The Korean Economic Review
Volume 38, Number 1, Winter 2022, 141-166.
DOI : 10.22841/kerdoi.2022.38.1.005

Tax Competition under Imperfect Labor Market*

Sangwha Shin** · Sang-Hyun Kim***

We develop a two-country model of tax competition in which governments attempt to attract more capital by adjusting the corporate income tax rate. We allow labor market imperfection and investigate how it relates to the intensity of tax competition. It is shown that in response to a symmetric increase in the labor market costs, capital becomes less sensitive to corporate income tax rates. When the labor market costs increase, firms' profits drop more greatly in the foreign market than in the domestic market due to the existence of trade costs. Thus, firms become less concerned about the level of tax rates in the locational decision.

JEL Classification: F16, F21, J64, H25
Keywords: Labor Market Imperfection, Tax Competition, Corporate Income Tax Rate

I. Introduction

Tax competition has been recognized as an important determinant of the corporate income tax rate. In South Korea, for example, there have been debates in recent years over the government's proposal of increasing the statutory corporate income tax rate for the most profitable firms. Opponents of the proposal argue that if the government increases the tax rate, it will incur an outflow of capital to competing countries.

Even in academic discussions, the extent and impacts of tax competition remain controversial (see, for instance, Devereux and Loretz, 2013).[1] One of the reasons

Received: Aug. 21, 2020. Revised: June 28, 2021. Accepted: Nov. 5, 2021.

* A primitive Korean version of this paper had been circulated by the Korea Institute of Public Finance (Shin and Kim, 2016).

** First Author, Assistant Professor, Department of International Trade, Chungnam National University, 99 Daehak-ro, Yuseong-gu, Daejeon 34134, Korea, E-mail: shinsan6@cnu.ac.kr

*** Corresponding Author, Associate Professor, School of Economics, Yonsei University, 50 Yonsei-ro Seodaemun-gu, Seoul, 03722, Korea, E-mail: sang.kim@yonsei.ac.kr

[1] In recent decades, the average statutory corporate income tax rate of the OECD countries shows a

why it is difficult to reach a definitive conclusion is that there exist other economic factors that can affect capital movements: when the effects of other factors on capital movement dominate that of tax rates, it would be difficult to find empirical evidence of tax competition. Thus, it is important to understand what economic factors can affect capital movement and the intensity of tax competition and how they are related.

In this study, we theoretically investigate how labor market imperfection and international trade relate to the intensity of tax competition. We develop a two-sector model in which the labor market in one sector is characterized by search and matching frictions. In this setting, firms in the search sector have to bear the labor market costs generated by frictions. This notion is important under the assumption of free capital movement since the labor market cost can directly affect the return for capital. In the model, there are two countries, and the two governments compete to attract more capital by adjusting the corporate income tax rate. Public goods in each country are financed by the tax revenue. Firms in the search sector produce differentiated goods and are allowed to engage in international trade. In the frictionless sector, a homogeneous good is produced and consumed domestically.

Given this framework, we find that a symmetric increase in the labor market inefficiencies renders capital less sensitive to the tax rates. When the labor market cost increases, monopolistically competitive firms increase the price of their goods by reducing the quantity produced. Under the existence of trade costs, the domestic market becomes more profitable than the foreign market, and thus gives the governments more autonomy in setting the tax rates. A similar effect arises when the trade cost increases: As the foreign market becomes less profitable, the capital becomes less sensitive to tax rates.

In the vast literature on international capital movement, most studies that focus on tax rate assume a perfect labor market. However, there exists a growing literature that explores how labor market imperfection affects firms' locational decisions. For example, Mitra and Ranjan (2010, 2013) and Davidson, Matusz, and Shevchenko (2008) investigate how offshoring outcomes change when the labor market imperfection is allowed in the model. Shin and Davidson (2020) analyze a model in which firms' decision between the FDI and outsourcing is directly affected by the labor market structure.

Our study is closely related to the literature that studies tax competition and labor market imperfection. Some papers assume that labor market outcome is determined by the negotiation between the firm and the union; examples would include Lejour and Verbon (1996), Fuest and Huber (1999), Richter and Schneider (2001), Koskela and Schöb (2002), Leite-Monteiro, Marchand and Pestieau (2003), Eichner and

clear downward trend (Loretz, 2008; Pomerleau and Potosky, 2015). Some argue that this may be a consequence of intensified tax competition.

Upmann (2012), Exbrayat, Gaigne and Riou (2012). Other studies consider tax competition models with search-generated unemployment. For example, Boadway, Cuff and Marceau (2002, 2004), and Sato (2009) use this approach.

Our analysis complements the literature by incorporating international trades of differentiated goods in a model of tax competition with imperfect labor markets. Most studies mentioned above assume that firms produce only a homogeneous good. Because there is no reason to trade the homogeneous good, international trades among competing countries are excluded from the model. In our model, monopolistically competitive firms produce and supply differentiated goods in both domestic and foreign markets.

To our knowledge, Egger and Seidel (2011) is the only study that analyzes a model with both an international trade of differentiated goods and labor market inefficiency at the same time. The conclusion of the study, however, differs from that derived in other studies in the literature: the labor market inefficiencies aggravate the intensity of tax competition. These conflicting results arise from the modeling choice of labor market imperfection. In their model, the labor market is inefficient due to the fair wage consideration of individuals, and this generates additional feedback effect from the labor market to the return for capital.[2] In contrast, we consider a different labor market imperfection, namely search and matching frictions, by adopting the framework in Helpman and Itskhoki (2010). Which imperfection is more relevant would depend on time and space. However, since search and matching friction has been recognized as one of the most important sources of labor market inefficiencies in the literature, it is worth investigating its impacts in the context of international trade and tax competition.

The remainder of this paper is organized as follows: In Section 2, we introduce the model, and in Section 3, we characterize the equilibrium under tax competition. Section 4 generalizes the baseline model by considering public input goods on top of public consumption goods. Section 5 summarizes the results with concluding remarks.

II. The Model

Consider a world economy with two countries. Countries are assumed to be similar in many aspects. More specifically, the total labor endowments, industrial structures, and production technologies are assumed to be the same across the countries.

[2] A symmetric increase in the labor market inefficiencies reduces the return for capital disproportionately by aggravating it more in a country with a higher tax rate. Hence, the capital becomes more sensitive to tax rates when the labor market cost increases.

In each country, there are two sectors: the homogeneous-good sector and the differentiated-goods sector. In the homogeneous-good sector, firms can hire workers in the frictionless labor market in producing the homogeneous good. The price of the homogeneous good is normalized to one so that it is treated as the numeraire. In the differentiated-goods sector, the labor market is characterized by search and matching frictions. Here, monopolistically competitive firms produce differentiated goods, and they can export some of their products to the foreign market.

2.1. Technology

In the homogeneous-good sector, one unit of labor produces one unit of homogeneous good:

$$q_0 = h, \tag{1}$$

where h is the measure of workers. The market is assumed to be perfectly competitive, and thus the wage is equal to the price of the homogeneous good.

Following the assumptions in Flam and Helpman (1987), Egger and Seidel (2011), and Sato (2009), we assume that firms require to have one unit of capital to start producing differentiated goods. This required capital can be understood as a fixed cost of producing differentiated goods. The variable cost part of the production technology is the same as that of the homogeneous good: one unit of labor is required to produce one unit of differentiated goods.

Since homogeneous goods produced in each country are identical, there is no trade in the homogeneous-good sector. Differentiated goods, however, cannot be a perfect substitute for each other, which gives room for trade.

2.2. Preferences

A representative household gets utility from consuming homogeneous goods (q_0) and a continuum of differentiated goods (Q), and public goods (G):

$$U = q_0 + \frac{Q^\gamma - 1}{\gamma} + v(G), \quad 0 < \gamma < 1. \tag{2}$$

The parameter γ governs the substitutability between homogeneous goods and differentiated goods. When γ approaches one, the substitutability gets higher.

