

Essays on Agglomeration and Economic Policy

by
Hayato Kato

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Preface

Even in the modern world where the advancements of transportation infrastructure and information technology make easy the international movement of goods, people and capital, we are, of course, still not free from various kinds of impediments like physical distance and barriers to trade. In such a world, where you locate matters a lot; special attention should be paid to spatial aspects of economic activities. Economic activities tend to be agglomerated in a particular place with a view to saving costs of transporting goods. This is the notion of “home-market effect”, or the fundamental wisdom we learn from the new trade theory/ new economic geography (Fujita et al., 1999).

When considering economic policies and development strategies, it is crucially vital for policy makers to take into account spatial aspects; otherwise they are likely to draw misguided conclusions. This dissertation consists of three essays on addressing the consequences of policies in agglomeration economies with specific focuses on tax competition and industrial development.

In Chapter 1, we give the basic introduction of economic geography models and selectively review the literature related to this thesis. We also briefly discuss the overviews of subsequent chapters.

Chapter 2 and 3 deal with tax competition. In Chapter 2, we analyze tax competition between countries with political motives. The governments are preoccupied with collecting contributions from capital owners so that they are likely to set their tax rate in favor of capital owners. Consequently, the small country in size has a lower tax rate and hosts a more-than-proportionate share of firms. The result is suggestive for explaining the success of some small and low-tax countries.

In Chapter 3, we examine the role of governments’ commitment to their long-term tax schedule. It is shown that if commitment is possible, all firms are located in one country whereas if it is impossible, firms are located evenly in countries. Commitment is helpful for attracting industry,

but it is at the same time harmful on account of the loss of flexibility of policies.

Chapter 4 turns the focus to the industrial development of countries. We explore the impact of trade liberalization on economic transition from traditional sectors to modern sectors. The openness of the traditional sector of a country turns out to be the key to modernizing economy. If the traditional product is not internationally traded, trade liberalization in the modern sector accelerates the industrialization of the country with a better technology in the traditional sector. However, if the product is traded, the conclusion is reversed.

In Chapter 5, we summarize the insights obtained in Chapters 2 to 4 and suggest directions for future research.

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Chapter 1

General Introduction

It is now widely recognized that careful consideration of spatial aspects of economic activities is essential to make public and industrial policies effective. In Japan, for example, policy makers attempt to enhance national competitiveness by promoting local industrial clusters (“Industrial Cluster Policy” by METI ¹). In developing countries, establishing special economic zones is a significantly effective policy measure to attract foreign direct investment where the host government sets more flexible policies and regulations.

Among various kinds of policies, we devote ourselves in this dissertation to study two specific policies: tax competition and development strategy of industrialization. Corporate tax policies and modernizing strategies distinctly illustrate the implications of agglomeration tendencies because both are designed to attract industry from around the world. In this chapter, we summarize the basic concepts of “new economic geography” models and give selective literature reviews on corporate tax policies and development. We also provide a brief overview of each chapter.

1.1 Basic Concepts of New Economic Geography Models

Little attention had been paid to the spatial aspects of economic activities until the seminal work by Krugman (1991b) gained popularity. Based on a monopolistic competition model of international trade, he allows factors of production to move between countries, unlike many other trade theories

¹Details can be found at: http://www.meti.go.jp/policy/local_economy/tiikiinnovation/industrial_cluster_en.html

such as Richardian and Heckscher-Ohlin theories and sees how economic activities are spatially distributed. Since his work, the research agenda on investigating the impact of factor mobility in imperfect competitive trade models has been the so-called “new economic geography”.

To illustrate the fundamental structure of spatial models, instead of elaborating Krugman (1991b)’s original core-periphery model, we go through a simple version of new economic geography models, i.e., the “footloose capital” model developed by Martin and Rogers (1995). In the following, we follow the expositions of Baldwin et al. (2003) and Forslid and Okubo (2012).

1.1.1 Review of the Footloose Capital Model

Setup

We consider two countries, indexed by 1 and 2, two sectors, traditional and modern sectors, and two factors, labor and capital. Country $i \in \{1, 2\}$ is endowed with $L_i = s_i L$ units of workers and $K_i = s_i K$ units of capital, where $s_i \in (0, 1)$ ($s_1 = s$; $s_2 = 1 - s_1$) denotes the endowment share in country i . Countries are symmetric except for size; we assume country 1 is larger: $s > 1/2$. To exclude the Heckscher-Ohline motives of trade, we ignore the difference of capital-labor ratio by assuming the identical ratio: $L_i/K_i = L/K$. Capital, which is specific to the modern sector, is “footloose” in the sense that it can move between countries. Workers own capital and can move between sectors but are internationally immobile. The traditional sector produces a homogeneous good with a constant-returns technology only using labor. The modern sector produces differentiated products with an increasing-returns technology using both capital and labor.²

Demand Side

The aggregate consumer in country i solves the following problem:

$$\max U_i = Q_i^\mu q_{i0}^{1-\mu}, \quad \text{s.t.} \quad \int_{\omega \in \Omega_i} p_{ii}(\omega) q_{ii}(\omega) d\omega + \int_{\omega \in \Omega_j} p_{ji}(\omega) q_{ji}(\omega) d\omega + p_{0i} q_{0i} = Y_i,$$

$$\text{where } Q_i = \left[\int_{\omega \in \Omega_i} q_{ii}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega + \int_{\omega \in \Omega_j} q_{ji}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}, \quad i, j \in \{1, 2\}, i \neq j.$$

²Following the literature, we also use the term of “agriculture” indicating the constant-returns sector and that of “manufacturing” representing the increasing-returns sector.

and where $\mu \in (0, 1)$ and $\sigma > 1$ are constants. ω indicates a brand of the differentiated products and Ω_i represents the set of consumed varieties in i . $q_{ji}(\omega)$ is the amount of consumed brand ω in i produced in j and Q_i is the consumption index of the modern products in i . q_{i0} is consumption of the traditional good in i . Y_i is national income in i , which we will discuss shortly.

The consumer spends a share μ of her income on modern goods so that total demand for a brand of modern goods becomes

$$q_{ij}(\omega) = \frac{p_{ij}(\omega)^{-\sigma}}{P_j^{1-\sigma}} \mu Y_j,$$

$$\text{where } P_j = \left[\int_{\omega \in \Omega_i} p_{ij}(\omega)^{1-\sigma} d\omega + \int_{\omega \in \Omega_j} p_{jj}(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}, \quad i, j \in \{1, 2\}, i \neq j,$$

where $p_{ij}(\omega)$ is the price of consumed brand ω in j produced in i , and P_j is a price index of modern goods in j . The demand for the traditional good is $q_{0i} = (1 - \mu)Y_i/p_{0i}$.

Supply Side

In the traditional sector, perfect competition due to a constant-returns technology implies that the price is equal to the marginal cost: $p_{0i} = w_i a_0$, where w_i is the wage rate in country i and a_0 is the unit labor requirement in the sector. We choose the traditional good as the numéraire and normalize a_0 to one. Since there are no costs of shipping the good abroad, we have $p_{0i} = w_i = 1$ for $i \in \{1, 2\}$.

Turning to the modern sector, firms in country i use labor as a variable input with the unit labor requirement a_i and need one unit of capital for start-up costs. The individual operating profit (sales subtracted by hiring costs of workers), denoted by π_i , is repatriated to its capital owners so that π_i also means the reward to one unit of capital.

Shipping the modern goods incurs a fractional trade cost of the iceberg form: firms must ship $\tau > 1$ units of good to deliver one unit to a foreign country. The maximizing behavior of a firm in country i gives the following constant mark up pricing for the domestic good:

$$p_{ii} = \frac{\sigma a_i}{\sigma - 1}.$$

The export price is $p_{ij} = \tau p_{ii}$, reflecting the iceberg trade costs. In this section we assume identical technology between the two countries: $a_1 = a_2 = a$.

Ownership of Capital

We assume that capital ownership is perfectly internationally diversified, in the sense that capital owners in each country receive the same return to capital. To be precise, the return is $r = \pi_1\lambda + \pi_2(1 - \lambda)$, where $\lambda \in [0, 1]$ is the share of capital (firm) employed in country 1. It is confirmed that the world capital market is clear: $rK_1 + rK_2 = \pi_1\lambda K + \pi_2(1 - \lambda)K$. Noting the constant mark up pricing and the market clearing condition for modern goods, the world income can be written as $Y_1 + Y_2 = Y^w = 1 \times L + rK = L + \mu Y^w / \sigma$, yielding $Y^w = [\sigma / (\sigma - \mu)]L$.³ The country i 's share of world income turns out to be the same as that of factor endowments:

$$Y_i = L_i + rK_i = s_i(L + rK) = s_i Y^w \left(= s_i \frac{\sigma L}{\sigma - \mu} \right).$$

³The operating profit can be written as $\pi = pq - aq = pq - [(\sigma - 1)/\sigma]pq = pq/\sigma$. The world market clearing condition for modern goods requires $\mu Y^w = \sigma\pi_1\lambda K + \sigma\pi_2(1 - \lambda)K$. The diversified portfolio implies $\pi_1\lambda K + \pi_2(1 - \lambda)K = rK$ so that it holds that $rK = \mu Y^w / \sigma$.

Location Tendencies

With the help of expressions derived so far, the operating profits can be expressed as the following simple forms:⁴

$$\pi_1 = \frac{\mu L}{(\sigma - \mu)K} \left[\frac{s}{\lambda + \phi(1 - \lambda)} + \frac{\phi(1 - s)}{\phi\lambda + 1 - \lambda} \right],$$

$$\pi_2 = \frac{\mu L}{(\sigma - \mu)K} \left[\frac{\phi s}{\lambda + \phi(1 - \lambda)} + \frac{1 - s}{\phi\lambda + 1 - \lambda} \right],$$

where $\phi = \tau^{1-\sigma} \in [0, 1]$ measures the freeness of trade and higher values mean more open.

To see forces at work, we look at the profit differential:

$$\Delta\pi = \pi_1 - \pi_2 = [\phi(2s - 1) - (1 - \phi)(\lambda - s)]\Pi, \quad (1.1)$$

where $\Pi = \frac{\mu L(1 - \phi)}{K(\sigma - \mu)[1 - (1 - \phi)\lambda][\lambda + \phi(1 - \lambda)]} > 0$.

The first term inside the square bracket, $\phi(2s - 1)$, shows the *market access effect*, i.e., how the difference of countries' expenditures affects the location incentives of firms. With positive trade costs ($\tau > 1$ or $\phi > 0$), firms are ready to locate the larger country to take the advantage of market access. This is the sole force to promote agglomeration in the footloose capital model.

The second term inside the square bracket, $-(1 - \phi)(\lambda - s)$, captures the *market crowding effect*,

⁴To be more precise, we have

$$\begin{aligned} \pi_1 &= (p_{11} - w_1 a_1)q_{11} + (p_{12} - w_1 \tau a_1)q_{12} \\ &= \left(\frac{\sigma w_1 a_1}{\sigma - 1} - w_1 a_1 \right) q_{11} + \left(\frac{\sigma w_1 \tau a_1}{\sigma - 1} - w_1 \tau a_1 \right) q_{12} \\ &= \left(\frac{w_1 a_1}{\sigma - 1} \right) \frac{p_{11}^{-\sigma}}{p_1^{1-\sigma}} \mu Y_1 + \left(\frac{w_1 a_1 \tau}{\sigma - 1} \right) \frac{p_{12}^{-\sigma}}{p_2^{1-\sigma}} \mu Y_2 \\ &= \frac{p_{11}^{1-\sigma}}{\sigma p_1^{1-\sigma}} \mu Y_1 + \frac{p_{12}^{1-\sigma}}{\sigma p_2^{1-\sigma}} \mu Y_2 \\ &= \frac{p_{11}^{1-\sigma}}{\sigma [\lambda K p_{11}^{1-\sigma} + (1 - \lambda) K p_{21}^{1-\sigma}]} \mu Y_1 + \frac{p_{12}^{1-\sigma}}{\sigma [\lambda K p_{12}^{1-\sigma} + (1 - \lambda) K p_{22}^{1-\sigma}]} \mu Y_2 \\ &= \frac{\mu L}{K(\sigma - \mu)} \left[\frac{s}{\lambda + (1 - \lambda)(p_{21}/p_{11})^{1-\sigma}} + \frac{(1 - s)(p_{12}/p_{22})^{1-\sigma}}{\lambda(p_{12}/p_{22})^{1-\sigma} + 1 - \lambda} \right] \\ &= \frac{\mu L}{K(\sigma - \mu)} \left[\frac{s}{\lambda + \phi(1 - \lambda)/\omega} + \frac{\omega\phi(1 - s)}{\omega\phi\lambda + 1 - \lambda} \right], \quad \text{where } \omega = \left(\frac{w_1 a_1}{w_2 a_2} \right)^{1-\sigma}. \end{aligned}$$

Substituting $w_1 = w_2 = 1$ and $a_1 = a_2 = a$ into the above expression gives the forms in the text.

i.e., how the spatial distribution of firms brings difference in profitability of each country. A country having a more share of firms than its endowment share ($\lambda_i > s_i$; $\lambda_1 = \lambda$; $\lambda_2 = 1 - \lambda$) discourages firms to locate in this competitive market. This is the sole dispersion force in the model.

In addition, the market access effect becomes more important relative to the market crowding effect as the trade freeness $\phi = \tau^{1-\sigma}$ gets higher. In other words, the lower trade costs τ and the elasticity of substitution σ are, the more pronounced the access advantage is. This point plays a key role in the analysis in Chapter 4.

Location Equilibrium and the Home Market Effect

Free movement of capital equalizes the operating profits to determine the equilibrium share of firms:

$$\Delta\pi = 0 \text{ or } \lambda = s + \frac{\phi(2s - 1)}{1 - \phi} > s. \quad (1.2)$$

Since country 1 is larger: $s > 1/2$, λ is greater than s . The result that the larger country hosts a greater share of firms than its endowment share is the so-called *home market effect*. One can naturally expect that the larger country attracts more than one-half of capital in the world; the notable thing here is that it hosts a more than proportionate share of capital. To see this, setting hypothetically $\lambda = s$ at (1.1), the profit gap $\Delta\pi$ becomes positive. The positive market access effect exceeds the negative market crowding effect so that the larger country hosting a more than one-half of firms is still a profitable market.

Another way of looking this is to take the derivative of the firm share with respect to the endowment share:

$$\frac{d\lambda}{ds} = 1 + \frac{2\phi}{1 - \phi} > 1.$$

An increase in the endowment share brings a more than proportionate increase in the firm share. It is easily seen that λ is increasing in ϕ if $s > 1/2$: the home-market magnification gets more powerful at lower trade costs. Locating in the smaller country protects firms there from tougher competition with many firms in the larger country. On the other hand, it brings firms lower profits due to the small demand. Reductions in trade costs exacerbate the former negative effect. The firm

share in the small country are so small that the penetration of cheaper imported products is tense. The location disadvantage of the small market gets larger as trade costs are reduced.

Agglomeration Rent

The impact of agglomeration can be clear when we consider the “core-periphery” situation: one country hosts all firms. Suppose $\lambda = 1$, the profit gap then becomes

$$\Delta\pi(\lambda = 1) = \frac{\mu L(1 - \phi)[s(1 + \phi) - 1]}{\phi K(\sigma - \mu)},$$

which is the so-called *agglomeration rent*. $\Delta\pi(\lambda = 1)$ as a function of ϕ takes zero both at $\phi = \phi^* = (1 - s)/s$ and at $\phi = 1$. It takes positive values in between and can be negative at $\phi \in (0, \phi^*)$. Moreover, it is readily confirmed that the rent is concave.⁵ The agglomeration rent is hump-shaped: it rises first and then falls. When considering tax policies, the core country is in an advantageous position over the peripheral country because of this taxable rent.

1.1.2 Terminology

It is worth spending some spaces on the specific terms routinely used in the thesis.

New Economic Geography and New Trade Theory

The so-called “new trade theory” dates back to the Krugman’s seminal works (Krugman, 1979 and Krugman, 1980), about ten years before the emergence of the new economic geography. Both fields use almost the same analytical tools such as the Dixit-Stiglitz preference and increasing-returns technologies and investigate intra-industry trade, which traditional trade theories cannot fully explain. The fundamental difference between the two fields is in whether or not factors of production move across countries. In the new trade theory, the factors are not mobile across countries and the equilibrium mass of firms in modern sectors subject to increasing returns is determined by free

⁵The first and second derivatives are

$$\frac{d\Delta\pi(\lambda = 1)}{d\phi} = \frac{\mu L[1 - s(1 + \phi^2)]}{\phi^2 K(\sigma - \mu)}, \quad \frac{d^2\Delta\pi(\lambda = 1)}{d\phi^2} = -\frac{2\mu L(1 - s)}{\phi^3 K(\sigma - \mu)} < 0.$$

$\Delta\pi(\lambda = 1)$ reaches its peak at $\phi^{**} = \sqrt{(1 - s)/s}$ and it holds that $\phi^* < \phi^{**}$ if $s > 1/2$.

entry and exit. In the new economic geography, on the other hand, the factors used for fixed inputs in modern sectors (e.g., capital in the FC model) are internationally mobile and the no-arbitrage condition, i.e., the factor price equalization, pins down the equilibrium mass of firms.

