Discussion Papers In Economics And Business

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Hikaru Ogawa† Jun Oshiro‡ Yasuhiro Sato§

March 25, 2012

Abstract

This paper investigates which of the two countries –resource-rich or resource-poor– gains from capital market integration and capital tax competition. We develop a framework involving vertical linkages via resource-based inputs as well as international fiscal linkages between resource-rich and resource-poor countries. Our analysis shows that capital market integration causes capital flows from resource-poor countries to resource-rich countries and thus improves production efficiency and global welfare. However, such gains accrue only to resource-poor countries, and capital mobility might even hurt resource-rich countries. In response to capital flows, the governments of both resource-rich and resource-poor countries have an incentive to tax capital. Such taxations would enable resource-rich countries to exploit their efficiency gains through capital market integration and become winners in the tax game.

Keywords: capital market integration, natural resource, resource curse, tax competition

JEL Classification: F21; H20; H77

*We thank Yoshitsugu Kanemoto, Mutsumi Matsumoto, Harris Selod, Takatoshi Tabuchi, and the participants of various seminars and conferences for their very useful comments and discussions. We acknowledge the financial support from RIETI, the Japan Society for the Promotion of Science, through a Grant-in-Aid for Scientific Research (S, A, B, C) and a Grant-in-Aid for Young Scientists (B).

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1 Introduction

In the past few decades, we have observed drastic increases in capital flows among countries. Such capital movements have provoked intensive discussions on where the capital is moving to and how the governments react to capital flows.

With respect to the first question, the availability of natural resources is regarded as one of the main factors that attract capital. Dunning [12] summarized the literature on foreign direct investment (FDI) and identified three very common investment motivations: resource-seeking, market-seeking, and efficiency-seeking. He suggested that capital is attracted to countries and regions that have large endowments of natural resources, large markets, and good economic and political environments, including infrastructure and institutions, to minimize production and transaction costs. Several studies support this view; for example, OECD [25] with regard to FDI to China and Asiedu [2] and Morisset [23] with regard to FDI to Africa. Morisset [23] (page 2) explains as follows: "not surprisingly, the African countries that have been able to attract most FDI have been those with the largest tangible assets such as natural and mineral resources as well as large domestic markets"; "the role of market size can be further evidenced by the almost perfect positive correlation between FDI inflows and GDP for a group of 29 African countries during 1996 and 1997 (the correlation coefficient equals 0.99)"; and "traditionally, about 60 per cent of FDI in Africa is allocated to oil and natural resources (UNCTAD, 1999). This is corroborated by the coefficient correlation between FDI inflows and the total value of natural resources in each country, which appears close to unity (i.e. 0.94) for the group of 29 African countries during 1996-1997." Also, Kudina and Jakubiak [21] (page 3) states, "historically, the most important host country determinant of FDI has been the availability of natural resources, e.g. minerals, raw materials and agricultural products."

Regarding the second question, the literature on tax competition theory, which dates back to at least Zodrow and Mieszkowski [46] and Wilson [41], has achieved certain results. The literature investigated the role of governments in attracting capital to their jurisdictions.[1] For example, Bucovetsky [5], Kanbur and Keen [20], Ottaviano and van Ypersele [28], Sato and Thisse [36], and Wilson [42] analyzed the effects of market size on capital

[1] Wilson [43], Wilson and Wildasin [44], and Fuest, Huber, and Mintz [15] provide surveys of the literature on tax competition.

flows and the governments' reactions to them. Studies such as Bayindir-Upmann [3], Fuest [17], Matsumoto [22], Noiset [24], and Wrede [45] examined the role of infrastructure and institutions provided by the local governments to benefit production possibilities.[2] However, another highly important factor to attract capital, the existence of natural resource wealth, has been overlooked in this literature.[3][4]

The purpose of this paper is to explore how the existence of natural resources affects the distribution of capital across countries, how governments react to capital flows, and how the welfare of a region is affected by capital flows and tax competition. For this, we develop a tax competition model involving two countries, one of which is endowed with natural resources. There are two sectors in these countries: the numéraire good sector and the resource-based intermediate good sector. The former is characterized by perfect competition, and its production requires capital, labor, land, and the intermediate good. The latter sector is characterized by oligopoly à la Cournot, and its production requires capital as a variable input and the numéraire good as a fixed input. We focus on the circumstances in which the intermediate good can be produced only in places where the natural resources exist, because it is prohibitively costly to transport the resource itself across countries. Using this framework, we first examine the impact of capital market integration in a laissez-faire economy (without government intervention). We show that once the capital markets are integrated, resource-rich countries can import capital from resource-poor countries. Although such capital movements help improve global production efficiency and increase global welfare, the gains of these accrue only to resource-poor countries, with resource-rich countries, in contrast, even suffering from capital movements. We refer to this as the *resource-curse* associated with capital market integration. We next investigate the implications of a tax game in our environment. In a tax game, governments can levy a tax/subsidize capital. In equilibrium, both countries

[2]More recent examples include Cai and Treisman [7] and Bucovetsky [6].

[3]To the best of the authors' knowledge, Raveh [33] is the only exception, studying the role of natural resources in tax competition. He incorporated a competitive resource sector into a standard capital tax competition model. However, his focus is on the differences in tax instruments available between countries and not on the resources of a particular country.