We assume the utility function $v(G)$ is a strictly increasing, strictly concave, and differentiable function that satisfies:

$$\lim_{G\to 0} v'(G) = \infty, \quad v(0) = 0, \tag{3}$$

and Q is a CES aggregate of a continuum of differentiated goods:

$$Q = \left[\int_j q_j^{\beta} dj \right]^{\frac{1}{\beta}}, \quad 0 < \beta < 1. \tag{4}$$

In Equation (4), the parameter β governs the elasticity of substitution between varieties. To make the substitutability among differentiated goods to be greater than the substitutability between Q and q_0, we also assume:

$$0 < \gamma < \beta < 1. \tag{5}$$

It is well known that under CES preferences the following demand for each variety is yielded:

$$q_j = Q^{-\frac{\beta-\gamma}{1-\beta}} p_j^{-\frac{1}{1-\beta}}. \tag{6}$$

The price index of Q is derived as

$$P = \left(\int_j p_j^{\frac{-\beta}{1-\beta}} dj \right)^{-\frac{1-\beta}{\beta}}. \tag{7}$$

In this setting, the representative household will choose the following Q and q_0 for utility maximization:

$$\begin{aligned} Q &= P^{-\frac{1}{1-\gamma}} \\ q_0 &= E - Q^{\gamma}, \end{aligned} \tag{8}$$

where E denotes the total spending.

2.3. The Labor and Capital Markets

There are three factor markets in the economy. For the homogeneous-good sector, there is a labor market. As we mentioned above, there are no frictions in hiring and firing workers, and the match between a firm and a worker is immediate. For the differentiated-goods sector, there are two factor markets for labor and capital. In the capital market, infinitely many latent firms compete for a limited amount of capital. With the free-entry condition, the equilibrium price of capital in the country c, r_c, is determined by the following zero profit condition:

$$r_c = \max_h R_c(h_c) - w_c(h_c)h_c - b_c h_c \,, \tag{9}$$

where $R_c(h_c)$, h_c, and $w_c(h_c)$ denote the revenue, the hiring level, and the wage, respectively. b_c represents the labor market cost of country c, which is explained in more detail below. In Equation (9), we replace subscript j with c as firms are homogeneous in terms of productivity, and thus they will choose the same hiring level.

In country c, there is a continuum of identical households of measure one. There are L_c units of homogeneous labor in each household, so that the total labor endowment of a country c is L_c.[3] Among L_c units of labor, L_{dc} units of labor choose to search in the differentiated-goods sector while the remaining $L_c - L_{dc}$ units of labor choose the homogeneous-good sector.

Following Helpman and Itskhoki (2010), the labor market in the differentiated-goods sector is featured by search and matching frictions. Because of this, firms in the differentiated-goods sector in country c face a labor market cost of b_c when they hire workers.

The labor market cost can be decomposed into hiring costs and firing costs. The hiring cost is incurred in the process of matching between job vacancies and workers. As in Helpman and Itskhoki (2010), we assume that firms realize whether hired workers are a good match for the job or not after they are being matched. Thus, it is required to fire some matched workers, and we assume that a fraction σ of the total matches will be fired.

More specifically, labor market tightness, x_c, is defined as

$$x_c = \frac{H_c}{(1-\sigma)L_{dc}} \,, \tag{10}$$

where H_c denotes the total hiring in the differentiated-goods sector. When H_c increases while L_{dc} is fixed, it is more difficult for firms to be matched with job seekers in the labor market. Thus, the hiring cost, b_{hc} is an increasing function of the labor market tightness, x_c:

$$b_{hc} = a_c x_c^{\alpha} \,, \quad a_c > 1, \alpha > 0 \,. \tag{11}$$

The parameter a_c governs the degree of labor market imperfection in country c,

[3] Worker heterogeneity can also affect firms' locational decisions. For example, Sato and Thisse (2007) establish a model where firms supply a homogeneous good by hiring heterogeneous workers. In this setting, firms' locational decisions are not influenced by the product market but are affected by worker heterogeneity. This contrast to our model in which workers are homogeneous, and firms' locational decision is made by product market conditions.

and α relates the labor market tightness and the hiring costs. We allow countries to have a different value of a_c: a country with a more efficient labor market has a lower value of a_c.[4]

Whenever a firm fires a worker, it bears the firing cost, b_{fc}. With the assumption that firms need to fire σ of workers that are matched, the labor market cost can be derived from the hiring costs and firing costs:

$$b_c = \frac{b_{hc} + \sigma b_{fc}}{1-\sigma}. \tag{12}$$

2.4. Wage Bargaining and Profit Maximization

We follow Stole and Zwiebel (1996a, 1996b) for the wage bargaining procedure: firms and workers engage in a generalized Nash Bargaining over the revenue that they jointly create. With equal bargaining power for a firm and a worker, the equilibrium wage can be derived from the following differential equation:

$$\frac{\partial}{\partial h_c}[R_c(h_c) - w_c(h_c)h_c] = w_c(h_c). \tag{13}$$

The left-hand side of Equation (13) denotes the marginal revenue from hiring an additional worker, and the right-hand side is the wage, which is a marginal benefit to a worker. By solving Equation (13), we get

$$w_c(h_c) = \frac{\beta}{1+\beta}\frac{R_c(h_c)}{h_c}. \tag{14}$$

From Equation (14), we can see that firms that hire h_c units of labor pay $\frac{\beta}{1+\beta}R_c(h_c)$ as wage payments. Thus, a firm in the differentiated-goods sector faces the following profit maximization problem:

$$\begin{aligned}\max_{h_c} \pi_c &= R_c(h_c) - w_c(h_c)h_c - b_c h_c - r_c \\ &= \frac{1}{1+\beta}R_c(h_c) - b_c h_c - r_c.\end{aligned} \tag{15}$$

[4] In data, the labor market flexibility index show little year-to-year within-country variation. This is why we treat the degrees of labor market inefficiencies to be fixed in this model. Labor market efficiencies, however, can also be an outcome of other economic conditions, and we cannot fully exclude the possibility that the matching efficiency improves due to increased public spending through various channels in the long run (see, for example, Kroft and Pope, 2014).

The revenue level of firms in the differentiated-goods sector, $R_c(h_c)$, can be derived directly from Equation (6):

$$\begin{aligned} R_c(h_c) &= Q^{-\frac{\beta-\gamma}{1-\beta}} p_c^{-\frac{\beta}{1-\beta}} \\ &= Q^{-(\beta-\gamma)} q_c^{\beta} \\ &= Q^{-(\beta-\gamma)} h_c^{\beta} \end{aligned} \tag{16}$$

With iceberg type trade cost, τ, firms that hire h_c units of labor will face the following revenue function:

$$\begin{aligned} R_c(h_c) &= \left(Q_c^{-\frac{\beta-\gamma}{1-\beta}} + \tau^{-\frac{\beta}{1-\beta}} Q_{-c}^{-\frac{\beta-\gamma}{1-\beta}} \right)^{1-\beta} h_c^{\beta} \\ &= Z_c^{1-\beta} h_c^{\beta}, \end{aligned} \tag{17}$$

where Q_{-c} denotes the quantity index (CES aggregate) of differentiated-goods in the foreign country. Thus, Z_c is a weighted average of the quantity indexes of the two countries. A decrease in Z_c means more competition in the market, which gives a negative effect on individual firm's revenue. In contrast, if the quantity index increases, the individual firm obtains a higher revenue as it faces less competition in the market.

