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Capital Mobility—a resource curse or blessing? How, when, and for whom? *OGAWA Hikaru[†] (Nagoya University)OSHIRO Jun[‡] (Osaka University)SATO Yasuhiro[§] (Osaka University)

Abstract

This paper investigates which of the two types of countries—resource-rich or resource-poor—gains from capital market integration and capital tax competition. We develop a framework involving vertical linkages through 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 the latter to the former and thus improves production efficiency and global welfare. However, such gains accrue only to resource-poor countries, and capital mobility might even negatively affect resource-rich countries. In response to capital flows, the governments of both types of countries have an incentive to tax capital. We thus conclude that such taxation enables 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; H73; H77; Q00

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1 Introduction

In the past few decades, we have observed drastic increases in capital flows between regions and countries. Such capital movements have provoked intensive discussions on the direction of capital move and governments' reaction to capital flows. These issues have been tackled by numerous studies in the literature of tax competition theory, whose long history dates back at least to Zodrow and Mieszkowski (1986) and Wilson (1986).¹ The literature investigates the role of governments in attracting capital to their jurisdictions by mainly focusing on the effects of capital tax and subsidy policies.² A significant strand of the literature emphasizes that regions and countries differ in many aspects and analyzes the case of asymmetric regions and countries. They place due importance on regional disparities in, for instance, population (Bucovetsky (1991), Kanbur and Keen (1993), Otaviano and van Ypersele (2005), Sato and Thisse (2007), and Wilson (1991)), capital endowment (DePater and Myers (1994), Peralta and van Ypersele (2005), and Itaya et al. (2008)), and degree of market competitiveness (Haufler and Mittermaier (2011), Egger and Seidel (2011), and Ogawa et al. (2010)). In this paper, we introduce an additional aspect of regional disparities – resource availability, – which is undoubtedly key to the production of firms and yet has been overlooked in this literature.³

More specifically, we explore the effects of natural resources on the distribution of capital across countries, governments' reaction to capital flows, and the influence on a regional welfare of capital flows and tax competition. To accomplish this, we develop a tax competition model involving two countries, of which one is endowed with natural resources. There are two sectors in the economy: the numéraire good sector and the resource-based intermediate good sector. The former is characterized by perfect competition, and its production requires capital, labor, and intermediate goods. The latter is characterized by oligopoly à la Cournot, and its production requires capital as a variable input and the numéraire goods 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

¹Wilson (1999), Wilson and Wildasin (2004), and Fuest et al. (2005) provide surveys on the literature of tax competition.

²Of course, this does not imply that the tax competition literature neglects other types of policies that might be relevant. For instance, studies such as Bayindir-Upmann (1998), Bucovetsky (2005), Cai and Treisman (2005), Fuest (1995), Matsumoto (1998), Noiset (1995), and Wrede (1997) examined the role of infrastructure and institutions provided by the local governments to benefit production possibilities.

³To the best of the authors' knowledge, Raveh (2011) is the only exception that studies 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.

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 accrue only to resource-poor countries. Resource-rich countries, in contrast, may suffer due to the 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/subsidy on capital. In equilibrium, both countries 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 (2004), who empirically showed that a country enjoying higher per capita income from natural resources (oil) is likely to levy higher taxes on corporate income.⁴ In addition, this paper shows that resource-rich countries gain from tax competition, while resource-poor countries are disadvantaged by 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.

Besides the tax competition literature, the importance of natural resources is widely recognized in the other fields of economics: beginning with a seminal article by Sachs and Warner (1995), many 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 through the Dutch disease, institutional quality, armed conflict, volatility of commodity prices, financial imperfection, or investment of human capital.⁵ However, none of these studies focused on the mechanisms for transferring natural resources to the economy through fiscal externalities arising from factor mobility. Given the increasingly pervasive influence of capital mobility and governments' concern about it, it is indispensable to understand the features and impacts of possible interactions among the unevenly distributed natural resources, capital mobility and the role of governments.

In the literature on growth and natural resources, Bretschger and Valente (forthcoming) would be the most closely related to this paper. Extending the two-country endogen-

⁴However, a controversy exists over the robustness of this empirical finding. Dharmapala and Hines Jr. (2009) concluded that higher corporate tax rates are not observed in the data of resource-abundant countries.

⁵The literature on the so-called "natural resource curse" is comprehensively reviewed by Frankel (2010) and van der Ploeg (2011). For an overview on the recent empirical literature, see Torvik (2009) and Rosser (2006).

ous growth model, they investigate the strategic resource taxation policies of resource-rich and resource-poor economies that are involved in an asymmetric trade structure induced by uneven endowments of natural resources.⁶ They showed that a resource-poor country has an incentive to levy taxes on the use of domestic resources at an excessively high rate to reduce resource dependency. In a similar vein, this paper examines an economy in which the geographical necessity and availability of natural resources induce an asymmetric industrial structure and then inter-industry trade linkages. The main difference is that this paper mainly examines the role of a mobile production factor (capital), whereas Bretschger and Valente (forthcoming) does not deal with this issue.

The rest of the paper is organized as follows. The basic environment is presented in Section 2. In Sections 3 and 4, we study the effects of capital market integration without government intervention and the effects of tax competition, respectively. Section 5 discusses the robustness of our main results against possible extensions and Section 6 concludes the paper.

2 The basic settings

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

Two goods are produced, a numéraire good (X) and a resource-based intermediate good (M) (e.g., petroleum, steel, and minor metals). X -good is produced using capital, labor, and the intermediate good (M -good) as inputs under perfect competition. The production of M -good requires capital as a variable input and X -good as a 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

⁶Wildasin (1993) also constructs a tax competition model with inter-industry trade linkages. In contrast, we characterize the equilibrium arising from tax competition and examine the welfare properties of such equilibrium.

employment.⁷ Natural resources exist only in country 1, and it is prohibitively costly to transport them to country 2. We call countries 1 and 2 the resource-rich and resource-poor countries, respectively. In country 1, firms start production after paying for the fixed input as entry costs; they exploit the natural resources (e.g., raw crude oil, iron ore, and other mineral ore) 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 quite 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 both the produced goods are traded freely without costs. Thus, country 2 imports M-good from country 1 while exporting X-good.⁸ Figure 1 describes the environment of the model.

[Figure 1 around here]

In the numéraire sector, the profit of the firm is given by

$$\Pi_i = X_i - (r_i + t_i)K_i - w_iL_i - p_M M_i,$$

where w_i , r_i , and t_i are the labor wage rate, capital price, and capital tax rate in country $i \in \{1, 2\}$, respectively; p_M represents the price of M-good, equalized across countries. The constant returns to scale production function for producing X-good in country i is assumed to be quadratic:

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

where α , β , and γ are constants satisfying $\alpha > 0$, $\beta > 0$ and $\beta + 2\gamma > 0$ to guarantee that the Hessian matrix of Π_i is negative definite.⁹ α represents the level of productivity, and β measures (inversely) the own-price effects on factor demands. γ captures the

⁷For 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.

⁸Of 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.

⁹ α is assumed to be sufficiently large to ensure that both factor prices and factor employments are positive in equilibrium.

substitutability/complementarity between capital and M-good in production: a positive (resp. negative) γ represents that capital and M-good are Pareto substitutes (resp. Pareto complements), that is, the marginal product of one input is decreasing (resp. increasing) in the other input. A quadratic production function is often used in the literature on tax competition. For example, see Bucovetsky (1991), Elitzur and Mintz (1996), Peralta and van Ypersele (2006), and Devereux et al. (2008).¹⁰

From a firm's profit maximization, we obtain the *linear* factor demand functions (relative to labor) as follows:

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

$$\frac{M_i}{L_i} = \frac{\alpha}{\beta + 2\gamma} - \frac{1}{\beta}p_M + \frac{\gamma}{\beta(\beta + 2\gamma)}(r_i + t_i + p_M). \quad (2)$$

The second terms on the right hand side are decreasing in their own factor prices. The third terms are either increasing or decreasing in a factor price index, $(r_i + t_i + p_M)$, depending on the sign of γ .