[4]There are studies on the role of other types of asymmetries: the effects of initial inequality of capital endowments are investigated by DePater and Myers [9], Peralta and van Ypersele [30], and Itaya et al. [19]; the difference in labor market institutions are introduced by Haufler and Mittermaier [18], Egger and Seidel [13], and Ogawa et al. [26].

levy a tax on capital, the rate being higher in the resource-rich country than in the resource-poor country. This is consistent with Slemrod [37], who empirically showed that a country enjoying higher per capita income from natural resources (oil) is likely to levy tax on corporate income at a higher rate.[5] In addition, this paper shows that resource-rich countries gain from tax competition, while resource-poor countries lose from it: there is a *resource-blessing* associated with tax competition. Since the latter loss dominates the former gain, the tax game reduces global welfare compared to the laissez-faire economy.

Beginning with a seminal article by Sachs and Warner [35], voluminous scholars have widely discussed the impacts of natural resource wealth on economic growth. This literature suggests that large natural resource endowments can affect economic performance both positively and negatively via Dutch disease, institutional quality, armed conflict, volatility of commodity prices, financial imperfection, or investment of human capital.[6] However, none of those studies focused on the transmission mechanism for natural resources to the economy through fiscal externalities arising from factor mobility. The study most closely related to this paper is Bretschger and Valente [4]. Extending the two-country endogenous growth model, they analyzed the strategic resource taxation policies between resource-rich and resource-poor economies involved in an asymmetric trade structure induced by uneven endowments of natural resources.[7] They showed that a resource-poor country has an incentive to levy tax on the use of domestic resources at an excessively high rate to reduce resource dependency. In a similar vein, this paper analyzes an economy in which the geographical necessity and availability of natural resources induce an asymmetric industrial structure and then inter-industry trade linkages.

The rest of the paper is organized as follows. The basic environment is presented in Section 2. In Section 3, we study the effects of capital market integration without government intervention. Section 4 examines the effects of tax competition, and Section 5 concludes the paper.

[5]There is a controversy over the robustness of this empirical finding. Dharmapala and Hines [11] concluded that higher corporate tax rates are not observed in the data of resource-abundant countries.

[6]The literature on the so-called "natural resource curse" is comprehensively reviewed by Frankel [16] and van der Ploeg [39]. For an overview on the recent empirical literature, see Torvik [38] and Rosser [34].

[7]Wildasin [40] also constructs a tax competition model with inter-industry trade linkages. In contrast to Wildasin [40], we characterize the equilibrium arising from tax competition and examine the welfare properties of such equilibrium.

2 The basic settings

Consider two countries (1 and 2) in each of which there is a representative individual of measure one possessing three factors of production, land, labor (L), and capital (K). Each factor endowment in each country is fixed at unity. We assume that individuals are immobile between countries and supply their labor in their own country of residence. In contrast, we consider two scenarios in which capital is either immobile or mobile. In the first case, all factor markets are local. In the second case, individuals can freely choose where to supply their capital, so that both labor markets are local but the capital market is global. We first compare these two cases without taxation, and then introduce the tax game to the case in which capital is mobile.

In this economy, two goods are produced, a numéraire good (X) and a resource-based intermediate good (M) (petroleum, steel, minor metals, etc.). The numéraire good (X-good) is produced using capital, labor, land, and the intermediate good (M-good) as inputs under perfect competition. The production of M-good requires capital as variable input and the numéraire X-good as fixed input. We assume that the production of M-good does not need labor because such resource-based sectors are considered highly capital intensive and account for only a small part of employment.[8] Natural resources exist only in country 1, and it is prohibitively costly to transport them to country 2. We call country 1 the resource-rich country and country 2 the resource-poor country. In country 1, firms start production after paying for the fixed input as entry costs; they exploit the natural resources (raw crude oil, iron ore, other mineral ore, etc.) and transform them into M-good, using capital. M-good is tradable without incurring additional costs. The mining industry is an example of the M-good sector. Imagine the production of rare earths. Exploration companies export purified and lighter rare earth elements after separating and refining them near the mine sites. This is because ores mined are so heavy that it would be highly costly to transport them, but purified rare earth elements are light enough to be exported. The concentration of resource-based intermediate production implies that X-good is produced in both countries whereas M-good is produced only in country 1, and

[8] For instance, among all the EU countries, Romania had the highest employment share of the mining and quarrying industry in 2009 (Eurostat, http://epp.eurostat.ec.europa.eu). Still, its employment share of the mining and quarrying industry is only 3.3 percent. The share in most EU countries is less than 2 percent.

that both the produced goods are traded freely without costs. Hence, country 2 imports M-good from country 1 while exporting X-good.[9] Figure 1 describes the environment of the model.