We briefly review a simple model in the new trade theory by Helpman and Krugman (1985) giving the results qualitatively similar to those in the FC model. We modify the FC model in three points; (i) allowing for free entry and exit in the modern sector, (ii) only one factor of production (labor) and (iii) the factor being immobile.

Let the fixed requirement of labor be f and the mass of firms in country i be M_i , we can confirm that the operating profits take the following forms, which is quite similar to the counterparts of the FC model:

$$\pi_1 = \frac{\mu L}{\sigma} \left[\frac{s}{M_1 + \phi M_2} + \frac{\phi(1-s)}{\phi M_1 + M_2} \right],$$

$$\pi_2 = \frac{\mu L}{\sigma} \left[\frac{\phi s}{M_1 + \phi M_2} + \frac{1-s}{\phi M_1 + M_2} \right],$$

where we use $Y_i = w_i L_i = L_i$ and note that the costless trade of the traditional good equalizes the price between the countries, which determines the wage rate ($p_{01} = w_1 = p_{02} = w_2 = 1$).

Free entry and exit, rather than the free movement of capital, pins down the equilibrium mass of firms; the above operating profits must be allotted for the the fixed labor requirement, i.e., $\pi_i = w_i f = f$. Solving these equilibrium equations for the mass of firms gives

$$M_1 = \frac{\mu L}{\sigma f} \frac{[s(1+\phi) - \phi]}{1 - \phi},$$

$$M_2 = \frac{\mu L}{\sigma f} \frac{[1 - s(1+\phi)]}{1 - \phi}.$$

Since we have $M_1 + M_2 = \mu L / (\sigma f)$, the equilibrium share of firms in i turns out to be the same as that in the FC model:

$$M_1 = (M_1 + M_2) \frac{[s(1+\phi) - \phi]}{1 - \phi},$$

$$\text{or } \lambda = \frac{M_1}{M_1 + M_2} = \frac{s(1+\phi) - \phi}{1 - \phi} = s + \frac{\phi(2s-1)}{1 - \phi}.$$

One difference between the above Helpman-Krugman model and the FC model appears in

income. In the FC model, residents earn capital income $(\pi_i K_i)$ as well as labor income $(w_i L_i)$. Since most studies in the literature consider the situation where the factor price equalization holds, this difference does not matter for the qualitative implications of the two models. If the factor prices are not equalized for some reasons such as the costly trade of the homogeneous good, however, the two models give different implications, which we will see in Section 1.3.1.⁶

Contexts: Cities, Regions and Countries

The major purposes of applied theoretical research are to explain stylized facts and provide predictions for empirical studies. It is thus essential to define the scope and context of theoretical analysis. If there are multiple isolated economies in a model, we can call them either city, regions, or countries. In the pioneering work of Fujita et al. (1999), they distinguish these three in the following way (Fujita et al., 1999, p.329); in “regional” models, manufacturing production is mobile but agriculture is not: in “urban” models, everything except land is mobile: in “international” models, production factors do not move. The new trade theory fits in “international” models since the unique factor of production, labor, is immobile between the two isolated economies.

However, previous and subsequent studies have not necessarily followed this classification. For example, Martin and Rogers (1995) first proposed the FC model as an “international” one although it is regarded as a “regional” model according to Fujita et al. (1999). Studies on tax competition and agglomeration economy we will introduce in the next section use “countries” and “regions” interchangeably. It would be a nice idea to use these terms of spatial units depending on the context of analysis. When considering international tax competition where countries try to attract capital for production rather than individual investors, the FC model is suited to examine the issue and is reasonably called an international model.

⁶The two models are also different in how output and input levels are linked with factor prices. To see this, we first re-express the operating profit in a simple form:

$$\begin{aligned}\pi_1 &= (p_{11} - w_1 a)q_{11} + (p_{12} - w_1 \tau a)q_{12} \\ &= p_{11}q_1/\sigma, \quad \text{where } q_1 = q_{11} + \tau q_{12},\end{aligned}$$

and where we use $p_{11} = (\sigma w_1 a)/(\sigma - 1)$ and $p_{12} = \tau p_{11}$. q_1 denotes the total output of each firm. In the Helpman-Krugman model, it holds that $\pi_1 = p_{11}q_1/\sigma = w_1 f$ or $q_1 = \sigma w_1 f/p_{11} = (\sigma - 1)f/a$ and the labor input of each firm is $n_1 = aq_1 = (\sigma - 1)f$. Both output and input are independent of the factor price. In the FC model, it holds that $\pi_1 = p_{11}q_1/\sigma = \pi_1 f$ or $q_1 = \sigma \pi_1 f/p_{11} = (\sigma - 1)\pi_1 f/(w_1 a)$ and the labor input of each firm is $n_1 = aq_1 = (\sigma - 1)\pi_1 f/w_1$. Here, unlike the former model, input and output depend on the factor prices.

1.1.3 Related Literature

Other New Economic Geography Models. The footloose capital model is the most parsimonious one to generate spatial agglomeration of economic activities. Its tractability is obtained at the expense of ignoring other interesting market forces. The original core-periphery model by Krugman (1991b) provides a richer framework, though it is hard to deal with analytically. He assumes that two factors of production, entrepreneurs and workers, are sector specific: entrepreneurs engage in the modern sector and workers in the traditional sector.⁷ Entrepreneurs are internationally mobile between countries so that the spatial patterns are affected by the international difference of real wages, not just the difference of factor rewards as in the footloose capital model. As can be seen in (1.2), if two countries are symmetric ($s = 1/2$), agglomeration never emerges in the footloose capital model. This is because the model captures only “backward-linkages” between supply and demand, which mean that suppliers are ready to locate in a place with a larger demand. In the core-periphery model, “forward-linkages” also come in; consumers try to move to a place with lower prices (many varieties). The agglomeration of entrepreneurs (as producers) in a country makes the cost of living there lower and thus attracts more entrepreneurs (as consumers) seeking higher real wages. The expansion of consumption in the country in turn induces further agglomeration of production. This circular causality gives strong agglomeration forces so that the core-periphery model generates a symmetry breaking result: even if two countries are totally symmetric, one country may end up with hosting all industry. The core-periphery model is simplified by the “footloose entrepreneur” model by Forslid and Ottaviano (2003).⁸

The new economic geography models introduced so far all adopt the CES preference as in Dixit and Stiglitz (1977). Ottaviano et al. (2002) use a quadratic utility in the footloose entrepreneur framework and give the qualitatively same results as other CES-type models. Their model is further simplified by Ludema and Wooton (2000) and Thisse (2010) in an oligopolistic competitive framework. The lists of geography models here are far from complete; see Baldwin et al. (2003) and Fujita and Thisse (2013) for comprehensive surveys.

Chapter 4 employs the footloose capital model presented here with several modifications. Chap-

⁷In Krugman (1991b), he calls the production factor specific to the agricultural (traditional) sector as a “farmer” and the factor specific to the manufacturing (modern) sector as a “worker”.

⁸Unlike Krugman (1991b), Forslid and Ottaviano (2003) assume that entrepreneurs are employed by modern firms as a fixed input and workers are employed as a variable input in both modern and traditional sectors.

ters 2 and 3 adopt the specification of Ludema and Wooton (2000) and Thisse (2010).

Forward-looking Behavior. One of the modeling tricks taken by Fujita et al. (1999) is to adopt ad-hoc dynamics based on myopic agents. Baldwin (2001) and Ottaviano (2001) are early attempts to treat forward-looking agents rigorously. They show that if migration costs of agents are high, the qualitative results remain the same as those under myopic agents, whereas if migration costs are low, expectations of agents are crucial for determining the spatial configurations of economic activities. Oyama (2009a,b) proceed dynamic analysis further to provide richer results such as the uniqueness of location equilibrium. Chapter 4 considers dynamic aspects of governments, rather than firms.

1.2 Agglomeration and Tax Competition

Economic geography models can be applicable to various kinds of policies such as preferential trade agreements and transportation infrastructure. However, according to Baldwin et al. (2003, p.365), “[O]ne of the most exciting applications of new economic geography models to policy questions lies in the area of taxation and tax competition.” The reason is that agglomeration economies are “lumpy” by nature: even a slight change of corporate tax rates can drastically change firms’ location incentives and spatial outcomes. This section reviews the literature in this line using the footloose capital model.

1.2.1 The Importance of Being Big

We briefly go over the central implications of the seminal paper by Baldwin and Krugman (2004). The interesting case is when trade costs are low enough to generate agglomeration tendencies: namely, $\phi \in (\phi^*, 1)$, in which range it holds that $\Delta\pi(\lambda = 1) > 0$. Consider a tax competition game in a Stackelberg fashion played by two countries. Taxes are imposed in a lump-sum way. Suppose that country 1 has all firms at the beginning of the game. The game proceeds as follows. Country 1 (the core) sets its tax rate first and then country 2 (the periphery) does so. Firms decide their location last responding to the after-tax profit gap: $[\pi_1(\lambda = 1) - T_1] - [\pi_2(\lambda = 1) - T_2]$, where T_i is the tax rate of country $i \in \{1, 2\}$.

Let us solve the problem backward. The core chooses its tax rate so as to make the after-tax gap zero to keep its industry: $\tilde{T}_1 = \Delta\pi(\lambda = 1) + T_2$. The periphery has no choice but to choose zero tax rate because only negative tax rates allow it to snatch firms from the core. To be specific, firms delocation occurs if $[\pi_1(\lambda = 1) - \tilde{T}_1] - [\pi_2(\lambda = 1) - T_2] < 0$ and this condition leads to $T_2 < \tilde{T}_1 - \Delta\pi(\lambda = 1) = 0$. The equilibrium tax rates are $T_1^* = \Delta\pi(\lambda = 1)$ and $T_2^* = 0$.

The core's tax rate are nothing but the agglomeration rent. The core keeps its initial advantageous position while imposing a higher tax rate than the periphery. This result clearly shows the importance of being big. Since the rent is inverted U-shaped and has its peak at $\phi^{**} (> \phi^*)$, the tax rate of the core first rises and then falls. Baldwin and Krugman (2004) call the result a "race to the top". They argue that this is supported by the recent pattern of effective tax rate gap between core and peripheral countries in the EU.

1.2.2 Related Literature

Apart from Baldwin and Krugman (2004), earlier contributions include Ludema and Wooton (2000); Kind et al. (2000); Andersson and Forslid (2003); and Borck and Pflüger (2006). The main findings of the literature are the superiority of the core country we just have seen. While most of these studies deal with symmetric market size, Ottaviano and van Ypersele (2005) and Haufler and Wooton (2010) analyze asymmetric tax competition in spatial models and obtain the similar results. In empirical studies, overall conclusions are mixed: Charlot and Paty (2007), Brülhart et al. (2012) and Koh et al. (2013) support the taxable-agglomeration-rents hypothesis, whereas Luthi and Schmidheiny (2014) and Brülhart and Simpson (2015) do not.

Tax Competition in Public Finance. Tax competition has been extensively analyzed in the neoclassical framework (Wilson, 1986; Zodrow and Mieszkowski, 1986; Keen and Konrad, 2012, for a comprehensive survey). The central message in the literature is that tax competition leads to a "race to the bottom"; countries end up with charging a lower tax rate and providing an inefficient level of public goods, relative to the case of no competition.⁹ This comes from the fact that the social marginal benefit of providing public goods exceeds the private marginal costs.

⁹To the author's limited knowledge, most papers in the literature discuss regional contexts and use the term "regions" rather than "countries".

To see this formally, we review a simple model of tax competition based on Zodrow and Mieszkowski (1986).¹⁰ There are two countries that own labor and capital; country $i \in \{1, 2\}$ is endowed with L_i units of labor and \bar{K}_i units of capital. We assume two countries are symmetric, i.e., $L_1 = L_2 = L$ and $\bar{K}_1 = \bar{K}_2 = \bar{K}$. Capital is internationally mobile whereas workers are not. We distinguish the amount of capital employed in a country from the amount of capital it owns, so we use K_i to indicate the former and \bar{K}_i to indicate the latter. Firms produce private goods using a constant-returns technology $F(L, K)$ with $F_K > 0$ and $F_{KK} < 0$. The national government in country i imposes a specific unit tax, T_i , on capital employed there. and transforms the collected tax revenues into public goods, $G_i = T_i K_i$.

Free movement of capital allows all capital to earn the same net return π between the two countries. Under the assumption of small open economy where firms perceive the net return to be fixed, the maximization behavior of firms in i implies

$$\max_{L_i, K_i} F(L_i, K_i) - w_i L_i - (\pi + T_i) K_i.$$

The FOCs yield

$$\begin{cases} F_K(L_1, K_1) - T_1 = F_K(L_2, K_2) - T_2 = \pi, \\ w_i L_i = F(L_i, K_i) - (\pi + T_i) K_i. \end{cases}$$

While taking into account the above conditions, the national government in i chooses its tax rate to maximize its residents' utility:

$$\begin{aligned} \max_{T_i} U(C_i, G_i) &= U^i, \\ \text{where } \begin{cases} C_i = (\text{Labor income}) + (\text{Net capital reward}) = [F(L_i, K_i) - (\pi + T_i) K_i] + \pi \bar{K}, \\ G_i = T_i K_i. \end{cases} \end{aligned}$$

¹⁰Baldwin and Krugman (2004, Section 2) summarize the basic results in the traditional tax competition literature.

The FOC gives

$$U_C^i \frac{dC_i}{dT_i} + U_G^i \frac{dG_i}{dT_i} = 0,$$

$$\text{or } \frac{U_G^i}{U_C^i} = -\frac{dC_i/dT_i}{dG_i/dT_i} = -\frac{F_K^i \frac{dK_i}{dT_i} - \left\{ K_i + (\pi + T_i) \frac{dK_i}{dT_i} \right\}}{K_i + T_i \frac{dK_i}{dT_i}} = \frac{1}{1 + \frac{dK_i}{dT_i} \frac{T_i}{K_i}} > 1,$$

where we use $F_K^i - T_i = F_K(L_i, K_i) - T_i = \pi$ and $dK_i/dT_i = 1/F_{KK}^i < 0$. In symmetric equilibrium such that $T_1^* = T_2^*$, the amount of capital employed in a country ends up with that the country owns: $\bar{K}_i = K_i = \bar{K}$, and the budget constraint of residents in each country is identical: $C = F(L, \bar{K}) - G$. The FOC reveals that the marginal rate of substitution between private and public goods is greater than the relative price of the two goods. Assuming the diminishing returns of marginal rate of substitution between private and public goods, we can conclude that the non-cooperative equilibrium tax rate is inefficiently low and public goods are undersupplied, which is known as the “race to the bottom”.

The inefficiency of tax competition results from the fact that each national government does not care about the positive externality of increasing its tax rate. If capital is immobile, an increase in the tax rate of a country decreases the consumption of private goods ($dC/dT = -\bar{K}$) and increases that of public goods by the same amount ($dG/dT = \bar{K}$). If capital is mobile, however, a tax increase induces some fraction of capital to relocate ($dK/dT < 0$) so that the consumption of public goods does not increase as much as that of private goods decreases ($dG/dT > -dC/dT$). National governments care solely about the impact of increasing their tax rate on capital operating in their own countries and do not count the benefits of capital inflow other countries may enjoy, so they tend to lower their tax rate inefficiently.

Unlike earlier studies dealing with symmetric regions, Bucovetsky (1991) and Wilson (1991) study tax competition between two asymmetric regions in the perfectly competitive framework. Suppose that country size is defined in terms of supplies of immobile factor, i.e., labor. In contrast to the studies on tax competition in agglomeration economies, they show that the smaller country levies a lower tax rate and has a higher capital-labor ratio than the larger country. This result indicates the “importance of being small” and can be explained by the fact that the tax base in the small country responds more elastically to changes in tax rate than that in the large country. We

illustrate the result using the previous formulas.