Using these expressions, we can solve the maximization problem to get the optimal level of hiring for a firm in the differentiated-goods sector as follows:

$$\begin{aligned} h_c^* &= \left(\frac{\beta}{b_c(1+\beta)} \right)^{\frac{1}{1-\beta}} Z_c \\ &= \left(\frac{\beta}{b_c(1+\beta)} \right)^{\frac{1}{1-\beta}} \left(Q_c^{-\frac{\beta-\gamma}{1-\beta}} + \tau^{\frac{\beta}{1-\beta}} Q_{-c}^{-\frac{\beta-\gamma}{1-\beta}} \right) \\ &= \left(\frac{\beta}{b_c(1+\beta)} \right)^{\frac{1}{1-\beta}} Q_c^{-\frac{\beta-\gamma}{1-\beta}} + \tau^{-\frac{\beta}{1-\beta}} \left(\frac{\beta}{b_c(1+\beta)} \right)^{\frac{1}{1-\beta}} Q_{-c}^{-\frac{\beta-\gamma}{1-\beta}} \\ &= h_{dc}^* + h_{xc}^*. \end{aligned} \tag{18}$$

where h_{dc} and h_{xc} denote the labor used to produce domestic and foreign sales, respectively. By inserting the optimal level of hiring into Equation (14), we get the optimal wage level as a function of the labor market cost:

$$
\begin{aligned}
w_c(h_c) &= \frac{\beta}{1+\beta}\frac{R_c(h_c)}{h_c} \\
&= \frac{\beta}{1+\beta} Z_c^{1-\beta} h_c^{\beta-1} \\
&= \frac{\beta}{1+\beta} Z_c^{1-\beta} \left(\frac{\beta}{b_c(1+\beta)} \right)^{-1} Z_c^{\beta-1} \\
&= b_c \,.
\end{aligned} \tag{19}
$$

Within a country, the expected return for a job seeker in choosing the two sectors should be the same. Thus, the expected wage from the differentiated-goods sector should be equalized with the expected wage from the homogeneous-good sector:

$$w_c(h_c)x_c = 1 \,. \tag{20}$$

2.5. The Indirect Utility Function and the Government

Each household in country c is endowed with $\hat{K}_c$ units of capital, and we use the notation of the total world endowment of capital, $\hat{K}_A + \hat{K}_B$, as $2K$. With L_c units of labor and $\hat{K}_c$ units of capital, a household in country c gets a total income of:

$$E_c = L_c + (1-t_c)r_c\hat{K}_c \,. \tag{21}$$

The first term of Equation (21) is the total labor income and the second term is the after-tax capital income.[5]

Using Equations (2) and (21), we can express the indirect utility function as follows:

$$
\begin{aligned}
V_c &= E_c + \frac{(1-\gamma)Q_c^{\gamma} - 1}{\gamma} + v(G_c) \\
&= L_c + (1-t_c)r_c\hat{K}_c + \frac{(1-\gamma)Q_c^{\gamma} - 1}{\gamma} + v(G_c)
\end{aligned} \tag{22}
$$

The government sets the tax rate on capital, t_c, and provides the public goods, G_c, using the tax revenue.[6] With the total capital that is invested in country c, K_c,

[5] As the expected wage is 1 in both sectors, the total wage income of a household becomes $L_c * 1 = L_c$.

[6] We exclude the labor income tax for simplicity. When the labor income tax is levied, it will be

we can express the budget constraint of the government as

$$G_c \leq t_c r_c K_c \,. \tag{23}$$

2.6. Equilibrium Conditions

In this subsection, we will derive the equilibrium conditions of the economy. The endogenous variables of the private sector are h_{dc}, h_{xc}, π_c, r_c, H_c, L_{dc}, K_c and Q_c. We start with the equilibrium levels of hiring which has been given in Equation (18):

$$\begin{aligned}
h_{dc}^* &= \left(\frac{\beta}{b_c(1+\beta)}\right)^{\frac{1}{1-\beta}} Q_c^{-\frac{\beta-\gamma}{1-\beta}} \\
h_{xc}^* &= \tau^{-\frac{\beta}{1-\beta}} \left(\frac{\beta}{b_c(1+\beta)}\right)^{\frac{1}{1-\beta}} Q_{-c}^{-\frac{\beta-\gamma}{1-\beta}} \\
h_c^* &= h_{dc}^* + h_{xc}^* \,.
\end{aligned} \tag{24}$$

By using Equations (24) and (15), we can express π_c as

$$\pi_c^* = \frac{1-\beta}{1+\beta}\left(\frac{\beta}{b_c(1+\beta)}\right)^{\frac{\beta}{1-\beta}} Z_c - r_c \,. \tag{25}$$

Together with the zero profit condition in Equation (9), r_c becomes

$$r_c = \frac{1-\beta}{1+\beta}\left(\frac{\beta}{b_c(1+\beta)}\right)^{\frac{\beta}{1-\beta}} Z_c \,. \tag{26}$$

The number of firms in the sector is the same as the total amount of capital invested in country c because one unit of capital is required to set up a firm in the differentiated-goods sector. Thus, the total hiring level of the differentiated-goods sector can be expressed as

$$H_c = h_c \times K_c \,. \tag{27}$$

---

shared by both firms and workers during the wage bargaining process. This sharing will lead to less severe capital income tax competition because some public goods can be financed with labor income tax revenue.

As L_c units of labor endowments are divided into two sectors, L_{dc} and L_{hc} become

$$L_{dc} = \frac{H_c}{(1-\sigma)x_c}$$
$$L_{xc} = L_c - L_{dc}. \tag{28}$$

From Equation (20), we can express x_c as

$$x_c = \frac{1}{w_c(h_c)} = \frac{1}{b_c} = \frac{1-\sigma}{a_c x_c^{\alpha} + \sigma b_{fc}}. \tag{29}$$

Note that this equation yields b_c solely as a function of labor market parameters. Because the capital can move freely across countries, the after-tax rate of return for capital in the two countries should be equalized:

$$(1-t_A)r_A = (1-t_B)r_B. \tag{30}$$

Finally Q_c and Q_{-c} can be derived from Equations (4) and (24). Using (4), Q_c is expressed as

$$Q_c = [K_c q_{dc}^{\beta} + (2K - K_c) q_{x(-c)}^{\beta}]^{\frac{1}{\beta}}, \tag{31}$$

where $q_{x(-c)}$ denotes the differentiated-goods that are produced in the foreign country and are exported to country c. Using Equation (24) to this equation, we get

$$Q_c = \left[K_c \left(\frac{\beta}{(1+\beta)b_c} \right)^{\frac{\beta}{1-\beta}} Q_c^{-\frac{\beta(\beta-\gamma)}{1-\beta}} + \right.$$
$$\left. (2K - K_c)\tau^{-\frac{\beta^2}{1-\beta}} \left(\frac{\beta}{(1+\beta)b_{-c}} \right)^{\frac{\beta}{1-\beta}} Q_c^{-\frac{\beta(\beta-\gamma)}{1-\beta}} \right]^{\frac{1}{\beta}}. \tag{32}$$

By rearranging this equation, we get:

$$Q_c = \left(\frac{\beta}{1+\beta} \right)^{\frac{1}{1-\gamma}} \left[K_c b_c^{-\frac{\beta}{1-\beta}} + (2K - K_c)\tau^{-\frac{\beta^2}{1-\beta}} b_{-c}^{-\frac{\beta}{1-\beta}} \right]^{\frac{1-\beta}{\beta(1-\gamma)}}. \tag{33}$$

Using Equation (33), we can express all endogenous variables as a function of b_c and K_c. As b_c is determined by labor market parameters, all the endogenous variables can be expressed as functions of K_c.