Substituting (1) and (2) into the profit function, the profit is rewritten as

$$\Pi_i = (\Lambda_i - w_i)L_i,$$

where

$$\Lambda_i \equiv \frac{2\beta\alpha(\alpha - r_i - t_i - p_M) + \beta[(r_i + t_i)^2 + p_M^2] + \gamma[(r_i + t_i) - p_M]^2}{2\beta(\beta + 2\gamma)}.$$

In the competitive environment, the labor markets are cleared and the wage rate is determined by the zero profit condition:

$$L_i = 1, \quad (3)$$

$$w_i = \Lambda_i.$$

The factor price frontiers are $\partial w_i / \partial r_i = -K_i / L_i < 0$ and $\partial w_i / \partial p_M = -M_i / L_i < 0$.

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

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

¹⁰Most of the existing studies assumed that goods are produced by using capital and labor. In such a case, our production function becomes $X = \alpha K - (\beta + \gamma)K^2 / (2L)$. This can be rearranged as $X/L = (K/L)[\alpha - (\beta + \gamma)(K/L)/2]$, which is identical to the one used in Section 5 of Bucovetsky (1991), for example. Note also that this type of functional form is also used by Ottaviano et al. (2002) for utility functions and Peng et al. (2006) for production functions.

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 determines the quantity of M-good supplied after paying for a fixed requirement, $F(> 0)$ units of the numéraire good, as the entry cost (e.g., a cost to procure mining concession). 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 is¹¹

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

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

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

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:¹²

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

We relax the free entry assumption in a later section.

The capital markets are perfectly competitive. Capital market clearing requires

$$K_1 + M = 1, \text{ and } K_2 = 1, \quad (8)$$

when the capital is immobile, and

$$K_1 + M + K_2 = 2 \quad (9)$$

when the capital is mobile. These market clearing conditions determine the capital prices r_i .

¹¹Amir and Lambson (2000) provide the conditions under which the Cournot equilibrium exists and is symmetric. Our settings satisfy those conditions: The profit is a supermodular function on the relevant domain.

¹²We ignore the integer constraint and consider the number of firms as a positive real number.

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 (Section 4).

3.1 Equilibrium factor prices

The equilibrium is characterized by profit maximization, free entry, and full employment conditions.

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

$$r_1 = \alpha - \gamma - \beta \frac{\beta + 2\gamma + n(\beta + \gamma)}{\beta + 2\gamma + n(3\beta + 4\gamma)}, \quad (10)$$

$$r_2 = \alpha - \gamma - \beta \frac{\beta + 2\gamma + n(3\beta + 5\gamma)}{\beta + 2\gamma + n(3\beta + 4\gamma)}. \quad (11)$$

Equations (10) and (11) show how the number of firms in the M-good sector affects capital prices: $dr_1/dn > 0$, and $dr_2/dn \lesseqgtr 0$ if and only if $\gamma \gtrless 0$. An increase in n would raise the demand for capital in country 1, resulting in an increase in the capital price. Although the increase in the capital price in country 1 raises the marginal cost that M-firms face, a larger number of M-firms would lower the price of M-good by intensifying competition. When capital and M-good are Pareto substitutes (resp. Pareto complements), a lower p_M will decrease (resp. increase) the demand for capital and lower (resp. raise) the capital price in country 2.

Plugging (10) and (11) into (7), we obtain the equilibrium number of M-firms as

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

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

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

Throughout the paper, we assume that the entry cost is sufficiently small:

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

Thus, the equilibrium number of M-firms is strictly positive.

From (12), the closed-form expressions of the equilibrium factor prices are as follows:

$$r_1^I = \alpha - \frac{(\beta + 2\gamma)^2 + (2\beta + 3\gamma)\sqrt{\beta\Phi F}}{3\beta + 4\gamma}, \quad (13)$$

$$r_2^I = \alpha - \frac{(\beta + 2\gamma)(3\beta + 2\gamma) - \gamma\sqrt{\beta\Phi F}}{3\beta + 4\gamma}, \quad (14)$$

$$p_M^I = \alpha - \frac{\beta^2}{3\beta + 4\gamma} + \frac{\beta + \gamma}{3\beta + 4\gamma} \left(\sqrt{\beta\Phi F} - 4\gamma \right), \quad (15)$$

$$w_1^I = \left(\frac{\beta + 2\gamma}{3\beta + 4\gamma} \right)^2 \left(\beta + 2\gamma + \sqrt{\beta\Phi F} \right) + \frac{(\beta + \gamma)(5\beta + 8\gamma)F\Phi}{2(3\beta + 4\gamma)^2}, \quad (16)$$

$$w_2^I = \frac{(\beta + 2\gamma)}{(3\beta + 4\gamma)^2} \left[5\beta^2 + 10\beta\gamma + 4\gamma^2 + \beta F/4 - (\beta + 2\gamma)\sqrt{\beta\Phi F} \right]. \quad (17)$$

From (13) and (14), 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 that in 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 markets are integrated.

Next, we introduce capital mobility. If we allow for capital mobility, the capital prices will be equalized between countries:¹³

$$r_1 = r_2 \equiv r. \quad (18)$$

Similar to the case of immobile capital, on the basis of (1) to (6), we rearrange the capital market clearing conditions (9) to yield the capital price as functions of the number of firms n :

$$r = \alpha - \gamma - t_1 - \frac{[\beta + 2\gamma + n(\beta + \gamma)](2\beta - t_1 + t_2)}{2[\beta + 2\gamma + 2n(\beta + \gamma)]}. \quad (19)$$

We then derive the equilibrium number of M-firms from (7) and $t_1 = t_2 = 0$. In this case, we obtain the number of firms and factor prices as follows:

$$n^M = \sqrt{\frac{\beta\Phi}{F}} - \Phi, \quad (20)$$

$$r^M = \alpha - \gamma - \frac{1}{2} \left(\beta + \sqrt{\beta\Phi F} \right) \quad (21)$$

$$p_M^M = \alpha - \gamma - \frac{1}{2} \left(\beta - \sqrt{\beta\Phi F} \right) \quad (22)$$

$$w_1^M = w_2^M = \frac{\beta + 2\gamma + \Phi F}{4}, \quad (23)$$

where the superscript M represents the equilibrium with capital mobility. Since $F < \beta/\Phi$, the equilibrium number of M-firms is positive (i.e., $n^M > 0$). 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.

¹³Such equalization of the marginal product of capital across countries is reported in Caselli and Feyrer (2007) and Hsieh and Klenow (2007).

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 as follows¹⁴

$$Y_1 = w_1 + r_1 + t_1(K_1 + M), \quad (24)$$

$$Y_2 = w_2 + r_2 + t_2K_2. \quad (25)$$

The national income can also be measured on the production side by using zero profit conditions in each sector:

$$Y_1 = X_1 - Fn + p_M M_2 + r_1(1 - K_1 - M), \quad (26)$$

$$Y_2 = X_2 - p_M M_2 + r_2(1 - K_2). \quad (27)$$

That is, the national income 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 a fixed requirement) plus the net factor income from abroad.

From (8), the net capital income of both countries is equal to zero when their capital is immobile. In the case of immobile capital, substituting the equilibrium number of M-firms (12) and the equilibrium factor prices (13)-(17) into the welfare functions (26) and (27), we obtain the equilibrium national welfare:

$$Y_1^I = \alpha - \frac{(\beta + \gamma)[-4(\beta + 2\gamma)^2 + (5\beta + 8\gamma)(\phi F - 2\sqrt{\beta\Phi F})]}{2(3\beta + 4\gamma)^2}, \quad (28)$$

$$Y_2^I = \alpha - \frac{(\beta + \gamma)[8(\beta + \gamma)(\beta + 2\gamma) - \beta\phi F + 2\beta\sqrt{\beta\Phi F}]}{2(3\beta + 4\gamma)^2}. \quad (29)$$

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

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

This shows that a resource-rich country benefits from the presence of natural resources, which is intuitively plausible.