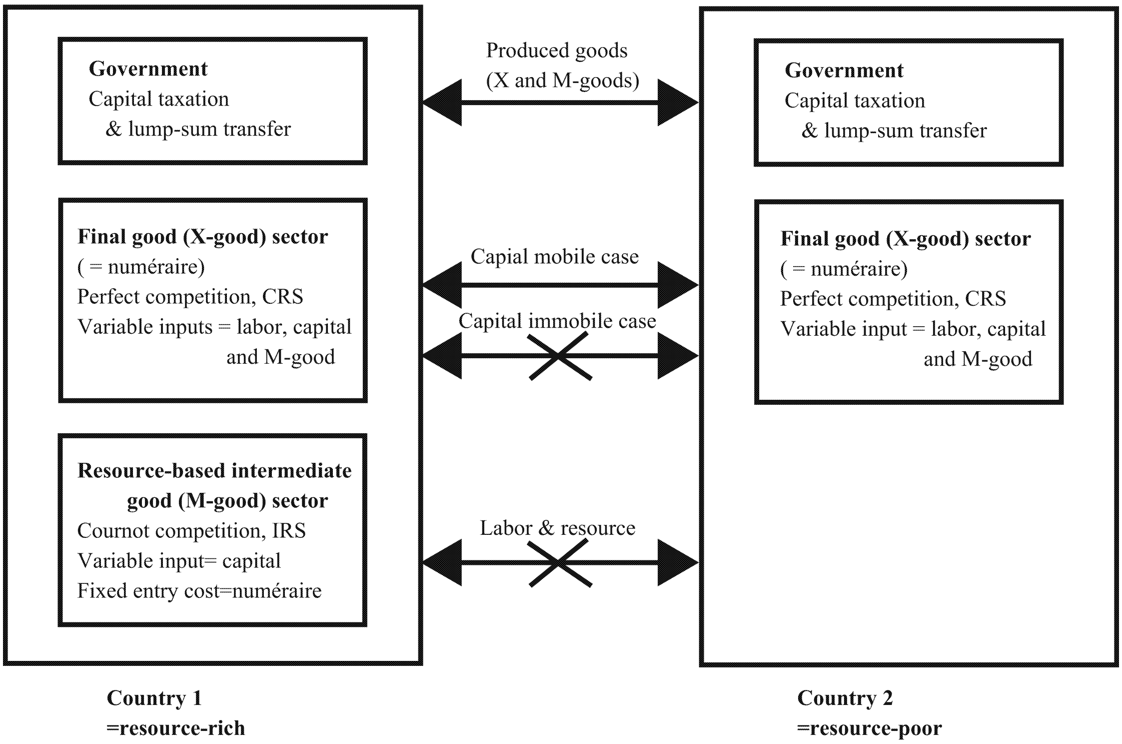

Figure 1: Schematic diagram of model

The mass of firms in X-sector is one in each country. Each firm operates a single plant. The firms are owned by individuals who reside where firms locate. We assume that the production of X-good requires labor as a variable input and land as a fixed input; fixed cost is associated with installing a new production line prior to entry. Without loss of generality, we normalize the land requirement to one. After renting one unit of land, a firm (an X-firm) produces X-good and earns profit in country i, given by

$$\Pi_i = X_i - (r_i + t_i)K_i - w_i L_i - p_M M_i - \psi_i,$$

where w_i, ψ_i, r_i, and t_i are the labor wage rate, land rent, capital price, and capital

[9] Of course, this is an extreme case. In the other extreme case, the production of M-good is equally possible in country 2 as well. Such a case yields the same allocation as the one observed in the mobile capital case without government interventions in this paper. The reality lies between the two: one country has some advantage in producing M-good over the other. Our analysis then works to pin down the upper limit of the possible effects of this type of asymmetry.

tax rate in country i, respectively; p_M represents the price of M-good, equalized across countries. The production function for producing X-good in country i is assumed to be quadratic:[10]

$$X_i = \alpha(K_i + L_i + M_i) - \frac{\beta}{2}(K_i^2 + L_i^2 + M_i^2) - \frac{\gamma}{2}(K_i + L_i + M_i)^2,$$

where α, β, and γ are constants satisfying $\alpha, \beta > 0$ and $\beta + 3\gamma > 0$.[11] α represents the level of total factor productivity, and a positive β ensures that the firms use all kinds of inputs. γ captures the substitutability/complementarity between the inputs in production: a positive (negative) γ represents that any pair of factors are Pareto-substitutes (Pareto-complements). The inequality $\beta + 3\gamma > 0$ is necessary for the equilibrium factor of employment and equilibrium number of firms to be a positive real number.

Note that each firm in the X-sector uses a fixed amount of land, regardless of the production. Land rent is determined through a bidding process by which the firms in country i compete to use the land. As a result, in an equilibrium where the land market clears, land rent is determined in such a manner that the profit of each firm is driven to zero.

From a firm's profit maximization, we obtain the *linear* factor demand functions as follows:

$$K_i = \frac{\alpha}{\beta + 3\gamma} - \frac{1}{\beta}(r_i + t_i) + \frac{\gamma}{\beta(\beta + 3\gamma)}(r_i + t_i + w_i + p_M), \tag{1}$$

$$L_i = \frac{\alpha}{\beta + 3\gamma} - \frac{1}{\beta}w_i + \frac{\gamma}{\beta(\beta + 3\gamma)}(r_i + t_i + w_i + p_M), \tag{2}$$

$$M_i = \frac{\alpha}{\beta + 3\gamma} - \frac{1}{\beta}p_M + \frac{\gamma}{\beta(\beta + 3\gamma)}(r_i + t_i + w_i + p_M). \tag{3}$$

The total demand for M-good is given by $M \equiv M_1 + M_2$, yielding the inverse demand function for the good:

$$p_M = \frac{2\alpha\beta - \beta(\beta + 3\gamma)M + \gamma\sum_{i=1}^{2}(w_i + r_i + t_i)}{2(\beta + 2\gamma)}. \tag{4}$$

[10] This functional form is already used by Ottaviano et al. [27] for utility functions and Peng et al. [29] for production functions. A production function is often specified as a quadratic form in the literature on tax competition. For example, see Bucovetsky [5], Elitzur and Mintz [14], Peralta and van Ypersele [31], and Devereux, Lockwood and Redoano [10].