We assume that country 1 is larger in the amount of immobile factor ($L_1 > L_2$) and that the ratios of capital and labor endowments are the same between the two countries ($\bar{K}_1/L_1 = \bar{K}_2/L_2$). Suppose for a moment that equilibrium taxes were equal ($T_1^{**} = T_2^{**}$) and let us see that this hypothesis turns out not to be true. Because of the constant-returns technology, the gross return to capital (F_K) only depends on the capital-labor ratio, so no capital move: $K_1 = \bar{K}_1 > \bar{K}_2 = K_2$.¹¹ Then we have $K_1/T_1^{**} > K_2/T_2^{**}$ and also have $dK_1/dT_1 = 1/F_{KK}^1 > 1/F_{KK}^2 = dK_2/dT_2$ at this hypothetical equilibrium by assuming $F_{KKL}^i < 0$, resulting a lower elasticity of tax base in the larger country than that in the smaller one, $-\frac{dK_1}{dT_1} / \frac{K_1}{T_1} < -\frac{dK_2}{dT_2} / \frac{K_2}{T_2}$. An inspection of the FOC by governments shows that the rates of marginal substitution must be different between the two countries, which requires different tax rates and violates our hypothesis. Moreover, it holds that $U_G^1/U_C^1 < U_G^2/U_C^2$ at this hypothetical equilibrium, meaning that at true equilibrium where $U_G^1/U_C^1 = U_G^2/U_C^2$, the larger country sets a higher tax rate and has a lower capital-labor ration than it does at the hypothetical equilibrium: $T_1^{**} > T_2^{**}$ and $K_1/L_1 < K_2/L_2$. In the larger country having more immobile factor, increasing its tax rate does not decrease as much (gross and net) returns to capital as in the smaller country and this asymmetric impact of taxes on tax base allows the larger country to have a higher rate.

The Importance of Being Small. There are several exceptions in the literature on agglomeration and tax competition that obtain the reversal of the home-market effect. Sato and Thisse (2007), Borck et al. (2012) and Miyagiwa and Sato (2014) derive the reverse home-market effect by highlighting competition among firms for hiring workers, industry spillovers and firms entry costs respectively. Ma and Raimondos-Møller (2015) show that the small country may win bidding competition for a single multinational plant through profit shifting opportunities. Chapter 2 is in line with these studies.

¹¹Since the homogeneity of degree one implies that $F(L, K) = L \cdot F(1, K/L) = Lf(k)$ where $k = K/L$, we have $F_K = L \cdot (dk/dK) \cdot f'(k) = f'(k)$.

1.3 Economic Development

The home market effect suggests that developed nations attract a more share of industries than its “fair” share, i.e., its share of world factor endowments, from developing nations. The result tells policymakers in developing economies that a precondition for industrialization is to overcome the size disadvantage. One advantage of poor nations over rich ones is lower wages in modern sectors: comparative advantage may help their economies get on track. This section examines the effects of technological differences on industrialization and reviews the related literature.

1.3.1 Introducing Comparative Advantage

We allow countries to have different technology levels so that the unit labor requirement of the modern sector a_i (that of the traditional sector a_{0i}) differs between countries. The operating profits are modified as follows:

$$\pi_1 = \frac{\mu L(a_1/a_{01})^{1-\sigma}}{(\sigma - \mu)K} \left[\frac{s}{(a_1/a_{01})^{1-\sigma}\lambda + (a_2/a_{02})^{1-\sigma}\phi(1-\lambda)} + \frac{\phi(1-s)}{(a_1/a_{01})^{1-\sigma}\lambda + (a_2/a_{02})^{1-\sigma}\phi(1-\lambda)} \right],$$

$$\pi_2 = \frac{\mu L(a_2/a_{02})^{1-\sigma}}{(\sigma - \mu)K} \left[\frac{\phi s}{(a_1/a_{01})^{1-\sigma}\lambda + (a_2/a_{02})^{1-\sigma}\phi(1-\lambda)} + \frac{1-s}{(a_1/a_{01})^{1-\sigma}\lambda + (a_2/a_{02})^{1-\sigma}\phi(1-\lambda)} \right].$$

The equalization of these profits results in

$$\lambda = s + \frac{\phi[(1-s) + \phi(2s-1)\chi - s\chi^2]}{(\phi\chi - 1)(\chi - \phi)}, \quad \text{where } \chi = \left(\frac{a_1/a_{01}}{a_2/a_{02}} \right)^{1-\sigma}.$$

To see comparative advantage, let us assume that country 1 has a better technology in the modern sector relative to country 2. This equivalent to $a_1/a_{01} < a_2/a_{02}$, or $\chi > 1$.

Does having a comparative advantage ensure the industrialization of country 1? The answer is not necessarily positive. To look at the “peripherality point”, namely, the smallest size that allows country 1 to have a positive share of firms (Baldwin et al., 2003, p.303), we solve $\lambda = 0$ for s to get

$$s^P = \frac{\phi}{1 - \phi^2} \left(\frac{1}{\chi} - \phi \right).$$

This is positive only when $\chi < 1/\phi$. If the comparative advantage immediately brought industries

to the country, s^P would be negative for all $\chi > 1$. However this is not the case: country 1 has to be large enough to get industrialized. The simple message from the present analysis is that poor nations can take off if they have a sufficiently strong comparative advantage in the modern sector over the traditional one.

Declining trade costs may help the country break off the fetter: if the comparative advantage of 1 is strong ($\chi > (1 + \phi^2)/2\phi$), the peripherality point gets lower as trade becomes more open ($ds^P/d\phi < 0$). Under perfect free trade where $\phi = 1$, firms can sell their products to both markets without incurring trade costs so that the difference of market size does not affect their location incentives. What matters for firms is hiring workers at lower wages and thus they agglomerate in country 1. Comparative advantage becomes crucial for location patterns in the fully integrated world.

Related Literature

Spread of Industry. Although the model presented here is highly stylized, the very basic intuition appears in studies on industrial development in economic geography models. In papers by Puga and Venables (1996, 1999), they describe the evolution of industrialization among countries using multi-country, multi-sector models where industries are vertically linked with each other. Consider an (exogenous) increase in demand for manufacturing goods relative to agricultural ones as economic growth. The growth of the modern sector bids up wages in an industrialized country and widens the wage gap between the core and other peripheral countries. When the wage gap reaches the point where it becomes unprofitable for modern firms to stay in the core, industrialization may spread in a series of waves from the core to the peripheries. Their models are much richer than the present model in that the comparative advantage of countries, i.e., the wage gap in their context, is endogenously determined and evolves over the growth process. However, both suggest the same message that the comparative advantage of peripheral countries needs to be high enough to cause the spread of industry. Chapter 4 contributes to this line of research by focusing on the openness of traditional sectors.

Robustness of the Home Market Effect. We have seen that the technological difference between countries may reverse the home market effect. Apart from the assumption of identical technology,

other assumptions of the standard new economic geography model may also be crucial for the home market effect. Focusing on the trade cost of the homogeneous sector, which is assumed to be zero in the standard model, some studies have attempted to identify conditions for the emergence of the home market effect.¹²

Davis (1998), Fujita et al. (1999, Chapter 7) and Yu (2005) suggest that the home market effect (or the core-periphery outcome) may disappear when there are trade costs on the perfectly competitive homogeneous sector.¹³ Takatsuka and Zeng (2012a), on the other hand, show that trade costs on the outside sector does not prevent the emergence of the home market effect in the FC model. They point out that the assumption of the costless trade of the homogeneous good is innocuous as long as there are multiple factors in the model.

This point can be explained as follows. Suppose that the homogeneous good is not traded and then the price and the wage rate are determined so as to meet the labor market clearing condition. In the new trade theory model of Helpman and Krugman (1985), the labor demand in the sector is $a_{01}q_{01} = (1 - \mu)(w_1L_1)/w_1 = (1 - \mu)L_1$, while the labor supply is $L_1 - M_1n_1 = L_1 - M_1(\sigma - 1)f$. The equilibrium mass of firms M_1 depends on the exogenous parameters and is proportional to the mass of residents, i.e., $M_1 = \mu L_1 / [(\sigma - 1)f]$, implying that the home market effect does not emerge. Even though the wage rate is endogenously determined, the goods and labor demand in the homogeneous sector are constant and proportional to the endowments that a country owns. To meet the domestic demand of the agricultural good by domestic production, the manufacturing employment as well as the agricultural one are also constrained by the endowment size.

In the FC model, on the other hand, the labor demand in the homogeneous sector is $a_{01}q_{01} = (1 - \mu)(w_1L_1 + \pi_1K_1)/w_1$, while the labor supply is $L_1 - (\lambda K)n_1 = L_1 - (\sigma - 1)\lambda K\pi_1/w_1$. Unlike the Helpman-Krugman model, both labor supply and demand depend on the factor prices. Suppose that country 1 with a larger demand imports capital from country 2. This capital inflow increases labor demand and thus pushes wages upward. A higher wage rate leads to a higher agricultural price, which discourages the agricultural demand, and, at the same time, to a higher income, which encourages the demand. In fact, the total income consisting of labor and capital income does not

¹²In addition, introducing some sort of (strategic) policies like corporate tax competition into geography models may give the reversal of the home market effect as we will see in Chapter 2.

¹³To be precise, in our definition, their models based on Helpman and Krugman (1985, Chapter 10) are not geography models because they do not allow factor mobility.

increase as much as the agricultural price increases, so that the agricultural demand goes down.¹⁴ The agricultural sector releases its workforce and allows the manufacturing sector to host a more than proportionate share of capital. The home market effect emerges in this model.

When the trade cost of the agricultural good is small enough for the good to be traded, it may be the case that the Helpman-Krugman model generates the home market effect (Takatsuka and Zeng, 2012b). In contrast, the FC model always generates the home market effect under arbitrary trade costs on the agricultural good (Takatsuka and Zeng, 2012a).

The results we have discussed so far are summarized as follows. Having more-than-proportionate share of firms in a country brings a large labor demand and puts an upward pressure on wages. If the country can costlessly import the agricultural good at an international price as in the standard new trade theory and new economic geography models, the domestic agricultural producers have to keep the price and the wage rate. They do so because otherwise their agricultural products would lose their competitiveness and be forced to shut down. Nothing prevents the emergence of the home market effect.

If there are trade costs on the agricultural goods, on the other hand, the price of the imported goods gets higher due to trade costs, which enables the domestic producers to raise the price and the wage rate. In the Helpman-Krugman model, this effect of increasing marginal costs of manufacturing firms may be strong enough to cancel the home market effect. In the FC model, however, capital income alleviates the increasing marginal costs by allowing the trade imbalance of the manufacturing sector. The home market effect is always observed in the two factor model, but it is not necessarily in the one factor model.

Unilateral Trade Policy. We have stressed the validity of economic geography models in policy

¹⁴In the Helpman-Krugman model, the agricultural demand is $q_0 = (1 - \mu)wL/p_0$ and its price is $p_0 = wa_0$. Changes in p_0 do not affect q_0 :

$$\begin{aligned} dq_0 &= (1 - \mu)(L/p_0)dw - (1 - \mu)[wL/p_0^2]dp_0 \\ &= (1 - \mu)[L/(p_0a_0)]dp - (1 - \mu)[L/(p_0a_0)]dp_0 = 0. \end{aligned}$$

In the FC model, the agricultural demand is modified as $q_0 = (1 - \mu)(wL + \pi K)/p_0$. An increase in p_0 decreases q_0 :

$$\begin{aligned} dq_0 &= (1 - \mu)(L/p_0)dw - (1 - \mu)[(wL + \pi K)/p_0^2]dp_0 \\ &= -(1 - \mu)(\pi K/p_0^2)dp_0 < 0. \end{aligned}$$

analysis, but there are some fields that draw markedly different conclusions from conventional wisdom. Unilateral trade policy is one of such fields. If a country raises its import tariff level unilaterally while the other one keeps its tariff level unchanged, then firms are ready to move to the high-tariff country.¹⁵ This relocation results from the “tariff jumping” motives of firms with a view to saving tariffs as well as being protected from imports from the world market. The industrial clustering in the protected country also brings it a lower price index and thus a higher welfare. In this sense, unilateral trade policy can be called the “price lowering protection” (Baldwin et al., 2003). This point was made clear first by Venables (1987) and recently highlighted in the context of tariff competition by Ossa (2011)

Taking the result literally, one may conclude that economic geography models provide a strong support for import substitution industrialization strategy, which has been cast doubt on since the (seemingly) unsuccessful experiences of Latin American countries during the 1930s to the 1970s.¹⁶ There are some ways to modify the price-lowering effect of unilateral trade policy like introducing relocation barriers: see Baldwin et al. (2003, Chapter 12) for more details.

1.4 Overview

We summarize the background and research questions of each chapter.

1.4.1 Background of Chapters 2 and 3

Capital tax competition is recognized to have involved a number of countries throughout the world and have been accelerated since the late 1990s (OECD, 1998). Although empirical studies are inconclusive as to whether tax rates in small countries are actually lower than those in large countries, a naive observation of the statutory tax rates of developed countries suggests that small countries

¹⁵To see this, we introduce asymmetric trade costs; denote τ_{ij} trade costs from country i to country j (a tariff set by j against imports from i) and let $\phi_{ij} = \tau_{ij}^{1-\sigma}$ be the associated trade freeness. The equilibrium industry share (1.2) is modified as

$$\lambda = \frac{\phi_{12}\phi_{21}(1-s) + s - \phi_{21}}{(1-\phi_{12})(1-\phi_{21})}.$$

This is decreasing in ϕ_{21} : $d\lambda/d\phi_{21} = -(1-s)/(1-\phi_{21})^2 < 0$.

¹⁶The result also indicates a necessity of multilateral agreements on reducing trade barriers; if there were no such agreements, all countries would raise their import tariffs as high as possible and be isolated. The author thanks to Anthony Venables for pointing me this out.

are more actively involved in tax competition.¹⁷ For example, the average statutory corporate tax rate of large-sized OECD countries (in GDP) decreased from 30.9% in 2000 to 24.9% in 2006 while the average rate of all OECD countries decreased from 33.6% in 2000 to 28.4% in 2006 (OECD, 2007). The positive correlation between country size and corporate tax rates is observed in more recent years as shown in Figure 1.1.

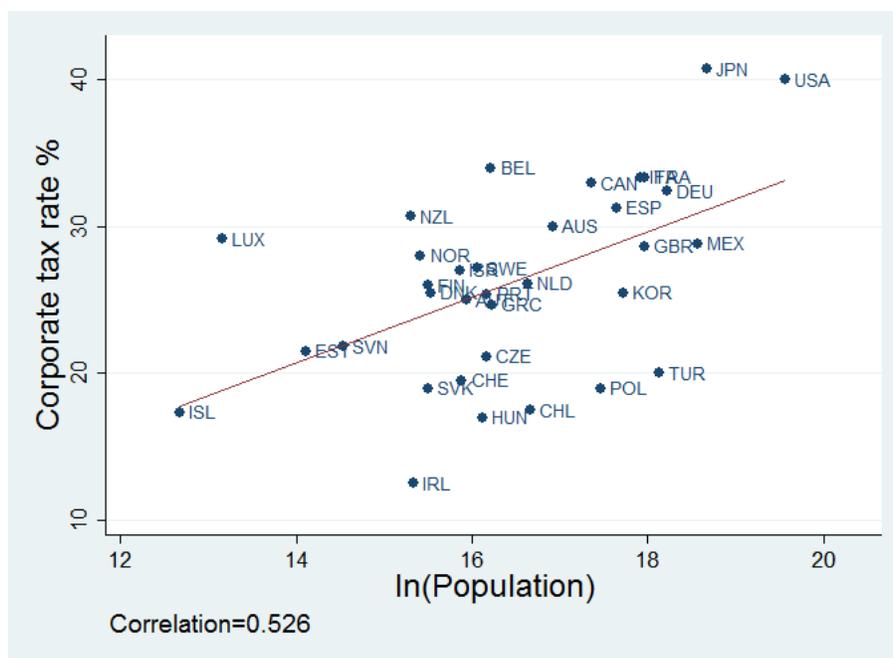


Figure 1.1. Country size and corporate tax rates in the OECD countries.

Note: Statutory corporate tax rates are simple averages between 2006 and 2011. Data on population and tax rates are from OECD Stat and OECD Tax Database, respectively.

The literature on agglomeration and tax competition emphasize that core industrialized countries have an advantage over peripheral ones (Ludema and Wooton, 2000; Baldwin and Krugman, 2004 among others). The result that the core nations keep their industrial base while setting higher tax rates is in stark contrast to the result of the race to the bottom in the literature on tax competition in neoclassical framework (Wilson, 1986; Zodrow and Mieszkowski, 1986).

However, the “importance of being big” is not always supported by real world examples. Some small countries like Ireland, Singapore and newly emerging Central and Eastern European countries have undertaken tax reductions and thrived through the attraction of foreign investment. Although

¹⁷The mixed empirical results are mainly due to the choice of the measure of corporate tax rates. Figure 1 in Lai (2014) shows that some smaller countries in the EU have much higher effective tax rates than other larger EU countries.

empirical studies on firms' location choice and taxes offer mixed results, some empirical evidences show that low corporate tax rate is effective in attracting foreign direct investment (Bellak and Leibrecht, 2009), which implies that small countries with a low corporate tax rate are expected become the winners of tax competition.