Using (20) to (23), we see that the welfare level across all countries under capital mobility is the same:

$$Y_1^M = Y_2^M = \alpha - \frac{(\beta + 2\gamma) - \Phi F + 2\sqrt{\beta\Phi F}}{4}. \quad (30)$$

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

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

¹⁴We assume that the tax revenues are redistributed equally and in a lump-sum fashion to each individual.

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 global welfare by comparing Y_i^M with Y_i^I . From (28)-(30), we obtain

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

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

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

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

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

Proposition 2 *Capital market integration negatively affects the resource-rich country (i.e., $Y_1^M < Y_1^I$) but benefits the resource-poor country (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 the resource-rich country will unambiguously decrease due to capital mobility. In other words, there exists *a resource-curse*, that is, the resource-rich country does not enjoy the benefits of capital market integration. When capital is immobile, the uneven distribution of natural resources induces a natural resource bonanza: the resource 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 access the benefits of the natural resources bonanza through capital investment. Corresponding to the capital inflows, country 1 has to pay for the import of capital. Since the negative effects of the leakage of the natural resource bonanza always exceed the positive effects of the expansion in both sectors in country 1, capital mobility leads to a resource-curse. In contrast, country 2 always gains from capital movements, because of the increasing capital income and the expanding M-sector.

4 Tax game

4.1 Non-cooperative tax competition

Given the effects of capital market integration, we next examine 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, firms enter into the markets; and finally, the production of all goods takes place and the market clearing determines all the prices. We solve the model backward to obtain the subgame-perfect Nash equilibrium.

Since the third stage is already described in Section 2, we can 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., the price-cost margin, $p_M - r_1 - t_1$, 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 (9) 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:

$$n^T = \frac{(2\beta - t_1 + t_2)}{2\beta F} \sqrt{\beta\Phi F} - \Phi, \quad (31)$$

$$r^T = \alpha - \beta - \gamma + \frac{2\beta - 3t_1 - t_2}{4} - \frac{1}{2} \sqrt{\beta\Phi F}, \quad (32)$$

$$p_M^T = \alpha - \beta - \gamma + \frac{2\beta + t_1 - t_2}{4} + \frac{1}{2} \sqrt{\beta\Phi F}, \quad (33)$$

$$w_1^T = \frac{(2\beta - t_1 + t_2 + 4\gamma)^2}{16(\beta + 2\gamma)} + \frac{\Phi F}{4}, \quad (34)$$

$$w_2^T = \frac{(t_1 - t_2) [(5\beta + 8\gamma)(t_1 - t_2) + 8(\beta + 2\gamma)\sqrt{\beta\Phi F}]}{16\beta(\beta + 2\gamma)} + \frac{\Phi F + \beta + 2\gamma + t_1 - t_2}{4}, \quad (35)$$

where the superscript T represents the tax game case. Note that taxation by country 1 has a greater impact on the 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 (31)-(35) and taking t_j ($i \neq j$) as given.

The best response functions are given by¹⁵

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

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,

¹⁵The associated second-order conditions are globally satisfied.

in which the tax rates are given by

$$t_1^T = \frac{\beta(7\beta + 8\gamma)(\beta + 2\gamma)}{2(3\beta + 4\gamma)^2} \left(1 - \sqrt{\Phi F/\beta}\right), \quad (36)$$

$$t_2^T = \frac{\beta^2(\beta + 2\gamma)}{2(3\beta + 4\gamma)^2} \left(1 - \sqrt{\Phi F/\beta}\right). \quad (37)$$

A simple comparison would show that $t_1^T > t_2^T > 0$ from $F < \beta/\Phi$.

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

This is consistent with the empirical evidence shown in Slemrod (2004). 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 maintain high capital prices. 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.

Further, note 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 $\partial(-p_M M_2)/\partial t_2 = \partial(p_M M_2)/\partial t_1$ 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:

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

The next question is, who gains from uncoordinated tax competition? Plugging the equilibrium conditions (1), (2), and (31) to (37) into (26) and (27), 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., $t_1 = t_2 = 0$):

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

$$Y_2^T - Y_2^M = -\frac{3(7\beta + 8\gamma)(\beta + 2\gamma)}{16(3\beta + 4\gamma)^2} \left(\sqrt{\beta} - \sqrt{\Phi F}\right)^2,$$

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

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 *The resource-rich country gains from tax competition (i.e., $Y_1^T > Y_1^M$), whereas the 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 the 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 the resource-poor country.

The intuition underlying the resource blessing is as follows. Rearranging the national income (24), we get

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

The first parenthesis on the right-hand side ($r + t_1 + w_1$) represents the factor incomes earned by the initial factor endowments in country 1. Substituting (31)-(35) into this, we have

$$r + t_1 + w_1 = \frac{(t_1 - t_2)^2}{16(\beta + 2\gamma)} + \alpha - \frac{\beta + 2\gamma - \Phi F}{4} - \frac{1}{2}\sqrt{\beta\Phi F}.$$

This sum of factor incomes earned by the initial endowments increases as the tax differential rises: while the tax differential causes the outflows of capital from country 1 and reduces both the net return to capital r and the wage, the reallocation of capital across countries encourages more efficient use of capital, which increases the gross return to capital, $r + t_1$. At the same time, even though country 1 aggressively levies a higher capital tax than country 2, country 1 is still a net importer of capital (i.e., $1 - K_2 > 0$). Thus, country 1 can increase its revenue by taxing the capital inflows attracted by the benefits of its natural resource 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 function. Consider a case in which 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 by¹⁶

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

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 undetermined¹⁷. 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.

Implementation of such tax coordination between countries would require a certain transfer from the resource-poor to the resource-rich country. Otherwise, the resource-rich country has an incentive to deviate from the coordination. One possible way of facilitating a transfer is by aid from the resource-poor country to improve infrastructure for the production of raw materials.

5 Robustness

In this section, we discuss the extent to which our results are robust against possible extensions. First, we replace our assumption of the free entry of firms in the resource based intermediate good sector (M-sector) to the assumption of entry restriction. Second, we introduce the possibility that M-good can also be produced in the resource-poor country by incurring transport costs. Third, we discuss how our results may change if M-sector firms are publicly rather than privately owned. Finally, we confirm that our results are unaltered if we use a production function different from a quadratic one.

5.1 Restricted entry

Thus far, we have assumed free entry and exit in M-sector. However, we sometimes observe that governments try to reduce and control the number of producers in resource sectors, partially because of political and environmental concern. For instance, Suxun and Chenjunnan (2008) and Conway et al. (2010) reported entry restrictions in the mining

¹⁶The second-order conditions are also satisfied.

¹⁷This indeterminacy is based on the linearity of utility and factor demand functions; for example, see Peralta and van Ypersele (2006) and Itaya et al. (2008).

industry in China. Here, we show that although the assumption of free entry plays an important role in analytically comparing the welfare outcomes, many of our results are unaltered if the entry of firms in M-sector is restricted.

Leaving aside the assumption of free entry, consider an exogenous number of M-firms.¹⁸ Assume that the excess profits in M-sector are equally redistributed to households in the resource-rich country (i.e., country 1). Then, the national income in country 1 is modified as

$$Y_1 = w_1 + r_1 + t_1(K_1 + M) + n\pi.$$

Given n , the equilibrium capital prices are given by (10) and (11) for the case of immobile capital, and by (19) for the other cases. Here, we investigate the robustness of the main results: (I) capital market integration induces a resource curse, and (II) tax competition results in a resource blessing.