[11] α is assumed to be sufficiently large to ensure that the production function is concave, and both factor prices and factor employment are positive in equilibrium.

We assume that the M-good sector is characterized by oligopoly, where n identical firms (M-firms) producing M-good engage in Cournot competition. Each firm in country 1, after paying for a fixed amount, F (> 0), of the numéraire good as the entry cost, determines the quantity of supply of M-good. Each firm needs one unit of capital to produce one unit of M-good. A firm's profit is given by

$$\pi = [p_M - (r_1 + t_1)]m - F,$$

where m gives the firm's supply of M-good, and r_1 and t_1 are the endogenous capital price and (temporarily exogenous) capital tax rate, respectively. For given factor prices, the Cournot equilibrium is characterized by the level of output m, the price of M-good p_M, and the number of firms in the M-good sector n. Using $M = \sum^n m$, the level of outputs in the Cournot equilibrium is[12]

$$m = \frac{M}{n} = \frac{2\alpha\beta - 2(\beta + 2\gamma)(r_1 + t_1) + \gamma \sum_{i=1}^{2}(w_i + r_i + t_i)}{\beta(\beta + 3\gamma)(1 + n)}. \tag{5}$$

Equations (4) and (5) give the equilibrium price of M-goods:

$$p_M = \frac{2\alpha\beta + 2(\beta + 2\gamma)n(r_1 + t_1) + \gamma \sum_{i=1}^{2}(w_i + r_i + t_i)}{2(\beta + 2\gamma)(1 + n)}. \tag{6}$$

We assume that firms enter and exit the market freely. Then, the profit of a firm is driven to zero, determining the equilibrium number of firms as follows:[13]

$$n = \frac{2\alpha\beta - 2(\beta + 2\gamma)(r_1 + t_1) + \gamma \sum_{i=1}^{2}(w_i + r_i + t_i)}{\sqrt{2\beta(\beta + 2\gamma)(\beta + 3\gamma)F}} - 1. \tag{7}$$

The factor markets are assumed to be perfectly competitive. The full employment condition of labor market is

$$L_1 = L_2 = 1, \tag{8}$$

Capital market clearing requires

$$\begin{aligned} K_1 + M &= 1, \\ K_2 &= 1, \end{aligned} \tag{9}$$

[12]Amir and Lambson [1] provide the conditions under which the Cournot equilibrium exists and is symmetric. Our settings satisfy those conditions.

[13]We ignore the integer constraint and consider the number of firms as a positive real number.

when the capital is immobile, and

$$K_1 + M + K_2 = 2 \tag{10}$$

when the capital is mobile. These market clearing conditions determine the remaining factor prices w_i and r_i.

3 Effects of capital mobility

Before considering the tax game, let us examine the effects of capital mobility by comparing the case of immobile capital with that of mobile capital in the absence of policy intervention (i.e., $t_1 = t_2 = 0$). This comparison will form the basis of our analysis of the tax game (in Section 4).

3.1 Equilibrium factor prices

The factor demands L_i, K_i, and M_i are determined by (1), (2), and (3). Equations (5) and (6) represent each firm's supply of M-good, m, and the price of M-good, p_M, respectively. The free-entry condition (7) yields the number of M-firms n. Substituting (2) into (8), we obtain the wage rate w_i. The capital price r_i is determined by (9) combined with (1) if the capital is immobile and (10) combined with (1) if the capital is mobile. Finally, the land rent ψ_i is determined by X-firms' zero profit condition, written as $\Pi_i = 0$.

We start from the case where there is no capital mobility. Using equations (1) to (6) and $t_1 = t_2 = 0$, the market clearing conditions (8) and (9) are rearranged to yield the factor prices as functions of the number of firms n:

$$\begin{aligned} w_1 &= \alpha - (\beta + 2\gamma)\left(1 + \frac{\beta\gamma n}{\Xi(n)}\right), \\ w_2 &= \alpha - (\beta+\gamma)(\beta + 2\gamma)\frac{(3\beta + 8\gamma)n + \beta + 3\gamma}{\Xi(n)}, \\ r_1 &= \alpha - \beta\frac{3+2n}{3+8n} - 2\gamma - \beta^2 n\frac{2(\beta+2\gamma)n + 3\gamma}{(3+8n)\Xi(n)}, \\ r_2 &= \alpha - \beta\frac{3+10n}{3+8n} - 2\gamma + \beta^2 n\frac{6(\beta+2\gamma)n + 2\beta + 5\gamma}{(3+8n)\Xi(n)}, \end{aligned} \tag{11}$$

where $\Xi(n)$ is defined as

$$\Xi(n) \equiv (\beta + 2\gamma)(3\beta + 4\gamma)n + (\beta+\gamma)(\beta + 3\gamma).$$