Among a number of factors that accelerates tax competition, it is worth noting the recent movement of lobbying by gigantic multinational firms to further reduction of taxes. Although there is little clear evidence how amount of contributions are spent on tax issues due to the limited accessibility of data, Drutman (2012) suggests that a fallen tax burden on large U.S. companies in recent years seems to be obtained through their lobbying efforts. And the fact that the total lobbying spending in the U.S. has become two-fold during 2001 (\$1.64 billion) to 2013 (\$3.21 billion) indirectly indicates the current expanding movement of tax lobbying.¹⁸ Governments cannot ignore the interests of such large firms in deciding their tax policy. Chapter 2 constructs a tax competition model based on politically-motivated governments and gives a possible explanation for why some small and low-tax countries achieve industrial agglomeration despite their small market size.

It is also worthwhile pointing out that the successful countries have different attitudes towards their tax policies from many others. In Ireland, for example, the government has kept announcing that it is committed to its world's lowest corporate tax rate. Singapore has a fairly stable political system allowing its government to have long-term economic plans, including keeping its tax rate low. Chapter 3 studies the role of governments' commitment to their tax schedule on the result of tax competition. To do so, it abstracts away from the difference of market size and focuses on dynamic strategic interactions between governments.

1.4.2 Overview of Chapter 2

This chapter studies tax competition between politically-motivated governments in a world economy with agglomeration forces. The well-known home-market effect, in which countries with a larger home market are attractive for firms, may be reversed as a result of tax competition played by politically-interested governments. The model economy includes trade costs, internationally mobile firms, and two countries of asymmetric size. Each national government sets its tax rate

¹⁸Details can be found at: Lobbying Database in *Open Secrets* (<http://www.opensecrets.org/lobby/index.php>)

strategically to maximize the weighted sum of residents' welfare and political contributions by owners of firms as a special interest group.

It is shown that, if the governments heavily care about contributions and trade costs are low, the small country attracts a more than proportionate share of firms by setting a lower tax rate.

1.4.3 Overview of Chapter 3

This chapter analyzes tax competition between two countries over an infinite time horizon in an economy with trade costs and internationally mobile industrial firms. Most of the previous studies on tax competition in the new economic geography framework employ static models. In this chapter, two governments dynamically compete with each other to attract firms through their choices of taxes and subsidies.

It is shown that the commitment of the governments to their policies is crucial in determining the distribution of firms in the long run. Specifically, if governments find each others' tax policies credible, then one country will attract all the firms when trade costs are low enough to make agglomeration forces dominant. If policies are not credible, both countries may attract an equal share of firms even when trade costs are low, as the lack of commitment by governments acts as a dispersion force.

1.4.4 Background of Chapter 4

Chapter 4 turns our attention to the specific development strategy, namely, increasing openness by liberalizing trade and attracting foreign direct investment (FDI). Proponents of the strategy argue that lowering barriers to trade enables domestic firms to focus on huge external markets and hosting multinational firms helps local economy develop its competitiveness. Both countries in East Asia and those in Latin America adopted the outward-looking policies, but the consequences were quite different. In East Asia, the export-led growth model turned out to be successful particularly in the four Asian Tigers (South Korea, Taiwan, Hong Kong and Singapore). In Latin American countries, however, the manufacturing value-added and the exports of manufactured goods did not grow in the 1990s as rapid as in East Asian counterparts, despite their comprehensive reforms and massive inflows of FDI (Shafaeddin, 2005).

It is fair to say that no conclusive answer has been offered as to why the same outward-looking strategy worked well in East Asia and it did not in Latin America. Chapter 5 attempts to explain this contrastive performances of industrialization focusing on the role of traditional sectors.

1.4.5 Overview of Chapter 4

This chapter develops a model of trade and geography to analyze (de-)industrialization process along with trade liberalization. The model economy consists of two countries and two industries, the traditional sector with constant returns and the modern sector with increasing returns. The two countries are symmetric except for the traditional sector: one country has a better technology in the sector than the other country.

The impact of liberalizing trade of the modern sector on industrial development depends on the openness of the traditional sector. If the traditional sector is not traded, trade liberalization in the modern sector promotes industrialization of the productive country, whereas it may de-industrialize the country if the traditional sector is open to international markets. Our results may help explain the different outcomes of outward-looking policies in East Asia and Latin America, considering the fact that the former region has emphasized liberalizing trade in manufacturing sectors over traditional sectors, while the latter region has liberalized sectors uniformly (Urata et al., 2005).

Chapter 2

Lobbying and Tax Competition in an Agglomeration Economy: A Reverse Home Market Effect

This chapter is based on Kato (2015b).

2.1 Introduction

As the continuing economic integration stimulates international trade of goods and movement of factors, a number of countries have engaged in competing for mobile firms and the competition has been accelerating since the late 1990s (OECD, 1998). A particularly notable observation is that small countries and regions in terms of their population and GDP such as Ireland, Singapore and Estonia tend to undertake a more aggressive reduction in corporate tax rates than large countries such as France, Japan and the U.S.¹ By looking at the statutory corporate tax rates from 1982 to 2006, OECD (2007) concludes that large-sized OECD countries in terms of GDP continue to levy

¹The statutory corporate tax rates of these countries in 2013 are 12.5% (Ireland), 17% (Singapore), 21% (Estonia), 33.33% (France), 38.01% (Japan), and 40% (U.S.). Source: KPMG, Corporate tax rates table: <http://www.kpmg.com/global/en/services/tax/tax-tools-and-resources/pages/corporate-tax-rates-table.aspx>

corporate taxes at higher rates than small-sized OECD member countries.²

The theory of tax competition in economic geography tells us that the positive relationship between country size and tax rates results from the agglomeration advantage of large countries (Kind et al., 2000; Ludema and Wooton, 2000; Andersson and Forslid, 2003; Baldwin and Krugman, 2004; Borck and Pflüger, 2006). Large countries offer bigger markets, which attract a large number of firms seeking to save transportation costs of goods. This agglomeration tendency generates taxable rents so that large countries can set its tax rate higher than small countries while keeping industries.

However, some small countries with low tax rates have succeeded in attracting a huge inflow of FDI into export-oriented industries where increasing returns to scale prevails, which contradicts the prediction of the theory of tax competition and agglomeration. Ireland, for instance, has hosted since the late 1970s a number of manufacturing multinational firms mainly in computer, instrument engineering, pharmaceutical, and chemical industries and these firms account for large proportion of employment and output (Barry and Bradley, 1997). In Irish manufacturing whose major target is foreign markets, the foreign multinational firms account for 91% of Ireland's tradeable exports in 2009.³ As for Singapore, policies including low tax rates and the liberalization of capital markets were basically for the purpose of export-oriented industrialization, which turned out to be successful in attracting increasing-returns industries such as electronics and biotechnology (Park, 2006). Estonia, undertaking pro-market reforms after the end of Soviet control, has established a competitive tax system and has grown manufacturing exports rapidly due to the inflow of FDI in recent years (UNCTAD, 2011).

In order to explain the observation that some nations with small size and low tax rates are attractive for export-oriented FDI, we examine tax competition between asymmetric countries in an

²In addition to observations on statutory tax rates, several studies find that small countries have a low *effective* tax rate defined as the ratio of taxes paid divided by profits. Grubert (2000), for example, examines the effects of effective tax rate on the U.S. outward foreign direct investment (FDI) in 60 countries between 1984 and 1992 and finds that small, open and poor countries decreased their effective tax rate the most. In the context of Europe, Elschner and Vanborren (2009) report that the countries accounting for 10% or more of total GDP of the EU27 have the highest effective tax rates. However, it is fair to say that empirical studies are inconclusive as to whether effective corporate tax rates in small countries are actually lower than those in large countries: see Devereux and Loretz (2012) for an extensive survey.

³"Foreign-owned firms accounted for 91% of Ireland's tradeable exports in 2009; Food & drink exports fell 15%," *Finfacts Business News Centre*, November 25th, 2010; http://www.finfacts.ie/irishfinancenews/article_1021094.shtml

oligopolistic industry. We then argue that the experience of these countries can be attributed to the political bias of governments. Specifically, we analyze capital tax competition between two governments based on a simple model characterized by increasing returns, international oligopoly and trade costs, following Haufler and Wooton (2010).⁴ In our model, internationally mobile firms (or capital) decide their location by responding to after-tax profits and engage in Cournot competition in the markets of both countries. Unlike many previous studies that adopt monopolistic competition with the Dixit-Stiglitz preference, we choose an oligopolistic competitive model. This is because we can analyze a pro-competitive effect, i.e., goods' prices being dependent on the number of firms, and can furthermore obtain interior spatial outcomes (or partial agglomeration of firms), which are in many cases hard to get in monopolistic competitive models.

The present model has two distinct features. First, two countries are *asymmetric* in that population and capital endowments are larger in one country than those in the other country. Asymmetric country size allows us to investigate the relationship between country size and tax rates. Second, capital owners engage in lobbying activities to extract favorable policies from governments. Based on the common agency approach developed by Grossman and Helpman (1994, 1995), the objective of governments is formulated in a way that they consider not only their domestic residents' welfare but also the political contributions by capital owners when deciding their tax rate.⁵ Consequently, the resulting tax policy and distribution of firms are biased in favor of the interests of capital owners, which seems plausible in the modern society where political pressure by firms influences policy decision-making processes. Since the world today has experienced a huge reduction in trade barriers, tax policies, rather than trade policies, is becoming a major concern of multinational companies in developed countries.⁶

⁴Similar models can be found in Ludema and Wooton (2000) and Thisse (2010).

⁵Grossman and Helpman (1994, 1995) analyze trade policies in perfect competitive models. More recent works apply the common agency approach to the analysis of trade policies in imperfectly competitive models. See Chang (2005), Bombardini (2008), and Chang and Willmann (2014) for monopolistic competition and Paltseva (2014) for oligopolistic competition.

⁶In Japan, for example, one of the most influential business lobbies called Japanese Business Federation has strongly urged the government to lower the high corporate tax rate in recent years ("New head of Japan business lobby seeks corporate tax cut," *NIKKEI ASIAN REVIEW*, June 3rd, 2014: <http://asia.nikkei.com/print/article/33880>). The lobby has attempted to increase political contributions to the ruling party, though in Japan interest groups are not allowed to donate to individual politicians ("Sadayuki Sakakibara confirms Keidanren will return to recommending political donations," *The Japan Times*, September 8th, 2014: <http://www.japantimes.co.jp/news/2014/09/08/national/politics-diplomacy/sadayuki-sakakibara-confirms-keidanren-will-return-recommending-political-donations/#.VSEdSvmsV1o>). Our approach can capture such a political aspect of tax policies.

The main result of our analysis is as follows. If the two governments are mainly concerned with contributions by their domestic capital owners and the cost of shipping goods abroad is low, tax competition leads firms in the large country to relocate to the small country. The result implies that the *home-market effect* (Helpman and Krugman, 1985), meaning that the country with a large market is attractive for industry, could be *reversed* when considering a non-cooperative policy game between politically-interested governments.⁷

To grab the intuition of the result, we look at the interests of capital owners in each country, who invest their capital in firms locating in their country and receive after-tax profits of firms. Increasing taxes not only decrease after-tax profits directly, but also indirectly affects them through changes in gross profits (or operating profits) due to the relocation of firms. The direct negative effect of imposing taxes on after-tax profits clearly motivates capital owners in both the large and the small countries to seek a lower tax rate, but the impact of the indirect effect is different between the two asymmetric countries. If one country increases its tax rate, some firms operating there move to the other country. This relocation in general reduces competition and raises gross profits of firms in the tax-raising-country. This indirect positive effect of the increased tax rate on after-tax profits mitigates the direct negative effect more in the large country than in the small country. This can be explained by the fact that, since firms in the large country can take advantage of their rich domestic market without incurring transportation costs, the importance of domestic profits relative to export profits is higher for firms in the large country than for those in the small country.

Thus, the overall negative effect of the increased tax rate on after-tax profits is more pronounced in the small country so that capital owners there are more eager to lower their tax rate than those in the large country. The resulting political pressure pushes the small country to lower taxes more than the large country so that the small country may host firms more than proportionately. Our results are roughly consistent with the mentioned-above observations that small countries imports capital (or firm) from the large countries and that firms located there enjoy large foreign markets.

⁷The reversal of the home-market effect is obtained by several studies including Head and Ries (2001); Head et al. (2002); Yu (2005); Behrens and Picard (2007); Takatsuka and Zeng (2012b). However, they do not consider policy competition, which is the focus of our analysis.

2.1.1 Contribution to the Literature

This chapter is related to two strands of the literature, but draws most on the analyses of tax competition in imperfect competitive models of trade and location. The main conclusion of earlier studies is that the country with a large number of firms at the beginning of the tax game can maintain its position while setting its tax rate higher than the rival country with few firms.⁸ While most of earlier studies deal with symmetric market size, Ottaviano and van Ypersele (2005) and Haufler and Wooton (2010) analyze asymmetric tax competition in related location models and obtain the similar results. In contrast, this chapter proposes a *reversal* of the home market effect by employing a similar framework but with political process. This would help understand successful experiences of some small countries and regions in hosting FDI, which the previous studies have difficulty explaining.

There are a few exceptions in the literature that obtain the reversal of the home-market effect. Sato and Thisse (2007) and Miyagiwa and Sato (2014) introduce mechanisms that weaken the market-size advantage of the large country; in Sato and Thisse (2007), agglomeration of firms raises wages due to a labor-market crowding effect while in Miyagiwa and Sato (2014), firms in a country face an entry cost that is increasing in the number of firms there. They show that the small country attracts a more than proportionate share of firms by setting a *higher* tax rate than the large country, which is opposite to our results. Borck et al. (2012) consider external scale economies and characterize the conditions under which the small region, starting from the situation where it hosts all firms, allows and prevents the relocation of firms to the large region. They show that the small region may defend its industry by offering lower taxes because the government there try to keep higher wages, which benefit workers there, due to external local scale economies. While these studies modify the *technology* side of the previous studies, our model generalizes the form of governments' objective while keeping the technology side as simple as possible.

This chapter is also related to the literature on tax competition in public finance. In perfectly competitive models, Bucovetsky (1991) and Wilson (1991) show that a small country in terms of the size of immobile factor attains a higher capital-labor ratio while charging a lower tax rate. This result comes from the diminishing returns to capital; (gross and net) returns to capital decreases

⁸This conclusion depends on static settings of the game (simultaneous or sequential game) which most of the studies deal with. In Chapter 3, we examine a tax game with an infinite time horizon and shows that rather than the initial condition, whether or not governments commit to their policies is crucial for the spatial outcome of tax competition.

more in response to increasing taxes in the small country than in the large country. The contribution of this chapter is to provide another rationale for the advantages of small countries in different standpoints (i.e., agglomeration, oligopolistic competition and political economy) from those of the literature on tax competition using the neoclassical production function. Furthermore, as Romalis (2007) empirically shows that Ireland expands its exports more in capital-intensive industries, which is thought to be subject to increasing returns, we believe that our framework may fit better in explaining experiences of some small countries such as Ireland.

In the literature on tax competition in perfectly competitive models, political aspects are highlighted by Lai (2014); he incorporates the common agency approach as in our analysis, into the standard tax competition model. He argues that the small country may set a *higher* tax rate than the large country unlike the models of Bucovetsky (1991) and Wilson (1991) and ours. In contrast to his prediction, we investigate the mechanism yielding the positive relationship between country size and tax rates.

The rest of the chapter is organized as follows. The next section develops a simple general equilibrium model that induces agglomeration forces. Section 2.3 formulates tax competition with political process. Section 2.4 characterizes the Nash equilibrium tax rates and the industry allocation. Welfare implications are also mentioned. The final section concludes.

2.2 The Model

The economy consists of two countries, indexed by 1 and 2. Each country has two factors of production; labor and capital. The two countries differ in size and country 1 is assumed to have a smaller share of labor and capital. That is, suppose that the world amount of labor is L and that of capital is K , country 1 has $L_1 = s_1L$ and $K_1 = s_1K$ ($s_1 < 1/2$) while country 2 has $L_2 = s_2L$ and $K_2 = s_2K$, where $s_2 \equiv 1 - s_1$.⁹ Residents are divided into two groups, workers and capital owners. Workers supply their labor services inelastically, while capital owners, whose fraction among residents are assumed to be negligible, invest their capital in domestic firms.

There are two industries that produce different homogeneous goods, the *modern* sector (its product is denoted by q) and the *traditional* sector (denoted by q_0). The modern sector is characterized

⁹ L is assumed to be sufficiently large to make the production of the numéraire good possible. K is larger than two for the sake of consistency with oligopolistic competition.

by oligopolistic competition. One unit of capital as a fixed plant cost is needed to set up a modern firm, which is the source of increasing returns. Firms play Cournot competition both in domestic and foreign markets. In contrast, the traditional sector is characterized by perfect competition. We choose the traditional good as numéraire. Shipment of one unit of the modern good incurs an additional τ unit of trade costs, while there are no such costs when shipping the traditional good.