III. Tax Competition

3.1. Optimal Choice of Government

The government maximizes the indirect utility by choosing the optimal tax rate on capital. The indirect utility function is given in Equation (22):

$$V_c = L_c + (1-t_c)r_c\hat{K}_c + \frac{(1-\gamma)Q_c^{\gamma}-1}{\gamma} + v(G_c)\,.$$

As all the variables in the RHS of the equation are a function of K_c, which can be expressed as a function of tax rates of the two countries, the equation can be rewritten as

$$V_c = L_c + (1-t_c)r_c(t_c,t_{-c})\hat{K}_c + \frac{(1-\gamma)Q_c(t_c,t_{-c})^{\gamma}-1}{\gamma} + v(t_c r_c(t_c,t_{-c})K_c(t_c,t_{-c}))\,. \tag{34}$$

The government in country c chooses the optimal t_c^* that maximizes Equation (34) while taking t_{-c} as given. If the function is continuous and differentiable around $t_c = t_{-c}$, we can derive the optimal levels of t_c and t_{-c} that maximize the objective functions of the two governments. Recall that we assume that $v(\cdot)$ is sufficiently concave. With proper parameter values that satisfy this condition, a Nash equilibrium is determined by the following first order condition:

$$\frac{\partial V_c}{\partial t_c} = -r_c\hat{K}_c + (1-t_c)\frac{\partial r_c}{\partial t_c}\hat{K}_c + (1-\gamma)Q_c^{\gamma-1}\frac{\partial Q_c}{\partial t_c} + \frac{\partial v_c}{\partial G_c}\left[r_cK_c + t_cK_c\frac{\partial r_c}{\partial t_c} + t_cr_c\frac{\partial K_c}{\partial t_c}\right] = 0\,. \tag{35}$$

Using the chain rule and the fact that Q_c, Q_{-c}, and r_c are all functions of K_c, we can express $\frac{\partial Q_c}{\partial t_c}$, $\frac{\partial Q_{-c}}{\partial t_c}$, and $\frac{\partial r_c}{\partial t_c}$ as

$$\frac{\partial Q_c}{\partial t_c} = \frac{\partial Q_c}{\partial K_c}\frac{\partial K_c}{\partial t_c}$$

$$\frac{\partial Q_{-c}}{\partial t_c} = \frac{\partial Q_{-c}}{\partial K_c}\frac{\partial K_c}{\partial t_c}$$
$$\frac{\partial r_c}{\partial t_c} = \frac{\partial r_c}{\partial Z_c}\frac{\partial Z_c}{\partial Q_c}\frac{\partial Q_c}{\partial K_c}\frac{\partial K_c}{\partial t_c} + \frac{\partial r_c}{\partial Z_c}\frac{\partial Z_c}{\partial Q_{-c}}\frac{\partial Q_{-c}}{\partial K_c}\frac{\partial K_c}{\partial t_c} \tag{36}$$

As there are only two countries, the capital inflows of a country is the same as the capital outflows of another country: $\frac{\partial K_c}{\partial t_c} = -\frac{\partial K_{-c}}{\partial t_c}$. Thus, $\frac{\partial Q_c}{\partial K_c}$ and $\frac{\partial Q_{-c}}{\partial K_c}$ become

$$\frac{\partial Q_c}{\partial K_c} = \Phi_c\left[b_c^{-\frac{\beta}{1-\beta}} - (\tau^\beta b_{-c})^{-\frac{\beta}{1-\beta}} \right]$$
$$\frac{\partial Q_{-c}}{\partial K_c} = \Phi_{-c}\left[(\tau^\beta b_c)^{-\frac{\beta}{1-\beta}} - b_{-c}^{-\frac{\beta}{1-\beta}} \right], \tag{37}$$

where

$$\Phi_c = \left(\frac{\beta}{1+\beta}\right)^{\frac{1}{1-\gamma}} \frac{1-\beta}{\beta(1-\gamma)}\left[K_c b_c^{-\frac{\beta}{1-\beta}} + K_{-c}(\tau^\beta b_{-c})^{-\frac{\beta}{1-\beta}} \right]$$
$$\Phi_{-c} = \left(\frac{\beta}{1+\beta}\right)^{\frac{1}{1-\gamma}} \frac{1-\beta}{\beta(1-\gamma)}\left[K_{-c} b_{-c}^{-\frac{\beta}{1-\beta}} + K_c(\tau^\beta b_c)^{-\frac{\beta}{1-\beta}} \right]. \tag{38}$$

The partial effect of Q on Z_c can be derived as

$$\frac{\partial Z_c}{\partial Q_c} = -\frac{\beta-\gamma}{1-\beta} Q_c^{-\frac{\beta-\gamma}{1-\beta}-1}$$
$$\frac{\partial Z_c}{\partial Q_{-c}} = -\frac{\beta-\gamma}{1-\beta}\tau^{-\frac{\beta}{1-\beta}} Q_{-c}^{-\frac{\beta-\gamma}{1-\beta}-1}, \tag{39}$$

and we can verify that both have negative values. Remember that a firm's revenue is increasing function of Z_c. As there is more supply in the differentiated-goods sector, the revenue that an individual firm receives decreases due to more competition in the market. Thus, an increase in either Q_c or Q_{-c} decreases Z_c.

Finally, $\frac{\partial r_c}{\partial Z_c}$ is

$$\frac{\partial r_c}{\partial Z_c} = \frac{1-\beta}{\beta}\left[\frac{\beta}{b_c(1+\beta)}\right]^{\frac{1}{1-\beta}} b_c. \tag{40}$$

The sign of this is positive, which is evident from the zero-profit condition in Equation (9).

3.2. Types of Equilibria

Our model is a variant of the standard trade model in which the existence of an equilibrium is usually not an issue. However, given that the capital is mobile and that we require the after-tax returns in the two countries to be equal (see Equation (30)), an equilibrium may not exist if the countries are very asymmetric. Since we, unfortunately, do not have a closed-form solution of the model, we do not know the necessary and sufficient condition of the existence. However, an equilibrium would exist if the two countries are sufficiently symmetric, and if $v(G)$ is sufficiently large and concave.

In the previous subsection, we derive the first order condition of the government's welfare maximization. We also check the signs of $\frac{\partial Z_c}{\partial Q_c}$, $\frac{\partial r_c}{\partial Z_c}$, and $\frac{\partial Q_c}{\partial K_c}$, where only the sign of $\frac{\partial Q_c}{\partial K_c}$ is not determined. From Equation (37), we can also verify that the signs of $\frac{\partial Q_c}{\partial K_c}$ and $\frac{\partial Q_c}{\partial K_{-c}}$ depend on the sign of the terms in the bracket: $[b_c^{-\frac{\beta}{1-\beta}} - (\tau^{\beta} b_{-c})^{-\frac{\beta}{1-\beta}}]$ and $[(\tau^{\beta} b_c)^{-\frac{\beta}{1-\beta}} - b_{-c}^{-\frac{\beta}{1-\beta}}]$. The signs of each bracket depends on the relative sizes of the labor market costs of the two countries and the trade cost. Without loss of generality, we assume that the country c has a relatively more efficient labor market $(b_c \le b_{-c})$ and derive the following result on the types of equilibria.

Result 1. *Suppose an equilibrium exists. Depending on the parameter values of* b_c, b_{-c}, *and* τ, *there are two types of equilibria:*

1. *(Type 1 equilibrium) If* $b_c < \tau^{-\beta} b_{-c}$, *an increase in* K_c *will increase not only* Q_c *but also* Q_{-c}.
2. *(Type 2 equilibrium) If* $\tau^{-\beta} b_{-c} \le b_c < b_{-c}$, *an increase in* K_c *will increase* Q_c *and decrease* Q_{-c}.

Proof. The results are immediate from Equation (37). □

Type 1 equilibrium arises either when the difference between b_c and b_{-c} is very large or when the trade cost is very low. In this case, when the capital moves from a less efficient county to a more efficient country, the output levels of both countries increase. Thus, it may be better to move all the capital to the more efficient country to increase the world output level. As the welfare level is an increasing function of the total world output level of differentiated goods, it is beneficial for both countries to produce all differentiated-goods in a more efficient country. Note that in Type 1 equilibrium, the efficiency advantage from the labor market can be nullified by the inefficiencies of the trade barriers. Thus, when we have freer international trade, we would have a higher chance of reaching Type 1 equilibrium.

Type 2 equilibrium is more consistent with what we normally expect: when the capital moves from one country to another, the total output of the recipient country increases while it decreases in the other country. The necessary condition, $\tau^{-\beta} b_c \leq b_c < b_{-c}$, simply means that the difference between the two labor market costs is not too different.