Equation (11) shows how the number of firms in the M-good sector affects factor prices: $\partial w_i/\partial n < 0$ $(i = 1, 2)$ and $\partial r_2/\partial n < 0$ if and only if the production factors are Pareto-substitutes in the production of X-good (i.e., $\gamma > 0$) and $\partial r_1/\partial n > 0$. An increase in n would raise the demand for capital in country 1, resulting in an increase in capital prices. This reduces the demand for both capital and labor in the X-sector and decreases the wage rate when the factors are Pareto-substitutes. This effect is transmitted to country 2 through reductions in the price of M-good, p_M. A larger number of firms in Cournot competition would lower the price of M-good, thereby increasing the demand for the good but reducing the demand for other factors. When the factors are Pareto-complements, a lower p_M would increase the demand for all factors and raise the prices of other production factors.

Plugging (11) into (7), we obtain the equilibrium number of M-firms as

$$n^I = \frac{2(\beta+\gamma)\Phi}{3\beta+4\gamma}\left[\sqrt{\frac{\beta}{F\Phi}}-1\right], \tag{12}$$

where the superscript I indicates that the variable is related to the equilibrium without capital mobility (i.e., the case of immobile capital) and Φ is defined as

$$\Phi \equiv \frac{\beta+3\gamma}{2(\beta+2\gamma)} > 0.$$

In the following analysis, we assume that the entry cost is sufficiently small:

$$F < \frac{\beta}{\Phi},$$

Thus, the equilibrium number of M-firms is strictly positive. From (11) and (12), the closed-form expression of the equilibrium factor price is as follows:

$$\begin{aligned}
w_1^I &= \alpha - \frac{3\beta^2+9\beta\gamma+8\gamma^2+\gamma\sqrt{\beta\Phi F}}{3\beta+4\gamma}, \\
w_2^I &= \alpha - \frac{(\beta+\gamma)(3\beta+8\gamma)-\gamma\sqrt{\beta\Phi F}}{3\beta+4\gamma}, \\
r_1^I &= \alpha - \frac{\beta^2+7\beta\gamma+8\gamma^2+(2\beta+3\gamma)\sqrt{\beta\Phi F}}{3\beta+4\gamma}, \\
r_2^I &= \alpha - \frac{(\beta+\gamma)(3\beta+8\gamma)-\gamma\sqrt{\beta\Phi F}}{3\beta+4\gamma}.
\end{aligned} \tag{13}$$

From (13), we find that $r_1^I > r_2^I$. Since the intermediate good sector exists, a resource-rich country can enjoy a higher capital price than a resource-poor country. Therefore, we will observe the flow of capital from the resource-poor country to the resource-rich country once the capital becomes mobile. A higher capital price in the resource-rich country will in turn increase the demand for labor and wage rates (i.e., $w_1^I > w_2^I$) if its labor and capital are Pareto-substitutes in the production of X-good (i.e., $\gamma > 0$); the opposite holds true (i.e., $w_1^I < w_2^I$) if they are Pareto-complements (i.e., $\gamma < 0$).

Next, we introduce capital mobility. If we allow for capital mobility, the capital prices will be equalized between countries:

$$r_1 = r_2 = r. \tag{14}$$

Similar to the case of immobile capital, on the basis of (1) to (6) and $t_1 = t_2 = 0$, we rearrange the market clearing conditions (8) and (10) to yield the factor prices as functions of the number of firms n. We then derive the equilibrium number of M-firms from (7). In this case, we obtain the number of firms and factor prices as follows:

$$\begin{aligned} n^M &= \sqrt{\frac{\beta\Phi}{F}} - \Phi, \\ w_1^M &= w_2^M = \alpha - \beta - 2\gamma, \\ r^M &= \alpha - \frac{\beta + 4\gamma}{2} - \frac{1}{2}\sqrt{\beta\Phi F}, \end{aligned} \tag{15}$$

where the superscript M represents the equilibrium with capital mobility. Since $F < \beta/\Phi$ is assumed, $n^M > 0$ is satisfied. A simple comparison will show that $r_1^I > r^M > r_2^I$, which is the result of capital export from country 2 to country 1 under an integrated capital market.

3.2 Welfare

Each individual gains utility from consuming the numéraire good. We take the amount of consumption of a representative individual as the criterion of national welfare. It is equal to the national income Y_i, which consists of the total market value of final goods (i.e., the output of X-good minus the amount to be used in M-sector as fixed requirement) plus the net factor income from abroad:

$$Y_1 = X_1 - Fn + p_M M_2 + r_1(1 - K_1 - M), \tag{16}$$

$$Y_2 = X_2 - p_M M_2 + r_2(1 - K_2). \tag{17}$$

From (9), the net capital income of both countries is equal to zero when their capital is immobile. Substituting the equilibrium factor prices (13) into welfare functions (16) and (17), we obtain the equilibrium national welfare in the case of immobile capital:

$$Y_1^I = 2\alpha - \frac{\Upsilon_1 - (\beta+\gamma)(5\beta+8\gamma)\Phi F + 2(5\beta^2+13\beta\gamma+8\gamma^2)\sqrt{\beta\Phi F}}{2(3\beta+4\gamma)^2}, \tag{18}$$