2.2.1 Demand Side

Residents in country $i \in \{1, 2\}$ share common preferences, and consume both the modern and traditional good:

$$u_i = \left(1 - \frac{q_i}{2}\right)q_i + q_{0i}.$$

Aggregating over individuals gives total utility in country i :

$$U_i = L_i u_i = \left(1 - \frac{Q_i}{2L_i}\right)Q_i + Q_{0i}, \quad (2.1)$$

where $Q_i \equiv L_i q_i$ is the aggregate demand in country i for the modern good and $Q_{0i} \equiv L_i q_{0i}$ is that for the traditional good. Given the price of the industrial good, denoted by p_i , utility maximization yields the demand function for the good:

$$p_i = 1 - Q_i/L_i. \quad (2.2)$$

The smaller the size of a country is, the lower is the price there. The country with small market is less profitable for firms than the country with large market.

2.2.2 Supply Side

In the traditional sector, the production of one unit of z requires one unit of L . Because of costless trade and the choice of numéraire, the price of the good in the two countries is equalized to unity. That is, let p_{0i} be the price, we have $p_{01} = p_{02} = 1$. Constant returns to scale production and the choice of units make the wage rates in both countries equal the price of the traditional good, i.e.,

$$w_1 = w_2 = p_0 = 1.$$

In the modern sector, after establishment, firms can produce without marginal costs and choose different quantities to be sold in domestic and export markets. The operating profit of a firm located in each country can be written as follows:

$$\begin{aligned}\pi_1 &= p_1 q_{11} + (p_2 - \tau) q_{12}, \\ \pi_2 &= (p_1 - \tau) q_{21} + p_2 q_{22},\end{aligned}\tag{2.3}$$

where π_i denotes the operating profit of a firm based in country i and q_{ij} represents the production level by a firm based in i , sold in j ($i, j \in \{1, 2\}$). Since shipping the modern goods incurs cost, trade costs $\tau > 0$ are subtracted from the export price. One unit of capital builds one firm so that the capital market clearing condition requires that the number of firms in country 1 is $\lambda_1 K$ and that in country 2 is $\lambda_2 K \equiv (1 - \lambda_1)K$, where $\lambda_i \in [0, 1]$ denotes the share of firms in i . The aggregate demand of a country is met by the total supply by firms in both countries:

$$\begin{aligned}Q_1 &= \lambda_1 K q_{11} + \lambda_2 K q_{21}, \\ Q_2 &= \lambda_1 K q_{12} + \lambda_2 K q_{22}.\end{aligned}$$

Each firm engages in Cournot competition both in domestic and foreign markets. Substituting the demand functions (2.2) into the operating profits (2.3) and taking the FOCs with respect to the quantity in both markets yield

$$\begin{aligned}q_{11} &= s_1 L p_1, & q_{12} &= s_2 L (p_2 - \tau), \\ q_{21} &= s_1 L (p_1 - \tau), & q_{22} &= s_2 L p_2,\end{aligned}\tag{2.4}$$

where

$$p_i = \frac{1 + \tau(1 - \lambda_i)K}{K + 1}.\tag{2.5}$$

The increase in the share of domestic firms and the reduction in trade costs make the domestic price decline.

Exporting is profitable for firms as long as the mill price $p_i - \tau$ is positive. In other words, trade

costs must not be prohibitively high:

$$\tau < \bar{\tau} \equiv \frac{1}{K+1}. \quad (2.6)$$

This inequality is assumed to hold throughout the analysis.

Substituting the equilibrium prices (2.5) and quantities (2.4) into the operating profits (2.3) gives

$$\begin{aligned} \pi_1 &= \frac{s_1 L [1 + \tau(1 - \lambda_1)K]^2}{(K+1)^2} + \frac{s_2 L [1 - \tau\{1 + (1 - \lambda_1)K\}]^2}{(K+1)^2}, \\ \pi_2 &= \frac{s_1 L [1 - \tau\{1 + (1 - \lambda_2)K\}]^2}{(K+1)^2} + \frac{s_2 L [1 + \tau(1 - \lambda_2)K]^2}{(K+1)^2}. \end{aligned}$$

A competitive bidding by capital owners forces firms to earn excess profits so that the operating profits become equal to the factor rewards to capital.

Although the share of firm λ_1 is endogenously determined in the location equilibrium, which we will discuss shortly, we treat it as an exogenous variable at the moment in order to illustrate the relationship between the individual firm's profit and the distribution of firms. The marginal effect of an increased share of domestic firms on their total profit depends on the market size:

$$\frac{\partial \pi_i}{\partial \lambda_i} = \frac{2\tau K L \Gamma_i}{(K+1)^2} \leq 0, \quad \Gamma_i \equiv 1 - 2s_i - \tau[1 - s_i + (1 - \lambda_i)K], \quad \Gamma_1 \leq 0, \quad \Gamma_2 < 0. \quad (2.7)$$

From the fact that country 1 is small ($s_1 < 1/2$; $s_2 \equiv 1 - s_1 > 1/2$), Γ_2 and thus the marginal effect for country 2, $d\pi_2/d\lambda_2$, are unambiguously negative. An expansion of domestic firms makes the local competition tougher by declining the domestic price, while at the same time it means an contraction of foreign firms, which relaxes the competition in the foreign market. For firms in the large country, the first negative effect always outweighs the second positive effect because of the large domestic market and thus $\partial\pi_2/\partial\lambda_2$ is negative. In contrast, the sign of the marginal effect for country 1, $\partial\pi_1/\partial\lambda_1$, is ambiguous. For firms in the small country, profits from exporting are more important than for firms in the large country so that the positive effect may exceed the negative effect. Especially when trade costs are sufficiently low (small τ) and the number of firms in country 1 is large (large λ_1), a greater number of domestic rivals helps a firm in 1 to earn higher total profits ($\partial\pi_1/\partial\lambda_1 > 0$). The impact of increased competition on profits is quite different between firms

based in the two asymmetric countries.

2.2.3 Location Equilibrium

Firms try to locate in a country that offers a higher profit. This implies that the profits in both countries must be equalized:

$$\pi_1(\lambda_1) = \pi_2(\lambda_2 \equiv 1 - \lambda_1),$$

as long as λ_1 is in the interior interval $(0, 1)$. If firms are completely agglomerated in one country, $\lambda_1 \in \{0, 1\}$, this equality does not hold. The above locational equilibrium condition gives an unique distribution of firms:

$$\tilde{\lambda}_1 = s_1 - \frac{(1 - 2s_1)[2 - \tau(K + 1)]}{2\tau K} < s_1. \quad (2.8)$$

Taking into account the small size of country 1 ($s_1 < 1/2$) and the regularity condition for trade costs ((2.6): $\tau < \bar{\tau}$), the second term is negative and thus it holds that $\tilde{\lambda}_1 < s_1$. The firm's share in country 1 is smaller than its capital share. Namely, the small country becomes the exporter of capital, while the large country becomes the importer. This result is the so-called *home-market effect* (Helpman and Krugman, 1985). Intuition behind this is easy to grasp. Consider, to the contrary, the case where each country owns a share of firms that equals its capital endowment, i.e., $\lambda_1 = s_1$. Locating in the larger market saves trade costs so that firms there earn more from exporting and thus obtain a higher total profit, implying that $\pi_1(\lambda_1 = s_1) < \pi_2(1 - \lambda_1 = 1 - s_1)$. Because of the profit difference, firms will seek to move into the large country until the difference disappears. In equilibrium, the distribution of firms becomes unequal in order to maintain the equalization of the profits.

As can be seen in (2.8), a reduction in trade costs makes the distribution more unequal ($d\tilde{\lambda}_1/d\tau < 0$) and it is possible that all firms relocate to the larger country when trade costs are extremely low. To ensure interior spatial outcomes, trade costs are assumed to be sufficiently large:

$$\tau > \underline{\tau} \equiv \frac{2(1 - 2s_1)}{K - 2s_1 + 1}. \quad (2.9)$$

We further assume the *no-black-hole* condition $\underline{\tau} < \bar{\tau}$ excluding the situation where agglomeration forces are too strong. This condition requires that country 1 should not be too small: $\underline{s} \equiv (K + 1)/[2(2K + 1)] < s_1 < 1/2$. If the condition does not hold: $s_1 \leq \underline{s}$, the economy always reaches full agglomeration in country 2 for all levels of trade costs.

2.3 Tax Competition by Politically-motivated Governments

This section introduces taxes and governments into the economy. The government in country $i \in \{1, 2\}$ imposes a lump-sum tax, T_i on each firm located in country i , and total tax revenue of country i is thus $T_i \lambda_i K$.¹⁰ Tax rates are allowed to be *negative*. The locational equilibrium requires the equalization of the after-tax profits:

$$\pi_1(\lambda_1) - T_1 = \pi_2(\lambda_2) - T_2.$$

The equilibrium share of firms is thus affected by the tax difference:

$$\lambda_1(T_1, T_2) = \tilde{\lambda}_1 - \frac{K + 1}{2\tau^2 KL}(T_1 - T_2), \quad (2.10)$$

where $\tilde{\lambda}_1$ is the equilibrium share of firms when there are no governments defined in (2.8). The higher the tax rate in a country, the fewer firms it obtains. Collected tax revenues are redistributed to the domestic residents.

Before discussing the objective of the governments, we compute the welfare of residents. The residents are divided into two groups: one is capital owners and the other is workers. From the assumptions that capital owners account for a sufficiently small fraction of the population and they invest their capital to the domestic firms, the welfare of the capital owners in country $i \in \{1, 2\}$ is simply represented as the rewards to capital, or the post-tax profits of firms in i :

$$W_i^c = (\pi_i - T_i)K_i.$$

¹⁰If a profit tax takes an ad-valorem form instead of a lump-sum form, our qualitative results would remain unchanged. This is because basic mechanisms (i.e., governments' incentives to tax) apply to both forms of taxation, which will be made clear in the next section.

The income of a worker consists of the wage paid to one unit of labor service in the traditional sector, the redistribution of tax revenue and the endowments of the numéraire. The individual budget constraint can be written as

$$p_i q_i + q_{0i} = 1 + T_i \lambda_i K / L_i + \bar{q}_{0i},$$

where \bar{q}_{0i} is the initial endowment of the numéraire good and is assumed to be large enough to ensure positive consumption of the good. The national budget constraint is obtained by aggregating the individual one across workers. By inserting this national budget constraint into the aggregate utility (2.1) and evaluating it at the equilibrium quantities (2.4) and prices (2.5), the aggregate welfare of workers in country 1 is given by

$$W_i^l = (CS_i + 1)L_i + T_i \lambda_i K + \bar{Q}_{0i},$$

where CS_i is the consumer surplus of an individual:

$$CS_i = \frac{(1 - p_i)^2}{2} = \frac{1}{2} \left[\frac{1 + K\{1 - \tau(1 - \lambda_i)\}}{K + 1} \right]^2.$$

The total welfare of residents in country i is thus $W_i = W_i^c + W_i^l$.

The problem of the governments is formulated as in Grossman and Helpman (1994, 1995). The governments care about not only the aggregate welfare of their residents but also campaign contributions. We assume only capital owners can organize a lobbying group and make contributions C to their domestic government. The objective function of the government in country i is

$$G_i(T_i; T_j) = \alpha_i W_i(T_i; T_j) + C_i(T_i; T_j),$$

where α_i denotes the weight that the governments place on their residents' welfare relative to the contributions.

Tax competition with political pressure is analyzed in the following three-stage game. First, capital owners in each country as a special interest group decide to form a lobbying group and choose a contribution schedule that depends on the domestic tax rate given the tax rate of the rival

country. Second, each government receives the contributions and non-cooperatively choose their tax rate so as to maximize the objective of the governments. Finally, relocation of firms occurs in response to the profit differential.

By making use of the truthful contribution schedule as in Bernheim and Whinston (1986), we can rewrite the government objective as¹¹

$$\begin{aligned} G_i(T_i; T_j) &= \alpha_i W_i(T_i; T_j) + W_i^c(T_i; T_j), \\ &= \alpha_i W_i^l(T_i; T_j) + (1 + \alpha_i) W_i^c(T_i; T_j). \end{aligned}$$

Because of the presence of the weight α_i , the government objective is biased toward the interest of capital owners. The problem can be solved backwardly. Given the distribution of firms defined in (2.10), we derive the FOCs of both governments by differentiating G_i with respect to T_i given T_j :

$$\frac{dG_i}{dT_i} = \alpha_i \frac{dW_i^l}{dT_i} + (1 + \alpha_i) \frac{dW_i^c}{dT_i} = 0 \quad \text{or} \quad \frac{1}{\alpha_i} \frac{dG_i}{dT_i} = \frac{dW_i^l}{dT_i} + \beta_i \frac{dW_i^c}{dT_i} = 0.$$

where $\beta_i \equiv (1 + \alpha_i)/\alpha_i$ is a political weight attached to the interests of capital owners. Solving the systems of equations yields equilibrium tax rates.

2.4 Consequence of Tax Competition

We now turn to the analysis of equilibrium tax rates and here assume that the two governments attach an equal political weight $\beta_1 = \beta_2 = \beta$ on the contributions. The assumption of the common political weight is relaxed in the next section. We impose a restriction on β so as to satisfy the second-order condition of the maximization problem such that $\beta < \bar{\beta} \equiv (4K + 3)/(2K)$.¹²

¹¹The truthful strategy of capital owners in i takes the form of $C_i = \max\{W_i^c - B_i, F\}$, where B_i is the welfare of capital owners net of the contributions and F is a negative constant because we allow for negative contributions.

¹²This is a sufficient condition for the second-order condition. That is, supposing $\beta < \bar{\beta}$ holds, then we have $(1/a)d^2G_1/dT_1 = [(2\beta K + 1)s_1 - 4(K + 1)]/(4L\tau^2) < 0$ for all $s_1 \in [0, 1]$. Symmetric expression holds for country 2.

2.4.1 The Incentives of Governments

The marginal impact of the tax rate of country $i \in \{1, 2\}$ on its government payoff is decomposed as follows (ignoring constant terms) :

$$\begin{aligned} \frac{1}{s_i} \left(\frac{dW_i^l}{dT_i} + \beta \frac{dW_i^c}{dT_i} \right) &= \frac{1}{s_i} \frac{d}{dT_i} [CS_i L_i + T_i \lambda_i K + \beta(\pi_i - T_i) K_i] \\ &= \frac{dCS_i}{dT_i} L + \left(\lambda_i + T_i \frac{d\lambda_i}{dT_i} \right) \frac{K}{s_i} + \beta \left(\frac{d\pi_i}{dT_i} - 1 \right) K = 0, \end{aligned} \quad (2.11)$$

where the whole term is divided by country size s_i for the sake of explanation. A close inspection of each channel reveals the forces at work in the present model. The first term in (2.11) represents the impact on consumer surplus:

$$\frac{d(CS_i L)}{dT_i} = \frac{\partial CS_i}{\partial \lambda_i} \frac{d\lambda_i}{dT_i} L = \frac{\tau K^2 (1 - \tau \lambda_i)}{(K + 1)^2} \left(-\frac{K + 1}{2\tau^2 K L} \right) L = -\frac{K(1 - \tau \lambda_i)}{2\tau(K + 1)} < 0.$$

The negative impact on consumer surplus is intuitive: the outflow of firms resulting from an increased tax rate causes the domestic price to rise. This consideration gives the governments in both the small and the large countries an incentive to lower their tax rate. In fact, the small country 1 has the stronger incentive than large country 2 because the marginal effect of firm size on the consumer surplus is diminishing ($\partial^2 CS_i / \partial \lambda_i^2 < 0$).¹³

The second term in (2.11) captures the impact on tax revenue. An increase in tax rate affects the tax revenue both in a positive and a negative way: it raises additional tax revenues from incumbent firms ($\lambda_i > 0$ in the bracket), but it also induces the erosion of the tax base ($T_i d\lambda_i / dT_i < 0$ in the bracket). Although the sign of the impact is ambiguous, the role of the asymmetric market size is clear: because of the larger share of incumbent firms, large country 1 has an larger incentive to increase its tax rate.¹⁴

The third term in (2.11) shows the impact on after-tax profits. An increase in the tax rate directly decreases after-tax profits and indirectly affects gross profits through the change of the distribution

¹³It is verified that $dCS_1/dT_1 < dCS_2/dT_2$ at $T_1 = T_2$.