As for the first point, we obtained the following result: When capital markets are integrated, the resource-rich country will be better off for a sufficiently small n (in contrast to Proposition 2) while the resource-poor country and global welfare will still be better off. After some calculations, we obtain the welfare differentials as follows

$$\bar{Y}_1^M - \bar{Y}_1^I = -\Psi_1\Psi_4,$$

$$\bar{Y}_2^M - \bar{Y}_2^I = \Psi_2\Psi_4 > 0,$$

$$\bar{Y}_1^M + \bar{Y}_2^M - \bar{Y}_1^I - \bar{Y}_2^I = \Psi_3\Psi_4 > 0,$$

where \bar{Y}_i are the equilibrium national welfare in country i when the number of M-firms is fixed in each case, and $\Psi_1, \Psi_2 > 0, \Psi_3 > 0$ and $\Psi_4 > 0$ are bundles of parameters defined in Appendix A. Superscripts I and M again represent that the variables are related to the capital immobile and mobile cases, respectively. Whether capital market integration is beneficial for the resource-rich country depends on the number of M-firms, n :

$$\mathbf{sgn} [\bar{Y}_1^M - \bar{Y}_1^I] = \mathbf{sgn} [\tilde{n} - n],$$

where \tilde{n} is defined as

$$\tilde{n} \equiv \frac{\Phi}{\beta} \left[2(3\beta + 4\gamma) + \sqrt{2(23\beta^2 + 53\beta\gamma + 32\gamma^2)} \right].$$

When firms can freely enter/exit the market, capital market integration reduces the marginal cost faced by M-firms, which induces the existing firms to expand production and new firms to enter the market. These two effects increase the overall supply of M-good

¹⁸In this section, we assume that F is sufficiently small so that n does not exceed the level under free entry.

and negatively affects terms of trade: a larger supply of M-good lowers its price, which is the export price of country 1, and raises the price of capital, which is the import price of country 1. Such a negative effect dominates the positive effect of increases in the outputs of both X- and M-goods under free entry. When entry is restricted, for a sufficiently small n ($< \tilde{n}$), the resource-rich country can benefit from capital market integration because entry restriction saves the country from the negative change in terms of trade. As a result, the positive effects of output increases dominate the negative effects of change in terms of trade. For a sufficiently large n ($> \tilde{n}$), on the other hand, the protection for the terms of trade by the entry restriction cannot be large enough to overcome the resource curse because a larger number of M-firms leads to a greater natural resource bonanza which will disappear by capital market integration.¹⁹ Note also that this result implies that we observe the resource curse under perfect competition in the M-sector (when $n \rightarrow \infty$). Thus, our result comes from the asymmetry of the production possibility, not from the assumption of Cournot competition.

As to the second point, although we are unable to completely characterize the welfare properties of tax competition, we show that given n , (i) the resource-rich country levies a higher tax on capital than the resource-poor country, (ii) tax competition is harmful to global welfare, and (iii) tax competition is likely to induce a resource blessing and a resourceless curse. At a unique Nash equilibrium in tax competition, the resource-rich country more aggressively levies a tax on mobile capital as in Proposition 3:

$$\bar{t}_1 - \bar{t}_2 = \frac{4\beta(\beta + \gamma)(\beta + 2\gamma)n^2}{4(\beta + \gamma)(3\beta + 4\gamma)n^2 + (\beta + 2\gamma)(9\beta + 10\gamma)n + 2(\beta + 2\gamma)^2} > 0.$$

This tax differential is increasing in n .

The global welfare is always worse off due to tax competition as in Proposition 4:

$$\bar{Y}_1^T + \bar{Y}_2^T - \bar{Y}_1^M - \bar{Y}_2^M = -\frac{(\beta + \gamma)(\beta + 2\gamma)(\bar{t}_1 - \bar{t}_2)}{[\beta + 2\gamma + 2n(\beta + \gamma)]^2} - \frac{\Phi\Psi_5(\bar{t}_1 - \bar{t}_2)^2}{8\beta} < 0,$$

where $\Psi_5 > 0$ is a bundle of parameters defined in Appendix A.

To evaluate the impacts of tax competition on each country's welfare, it is necessary to compute quintic functions²⁰, and so we shall confirm Proposition 4 by numerical investigations. Figure 2 shows sets of parameters (β, γ) in which tax competition still leads to a resource blessing in the case $n = 1, 3/2, 2, 3, 10, 20$, or 100 .

[Figure 2 around here]

¹⁹From (10) and (11), we have $dr_1/dn > 0$ and $d(r_1 - r_2)/dn > 0$ in the case of immobile capital.

²⁰If we assume $\gamma \geq 0$, then we can analytically show that $\bar{Y}_1^T > \bar{Y}_1^M$ and $\bar{Y}_2^T < \bar{Y}_2^M$ for all $\beta > 0$, $\gamma \geq 0$ and $n \geq 2$.

The light shaded areas represent a parameter set (β, γ) such that $\bar{Y}_1^T > \bar{Y}_1^M$ for each n . The dark shaded areas represent a parameter set (β, γ) such that $\bar{Y}_1^T < \bar{Y}_1^M$ for each n . The white triangles represent the invalid areas in which $\beta + \gamma \leq 2$.

The figures indicate that $\bar{Y}_1^T > \bar{Y}_1^M$ may hold true for $n \geq 2$.²¹ There exists a case of $\bar{Y}_1^T \leq \bar{Y}_1^M$ for a sufficiently small n , however, such n is smaller than a plausible domain for oligopolistic markets. Note that when n is sufficiently smaller than 2, the equilibrium tax rate charged by the resource-rich country can be negative such that welfare in the resource-rich country would deteriorate following the subsidization of larger net inflows of capital than in the case of free entry.

In sum, Propositions 2-4 are reasonably robust even without free entry in M-sector, except that contrary to Proposition 2 capital market integration will result in Pareto improving outcomes for very small n .

5.2 Tradable resources

In the baseline model, we have assumed that the production of M-good is possible only in the resource-rich country. Of course, this is an extreme assumption, and hence, it would be worth examining how the results may change if we assume that M-sector can operate even in the resource-poor countries if firms pay an additional cost to transport the resources and/or develop new deposits of the resources, or if firms succeed in technological innovation, allowing them to produce substitutes to the resource-based intermediate goods without particular resource wealth.

This section relaxes the important assumption that the resource-poor countries have no capacity to accommodate M-sector by supposing that M-firms can be set up in the resource-poor country by incurring additional costs to transport the resource wealth. First note that if there is free entry (at least in country 1), no firms operate profitably in country 2 because the trade cost of natural resources makes the marginal cost in country 2 higher than that in country 1. This scenario results in the same allocations in our benchmark cases, i.e., the trade possibility of M-good does not affect our results.

If entry is restricted, trade possibility may change the prediction of our model. To prove this, we assume that each country has a single M-firm. This case is comparable to that of monopoly described in the previous subsection. Let τ be the positive transport cost of natural resources in terms of the numéraire and π_i be the profit of an M-firm in country i :

$$\pi_1 = [p_M - (r_1 + t_1)]m_1 - F,$$

²¹Taking the limit as $n \rightarrow \infty$, we obtain $\bar{Y}_1^T - \bar{Y}_1^M = \beta(\beta + 2\gamma)(15\beta + 16\gamma)/[16(3\beta + 4\gamma)^2] > 0$ and $\bar{Y}_2^T - \bar{Y}_2^M = -3\beta(\beta + 2\gamma)(7\beta + 8\gamma)/[16(3\beta + 4\gamma)^2] < 0$.

$$\pi_2 = [p_M - (r_2 + t_2) - \tau]m_2 - F,$$

where m_i is the sales of each firm, with $m_1 + m_2 = M$. We assume that τ is low enough (in particular, $\tau < \beta(\beta + 2\gamma)/(3\beta + 4\gamma)$) for both firms in M-sector to be profitable. National welfare in each country is given by

$$\begin{aligned} Y_1 &= w_1 + r_1 + t_1(K_1 + m_1) + \pi_1 \\ &= X_1 + r_1(1 - K_1 - m_1) + p_M(q_1 - M_1) - F, \end{aligned}$$

$$\begin{aligned} Y_2 &= w_2 + r_2 + t_2(K_2 + m_2) + \pi_2 \\ &= X_2 + r_2(1 - K_2 - m_2) + p_M(q_2 - M_2) - \tau m_2 - F. \end{aligned}$$

When $\tau = 0$, the two countries are completely symmetric.