$$Y_2^I = 2\alpha - \frac{\Upsilon_2 - \beta(\beta+\gamma)\Phi F + 2\beta(\beta+\gamma)\sqrt{\beta\Phi F}}{2(3\beta+4\gamma)^2},$$

where Υ_1 and Υ_2 are defined as

$$\Upsilon_1 \equiv 13\beta^3 + 71\beta^2\gamma + 120\beta\gamma^2 + 64\gamma^3,$$

$$\Upsilon_2 \equiv \Upsilon_1 + 4\beta(\beta+\gamma)(\beta+2\gamma).$$

Welfare is unambiguously higher in country 1 than in country 2 under the assumption that $F < \beta/\Phi$. This is confirmed by

$$Y_1^I - Y_2^I = \frac{2(\beta+\gamma)(\beta+2\gamma)}{(3\beta+4\gamma)^2}\left(\beta + \Phi F - 2\sqrt{\beta\Phi F}\right) > 0.$$

Note that $\beta + \Phi F - 2\sqrt{\beta\Phi F} > 0$ under the assumption that $0 < F < \beta/\Phi$, since the geometric mean does not exceed the arithmetic mean. This shows that a resource-rich country enjoys higher welfare than a resource-poor country, which is intuitively plausible.

From (15), (16), and (17), we see that the welfare level across all countries under capital mobility is the same:

$$Y_1^M = Y_2^M = 2\alpha - \frac{(3\beta+8\gamma) - \Phi F + 2\sqrt{\beta\Phi F}}{4}. \tag{19}$$

This is a direct result of factor price equalization under free trade.

Proposition 1 *If capital is immobile, welfare is higher in resource-rich countries than in resource-poor countries (i.e., $Y_1^I > Y_2^I$). If capital is mobile, welfare is the same across countries (i.e., $Y_1^M = Y_2^M$).*

3.3 Welfare implications of capital mobility: a resource curse or blessing?

Here, we examine the impacts of capital market integration on the welfare of each country and on global welfare by comparing Y_i^M with Y_i^I. From (18) and (19), we obtain

$$Y_1^M - Y_1^I = -\frac{\beta(\beta+2\gamma)}{4(3\beta+4\gamma)^2}\left(\beta + \Phi F - 2\sqrt{\beta\Phi F}\right) < 0.$$

The difference is strictly concave in F. Similarly, for country 2,

$$Y_2^M - Y_2^I = \frac{(7\beta + 8\gamma)(\beta + 2\gamma)}{4(3\beta + 4\gamma)^2} \left(\beta + \Phi F - 2\sqrt{\beta \Phi F}\right) > 0.$$

Furthermore, we can also explore the impacts of such changes on global welfare. In our environment, it is natural to consider global income, defined by $Y_1 + Y_2$, as the criterion of global welfare. We can readily see that $Y_1 + Y_2$ changes as

$$Y_1^M + Y_2^M - Y_1^I - Y_2^I = \frac{(\beta + 2\gamma)}{2(3\beta + 4\gamma)} \left(\beta + \Phi F - 2\sqrt{\beta \Phi F}\right) > 0.$$

Proposition 2 *Capital market integration hurts the resource-rich countries (i.e., $Y_1^M < Y_1^I$) but benefits resource-poor countries (i.e., $Y_2^M > Y_2^I$). It further enhances global welfare (i.e., $Y_1^M + Y_2^M > Y_1^I + Y_2^I$).*

Proposition 2 implies that the national income of resource-rich countries will unambiguously decrease due to capital mobility. That is, there exists *a resource-curse*, in the sense that resource-rich countries do not enjoy the benefits of globalization. When capital is immobile, the "manna from heaven" wealth that raises the rate of returns on capital and then increases capital income would make country 1 better off than country 2 (cf. Proposition 1). Once the capital markets are integrated, however, country 2 will be able to exploit the benefits of its natural resources bonanza through capital investment. Corresponding to its capital inflows, country 1 has to pay for the import of capital. Meanwhile, capital inflows are used not only in the X-sector but also in the M-sector, leading to an increase in the production of M-good. Since the negative effects of the leakage of the natural resources bonanza always exceed the positive effects of the expansion in both sectors, capital mobility leads to a resource-curse. In contrast, country 2 always gains from capital movements, not only because of the increasing capital income but also because of the expanding M-sector.

4 Tax game

4.1 Non-cooperative tax competition

Given the effects of capital market integration, we next examine the governments' reactions to such integration, and its welfare implications. In the tax game, the government of each country simultaneously chooses its capital tax level in order to maximize national welfare, anticipating market reactions and taking the tax policy of the other country as given. The tax game consists of three stages: first, the governments determine their tax rates; second, the distribution of capital is determined; and finally, the production of all goods takes place and all prices are determined so that all the markets clear. We solve the model backward to obtain the subgame-perfect Nash equilibrium.