¹⁴It holds that $d(T_1 \lambda_1 K / s_1) / dT_1 < d(T_2 \lambda_2 K / s_2) / dT_2$ at $T_1 = T_2$.

of firms in the following way:

$$\begin{aligned} \frac{d[\beta(\pi_1 - T_1)K]}{dT_1} &= \beta K \left(\underbrace{\frac{\partial \pi_1}{\partial \lambda_1}}_{\leq 0} \underbrace{\frac{d\lambda_1}{dT_1}}_{< 0} - 1 \right) = -\frac{\beta K[\tau(s_1 + \lambda_1 K) + 1 - 2s_1]}{\tau(K + 1)} < 0, \\ \frac{d[\beta(\pi_2 - T_2)K]}{dT_2} &= \beta K \left(\underbrace{\frac{\partial \pi_2}{\partial \lambda_2}}_{< 0} \underbrace{\frac{d\lambda_2}{dT_2}}_{< 0} - 1 \right) = -\frac{\beta K[\tau(s_2 + \lambda_2 K) + 1 - 2s_2]}{\tau(K + 1)} \leq 0. \end{aligned} \quad (2.12)$$

As for the sign of $\partial \pi_i / \partial \lambda_i$, the results of (2.7) should be noted. In most cases, the marginal impacts of taxes (2.12) tend to be negative, which means that the governments (and capital owners) in both countries prefer low taxes.¹⁵ However, the magnitude of the impacts varies in country size. The importance of export profits relative to domestic profits is higher for firms in the small country 1 than for those in large country 2 because firms in 1 (or 2) face a small (or large) local market and a large (or small) foreign market. Thus, government 1 engages in tax reductions more intensively than government 2, not only because low taxes mitigate the direct incidence on after-tax profits, but also because they induce firm relocation and thereby reduce rivals in the large foreign market.¹⁶ This different incentives to tax are more pronounced as the political weight β gets higher.

Furthermore, we can confirm¹⁷

$$\frac{d[\beta(\pi_1 - T_1)K]}{dT_1} - \frac{d[\beta(\pi_2 - T_2)K]}{dT_2} \equiv \phi(s_1) < 0, \quad \phi'(s_1) > 0.$$

An increase in the tax rate of a country tends to reduce more the after-tax profit of firms in the small country 1 than that in the large country 2. The difference of the impacts shrinks as the two countries get more equalized in size. In sum, we can conclude that the small country tends to have larger incentives to lower taxes than the large country and the political-bias strengthens this tendency.¹⁸

¹⁵In a special case where trade costs are extremely low and the number of firms in country 1 is relatively large (i.e., $\Gamma_1 < 0$), it is possible that (2.12) for country 2 is positive.

¹⁶It holds that $d(\pi_1 - T_1)/dT_1 < d(\pi_2 - T_2)/dT_2$ at $T_1 = T_2$.

¹⁷To be concrete, we have $\phi(s_1) = \beta K[2s_1(2 - \tau) + \tau\{K(1 - 2\lambda_1) + 1\} - 2]/[\tau(K + 1)]$.

¹⁸From the discussions so far, this equivalent to $d[G_1/(\alpha s_1)]/dT_1 < d[G_2/(\alpha s_2)]/dT_2$ at $T_1 = T_2$.

2.4.2 Tax Rates and Firm Distribution in Equilibrium

We solve the FOCs of both countries as a system of equations for tax rates (see Appendix 2.A.1. for details):

$$T_i^* = \frac{\tau KL}{K+1} \left[\tau - \frac{\beta\tau}{2} - \frac{2-\tau}{4(K+1)} \right] - \frac{\tau L(1-2s_i)\Theta_i^*}{4(K+1)^2[2(3-\beta)K+5]}, \quad (2.13)$$

where Θ_i^* is a positive bundling parameter that includes β , K , s_1 and τ . where the superscript n stands for the no lobbying case and Θ_i^n is a positive bundling parameter that includes τ , s_1 and K . Both T_1^* and T_2^* can be positive or negative.

Supposing that the two countries were identical in size ($s_1 = 1/2$), only the first term in (2.13) is left and thus the equilibrium tax rates and the distribution of firms becomes symmetric. Each term in the big square brackets (partly) represents the consideration of each component of the government's objective, each of which has been discussed above (see Appendix 2.A.2. for details).¹⁹ The first positive term in the brackets comes from a *tax-revenue effect*, which means that governments can exploit location rents of incumbent firms avoiding competitive market with many rivals. The second negative term in the brackets we call a *profit-income effect* reflects the fact that governments seek to lessen the direct burden of tax incidence on domestic capital owners. The profit-income effect is reinforced by the political weight β . The third negative term in the brackets resulting from a *consumer-price effect* reflects the motivation of governments to attract firms so as to decrease consumer prices.

If the two countries differ in size, the second fractional term in (2.13), which we call a *market-size effect*, appears and the tax rates and the industrial configuration are no longer symmetric. The market-size effect incorporates all the impacts resulting from the difference of market size and modifies the three effects mentioned above. Due to the firms' motives of locating a larger market for saving trade costs, large country 2 can levy a higher tax rate than the small country 1. Note that the market-size effect for T_1^* is negative whereas that for T_2^* is positive.²⁰

¹⁹This decomposition is first proposed by Haufler and Wooton (2010).

²⁰Note that Θ_i^* and the denominators of the fractional term are positive under $\beta \in [1, \bar{\beta})$.

The difference of the tax rate is given by

$$T_1^* - T_2^* = -\frac{\tau L(1 - 2s_1)[6 - \tau(2\beta K + 3)]}{2(3 - \beta)K + 5} < 0. \quad (2.14)$$

The regularity condition on trade costs ($\tau \in (\underline{\tau}, \bar{\tau})$) ensures that the square bracket in the numerator of (2.14) is positive. It turns out that country 1 with $s < 1/2$ always sets a lower tax rate than country 2. Furthermore, a higher political weight in general leads to lower taxes as Figure 2.1 shows. There may be a case where a higher weight makes the large country choose a higher tax rate if raising taxes causes massive capital outflow and thereby brings huge profits to domestic firms.

Combining the tax differential defined above with the location equilibrium condition (2.10) gives

$$\lambda_1^* = s_1 - \frac{(1 - 2s_1)[K + 2 - \tau(K + 1)^2 - 2(\beta - 1)K\{1 - \tau(K + 1)\}]}{\tau K[2(3 - \beta)K + 5]}, \quad (2.15)$$

where the denominator of the second term is positive under $\beta \in [1, \bar{\beta})$. Our assumptions ensures that λ_1^* lies in between zero and one.

Consider first the case of benevolent governments, i.e., $\beta = 1$. It is verified that the distribution of firms in country 1 under the lobbying-free governments, denoted by λ_1^n , is greater than the distribution under no taxes. i.e., $\lambda_1^n > \tilde{\lambda}_1$ because country 1 chooses a lower tax rate. However, the firm share is smaller than the capital share, i.e., $\lambda_1^n < s_1$, due to the large market size of country 2. The fact that the home-market effect still prevails under tax competition is consistent with previous studies such as Ottaviano and van Ypersele (2005) and Haufler and Wooton (2010).

Consider then the case of politically-biased governments, i.e., $\beta > 1$. Whether country 1 exports or imports capital depends on the sign of the second term in (2.15). Let β^* be the critical value that changes the sign:

$$\beta^* \equiv \frac{3K + 2 - \tau(K + 1)(3K + 1)}{2K[1 - \tau(K + 1)]}.$$

We can confirm that β^* is smaller than the upper bound $\bar{\beta}$ when

$$\tau < \tau^* \equiv \frac{1}{K+2}.$$

If the political weight is small ($\beta < \beta^*$) holds and/or trade costs are high ($\tau > \tau^*$), the second term in (2.15) is negative, which means that the share of firms in country 1 is smaller than its capital share ($\lambda_1^* < s_1$). Tax competition played by relatively benevolent governments gives the qualitatively same results as in the lobbying-free case. Higher trade impediments also preserve the advantage of large country 2 by enhancing the incentives of firms to relocate to the larger market and save trade costs.

On the other hand, if the political weight is large ($\beta > \beta^*$) and trade costs are low ($\tau < \tau^*$), the direction of capital flow becomes opposite; we can observe a *reversal* of the home-market effect ($\lambda_1^* > s_1$). If both the governments heavily care about the capital owners, they determine their tax rates so as to realize the industrial configuration in favor of profit income owned by capital owners. As a result, the small country 1 chooses a lower tax rate and imports capital while larger country 2 chooses a higher rate and becomes a capital exporter, contrary to what the home-market effect suggests. For the reverse home-market effect to emerge, trade costs should be small enough for firms in 1 to make exporting fairly profitable compared to serving domestic market.

These findings are summarized in

Proposition 2.1. *Consider tax competition between the politically-motivated governments with a common political weight $\beta \in [1, \bar{\beta})$. Assume that country 1 is small ($s_1 \in (\underline{s}, 1/2)$) and $\tau \in (\underline{\tau}, \bar{\tau})$ holds. Then two cases may arise:*

(i) *if the political weight is small ($\beta < \beta^*$) and/or trade costs are large ($\tau > \tau^*$), country 1 hosts a smaller share of firms than its capital share ($\lambda_1^* < s_1$).*

(ii) *if the political weight is large ($\beta > \beta^*$) and trade costs are small ($\tau < \tau^*$), country 1 hosts a larger share of firms than its capital share (the reverse home-market effect: $\lambda_1^* > s_1$).*

In both cases, the tax rate of country 1 is always lower than that of country 2 ($T_1^ < T_2^*$).*

The reversal of the home-market effect is illustrated in the range $\beta \in (\beta^*, \bar{\beta})$ in Figure 2.2. Country 1 attracts more firms as the governments put more emphasis on the interests of capital

owners.²¹ The result may explain well the fact that small countries with a lower corporate tax rate have succeeded better in attracting FDI than large countries with a higher rate.²²

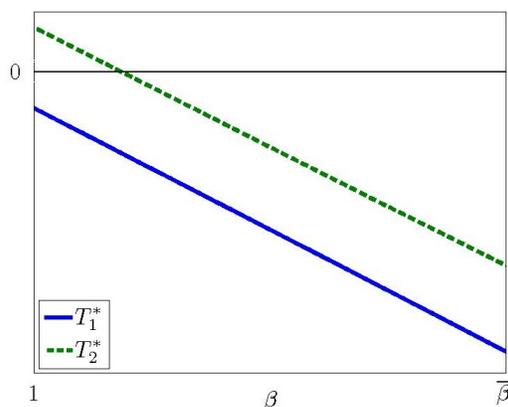


Figure 2.1. The relationship between equilibrium tax rates and the political weight.

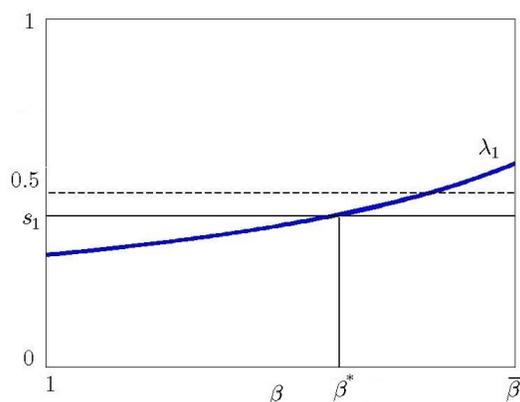


Figure 2.2. The relationship between equilibrium share of firms and the political weight.

2.4.3 Welfare Implications

To see welfare implications, we compare the socially desirable industrial configuration to the spatial outcome under tax competition. We consider the social planner who chooses the industry alloca-

²¹To check this formally, it is verified that $d\lambda_1^*/d\beta = -\Psi d(T_1^* - T_2^*)/d\beta > 0$ for all $\tau \in (\tau, 3/(3K + 4))$ where $\Psi \equiv (K + 1)/2\tau^2 KL > 0$. Since $\tau^* < 3/(3K + 4)$ holds, we have $d\lambda_1^*/d\beta > 0$ when the reverse home market effect prevails ($\beta > \beta^*$ and $\tau < \tau^*$).

²²Although many empirical studies on the protection-for-sale model obtain remarkably low estimates of political weight β (or high estimates of α) (Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000), there are several studies that obtain fairly high estimates of β (Mitra et al., 2006; Gawande et al., 2012) or report mixed results (McCalman, 2004).

tion λ_1 to maximize the sum of national welfare of the two countries $W \equiv W_1 + W_2$. The social planner implements the policy through lump-sum transfers among agents while taking as given the equilibrium market prices (2.5) and quantities (2.4) (see Appendix 2.A.3. for details).

Figure 2.3 shows the global welfare function along with the distribution of firms that attains the optimum λ_1^o , that under benevolent governments λ_1^n and that under politically-interested governments λ_1^* . λ_1^n is larger than λ_1^o , meaning that tax competition played by lobbying-free governments leads to an excessive tax gap and thus to a more equalized distribution. This can be explained by international externalities resulting from market size asymmetry. Country 1 is exporting capital and thus bears the burden of tax incidence imposed by country 2. Since an increase in the tax rate of 1 brings the positive externality from 1 to 2, i.e., the delocation of firms in 1, government 1 sets a too low tax rate from the global welfare point of view. In contrast, from the fact that country 2 is importing capital and its tax rate has the negative externality, government 2 ends up choosing an inefficiently higher tax rate. The large tax difference generates arbitrage opportunities for capital owners and as a consequence yields an inefficiently equalized distribution.

As we have seen in the previous sections, the relationship between λ_1^n and λ_1^* is clear: when the governments are heavily biased in favor of capital owners and trade barriers are low, λ_1^* is greater than s_1 ($> \lambda_1^n$) and the more so, the higher political weight β .

We summarize these as follows:

Proposition 2.2. *The equilibrium share of firms where the reverse home market effect is prevailing is more socially inefficient than that under the benevolent governments ($\lambda_1^o < \lambda_1^n < s_1 < \lambda_1^*$).*

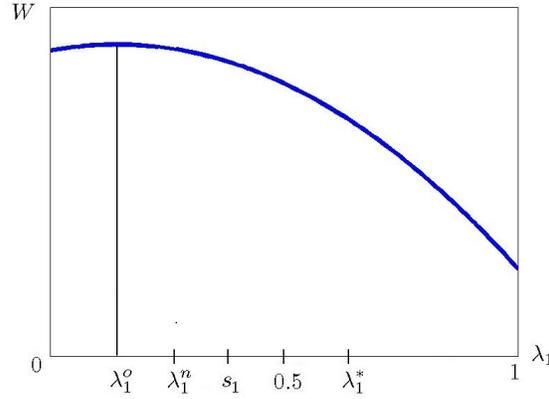


Figure 2.3. Global welfare.

2.5 Extensions: Asymmetric Political Weight

In the previous analysis, we assumed the political weight β is common to the two governments. In this section, we allow for the asymmetry of the weight and confirm that our main result of the reverse home-market effect still holds. In order to single out the effect of different political weights, we first analyze the case of symmetric market size, i.e., $s_1 = 1/2$. The equilibrium tax rate in country $i \in \{1, 2\}$ is given by

$$T_i^{**} = \frac{\tau KL}{K+1} \left[\tau - \frac{\beta_i \tau}{2} - \frac{2-\tau}{4(K+1)} \right].$$

The profit-income effect, the second term in the square bracket, reflects the asymmetric weights and is stronger as the weight gets higher. The tax differential becomes

$$T_1^{**} - T_2^{**} = -\frac{\tau^2 KL(\beta_1 - \beta_2)}{[6 - (\beta_1 + \beta_2)]K + 5},$$

which is negative if $\beta_1 > \beta_2$ holds.²³ The government with a higher weight sets a lower tax rate so as to reduce the direct tax burden on capital owners.

²³The denominator is positive as long as $\beta_i < \bar{\beta}$ holds as we have assumed in the previous analysis.

Since there is no market-size effect and thus only the tax differential matters for the industrial configuration, the more politically-motivated government setting a lower tax rate attracts more firms than its capital share:

$$\lambda_1^{**} = \frac{1}{2} + \frac{(K+1)(\beta_1 - \beta_2)}{2[6 - (\beta_1 + \beta_2)K + 5]} > s_1,$$

as long as $\beta_1 > \beta_2$ holds.

Having made clear the role of different political weights, we then consider the most general situation where both country size and weights are asymmetric. Since it is hard to analytically characterize the conditions that make the home-market effect reversed, we rely on numerical simulations. Figures 2.4 and 2.5 show the equilibrium share of firms based in country 1 (z -axis) for various levels of political weights along with the horizontal plane representing the country 1's size: $s_1 = 0.4$. The diagonal line linking the north corner to the south corner corresponds to the case of symmetric weight. As β_i moves from low to high given a particular level of β_j , the share of firms based in country i increases for $i \neq j$. Moreover, the government with a higher political weight (e.g., $\beta_1 > \beta_2$), which engages actively in tax reduction, is likely to host a more than proportionate share of firms ($\lambda_1^{**} > s_1$).