In this economy, there exists a unique equilibrium in each case for all $\beta > 0$, $\beta + 2\gamma > 0$, $\tau < \beta(\beta + 2\gamma)/(3\beta + 4\gamma)$ and sufficiently large $\alpha > 0$. Details are shown in Appendix B.

There are two major differences between this extension and the benchmark model. First, when an M-firm operates in country 2, a difference between r_1 and r_2 in the case of immobile capital becomes small enough to diminish the natural resource bonanza. Thus if the capital market integrates, welfare in the resource-rich country will always increase, which is in contrast to Proposition 2, because the loss of capital income is fully offset by the improvement in production efficiency through the international reallocation of capital. Welfare in the resource-poor country may increase or decrease with capital mobility. When the production of M-good is costly enough (i.e., τ is sufficiently large), the resource-poor country benefits from capital mobility as in Proposition 2. By contrast, when τ is small, capital market integration negatively affects the resource-poor country. As the rates of return on capital are equalized, a share of M-good market shifts from the less efficient firm located in country 2 to the more efficient one that has a cost advantage. This shift results in an increase in imports of M-good and thus a decrease in national welfare in country 2, which may dominate the positive effects driven by efficiency gains in X-sector, capital income gains, and transport cost savings.

Second, the direction of inequalities in Proposition 4 is reversed: tax competition always negatively affects the resource-rich country but benefits the resource-poor country. In tax competition equilibrium, both countries will subsidize capital at a common rate and the capital price, r , rises at the same rate as the subsidy rate so that the overall capital cost faced by firms, $r + t_i$, and hence the capital allocation remains unchanged from the laissez-faire equilibrium.²² As a result, country 1 that imports capital will merely transfer

²²A non-cooperative game does not implement the allocation under tax coordination, which requires $t_2 - t_1 = 2\tau \neq 0$.

income to country 2 while global welfare remains unchanged.

In a nutshell, the trade possibility of M-good has no effect on our results under free entry whereas it may change the results in the previous subsection if entry is restricted. In particular, there is a discontinuous change in the welfare implication of capital market integration in country 1 when the resource-based sector operates in both countries. The discontinuity reflects the fact that when M-sector is active but may not necessarily be profitable in country 2, the return to immobile capital jumps so that the resource bonanza becomes small.

5.3 Publicly owned monopolist

When governments restrict entry of firms in the resource sector, they often put other types of restrictions on firms' activity, or, place firms under national control. This subsection investigates the impacts of such nationalization. The free entry assumption is implausible in the context of publicly-owned firms. Therefore, we focus on the case of restricted entry. More specifically, we consider that country 1 has a welfare-oriented publicly-owned firm in M-sector. At the third stage of the game, taking the factor prices, r_i , and, w_i , and tax rates, t_i , as given but taking into account the factor demands of X-sector, the public firm chooses its output M to maximize the following objective function²³

$$\pi_p = \lambda[(p_M - r_1 - t_1)M - F] + (1 - \lambda)Y_1.$$

The parameter $\lambda \in [0, 1]$ captures (inversely) the importance of welfare considerations in the firm's objective: when λ is lower, national welfare is more important. When $\lambda = 1$, the resulting equilibrium coincides with the one discussed in Section 5.1, where $n = 1$. Therefore, when λ is high, as expected, our main results are largely unaffected by introducing the public ownership.

A fall in λ is likely to leads to an increase in the total output of M-good, $M = M_1 + M_2$, and a decrease in price-cost margins in each case.²⁴ In the absence of government interventions, this expansion in production of M-good increases the capital demand and pushes the capital prices up. In the case of immobile capital, it reinforces the natural resource bonanza by widening the difference in the return to capital $r_1 - r_2$. In the case of mobile capital, since the public firm takes the capital price as given, the public firm ignores the terms of trade loss that accrues to a capital-importing country with each

²³We base our description of public firms on the existing studies in the literature of mixed oligopoly, e.g., De Fraja and Delbono (1989), Pal (1998), and Matsushima and Matsumura (2003).

²⁴At tax competition equilibrium, the sales of M-good may increase with λ when λ and γ are sufficiently small. Without tax competition, the equilibrium price of M-good must be increasing in λ .

additional unit of M-good. Therefore, the likelihood of a resource curse due to capital market integration rises as the public firm becomes more welfare conscious (i.e., lower λ). On the other hand, the lower λ is, the higher welfare is in country 2 at interior equilibrium because the public firm lowers the import price of M-good, p_M , and raises the export price of capital, r .²⁵

The impacts of public ownership on tax competition are nonlinear and not obvious. In tax competition, country 1 has an incentive to lower its tax rate and thus reduce the tax differential in order to raise the net return to capital since the public firm that ignores the impacts on r tends to excessively raise r . At the same time, since the welfare-oriented firm employs more capital than the profit-maximizing firm, country 1 has an incentive to raise its tax rate to exploit benefits that accrue to the inflows of capital.

Figure 3 describes the overall effects of tax competition on welfare with $\alpha = 5$.²⁶ The horizontal and vertical axes are β and γ , respectively. The light shaded areas represent the domain (β, γ) such that $Y_i^{TP} > Y_i^{MP}$ for country i or $Y_1^{TP} + Y_2^{TP} > Y_1^{MP} + Y_2^{MP}$ for the global economy. The dark shaded areas represent (β, γ) such that $Y_i^{TP} < Y_i^{MP}$ for country i or $Y_1^{TP} + Y_2^{TP} < Y_1^{MP} + Y_2^{MP}$ for the global economy. The white triangles represent the irrelevant area such that $\beta + 2\gamma \leq 0$. The columns in Figure 3 provides an overview of how the impacts of tax competition change in relationship to welfare consciousness ($\lambda = 0, 1/3, 2/3, 1$).

[Figure 3 around here]

We find that for sufficiently low λ tax competition may Pareto-improve welfare: both countries are better off than in the case without government intervention. In such a case, country 1 levies the capital tax more aggressively than country 2 as in our baseline model. This tax differential causes the international reallocation of capital from country 1 to country 2 and decreases the net return to capital, r . The decrease in r weakens an incentive for the public firm to decrease the production of M-good to avoid the loss of net

²⁵The derivative of equilibrium welfare in the case of mobile capital with a public firm (superscript *MP*) is

$$\frac{dY_1^{MP}}{d\lambda} = \frac{4\beta(\beta + \gamma)(\beta + 2\gamma)[\beta - (\beta + 2\gamma)\lambda]}{[5\beta + 6\gamma + (\beta + 2\gamma)\lambda]^3}.$$

$$\frac{dY_2^{MP}}{d\lambda} = -\frac{8\beta(\beta + \gamma)^2(\beta + 2\gamma)}{[5\beta + 6\gamma + (\beta + 2\gamma)\lambda]^3} < 0.$$

Therefore we have $dY_1^{MP}/d\lambda > 0$ for $\lambda < \beta/(\beta + 2\gamma)$.