Since the third stage is already described in Section 2, we start from the second stage. Temporarily, we assume that the tax differences are sufficiently small; that is, $2\beta > t_1 - t_2$. This is necessary for M-firms to have the incentive to produce (i.e., $p_M - r_1 - t_1$ is positive). As will be shown later, this condition is satisfied in equilibrium. Just as in the case when capital is mobile and governments are inactive, we use equations (1) to (6) and rearrange the market clearing conditions (8) and (10) to obtain the factor prices as functions of the number of firms n. We then derive the equilibrium number of M-firms from (7). In this case, we obtain the number of M-firms and factor prices as follows:

$$\begin{aligned}
n^T &= \frac{(2\beta - t_1 + t_2)}{2\beta F}\sqrt{\beta \Phi F} - \Phi, \\
w_1^T &= \alpha - \beta - 2\gamma + \frac{\gamma(t_1 - t_2)}{2(\beta + 2\gamma)}, \\
w_2^T &= \alpha - \beta - 2\gamma + \frac{\gamma(t_2 - t_1)}{2(\beta + 2\gamma)}, \\
r^T &= \alpha - \beta - 2\gamma + \frac{2\beta - 3t_1 - t_2}{4} - \frac{1}{2}\sqrt{\beta \Phi F}, \\
p_M^T &= \alpha - \beta - 2\gamma + \frac{2\beta + t_1 - t_2}{4} + \frac{1}{2}\sqrt{\beta \Phi F},
\end{aligned} \tag{20}$$

where the superscript T represents the tax game case. Note that taxation by country 1 has a greater impact on capital prices than that by country 2: $\partial r^T/\partial t_1 < \partial r^T/\partial t_2 < 0$.

In the first stage, each government simultaneously chooses t_i to maximize Y_i, anticipating the market reactions described in (20) and taking t_j $(i \neq j)$ as given. We assume that the tax revenues are redistributed equally and in a lump-sum fashion to each individual. Then, the national welfare is given by (16) and (17).

The best response functions are given by[14]

$$\begin{aligned}
\frac{\partial Y_1}{\partial t_1} &= \frac{-(11\beta + 16\gamma)t_1 + (5\beta + 8\gamma)t_2}{8\beta(\beta + 2\gamma)} + \frac{1}{2}\left(1 - \sqrt{\Phi F/\beta}\right) = 0, \\
\frac{\partial Y_2}{\partial t_2} &= \frac{\beta t_1 - (7\beta + 8\gamma)t_2}{8\beta(\beta + 2\gamma)} = 0.
\end{aligned}$$

[14]The associated second-order conditions are globally satisfied.

Note that we observe a strategic complement in tax decisions. Still, the global concavity of Y_i with respect to t_i ensures the existence of the unique non-cooperative Nash equilibrium, in which the tax rates are given by

$$t_1^T = \frac{\beta(7\beta+8\gamma)(\beta+2\gamma)\left(1-\sqrt{\Phi F/\beta}\right)}{2(3\beta+4\gamma)^2}, \tag{21}$$
$$t_2^T = \frac{\beta^2(\beta+2\gamma)\left(1-\sqrt{\Phi F/\beta}\right)}{2(3\beta+4\gamma)^2}.$$

A simple comparison would show that $t_1^T > t_2^T > 0$, because we have assumed that $F < \beta/\Phi$.

Proposition 3 *In a subgame-perfect Nash equilibrium, both countries impose positive capital taxes. In particular, resource-rich countries levy a higher tax rate than resource-poor countries; that is,* $t_1^T > t_2^T > 0$.

This is consistent with the empirical evidence shown in Slemrod [37]. Note that capital taxation in either country reduces the capital price (i.e., $dr^T/dt_1 < 0$ and $dr^T/dt_2 < 0$). Since country 1 is an importer of capital, it has an incentive to raise t_1 in order to exploit the return to capital and lower capital prices. In contrast, country 2 is an exporter of capital, and hence has a weaker incentive to raise t_2 to keep the capital prices high. These terms-of-trade effects lead to a higher tax rate in country 1 than in country 2. When country 1 levies a positive tax rate on capital, the amount of capital exported from country 2 declines if country 2 imposes no tax. In such a case, country 2 can regain the rent originated from capital mobility by setting a positive tax rate as long as its tax rate is lower than the tax rate of country 1.

Note further that capital taxation lowers the price of M-good ($\partial p_M^T/\partial t_1 > 0$ and $\partial p_M^T/\partial t_2 < 0$), implying that country 1 has an incentive to raise its capital tax rate in order to increase its revenue from the export of M-good; country 2 also has an incentive to raise its capital tax rate to reduce its payment for M-good. However, because $\partial(-p_M M_2)/\partial t_2 = \partial(p_M M_1)/\partial t_1$ holds true in equilibrium, we know that such incentives are counteracted by each other, and do not lead to tax differentials.

Here, the equilibrium tax rates satisfy the condition $2\beta > t_1^T - t_2^T$ assumed above:

$$2\beta - t_1^T + t_2^T = \frac{2\beta(5\beta+6\gamma)+\sqrt{2\beta(\beta+2\gamma)(\beta+3\gamma)F}}{2(3\beta+4\gamma)} > 0.$$

The next question we ask is, who gains from uncoordinated tax competition? Plugging the equilibrium conditions (1), (3), (20), and (21) into (16) and (17), we obtain the equilibrium national incomes Y_1^T and Y_2^T. We can compare these with Y_i^M, i.e., the welfare level under capital mobility in the absence of government interventions (i.e., $t_1 = t_2 = 0$):

$$Y_1^T - Y_1^M = \frac{(15\beta + 16\gamma)(\beta + 3\gamma)(F + \beta/\Phi - 2\sqrt{F\beta/\Phi})}{32(3\beta + 4\gamma)^2},$$

$$Y_2^T - Y_2^M = -\frac{(7\beta + 8\gamma)(\beta + 3\gamma)(F + \beta/\Phi - 2\sqrt{F\beta/\Phi})}{32(3\beta + 4\gamma)^2},$$

$$Y_1^T + Y_2^T - Y_1^M - Y_2^M = -\frac{(\beta + 3\gamma)(F + \beta/\Phi - 2\sqrt{F\beta/\Phi})}{16(3\beta + 4\gamma)}.$$