Depending on the type of equilibrium, we can now derive how K_c is affected by changes in t_c.

Result 2. $\frac{\partial K_c}{\partial t_c} > 0$ *in Type 1 equilibrium while* $\frac{\partial K_c}{\partial t_c} < 0$ *in Type 2 equilibrium.*

Proof. In Type 1 equilibrium, when K_c increases Q_c increases while Q_{-c} decreases. By Equations (39) and (40), this implies that r_c increases and r_{-c} decreases. Thus, t_c should increase to satisfy Equation (30), meaning that K_c and t_c are positively associated. We can apply the same logic to Type 2 equilibrium. □

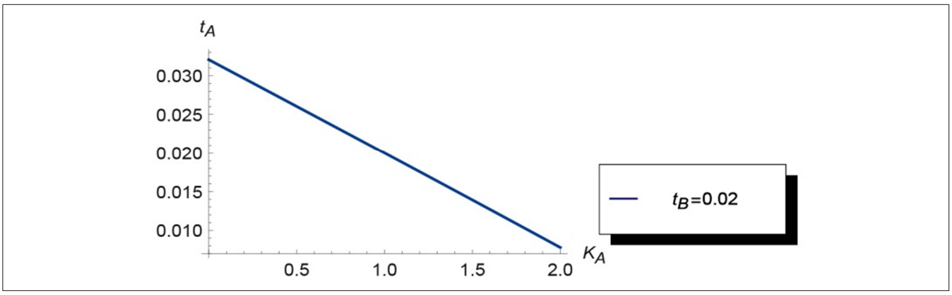
Because we find Type 1 equilibrium to be rather unrealistic, we focus on Type 2 equilibrium where the labor market conditions are similar in both countries. As an analytical solution of the model is infeasible, we use numerical analysis to explore the equilibrium behavior of the model. In doing so, we do not try to fit any data because our model is complicated but still very stylized, and our exercise is mainly to develop intuitions. We have attempted various parameter values, and the pattern reported below has also been found in other simulations. Below, we report the results of the simulation with the assumption that $v(G) = 50\sqrt{G}$, $\beta = 0.6$, $\gamma = 0.4$, $\tau = 1.2$. The two labor market costs are set to be 1.5, but all values in $\tau^{-\beta} b_B \leq b_A \leq b_B$ gives the same result qualitatively.

3.3. An Individual Government's Choice

In this subsection, we present how an individual government's choice affects endogenous variables, that is, how variables of interest respond to a change in t_A. We adopt the following strategy: we initially fix the corporate income tax rate of country B at 2%. Because we find t_A and K_A to have a monotonic relationship from Result 2, we regard K_A as a policy variable (also see Figure 1). In other words, because choosing t_A is equivalent to selecting K_A, we allow the government choose a target level of K_A.

The first thing we consider is the quantity index of differentiated goods in each country. Figure 2 shows what we expect from Result 1: as the government A increases K_A, the quantity index of country A increases, whereas the quantity index of country B decreases.

[Figure 1] Tax rates and amount of capital



[Figure 2] Quantity index of differentiated goods

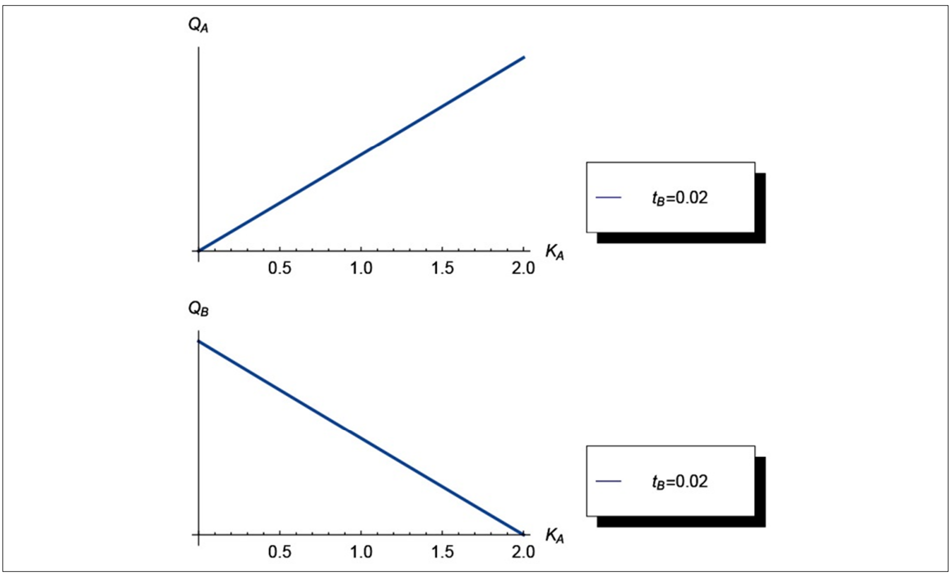


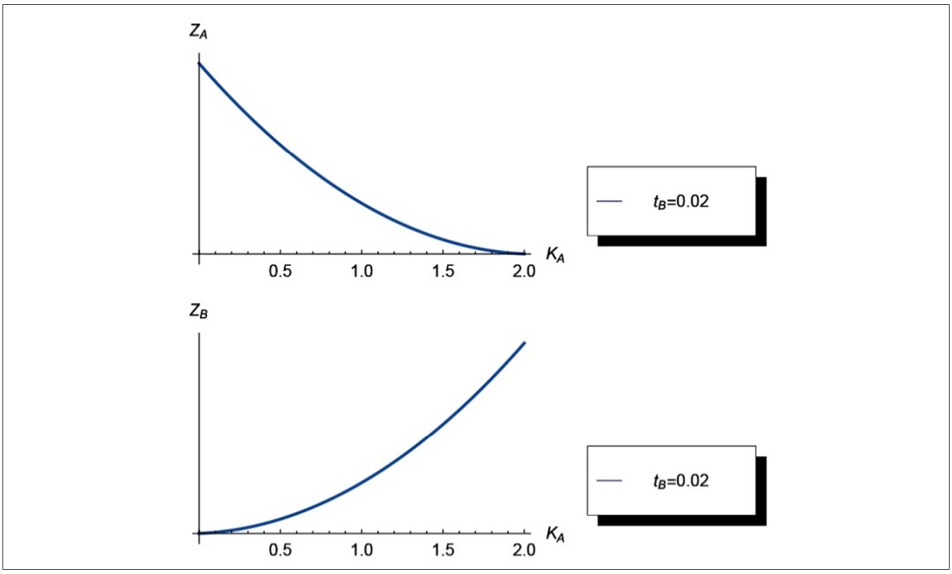
Figure 3 depicts how the perceived market profitability for firms, Z_c, is affected by K_A. Z_c is the weighted average of Q_c and Q_{-c} where Q_C gets higher weight due to the existence of trade costs. As Z_c is a decreasing function of the two, we can see that it is a decreasing function of K_c. When there is more capital in the home country the competition in the domestic market gets higher because of the increased production of differentiated goods in the domestic market. Similarly, the competition in the foreign market decreases when the amount of capital in the domestic market increases.

As shown in Equation (40) the return for capital, r_c, is directly affected by Z_c. Figure 4 shows that higher competition in the market leads to a lower profitability of individual firms, and thus the capital return.