In the case of common political weight, as the key to the reverse home-market effect, we pointed out the coincidence of the desirable industrial configuration for firms both in the small and the large countries. The mechanism still works when trade costs are low (Figure 2.5). If β_1 and β_2 are in $[2, 2.5]$, λ_1^{**} may exceed s even when $\beta_1 < \beta_2$ holds, meaning that the profit-income effect of government 2 is stronger than that of government 1. Although the stronger profit-income effect of government 2 puts more downward pressure on the tax rate of 2, the market-size effect works in a way that government 2 reduces the pressure on tax cut with a view to avoiding the influx of capital, which hurts profits of firms in large country 2. The emergence of the reverse home-market effect and its mechanism remain unchanged in the general situation.

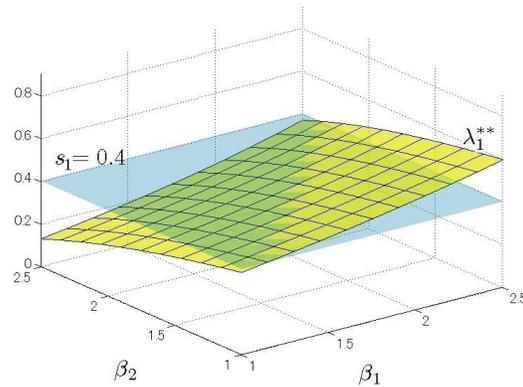


Figure 2.4. Equilibrium share of firms under asymmetric political weight and high trade costs.

Note: Parameter values are $K = 3$, $s_1 = 0.4$ and $\tau = 0.249$.

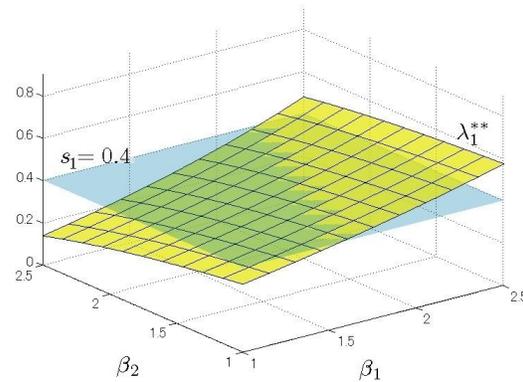


Figure 2.5. Equilibrium share of firms under asymmetric political weight and low trade costs.

Note: Parameter values are $K = 3$, $s_1 = 0.4$ and $\tau = 0.138$.

2.6 Conclusion

This study has analyzed a tax game between two countries of asymmetric size taking into account a political economic issue. The political process is modeled as a Principle-Agent relationship between the governments and the capital owners as in Grossman and Helpman (1994, 1995). It is shown that if the governments are sufficiently biased toward the interests of capital owners and trade costs are low, the smaller country attracts a more than proportionate share of firms (the reverse home-market effect). The important source of the profit of firms in the small country is from

exporting to the large foreign market, while that of firms in the large country is from serving the large domestic market. Therefore, capital owners, whose rewards are equal to the after-tax profits of domestic firms, prefer capital movement from the large country to the small country, in which case the profit of firms both in the small country and in the large country tends to be higher. The interests of capital owners are well reflected in the spatial outcome of tax competition if the governments heavily care about the welfare of capital owners.

The reverse home-market effect caused by the willingness of firms to avoid competition is a new insight into the literature of agglomeration and tax competition, which conclude that the larger market size and/or the initial locational advantage are crucial for determining the winner of competition. The implication that the smaller market size can be attractive for firms when considering politically-biased governments may help understand how tax competition works in the real world.

2.A Appendix

2.A.1 Derivation of Equilibrium Tax Rates

Consider the most general case where two countries differ in size and political weight. From the first-order condition $(1/\alpha_i)dG_i/dT_i = 0$, we obtain the following best response function for each government:

$$\begin{aligned} & \frac{s_1(2K+1) - 4(K+1) + 2s_1K(\beta_1 - 1)}{4\tau^2L}T_1 - \frac{s_1(2K+1) - 2(K+1) + 2s_1K(\beta_1 - 1)}{4\tau^2L}T_2 \\ &= -\frac{2\tau(1-s)K^2 - (5s_1\tau - 4\tau - 6s_1 + 4)K + (1-2s_1)(2-s_1)(2-\tau)}{4\tau(K+1)} + \frac{s_1K(\beta_1 - 1)}{2}, \end{aligned} \quad (2.A.11)$$

$$\begin{aligned} & \frac{s_1(2K+1) + 1 - 2K(1-s_1)(\beta_2 - 1)}{4\tau^2L}T_1 - \frac{s_1(2K+1) + 2K + 3 - 2K(1-s_1)(\beta_2 - 1)}{4\tau^2L}T_2 \\ &= -\frac{2s_1\tau K^2 + (5s_1\tau - \tau + 6s_1 + 2)K + (1-2s_1)(s_1+1)(2-\tau)}{4\tau(K+1)} + \frac{K(1-s_1)(\beta_2 - 1)}{2}, \end{aligned} \quad (2.A.12)$$

where (2.A.11) is the best response function for government 1 and (2.A.12) for government 2.

Politically-motivated Governments with Symmetric Political Weight. We first consider the case where both governments place an equal weight on their contributions. Imposing $\beta_1 = \beta_2 = \beta$ on (2.A.11) and (2.A.12) and solving the system of equation, we obtain the following equilibrium tax rates:

$$T_1^* = \frac{\tau KL}{K+1} \left[\tau - \frac{\beta\tau}{2} - \frac{2-\tau}{4(K+1)} \right] - \frac{\tau L(1-2s_1)\Theta_1^*}{4(K+1)^2[2(3-\beta)K+5]},$$

$$T_2^* = \frac{\tau KL}{K+1} \left[\tau - \frac{\beta\tau}{2} - \frac{2-\tau}{4(K+1)} \right] + \frac{\tau L(1-2s_1)\Theta_2^*}{4(K+1)^2[2(3-\beta)K+5]},$$

$$\Theta_1^* \equiv \delta s_1 + \epsilon, \quad \Theta_2^* \equiv \delta(1-s_1) + \epsilon,$$

$$\delta \equiv -2[4K^2(K+1)\beta^2 - 2K(4K+5)\beta + 3K+4]\tau + 4[2\beta K(3K+4) - (3K+2)],$$

$$\epsilon \equiv [4K^2(K+1)\beta^2 - 2K(2K^2-3)\beta - (6K^2+15K+8)]\tau - 4K(3K+4)\beta + 2(6K^2+15K+8),$$

as given by (2.13). δ and ϵ can be negative.

Politically-motivated Governments with Asymmetric Political Weight. In the most general case where the political weights are different in countries, we get the following equilibrium tax rates by directly dealing

with (2.A.11) and (2.A.12) :

$$\begin{aligned}
 T_1^{**} &= \frac{\tau KL}{K+1} \left[\tau - \frac{\beta_1 \tau}{2} - \frac{2-\tau}{4(K+1)} \right] - \frac{\tau L(1-2s_1)\Theta_1^{**}}{4(K+1)^2 \{ [6 - (\beta_1 + \beta_2)]K + 5 \} [2\{3 - (\beta_1 s_1 + \beta_2(1-s_1))\}K + 5]}, \\
 T_2^{**} &= \frac{\tau KL}{K+1} \left[\tau - \frac{\beta_2 \tau}{2} - \frac{2-\tau}{4(K+1)} \right] + \frac{\tau L(1-2s_1)\Theta_2^{**}}{4(K+1)^2 \{ [6 - (\beta_1 + \beta_2)]K + 5 \} [2\{3 - (\beta_1 s_1 + \beta_2(1-s_1))\}K + 5]}, \\
 \Theta_1^{**} &\equiv \zeta s_1^2 + \eta s_1 + \theta, \quad \Theta_2^{**} \equiv \zeta(1-s_1)^2 + \eta(1-s_1) + \iota, \\
 \zeta &\equiv 4K(\beta_1 - \beta_2)(2-\tau) \{ [6 - (\beta_1 - \beta_2)]K + 5 \}, \\
 \eta &\equiv -2 \{ [6 - (\beta_1 + \beta_2)]K + 5 \} \\
 &\quad \times [4\beta_1\beta_2\tau K^3 + 2\{4(\beta_1 + \beta_2 + \beta_1\beta_2) - 3(\beta_1 + \beta_2)\}K^2 + \{(3\beta_1 + 7\beta_2 - 3)\tau + 2(3 - 6\beta_2 - 2\beta_1)\}K + 2(2-\tau)], \\
 \theta &\equiv -8\tau(6\beta_1 - 3\beta_2 - 4\beta_1\beta_2 + \beta_1\beta_2^2)K^4 \\
 &\quad - [4(31\beta_1 - 29\beta_2 - 13\beta_1\beta_2 + 2\beta_1\beta_2^2 + 2\beta_2^2 + 9)\tau + 12(\beta_2 - 1)(6 - \beta_1 - \beta_2)]K^3 \\
 &\quad + 2[(84\beta_2 - 51\beta_1 + 9\beta_1\beta_2 - 5\beta_2^2 - 60)\tau + 8\beta_1\beta_2 - 93\beta_2 - 15\beta_1 + 8\beta_2^2 + 120]K^2 \\
 &\quad + [(73\beta_2 - 27\beta_1 - 123)\tau + 2\{123 - 8(\beta_1 + 6\beta_2)\}]K + 40(2-\tau), \\
 \iota &\equiv \theta - 2K(\beta_1 - \beta_2)[4\tau(\beta_1\beta_2 - 9)K^3 + 2\{2(\beta_1 + \beta_2 + \beta_1\beta_2 - 30)\tau + 3(6 - (\beta_1 + \beta_2))\}]K^2 \\
 &\quad + \{4s_1(s_1 - 1)(6 - (\beta_1 + \beta_2))(2-\tau) + (5(\beta_1 + \beta_2) - 135)\tau + 2(39 - 4(\beta_1 + \beta_2))\}K \\
 &\quad + 40(s_1^2 - s_1 + 1) - 10(2s_1^2 - 2s_1 + 5)\tau],
 \end{aligned}$$

which reduce to (2.13) when $\beta_1 = \beta_2 = \beta$. The tax differential and the resulting distribution of firms become

$$\begin{aligned}
 T_1^{**} - T_2^{**} &= -\frac{\tau L[2\tau K\{\beta_1 s_1 - \beta_2(1-s_1)\} + 3(3s_1\tau - 4s_1 - \tau + 2)]}{2\{[3 - (\beta_1 s_1 + \beta_2(1-s_1))]K + 5\}}, \\
 \lambda_1^{**} &= \frac{2K[\beta_1 s_1(s_1\tau - 2s_1 + 1) + \beta_2(1-s_1)(s_1\tau - 2s_1 - \tau - \tau K + 1)] + (3K+2)[(2-\tau)s_1 - 1] + (K+1)(3K+1)\tau}{\tau K\{[6 - (\beta_1 s_1 + \beta_2(1-s_1))]K + 5\}}.
 \end{aligned}$$

We use λ_1^{**} for the simulation analysis in Section 2.5.

2.A.2 Three Effects on Tax Rates

We show that equilibrium tax rates can be decomposed into three effects, namely, the consumer-price effect, the profit-income effect and the tax-revenue effect as explored in Section 2.4.1. For the sake of illustration,

we restrict our attention to the no-lobbying case and put weights ω_{CS} and ω_π on components of welfare:

$$W_i = \omega_{CS} CS_i L_i + \omega_\pi (\pi_i - T_i) K_i + T_i \lambda_i K, \quad i \in \{1, 2\}.$$

Supposing $s = 1/2$, where an additional market-size effect does not emerge, as in Appendix 2.A.1, we can compute equilibrium tax rates as follows:

$$T_1 = T_2 = \frac{4\tau KL}{K+1} \left[\tau - \frac{\omega_\pi \tau}{2} - \frac{\omega_{CS}(2-\tau)}{4(K+1)} \right].$$

If the government solely care about the tax revenue, the two weights are zero ($\omega_{CS} = \omega_\pi = 0$) and only the first term (τ) in the square bracket remains, which we call a *tax-revenue effect*. Clearly, the second term ($-\omega_\pi \tau/2$) and the third term ($-\omega_{CS}(2-\tau)/[4(K+1)]$) come from the after-tax profit income ($(\pi_i - T_i)K_i$) and from the consumer surplus ($CS_i L_i$), respectively. Hence, we name the second term a *profit-income effect* and the third term a *consumer-price effect*.

2.A.3 Welfare Analysis

Quasi-linear preferences imply that the sum of the two countries' indirect utilities consists the global welfare as follows (ignoring constants):

$$\begin{aligned} W(\lambda_1) &\equiv W_1(\lambda_1) + W_2(\lambda_2 \equiv 1 - \lambda_1) \\ &= [s_1 CS_1(\lambda_1) + (1 - s_1) CS_2(\lambda_1)]L + [\pi_1(\lambda_1) - T_1]K_1 + [\pi_2(\lambda_1) - T_2]K_2 + T_1 \lambda_1 K + T_2(1 - \lambda_1)K \\ &= [s_1 CS_1(\lambda_1) + (1 - s_1) CS_2(\lambda_1)]L \\ &\quad + \{[\pi_1(\lambda_1) - T_1] - [\pi_2(\lambda_1) - T_2]\}(s_1 - \lambda_1)K + \pi_1(\lambda_1)\lambda_1 K + \pi_2(\lambda_1)(1 - \lambda_1)K \\ &= [s_1 CS_1(\lambda_1) + (1 - s_1) CS_2(\lambda_1)]L + \pi_1(\lambda_1)\lambda_1 K + \pi_2(\lambda_1)(1 - \lambda_1)K. \end{aligned}$$

From the third line to the forth, we use the fact that $\pi_1 - T_1 = \pi_2 - T_2$. Solving the FOC of the social planner's problem in λ_1 gives the globally optimal level of industry allocation:

$$\lambda_1^o = s_1 - \frac{(1 - 2s_1)[K + 2 - \tau(K + 1)^2]}{\tau K(2K + 3)}.$$

We can check that the second-order condition trivially holds: $-\tau^2 K^2 L(2K + 3)/(K + 1)^2 < 0$. We have $\lambda_1^o < \lambda_1^n$ for all $\tau \in (\underline{\tau}, \bar{\tau})$ and $\lambda_1^n < \lambda_1^*$ for all $\tau \in (\underline{\tau}, \tau^*)$. Therefore, when the reverse home market effect is dominant ($\beta > \beta^*$ and $\tau \in (\underline{\tau}, \tau^*)$), we order the spatial outcomes in this way: $\lambda_1^o < \lambda_1^n < \lambda_1^*$.

Additionally, we can compute the tax differential to replicate λ_1^o from the location equilibrium condition (2.10):

$$\lambda_1^o = \tilde{\lambda}_1 - \frac{K+1}{2\tau^2 KL}(T_1^o - T_2^o)$$

$$\text{or } T_1^o - T_2^o = -\frac{\tau L(1 - 2s_1)(2 - \tau)}{2K + 3},$$

where $\tilde{\lambda}_1$ is defined in (2.8) and the level of each country's tax rate is indeterminate. Comparing this to the tax differential under benevolent governments gives

$$|T_1^n - T_2^n| - |T_1^o - T_2^o| = \frac{4\tau KL(\beta - 1)(1 - 2s_1)[3 - \tau(3K + 4)]}{(4K + 5)[2(3 - \beta)K + 5]},$$

which is positive when $\tau \in (\underline{\tau}, \tau^*)$ holds.

By noting that $d|T_1^* - T_2^*|/d\beta = -d(T_1^* - T_2^*)/d\beta = \Phi(1 - 2s_1)[3 - \tau(3K + 4)] > 0$ for $\tau \in (\underline{\tau}, 3/(3K + 4))$ where $\Phi \equiv 4\tau KL(1 - 2s_1)/[2(3 - \beta)K + 5]^2 > 0$, we have $|T_1^o - T_2^o| < |T_1^n - T_2^n| < |T_1^* - T_2^*|$ for $\tau \in (\underline{\tau}, \tau^*)$.

Chapter 3

The Importance of Government

Commitment in Attracting Firms: A

Dynamic Analysis of Tax Competition in an

Agglomeration Economy

This chapter is based on Kato (2015a). The author thanks Elsevier for granting me permission to use material from the paper.