²⁶A Sufficiently large α ensures that all endogenous variables are strictly positive. In addition, we can show that in the tax game the second-order conditions with respect to taxes are satisfied and the equilibrium is uniquely determined for all $\lambda \in [0, 1]$.

capital income, $r(1 - K_1 - M)$. Furthermore, when capital and M-good are sufficiently complementary, the capital inflows into country 2 stimulates X-sector production and increases the demand for M-good there. It amplifies an incentive for the public firm to increase its output to gain the revenue from exporting the intermediates, $p_M M_2$. These increased production in M-sector would benefit not only the resource-rich country but also the resource-poor country when capital and M-good are sufficiently complementary.

5.4 Cobb-Douglas production technology

Finally, we briefly discuss the specifications of technology for X-sector. In the baseline model, we have based our arguments on the quadratic production function in X-sector. How valid is this assumption in obtaining our main results? In fact, we can demonstrate that other types of production functions will lead to the same conclusions. As an example, consider a Cobb-Douglas production function in X-sector:

$$X_i = AK_i^a L_i^b M_i^{1-a-b}.$$

We maintain all the settings of the baseline model, except for the production function in X-sector. The equilibrium conditions are given in Appendix C. Although it is difficult to characterize the welfare properties analytically, numerical exercises indicate that the Cobb-Douglas production function generates similar results to those shown in the baseline model.

[Figures 4 and 5 around here]

Figures 4 and 5 depict the levels of the equilibrium welfare in each case with setting $a = b = 1/3$ and $A = 256$.²⁷ The domain of F is chosen to be $n \geq 2$. These numerical results turn out to be thoroughly consistent with the results obtained in the baseline model: capital mobility induces a resource curse, but tax competition creates a resource blessing.

6 Concluding remarks

The literature on capital market integration and tax competition has overlooked the role of natural resources. We examined how the availability of natural resources affects capital flow and governments' reactions to them, who benefits from capital mobility and

²⁷We have checked that other parameter values such as $a = b/4 = 1/6$ lead to similar results for a sufficiently small entry cost, F (i.e., a sufficiently large number of firms, n). These results are available upon request.

tax competition, and what are the welfare implications. In so doing, we developed an analytically solvable framework involving vertical linkages through 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 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 response 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 in the tax game. As a result, tax competition negatively affects global welfare. We also discussed the robustness of our results against possible extensions: our results hold true if the resource based sector is sufficiently competitive and trade costs of raw natural resources are sufficiently high.

Our findings shown in 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.

A Appendix

A.1 A. Definitions of parameter bundles

$$\Psi_1 \equiv 2\beta(\beta + \gamma)n^2 - 4(\beta + 2\gamma)(3\beta + 4\gamma)n - 5(\beta + 2\gamma)^2,$$

$$\Psi_2 \equiv 2(\beta + \gamma)(7\beta + 8\gamma)n^2 + 8(\beta + \gamma)(\beta + 2\gamma)n + (\beta + 2\gamma)^2,$$

$$\Psi_3 \equiv \Psi_2 - \Psi_1 = 2(\beta + \gamma)(3\beta + 4\gamma)n^2 + 2(\beta + 2\gamma)(5\beta + 6\gamma)n + 3(\beta + 2\gamma)^2,$$

$$\Psi_4 \equiv \frac{\beta(\beta + \gamma)(\beta + 2\gamma)n^2}{2[\beta + 2\gamma + n(3\beta + 4\gamma)]^2[\beta + 2\gamma + 2n(\beta + \gamma)]^2},$$

$$\Psi_5 \equiv \frac{2(\beta + \gamma)(3\beta + 4\gamma)n^2 + 4(\beta + \gamma)(\beta + 2\gamma)n + (\beta + 2\gamma)^2}{[\beta + 2\gamma + 2n(\beta + \gamma)]^2}.$$

A.2 B. Equilibrium conditions with tradable resources

We denote the equilibrium value of variable x by \hat{x} .

- in an autarky equilibrium:

$$\hat{r}_1^I = \alpha - \frac{9(\beta + \gamma)(\beta + 2\gamma) - (2\beta + 3\gamma)\tau}{3(5\beta + 6\gamma)},$$

$$\hat{r}_2^I = \hat{r}_1^I - \frac{2}{3}\tau,$$

$$\hat{p}_M^I = \alpha - \frac{(\beta + 2\gamma)(2\beta + 3\gamma) - (\beta + \gamma)\tau}{5\beta + 6\gamma}.$$

- in a laissez-faire equilibrium:

$$\hat{r}^M = \alpha - \frac{(\beta + \gamma)(3\beta + 6\gamma + \tau)}{5\beta + 6\gamma},$$

$$\hat{p}_M^M = \hat{p}_M^I.$$

- in a tax game:

$$\hat{r}^T = \alpha - \frac{(\beta + 2\gamma)(7\beta + 9\gamma) + (4\beta + 5\gamma)\tau}{3(5\beta + 6\gamma)},$$

$$\hat{t}_1^T = \hat{t}_2^T = -\frac{(\beta + 2\gamma)(2\beta - \tau)}{3(5\beta + 6\gamma)} < 0,$$

$$\hat{p}_M^T = \hat{p}_M^I.$$

The restriction of $\tau < \beta(\beta + 2\gamma)/(3\beta + 4\gamma)$ is required to guarantee that $p_M - r_2 - t_2 - \tau > 0$. This restriction also implies $\tau < 2\beta$, in which K_i and M_i are strictly positive. In addition, we assume that $\alpha > [(\beta + 2\gamma)(7\beta + 9\gamma) + (4\beta + 5\gamma)\tau]/[3(5\beta + 6\gamma)]$ such that r_i and w_i are strictly positive.

The welfare differentials are given by

$$\hat{Y}_1^I - \hat{Y}_2^I = \frac{4(\beta + \gamma)(2\beta - \tau)\tau}{3\beta(5\beta + 6\gamma)} > 0,$$

$$\hat{Y}_1^M - \hat{Y}_2^M = \frac{2(\beta + \gamma)(2\beta - \tau)\tau}{3\beta(5\beta + 6\gamma)} > 0,$$

$$\hat{Y}_1^T - \hat{Y}_2^T = \frac{4(\beta + \gamma)(2\beta - \tau)\tau}{3\beta(5\beta + 6\gamma)} > 0,$$

$$\hat{Y}_1^M - \hat{Y}_1^I = \frac{(\beta + \gamma)[12\beta(\beta + 2\gamma) + (29\beta + 30\gamma)\tau]\tau}{18\beta(\beta + 2\gamma)(5\beta + 6\gamma)} > 0,$$

$$\hat{Y}_2^M - \hat{Y}_2^I = -\frac{(\beta + \gamma)[12\beta(\beta + 2\gamma) - (41\beta + 54\gamma)\tau]\tau}{18\beta(\beta + 2\gamma)(5\beta + 6\gamma)},$$

$$\hat{Y}_1^M + \hat{Y}_2^M - \hat{Y}_1^I - \hat{Y}_2^I = \frac{7(\beta + \gamma)\tau^2}{9\beta(\beta + 2\gamma)} > 0,$$

$$\hat{Y}_1^T - \hat{Y}_1^M = -\frac{(\beta + \gamma)(2\beta - \tau)\tau}{3\beta(5\beta + 6\gamma)} < 0,$$

$$\hat{Y}_2^T - \hat{Y}_2^M = \frac{(\beta + \gamma)(2\beta - \tau)\tau}{3\beta(5\beta + 6\gamma)} > 0,$$

$$\begin{aligned}\hat{Y}_1^T + \hat{Y}_2^T - \hat{Y}_1^M - \hat{Y}_2^M &= 0, \\ \hat{Y}_1^T - \hat{Y}_1^I &= \hat{Y}_2^T - \hat{Y}_2^I = \frac{7(\beta + \gamma)\tau^2}{18\beta(\beta + 2\gamma)} > 0.\end{aligned}$$