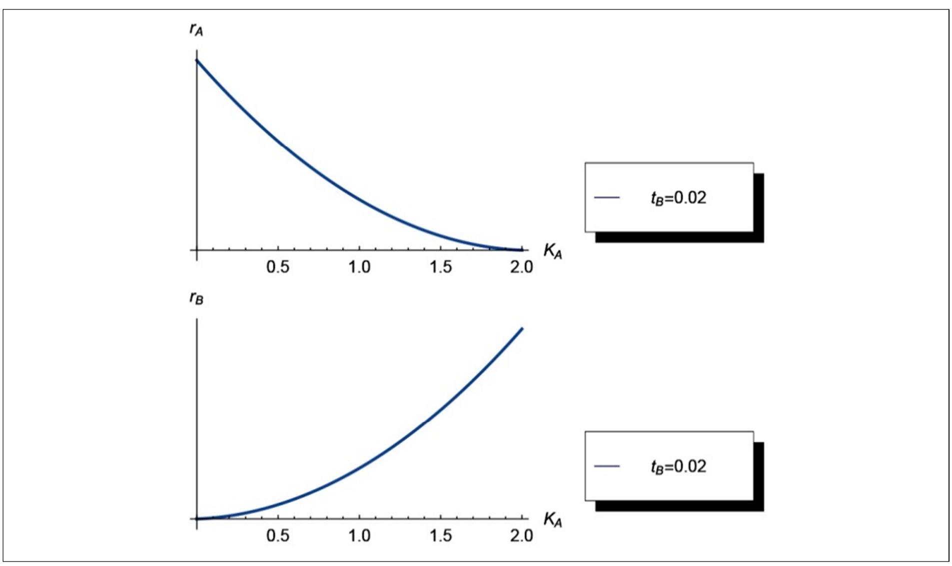
In Figure 5, the relationship between the capital level and the provision of public goods takes an inverted U-shape curve. To increase the capital level, the government should cut the tax rate. When the government starts to decrease the tax rate from a high level to increase the capital level, the increases in the tax base initially dominate, but further cuts in the tax rate decrease the tax revenues eventually.

Lastly, the social welfare function also shows an inverted U-shape curve like the public good function. An individual government would choose the capital level that gives the highest level of social welfare.

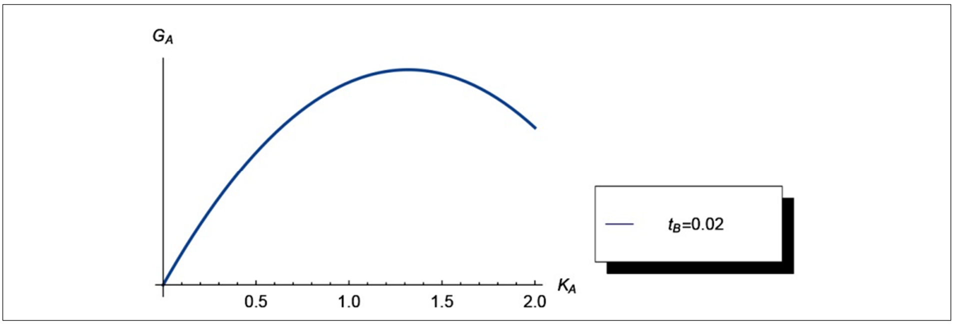
[Figure 3] Profitability of firms



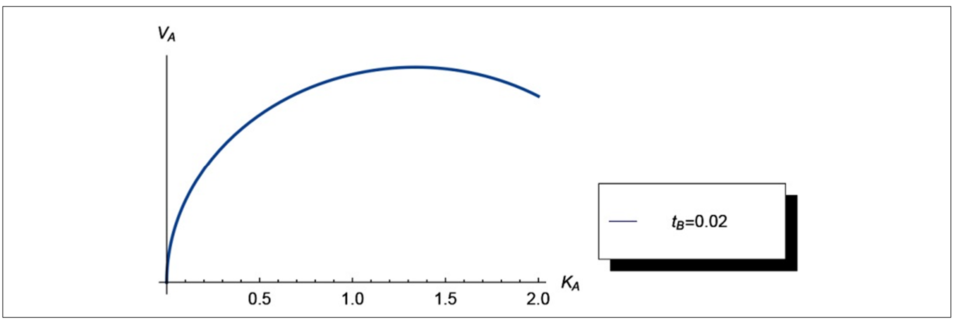
[Figure 4] Return for capital



[Figure 5] Public goods



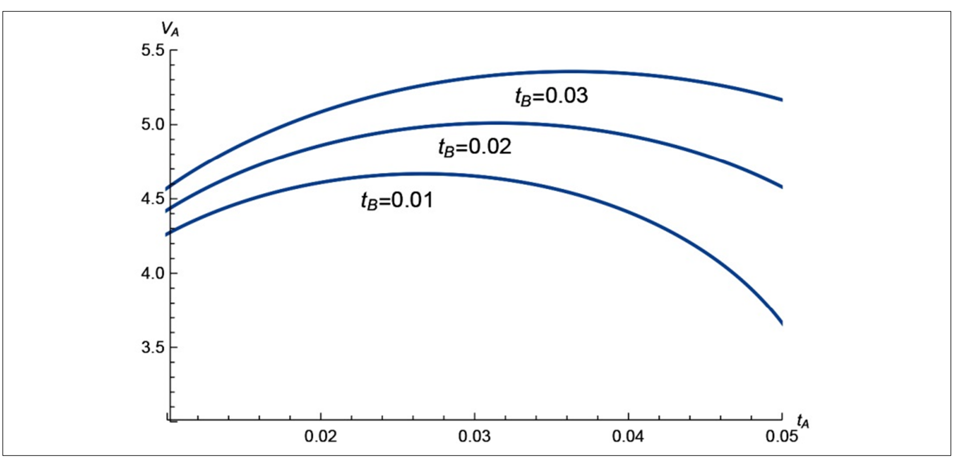
[Figure 6] Social welfare



3.4. Strategic Interactions of governments

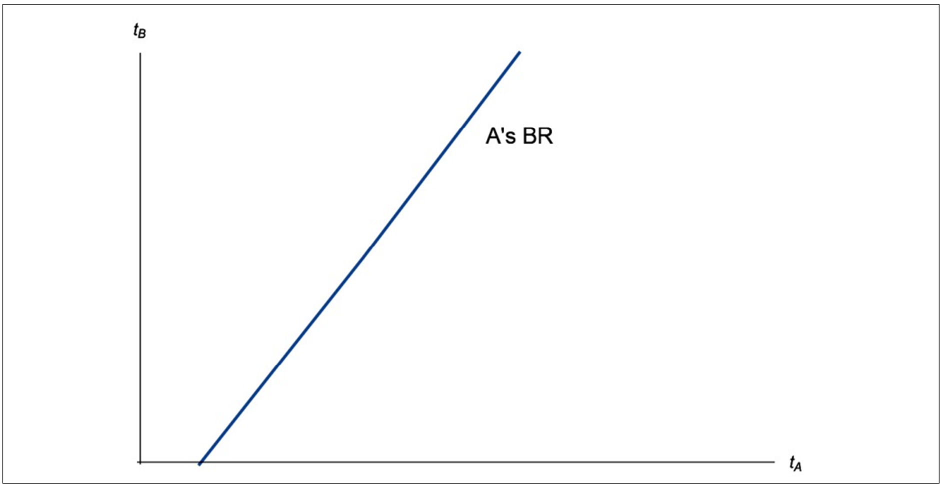
Each government treats the tax rate of the other as given when it sets its corporate income tax rate. Figure 7 shows how country A's welfare function changes when t_B changes. We can verify that as t_B increases the optimal level of t_A also increases.

[Figure 7] Changes in the social welfare function of country A



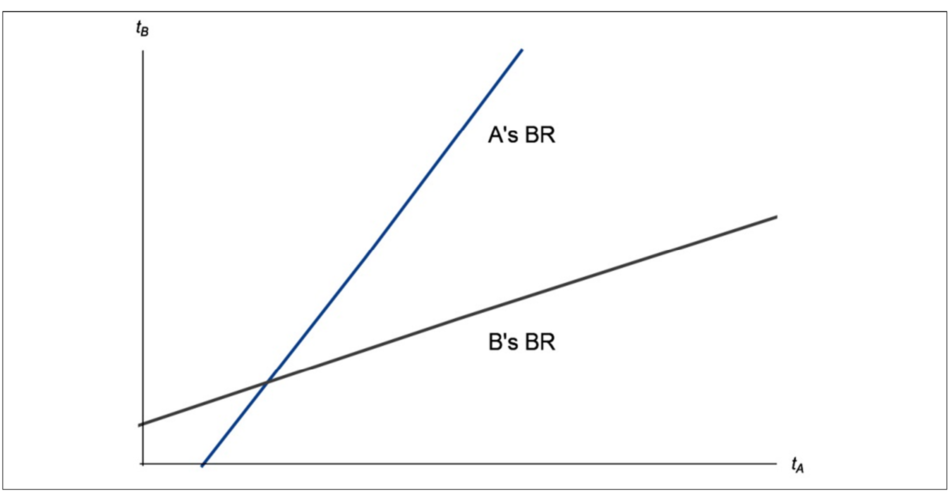
This relationship implies a strategic complementarity in the game of setting tax rates. In this game, if the other country's government increases the tax rate, increasing its tax rate will also be optimal. As a result, the best response curve is upward sloping, as in Figure 8.

