but the second bracket is negative. Then, equation (20) is strictly positive. When $\alpha_1 = 0$ and $\alpha_2 = 1$, we obtain

$$W_1^L - W_1^F = \{\frac{(\Delta + 2\bar{k}(4-\theta))}{\sqrt{24}} - \frac{(\Delta + 2\bar{k}(8-3\theta))}{\sqrt{49}}\}\{\frac{(\Delta + 2\bar{k}(4-\theta))}{\sqrt{24}} + \frac{(\Delta + 2\bar{k}(8-3\theta))}{\sqrt{49}}\} \quad \text{(B.3)}$$

$$W_2^L - W_2^F = -\frac{\bar{k}^2}{336}(\frac{\Delta}{\bar{k}} - \delta_2)(\frac{\Delta}{\bar{k}} - \delta_3) \quad \text{(B.4)}$$

where $\delta_2 \equiv \frac{16-13\theta-\sqrt{3}\sqrt{192-32\theta-57\theta^2}}{5}$ and $\delta_3 \equiv \frac{16-13\theta+\sqrt{3}\sqrt{192-32\theta-57\theta^2}}{5}$. Under Assumption 2, the first bracket of equation (B.3) is negative. Then, equation (21) is strictly positive. The sign of equation (B.4) depends on both first and second brackets. Then, we get equation (22). When $\alpha_1 = 1$, and $\alpha_2 = 0$, we obtain

$$W_1^L - W_1^F = \frac{\bar{k}^2}{336}(\frac{\Delta}{\bar{k}} - \delta_4)(\frac{\Delta}{\bar{k}} - \delta_5) \quad \text{(B.5)}$$

where $\delta_4 \equiv \frac{2}{5}(-16+13\theta+2\sqrt{21}(2-\theta))$ and $\delta_5 \equiv \frac{2}{5}(-16+13\theta-2\sqrt{21}(2-\theta))$.

$$W_2^L - W_2^F = -\frac{(\Delta - 2\bar{k}(8-3\theta))^2}{49} + \frac{(\Delta - 2\bar{k}(4-\theta))^2}{24} \quad \text{(B.6)}$$

Under Assumption 3, the second bracket is positive. Then, the sign of equation (B.5) depends on the first bracket. It is obvious that the first term of equation (B.6) is smaller than the second term. Then, equation (24) is strictly positive. □

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