We can easily see all the signs of welfare differentials for all $\beta > 0$, $\beta + 2\gamma > 0$ and $\tau < \beta(\beta + 2\gamma)/(3\beta + 4\gamma) < 2\beta$ except for $\hat{Y}_2^M - \hat{Y}_2^I$. One has

$$\text{sgn} \left[\hat{Y}_2^M - \hat{Y}_2^I \right] = \text{sgn} \left[\tau - \frac{12\beta(\beta + 2\gamma)}{41\beta + 54\gamma} \right].$$

A.3 C. Equilibrium conditions under a Cobb-Douglas production function

From the profit maximization in X-sector, the inverse demand function for M-good is

$$p_M = (1 - a - b)A\Psi_6 M^{-a-b},$$

where

$$\Psi_6 \equiv [(K_1^a L_1^b)^{\frac{1}{a+b}} + (K_2^a L_2^b)^{\frac{1}{a+b}}]^{a+b}.$$

In the symmetric Cournot equilibrium, the sales of M-good in country i are

$$M_i = \left[\frac{(1 - a - b)(n - a - b)AK_i^a L_i^b}{(r_1 + t_1)n} \right]^{\frac{1}{a+b}},$$

and the price of M-good is

$$p_M = \frac{(r_1 + t_1)n}{n - a - b}.$$

The number of M-firms is determined by the zero profit condition

$$nF = (p_M - r_1 - t_1)M.$$

The profit maximization in X-sector and the labor market clearing ($L_i = 1$) yield the wage rate

$$w_i = b\Psi_7 K_i^{\frac{a}{a+b}} (r_1 + t_1)^{-\frac{1-a-b}{a+b}},$$

where

$$\Psi_7 \equiv A^{\frac{1}{a+b}} \left[\frac{(1 - a - b)(n - a - b)}{n} \right]^{\frac{1-a-b}{a+b}} > 0.$$

The capital demand in X-sector in country i is

$$\begin{aligned}r_1 + t_1 &= (a\Psi_7)^{a+b} K_1^{-b}, \\ r_2 + t_2 &= a\Psi_7 K_2^{-\frac{b}{a+b}} (r_1 + t_1)^{-\frac{1-a-b}{a+b}}.\end{aligned}$$

The capital demand in M-sector is $M = M_1 + M_2$. The capital market equilibrium requires eq.(8) for the case of immobile capital, and eq.(9) and $r_1 = r_2$ for the other cases.

The tax competition equilibrium requires $\partial Y_1 / \partial t_1 = \partial Y_2 / \partial t_2 = 0$ in addition to the profit maximization, the free entry conditions, and the factor market clearing conditions.

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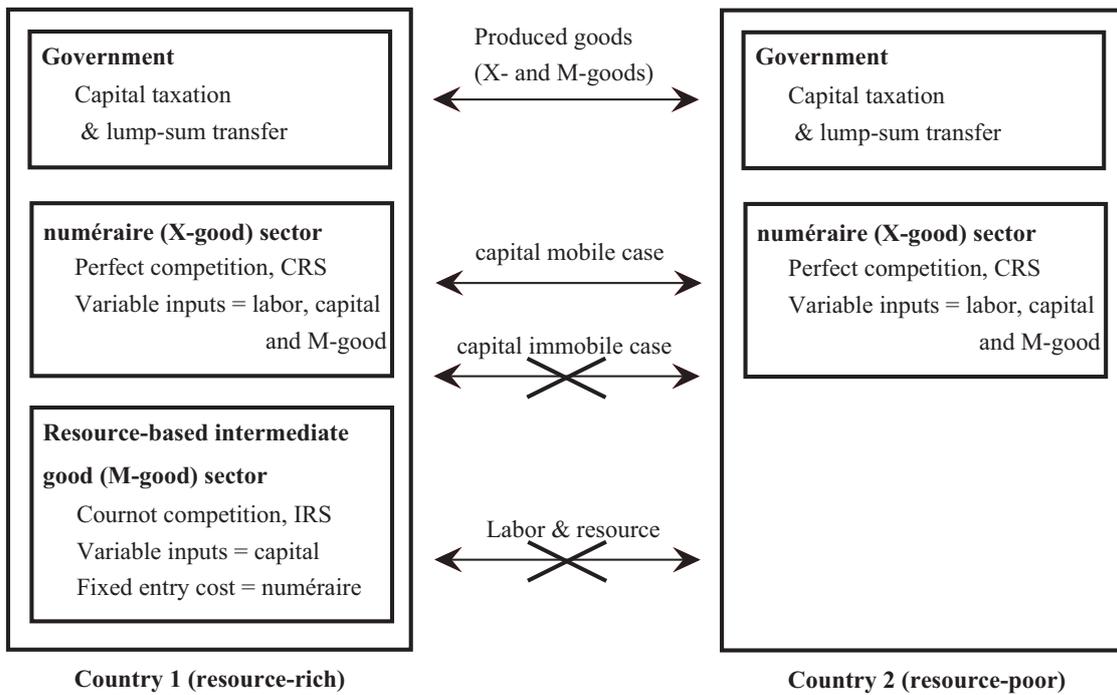
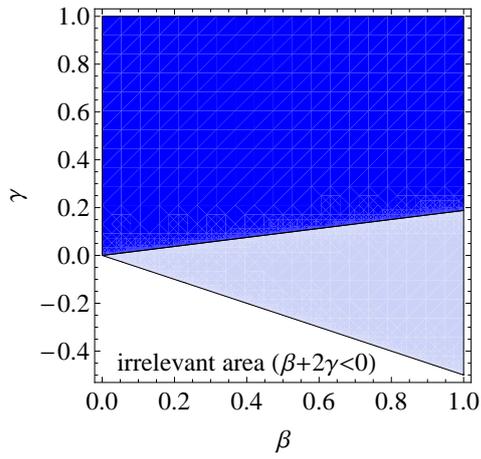
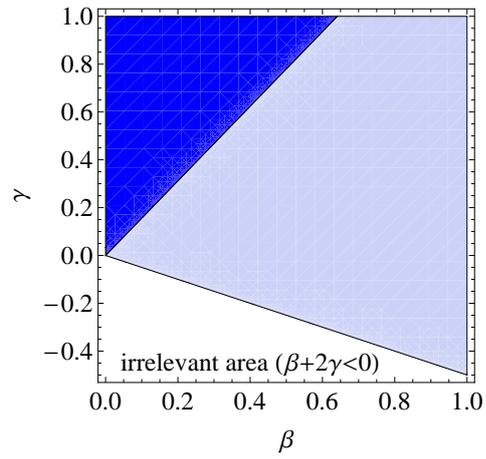


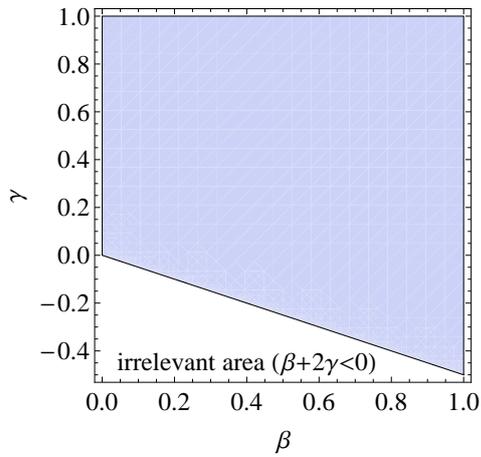
Figure 1: Schematic diagram of the model



(A) $n = 1$.



(B) $n = 3/2$.



(C) $n = 2, 3, 10, 20, \text{ or } 100$.

Figure 2: Numerical examples. *Notes:* The horizontal and vertical axes represent β and γ , respectively. The light shaded areas represent a parameter set (β, γ) such that country 1 gains for each n . The dark shaded areas represent (β, γ) such that country 1 loses for each n . The white triangles represent the invalid areas in which $\beta + \gamma \leq 2$.