[Figure 8] The best response curve of country A



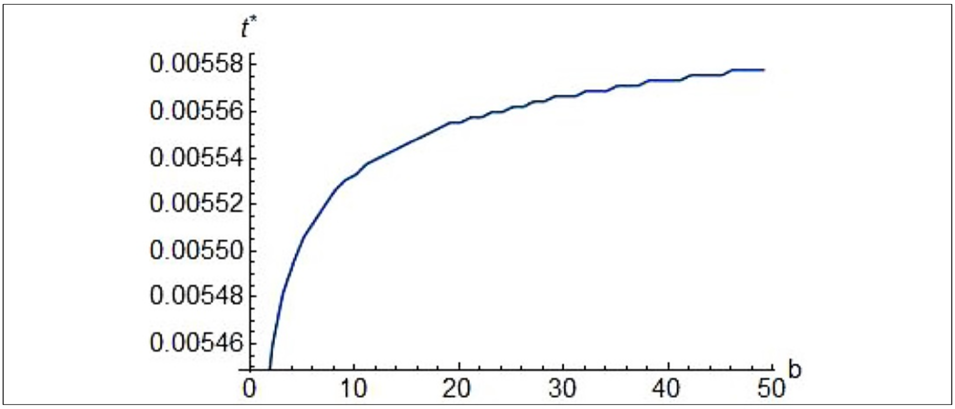
By repeating the same simulation on country B, we get the best response function of country B, which is shown in Figure 9. The Nash equilibrium of this economy can be found where the two curves intersect each other. We can find that the equilibrium tax rates are greater than zero for both countries. This implies that there is no race-to-the-bottom in this economy.

[Figure 9] Best response curves



We can track the Nash equilibrium tax rate when the symmetric labor market cost ($b = b_A = b_B$) increases. Figure 10 depicts the optimal corporate income tax rate as a function of b. From this graph, we can verify that the optimal tax rate increases in b. This result implies that tax competition gets less severe when the labor market inefficiencies increase in both countries. We can also find that the changes in t^* decreases as b becomes very high.

[Figure 10] The optimal tax rate and the labor market cost($\tau = 1.1$)

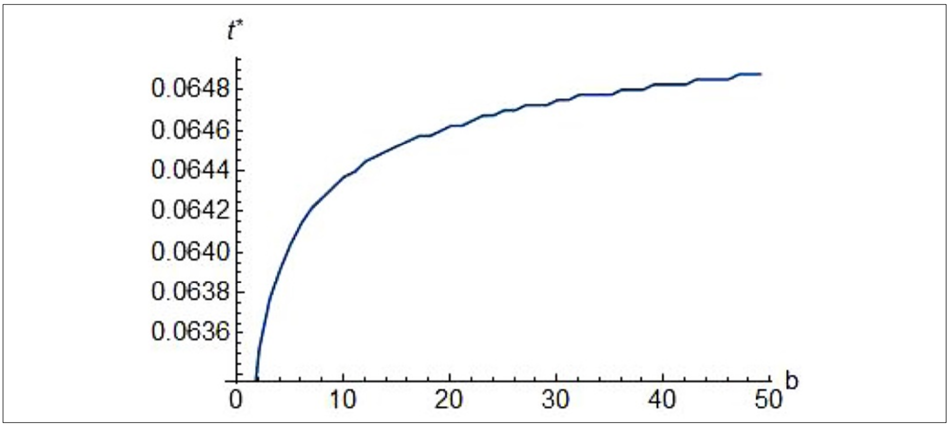


The intuition behind this result is straightforward. When labor market inefficiencies in both countries increase, monopolistically competitive firms in the differentiated-goods sector increase the price of their product to compensate for increased costs, and this is done by reducing the quantity produced. This process implies reductions in both Q_c and Q_{-c}. By Equation (39), a reduction in the quantity index incurs higher market profitability in both markets. However, operating in the foreign market entails additional trade costs, and the domestic market becomes more profitable for firms. As a result, both governments can have more autonomy in setting tax rates when b increases.

Similar effects arise when trade costs increase. With higher τ, the relative profitability of the domestic market becomes greater for firms in the differentiated-goods sector. The result is the same as the case of increased labor market inefficiencies: tax competition will be less severe.[7] Figure 11 graphs the optimal tax rate as a function of b with a greater level of trade costs. We can verify that the optimal tax rate of the Nash equilibrium is higher than the case of Figure 10 for a given level of b.

[7] Please note that this result is confined to the case of symmetric countries. If countries are asymmetric, the result can be changed. For example, increases in trade costs can make tax competition more severe in the case of the market seeking FDI when one country is significantly bigger than the other.

[Figure 11] The optimal tax rate and the labor market cost($\tau = 1.4$)



IV. Extension

In our baseline model, we assume public goods to be final goods in the sense that firms do not use them in the production process. In reality, however, numerous public goods are crucial for economic activities (e.g., Aronsson and Wehke, 2008), and governments have to provide such goods. Extending the model by including a public input good, such as social infrastructures, public education, etc., would allow us to explore several interesting issues, e.g., how tax competition affects government spending patterns and the role of labor market imperfection plays there. However, such an analysis is not straightforward and probably merits another study. Thus, we limit ourselves to examining how our results would change if we add a public input good to the model.

Suppose that an individual firm's production is scaled up as the amount of a public input good increases, i.e., $q_j = s_c(g_c)h_j$ where $s_c(g_c)$ is a non-decreasing, concave function of the government's investment g_c. We can regard it as a sort of labor augmenting productivity. Having the public input does not change the equations drastically, but a few changes are noteworthy. For example, h_c^* in Equation (18) is just factored up by $s_c^{\beta/1-\beta}$, and the wage in Equation (19) remains the same, i.e., $w_c(h_c) = b_c$. The government budget constraint in Equation (23) will now become $g_c = G_c \le t_c r_c K_c$. Differentiated goods consumption level characterized in Equation (33) is modified as follows:

$$Q_c = \left(\frac{\beta}{1+\beta}\right)^{\frac{1}{1-\gamma}} \left[K_c s_c^{\frac{\beta^2}{1-\beta}} b_c^{-\frac{\beta}{1-\beta}} + (2K - K_c)\tau^{-\frac{\beta^2}{1-\beta}} s_{-c}^{\frac{\beta^2}{1-\beta}} b_{-c}^{-\frac{\beta}{1-\beta}} \right]^{\frac{1-\beta}{\beta(1-\gamma)}} . \tag{41}$$

This modification shows that public investment increases firms' productivity, as well as private consumption and welfare. Meanwhile, the rental rate of capital in Equation (26) is now:

$$r_c = \frac{1-\beta}{1+\beta}\left(\frac{\beta}{b_c(1+\beta)}\right)^{\frac{\beta}{1-\beta}} s_c^{\frac{\beta^2}{1-\beta}} Z_c . \tag{42}$$

As the government makes more investments, the rental rate of capital increases, making the country more attractive. Therefore, the net return of capital investment, $(1-t_c)\,r_c$, may increase in t_c in a range where $s_c(g_c)$ increases in g_c rapidly, and the optimal tax rate will be pushed up, which means that tax competition becomes less intense. With the public input good which increases the labor productivity, Result 1 is modified as follows:

Result 3. *Suppose an equilibrium exists. Depending on parameter values, there are two types of equilibria:*

1. *(Type 1 equilibrium) If* $b_c / s_c^{\beta} < \tau^{-\beta} b_{-c} / s_{-c}^{\beta}$, *an increase in* K_c *will increase not only* Q_c *but also* Q_{-c}.
2. *(Type 2 equilibrium) If* $\tau^{-\beta} b_{-c} / s_{-c}^{\beta} \le b_c / s_c^{\beta} \le b_{-c} / s_{-c}^{\beta}$, *an increase in* K_c *will increase* Q_c *and decrease* Q_{-c}.