Note that $F + \beta/\Phi - 2\sqrt{F\beta/\Phi} > 0$ holds true under the assumption of $0 < F < \beta/\Phi$ because of the inequality of arithmetic and geometric means. Therefore, we have $Y_1^T - Y_1^M > 0$, $Y_2^T - Y_2^M < 0$, and $Y_1^T + Y_2^T - Y_1^M - Y_2^M < 0$. These results can be summarized as follows.

Proposition 4 *A resource-rich country gains from tax competition (i.e., $Y_1^T > Y_1^M$), whereas a resource-poor country loses from it (i.e., $Y_2^T < Y_2^M$). The latter loss dominates the former gain, and therefore, tax competition hurts global welfare (i.e., $Y_1^T + Y_2^T < Y_1^M + Y_2^M$).*

There is *a resource-blessing* in the sense that the presence of a resource-based sector enables a resource-rich country to gain from fiscal competition. However, the tax differentials created by such competition induce losses in global welfare, resulting in welfare losses in resource-poor countries.

The intuition underlying the resource blessing is as follows. Rearranging the national income from the income side, we get

$$Y_1 = (w_1 + r + t_1 + \psi_1) + t_1(1 - K_2).$$

The first parenthesis on the right-hand side $(w_1 + r + t_1 + \psi_1)$ represents the factor incomes earned by the initial factor endowments in country 1. Substituting (20) into this, we have

$$w_1 + r + t_1 + \psi_1 = \frac{(t_1 - t_2)^2}{16(\beta + 2\gamma)} + \Upsilon_3,$$

where Υ_3 is a bundle of parameters. The sum of factor incomes increases in tax differentials: the outflows of capital induced by tax gaps increase the scarcity of initial endowments. At the same time, country 1 is still a net importer of capital, i.e., $1 - K_2 > 0$, even though country 1 aggressively levies a higher capital tax than country 2. Thus, country 1 can increase its revenue by taxing capital inflows attracted by the benefits of its natural resources bonanza: that is, $t_1(1 - K_2) > 0$. In contrast, country 2 is doubly cursed in the sense that at a subgame-perfect Nash equilibrium, its initial factor endowments lead to the loss of factor incomes, and it loses the opportunity to levy tax on capital.

4.2 Tax coordination

The inefficiency (losses in global welfare) arising from tax competition makes room for tax coordination to work. Consider the case where countries coordinate their policies and jointly make a tax offer to maximize global income, $Y_1 + Y_2$. The first-order conditions for global welfare maximization are given by[15]

$$\frac{\partial(Y_1+Y_2)}{\partial t_1} = \frac{(t_2-t_1)(3\beta+4\gamma)}{4\beta(\beta+2\gamma)} = 0,$$
$$\frac{\partial(Y_1+Y_2)}{\partial t_2} = \frac{(t_1-t_2)(3\beta+4\gamma)}{4\beta(\beta+2\gamma)} = 0.$$

These conditions require that $t_1 = t_2$ as long as the solution is interior.

Proposition 5 *Global welfare maximization requires that the capital tax rates in the two countries be harmonized to reach the same level.*

Note that the level of coordinated tax rates is undetermined[16]. Tax rate equalization $t_1 = t_2$ leads to factor price equalization, implying that capital distribution goes back to the one observed in the case of mobile capital without government intervention.

5 Concluding remarks

The literature on capital market integration and tax competition has overlooked the role of natural resources. We examined how the natural resources of a particular country

[15] The second-order conditions are also satisfied.

[16] This indeterminacy is based on the linearity of utility and factor demand functions; for example, see Peralta and van Ypersele [31] and Itaya et al. [19].

affect the flow of capital and the governments' reactions to them, who benefits from capital mobility and tax competition, and what are the welfare implications. In so doing, we developed an analytically solvable framework involving vertical linkages via resource-based inputs and international fiscal linkages between resource-rich and resource-poor countries. Our analysis showed that capital market integration yields capital flows from resource-poor countries to resource-rich countries, improving production efficiency and global welfare. However, such gains accrue only to resource-poor countries, and capital mobility can even make resource-rich countries worse off. Once we introduce the possibility of governments intervening in reaction to capital flows, both countries can levy a positive tax rate on capital. In particular, resource-rich countries will levy a higher tax rate than resource-poor countries. This tax wedge would make the resource-rich country a winner and the resource-poor country a loser. As a result, tax competition hurts global welfare.

Propositions 4 and 5 imply that while a tax harmonization policy among countries would enhance global welfare, it inevitably will invoke a resource curse if there are no transfers among them. This is because the interests of the two countries are directly in conflict and no Pareto-improvement is possible. It is thus worth investigating a mechanism to implement tax harmonization policies among asymmetric countries, which will be an important topic for future research.

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