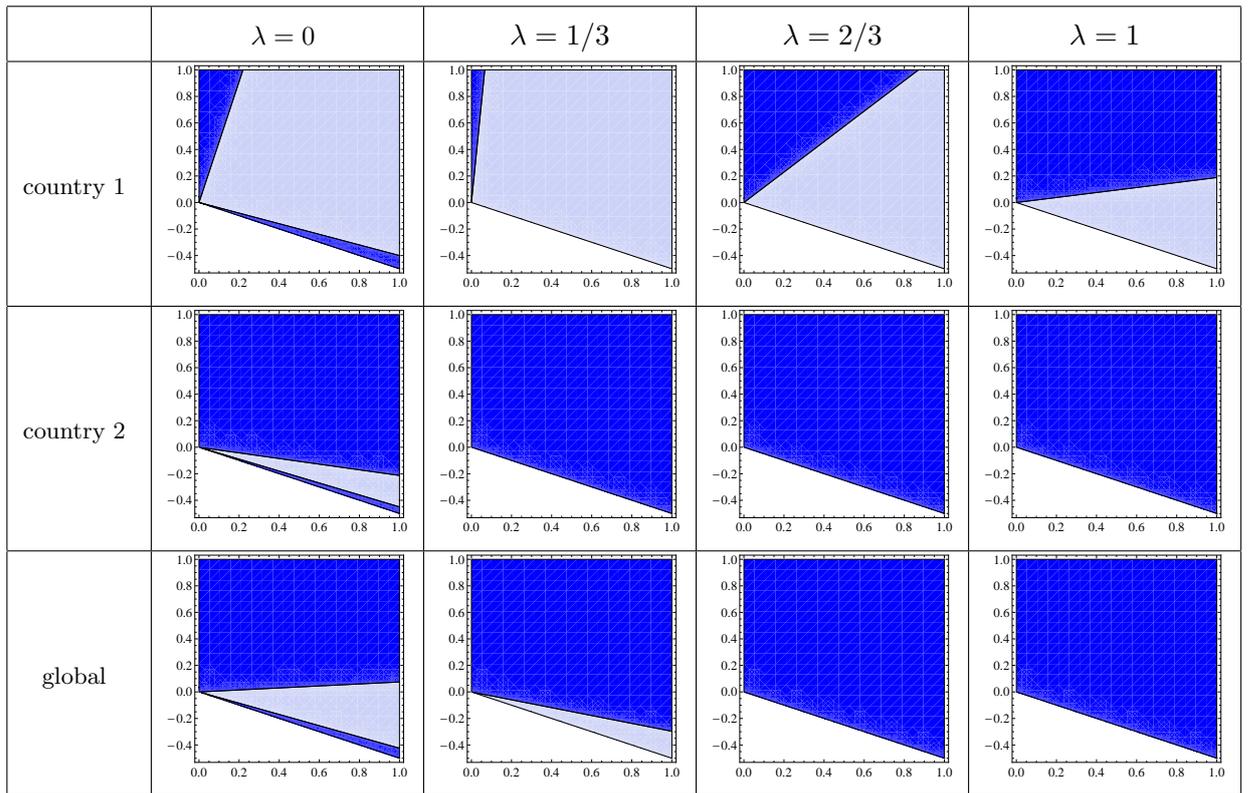


Figure 3: Welfare effects of tax competition with a publicfirm. *Notes:* The horizontal and vertical axes represent β and γ , respectively. The light shaded areas represent a parameter set (β, γ) such that country i or the global economy gains. The dark shaded areas represent (β, γ) such that country i or the global economy loses. The white triangles represent the invalid areas in which $\beta + \gamma \leq 2$.

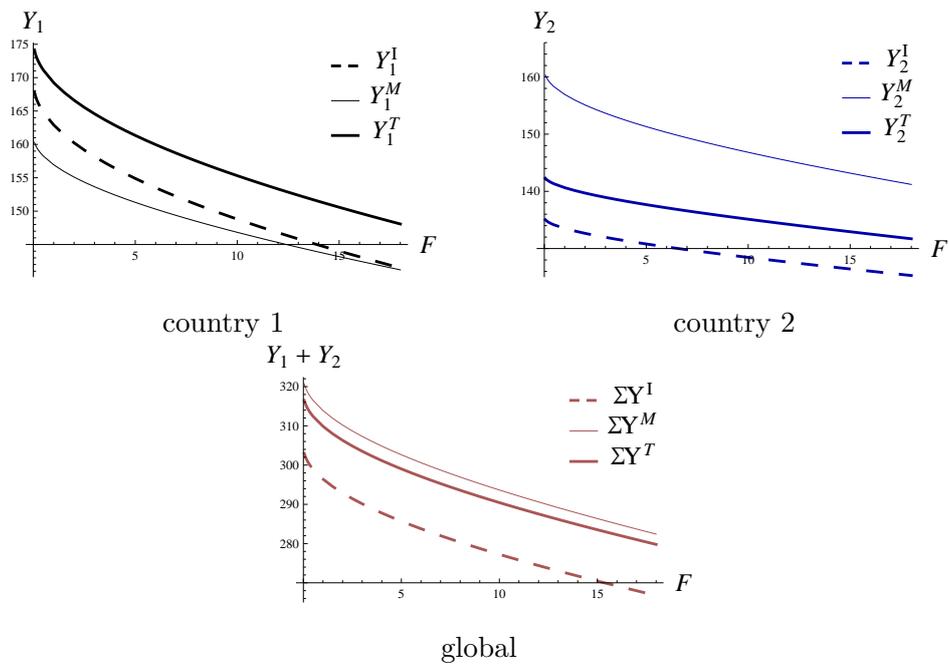


Figure 4: Comparisons among the cases.

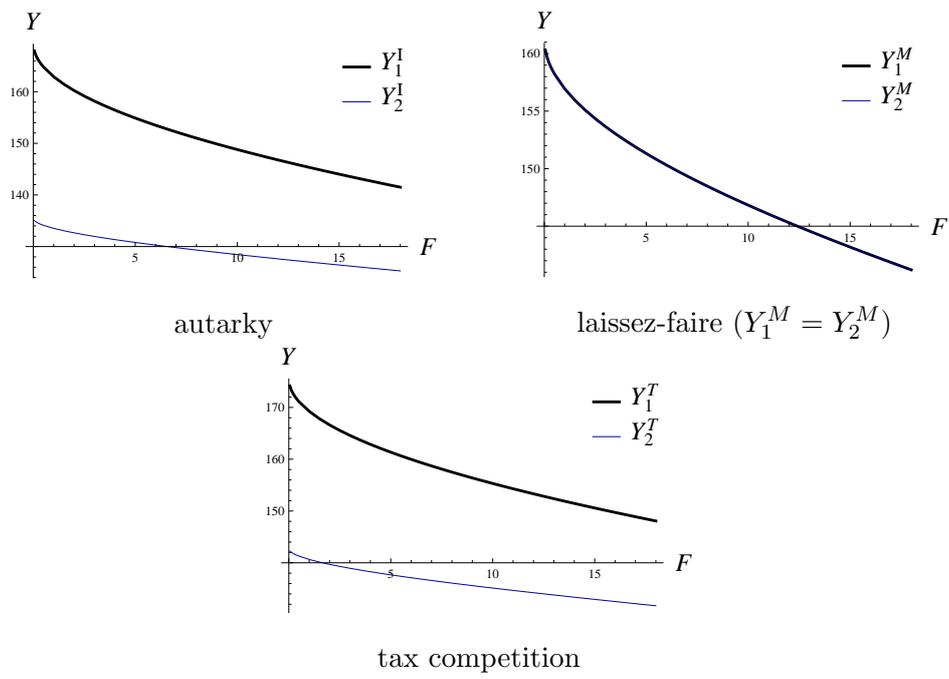


Figure 5: Cross-country comparisons.