Not surprisingly, the labor market costs b_c and b_{-c} are adjusted by the labor augmenting productivity s_c and s_{-c}, respectively, meaning that high labor productivity due to the public input good may compensate for a high labor market cost.

The public input good brings additional benefits of increasing the tax rate into the picture. Since the optimal tax rate balances the benefits and costs of increasing/decreasing it, adding more benefits would result in a higher optimal tax rate. However, this addition would not change the nature of tax competition: it is still characterized by strategic complementarity. Moreover, the effects of trade cost and labor market friction remain qualitatively the same. Simulation results are thus omitted.

V. Conclusion

In this study, we have developed a two-sector, two-country model of tax competition in which one sector is under search and matching frictions. In this model, we demonstrate that the tax competition between governments becomes less severe when labor market inefficiencies increase symmetrically. The results of our model suggest that governments will be pushed toward more intense tax competition to attract capital when the efficiency of labor markets improves. The model also predicts that we have a more severe tax competition with freer world trade. This implies that recent downward trends in OECD countries might be the outcome of either increased efficiencies in the labor market or lowered trade costs.

We also extend the model by relaxing the assumption that public goods are consumed as final goods. In an extended model with public input good, we demonstrate that public input good may compensate for a high labor market cost by increasing labor augmenting productivity, while the qualitative results of the extended model are the same as the baseline case.

References

Aronsson, T. and S. Wehke (2008), "Public Goods, Unemployment and Policy Coordination," *Regional Science and Urban Economics*, 38(3), 285–298.

Boadway, R., K. Cuff and N. Marceau (2002), "Inter-Jurisdictional Competition for Firms," *International Economic Review*, 43(3), 761–782.

____________________ (2004), "Agglomeration Effects and the Competition for Firms," *International Tax and Public Finance*, 11(5), 623–645.

Davidson, C., S. J. Matusz, and A. Shevchenko (2008), "Outsourcing Peter to Pay Paul: High-skill Expectations and Low-skill Wages with Imperfect Labor Markets," *Macroeconomic Dynamics*, 12(4), 463–479.

Devereux, M. P., S. Loretz, et al. (2013), "What do we Know about Corporate Tax Competition," *National Tax Journal*, 66(3), 745–774.

Egger, P. and T. Seide (2011), "Tax Competition, Trade Liberalization, and Imperfect Labour Markets," *Oxford Economic Papers*, 63(4), 722–739.

Eichner, T. and T. Upmann (2012), "Labor Markets and Capital Tax Competition," *International Tax and Public Finance*, 19(2), 203–215.

Exbrayat, N., C. Gaigne, and S. Riou (2012), "The Effects of Labour Unions on International Capital Tax Competition," *Canadian Journal of Economics*, 45(4), 1480–1503.

Flam, H. and E. Helpman (1987), "Vertical Product Differentiation and North-South Trade," *The American Economic Review*, pages 810–822.

Fuest, C. and B. Huber (1999), "Tax Coordination and Unemployment," *International Tax and Public Finance*, 6(1), 7–26.

Helpman, E. and O. Itskhoki (2010), "Labour Market Rigidities, Trade and Unemployment," *Review of Economic Studies*, 77(3), 1100–1137.

Koskela, E. and R. Schöb (2002), "Optimal Factor Income Taxation in the Presence of Unemployment," *Journal of Public Economic Theory*, 4(3), 387–404.

Kroft, K. and D. G. Pope (2014), "Does Online Search Crowd out Traditional Search and Improve Matching Efficiency? Evidence from Craigslist," *Journal of Labor Economics*, 32(2), 259–303.

Leite-Monteiro, M., M. Marchand and P. Pestieau (2003), "Employment Subsidy with Capital Mobility," *Journal of Public Economic Theory*, 5(2), 327–344.

Lejour, A. M. and H. A. A. Verbon (1996), "Capital Mobility, Wage Bargaining, and Social Insurance Policies in an Economic Union," *International Tax and Public Finance*, 3(4), 495–513.

Loretz, S. (2008), "Corporate Taxation in the Oecd in a Wider Context," *Oxford Review of Economic Policy*, 24(4), 639–660.

Mitra, D. and P. Ranjan (2010), "Offshoring and Unemployment: The Role of Search Frictions Labor Mobility," *Journal of International Economics*, 81(2), 219–229.

________________ (2013), "Fairness, Search Frictions, and Offshoring," *The BE Journal of Economic Analysis & Policy*, 14(1), 137–172.

Pomerleau, K. and E. Potosky (2015), “Corporate Income Tax Rates Around the World, 2015,” *Tax Foundation, available online at http://taxfoundation.org/article/corporate-income-tax-rates-aroundworld-2015*.

Richter, W. F. and K. Schneider (2001), “Taxing Mobile Capital with Labor Market Imperfections,” *International Tax and Public Finance*, 8(3), 245–262.

Sato, Y. (2009), “Capital Tax Competition and Search Unemployment,” Papers in Regional Science, 88(4), 749–764.

Sato, Y. and J. F. Thisse (2007), “Competing for Capital when Labor is Heterogeneous,” *European Economic Review*, 51(8), 2054–2079.

Shin, S. and C. Davidson (2020), “Labor Market Structure and Offshoring,” *Review of International Economics*, 28(4), 933–956.

Shin, S. and S.-H. Kim (2016), “Analysis of the Tax Competition Model between Countries under the Incomplete Labor Market,” *KIPF Research Report*, 16-1.

Stole, L. A. and J. Zwiebel (1996a), “Intra-firm Bargaining under Nonbinding Contracts,” *Review of Economic Studies*, 63(3), 375–410.

____________________ (1996b). Organizational Design and Technology Choice under Intrafirm Bargaining,” *The American Economic Review*, 86(1), 195–222.

불완전 노동시장 하에서의 조세경쟁

신 상 화* · 김 상 현**

초 록 이 연구는 자본에 대한 세율을 조절하여 더 많은 자본을 유치하려는 경쟁 상황에 놓인 두 정부를 분석한다. 보다 구체적으로, 여러 선행연구들에서 가정한 완전한 노동시장 가정을 완화하여 불완전 노동시장을 모형화하고 이것이 두 국가의 조세경쟁 양상에 어떠한 영향을 주는지를 분석하였다. 분석 결과 양국의 노동시장비용이 대칭적으로 증가할 경우 자본이 세율 수준에 둔감해지는 것을 확인할 수 있었다. 무역비용이 존재하기 때문에 노동시장비용이 증가하게 될 경우 국내시장에서의 이익보다 해외시장에서의 이익이 더 크게 떨어지게 되며 그 결과 기업은 자본에 대한 세율이 아닌 생산비용에 더욱 민감해지게 되는 것이다.

핵심 주제어: 불완전 노동시장, 조세경쟁, 법인세율

경제학문헌목록 주제분류: F16, F21, J64, H25

투고 일자: 2020. 8. 21. 심사 및 수정 일자: 2021. 6. 28. 게재 확정 일자: 2021. 11. 5.

* 제1저자, 충남대학교 무역학과 조교수, e-mail: shinsan6@cnu.ac.kr

** 교신저자, 연세대학교 경제학과 부교수, e-mail: sang.kim@yonsei.ac.kr