3.1 Introduction

Since the 1990s, low corporate tax rates have been a main driver for attracting foreign direct investment (FDI) and thereby promoting economic growth in some European countries such as Luxembourg and Ireland. Ireland is particularly noteworthy, as it drastically reduced its corporate income tax rate from 45% to 12.5% between 1998 and 2003. This rate is much lower than that of other EU15 countries, which was 25% on average in 2012. Due to this reduction, Ireland succeeded in hosting several multinational enterprises including Hewlett-Packard and Intel, and achieved a massive inflow of FDI. The geometric mean of the ratio of the net inflow of FDI to GDP in Ire-

land was 15.8% from 1998 to 2003, far higher than that of other EU15 countries: 3.3%(data are from UNCTAD). The success of Ireland seems to have fanned the fear of fierce tax competition among European countries, which had led to the international pressure on Ireland to raise its tax rate. France and Germany, for example, have requested Ireland to raise its taxes in return for its bailout rescue since 2010 (see, e.g. Mitchell, 2009; Stewart, 2011). However, Ireland confirmed its commitment to the 12.5% tax rate and has since maintained this rate. Through this commitment, Ireland has tried to establish a reputation that it will continue to keep its tax rate low among rival countries.

The objective of this chapter is to investigate how government commitment affects the location of industrial firms as a result of tax competition. In a symmetric two-country economy with agglomeration forces, we model the strategic interactions between two governments as an infinite-horizon dynamic game. The governments maximize their life-time payoffs through taxes and subsidies while considering the migration process of myopic firms. Assuming the governments care mostly about future payoffs and that they will agree on Pareto efficient locations, we examine two forms of commitment governments may make: full commitment and no commitment. The former corresponds to the open-loop Nash equilibrium while the latter corresponds the Markov-perfect Nash equilibrium. In the full commitment case, both governments announce a tax schedule over the entire horizon at the outset of the game and never change it. In the no commitment case, however, they choose their tax rate at each point in time by observing the current distribution of firms.

The results of tax competition dramatically change depending on whether or not commitment is possible. We find that tax competition with full commitment leads to the core-periphery configuration of firms when trade costs are low enough for the concentration of firms to supply an ample tax base. This result can be explained by the fact that the governments face the situation known as the “battle of the sexes”. The dispersed configuration where both the governments share firms evenly is too costly for them because they must provide negative taxes (or subsidies) to prevent firms with strong agglomeration motives from clustering into one country. Of course, the core position where all firms are clustered is the most desirable for both governments. However, the peripheral position where no firms are located is better than the dispersed configuration because the government in the periphery does not have to subsidize firms and avoids the intense competition. Either country may

become the core so that self-fulfilling expectations of both governments select the long-run outcome; the country that succeeds in convincing the counterpart will eventually attract all the firms. We also find that tax competition without commitment may result in the dispersed configuration of firms even when trade costs are so low that benefits from agglomeration are large. Compared to the full-commitment case, the governments have more incentive to raise their tax rate because they know that the loss of firms from raising their own tax rate will be partially diminished by the reaction (i.e., tax increase) of the rival. Both governments may set a higher tax rate while sharing firms evenly so that the dispersed pattern may be more desirable than the core status.

With these results, we draw the implication that, in the contemporary environment of deepening economic integration, effective tax competition relies critically on a government's commitment to its policies and its ability to convince foreign rivals that they will be implemented. This may explain the success of Ireland. But, at the same time, we also emphasize the weakness of commitment strategies. Credible policies imply that governments promise to keep their original policies even if they are aware that the policies are no longer optimal. Thus, such rigid policies are vulnerable to unexpected events such as sudden changes in the industrial location or policy changes in foreign rivals. When policymakers decide attitudes toward policies, it is worth recognizing the positive and negative aspects of such rigorous commitment.

3.1.1 Contribution to the Literature

This chapter draws from the literature on tax competition in new economic geography (see Chapter 1 for more details). The main findings of the literature on agglomeration and tax competition are the superiority of the core country and a “race to the top” (Baldwin and Krugman, 2004; Borck and Pflüger, 2006, among others); the ability of the core country to charge a higher tax rate, and the inverted U-shaped relationship of the tax differential in terms of trade costs between the core and periphery.¹ For example, Baldwin and Krugman (2004) consider a Stackelberg game played by the core (leader) and peripheral country (follower), and show that, when trade costs are low, the industrial cluster brings about to the core a taxable rent (“agglomeration rent”). They also show that a decline in trade costs first increases and then decreases the tax gap. Borck and Pflüger

¹Recent studies such as the paper by Ottaviano and van Ypersele (2005), which allows for differences in the size of immobile factors, and the paper by Baldwin and Okubo (2014), which introduces firm heterogeneity in productivity, also observe the superiority of the core country.

(2006) confirm the result in a core-periphery model allowing for partial agglomeration. These results contrast with the conclusion of the standard neoclassical tax competition model that tax competition results in a “race to the bottom”.² The existence of a taxable agglomeration rent is also supported by some empirical research (e.g., Charlot and Paty, 2007 for French data; Coulibaly, 2008 and Brülhart et al., 2012 for Swiss data).

The conclusions of the previous studies crucially depend on the initial industrial locations. To avoid the difficulty of discontinuities in the reaction functions, which is a by-product of the core-periphery model, most existing studies assume that one country is the core from the beginning. Because policy implementation and firm migration are allowed to occur after the announcement of the policy in these models, the number of firms located in each country at the beginning of the game plays a decisive role in determining the equilibrium outcome. The advantages of the agglomerated position are thus assumed, and the strategic aspect of competition over mobile factors is not completely captured. Also, since the policy schedule consists of one tax rate, the effect of government commitment to the policy cannot be fully examined.

This chapter differs from the previous studies in that it considers tax competition in a fully dynamic context so as to treat agglomeration forces endogenously. By analyzing an infinite-horizon game, we avoid the difficulty of discontinuities and allow for *all possible* initial conditions in order to not be restricted to the core-periphery configuration. Moreover, by utilizing differential game theory, we can analyze the impact of different forms of government commitment, which is not addressed in the previous studies. We show that, contrary to previous research, the core-periphery pattern may not emerge as a result of tax competition between governments without commitment. Even when the core-periphery pattern emerges in the full-commitment case, initially being the core is of little importance, as expectations of governments instead determine which country will be the core. However, the “race to the top” result on the relationship between the core’s tax rate and trade costs still holds whenever the core-periphery pattern emerges.

This chapter is not the first to incorporate forward-looking behavior into the new economic geography framework (see, e.g., Baldwin, 2001; Ottaviano, 2001; Ottaviano et al., 2002 Section 6; Oyama, 2009a,b).³ However, these studies deal only with the forward-looking behavior of indus-

²See Keen and Konrad (2012) for a comprehensive survey on tax competition in the neoclassical framework.

³The first three consider the Krugman (1991a) type migration dynamics, where firms can move freely by paying costs determined by the current flow of migrants. The last one adopts Matsuyama (1991) type migration dynamics,

trial firms and do not model governments explicitly. In contrast, the present analysis allows only governments to be forward-looking agents.⁴ This chapter and the studies just mentioned should be seen as complements because both try to investigate the role of far-sighted behavior but of different agents. In spite of this difference, one of the results we obtain that, ‘expectations matter’ for equilibrium selection, can be found in Baldwin (2001), Ottaviano (2001) and Ottaviano et al. (2002).

Dynamic aspects and commitment issues have been addressed in the literature of the standard tax competition without agglomeration forces (see, e.g., Janeba, 2000; Keen and Konrad, 2012, Section 2.3 and the references therein). The closest study in that field to this paper is Han et al. (2014). They consider an infinite-horizon tax game between two countries of unequal size. An asymmetric form of government commitment, which is not addressed in this paper, is assumed and the larger country adopts open-loop strategies while the smaller country adopts Markov-perfect strategies. They show that, if mobility of firms is high and the future payoff is important (as in this paper), the smaller country will lose all the firms in the long run. The result that a government without commitment will be the periphery is similar to one of the results we obtain. However, the model we present describes not only the conflict between governments but also the interaction among governments and firms with agglomeration motives. When considering a world economy in which FDI is motivated mainly by reducing transport costs and exploiting economies of scale (see, e.g., Markusen and Maskus, 2002), examining tax competition in the core-periphery model may be more relevant today than in the neoclassical world with constant returns to scale and perfect competition.

The rest of the chapter proceeds as follows. The next section develops a simple general equilibrium model that induces agglomeration forces. Section 3.3 introduces governments and formulates a dynamic tax competition. The two equilibrium concepts in dynamic games, the open-loop Nash equilibrium (OLNE) and the Markov-perfect Nash equilibrium (MPNE), are also explained. The assumptions imposed on the analysis are also discussed. Section 3.4 presents the results whereby I characterize the stable steady state both under OLNE and under MPNE. Section 3.5 concludes.

where only firms that receive an opportunity to revise their location choice can move without any costs. This chapter and most of the studies in the new economic geography are in line with the myopic version of the Krugman (1991a) dynamics.

⁴Oyama (2009a) discusses tax policy and points out that agglomeration rents should be much smaller because of the possibility of self-fulfilling coordinated migration, but the paper does not explicitly model governments.

3.2 The Model

In this section, we consider the Ludema and Wooton (2000) and Thisse (2010) version of the core-periphery model. The model may be viewed as the “minimalist framework” of economic geography and has several distinct features that make the analysis simple. First, the model follows the “footloose entrepreneur” setting as in Forslid and Ottaviano (2003) whereby the manufacturing industry needs internationally immobile workers for variable inputs and mobile entrepreneurs for fixed inputs. Second, consumers’ preferences are described by the quadratic quasi-linear utility function as in Ottaviano et al. (2002). Third, contrary to most of the core-periphery models, manufacturing firms produce a homogeneous product and engage in Cournot competition. Due to these simplifications, closed-form solutions can be obtained with a reduced number of parameters, though qualitative results are quite similar to the linear version of the core-periphery model by Ottaviano et al. (2002).

In this model, the economy consists of two countries (1 and foreign 2), two homogeneous goods (traditional and modern goods), and two factors of production (workers and entrepreneurs). The total mass of workers in the world is L , and that of entrepreneurs is K . While two countries have an equal share of workers are equally distributed between countries, the λ proportion of the entrepreneurs resides in country 1 where $\lambda \in [0, 1]$. The total population of country $i \in \{1, 2\}$ becomes $S_i = L/2 + \lambda_i K$, where $\lambda_1 \equiv \lambda$ and $\lambda_2 \equiv 1 - \lambda$.

The two types of factors are different in their place of employment and in their mobility. Each entrepreneur can move between countries and provides one unit of headquarter service with the modern sector in the country where she resides, while each worker is immobile and provides one unit of labor service with the traditional sector.

The traditional sector is characterized by perfect competition and constant returns-to-scale technology. The goods are freely traded internationally without any trade costs. The price of the traditional good is chosen as a numéraire, and only labor services by workers are required as variable inputs. The modern sector, on the other hand, is characterized by imperfect competition and increasing returns to scale technology. The shipment of one unit of the modern good incurs additional τ units of trade costs. To start a business, a potential firm in the sector hires one entrepreneur as a fixed input, but needs no variable inputs.

3.2.1 Demand Side

Every individual in country 1 has the same preferences, and their utility function takes the following quasi-linear quadratic form:⁵

$$u_1 = \left[1 - \frac{1}{2} \left(\frac{Q_1}{S_1} \right) \right] \left(\frac{Q_1}{S_1} \right) + \frac{Q_{01}}{S_1}, \quad (3.1)$$

where Q_1 (Q_1/S_1 , respectively) is the total (per-capita, resp.) demand for the modern good and Q_{01} (Q_{01}/S_1 , resp.) is total (per-capita, resp.) demand for the traditional good. Aggregating across individuals, total utility in the home country is given by the following:

$$U_1 = S_1 u_1 = \left[1 - \frac{1}{2} \left(\frac{Q_1}{S_1} \right) \right] Q_1 + Q_{01}. \quad (3.2)$$

The national budget constraint requires that the expenditure on the two goods equals the remuneration of production factors and the endowment of the numéraire good. We focus only on the case where \bar{Q}_{01} is sufficiently large for the numéraire good to be consumed. Letting p_i be the price of the modern good, Y_i the total reward for factors,⁶ and \bar{Q}_{01} the endowment of numéraire good, the national budget constraint can be written as follows:

$$p_1 Q_1 + Q_{01} = Y_1 + \bar{Q}_{01}. \quad (3.3)$$

The representative agent in country 1 maximizes aggregate utility (3.2) subject to the national budget constraint (3.3) by choosing the total demand for the industrial good, Q_1 . Optimization yields a linear-demand function for the manufactured product independent of income level:

$$p_1 = 1 - Q_1/S_1.$$

⁵In what follows, we concentrate on 1. Symmetric expressions hold for 2.

⁶As will be clear in the following discussion, suppose w_0 is the wage for a worker and w for an entrepreneur, the reward to a worker is w_{01} and the reward to an entrepreneur is w_1 . Total reward to the factors in 1 becomes $Y_1 = w_{01}L/2 + w_1\lambda K$.

3.2.2 Supply Side

For the traditional sector, perfect competition and costless trade lead to the equalization of prices between countries. One unit of labor supplied by a worker produces one unit of the traditional good, so that its price denoted by p_{0i} and the wage of a worker denoted by w_{0i} in both countries are equalized to unity: $p_{01} = p_{02} = w_{01} = w_{02} = 1$.

For the modern sector, firms located in i provide their goods to both domestic and foreign markets. Since an entrepreneur is needed to launch one industrial firm, country 1 has λK firms and country 2 has $(1 - \lambda)K$ firms. The operating profit of a firm in i can be written as follows:

$$\pi_i = p_1 q_{i1} + (p_2 - \tau) q_{i2}, \quad (3.4)$$

where q_{ij} denotes the amount of production by a firm in i , sold in j ($i, j \in \{1, 2\}$). For the industrial good market to clear, it must hold that:

$$Q_1 = \lambda K q_{11} + (1 - \lambda) K q_{21}.$$

Due to the separation of markets, firms can choose different quantities for each market given the inverse demand functions they face. As a result of Cournot competition, the market outcome is determined by a Nash equilibrium:

$$q_{11} = S_1 p_1, \quad q_{21} = S_2 (p_2 - \tau),$$

where

$$p_1 = \frac{1 + (1 - \lambda)K\tau}{K + 1}, \quad p_2 = \frac{1 + \lambda K\tau}{K + 1}.$$

The increase in the share of domestic firms and decline in trade costs make the domestic price go down.

For international trade to occur, trade costs must be low enough for the mill price $p_2 - \tau$ to be

positive whatever the distribution of firms may be:

Assumption 1. $\tau < \bar{\tau} \equiv \frac{1}{K+1}$.

This assumption holds throughout the analysis.

By substituting equilibrium prices and quantities into (3.4), the equilibrium operating profit can be calculated as follows:

$$\begin{aligned} \pi_1 &= S_1 p_1^2 + S_2 (p_2 - \tau)^2 \\ &= \left(\frac{L}{2} + \lambda K\right) \cdot \frac{[1 + (1 - \lambda)K\tau]^2}{(K + 1)^2} + \left(\frac{L}{2} + (1 - \lambda)K\right) \cdot \frac{[1 - \{1 + (1 - \lambda)K\}\tau]^2}{(K + 1)^2}. \end{aligned}$$

Under Assumption 1, falling trade costs decrease the profits from the domestic market but increase those from the foreign market. Allowing for free entry and exit, the operating profit of a firm goes to the entrepreneur so that it becomes equal to the reward. Letting w_i be the reward to an entrepreneur in i , it holds that $\pi_i = w_i$. Since there is one entrepreneur for every modern firms, we refer to them interchangeably in what follows.

The utility of an entrepreneur in 1 evaluated at the equilibrium prices and quantities is expressed as

$$u_1 = CS_1 + w_1 + \bar{q}_{01}.$$

where $\bar{q}_{01} = \bar{Q}_{01}/S_1$ is the endowment for individuals and CS_1 is the individual consumer surplus:⁷

$$CS_1 = \frac{K^2}{2(K + 1)^2} [1 - (1 - \lambda)\tau]^2.$$

CS_1 is increasing in the domestic firm's share, but is decreasing in trade costs as long as Assumption 1 holds. An entrepreneur, as a consumer, benefits from a lower price due to the expansion of the domestic firm's share.

⁷ \bar{q}_{01} is supposed to be sufficiently large for taxes, which will be introduced in the next section, to be paid. Further, \bar{q}^a is assumed to be identical between countries so that it does not affect international differences in indirect utility.

3.2.3 Location Equilibrium

The gap of the indirect utility, which determines the entrepreneurs' location choice, can be expressed as

$$\begin{aligned}\Delta u(\lambda) &\equiv u_1 - u_2 \\ &= CS_1 + w_1 - (CS_2 + w_2) \\ &= Z(\lambda - 1/2),\end{aligned}$$

where

$$Z = \frac{K[2K^2 + (2L + 5)K + 2(L + 1)]}{(K + 1)^2} \tau(\tau^* - \tau), \quad \tau^* = \frac{2(3K + 2)}{2K^2 + (2L + 5)K + 2(L + 1)}.$$

Figure 3.1 shows the relationship between Z and trade costs for particular parameter values; $K = 1$ and $L = 5$, which implies $\bar{\tau} = 0.5$.

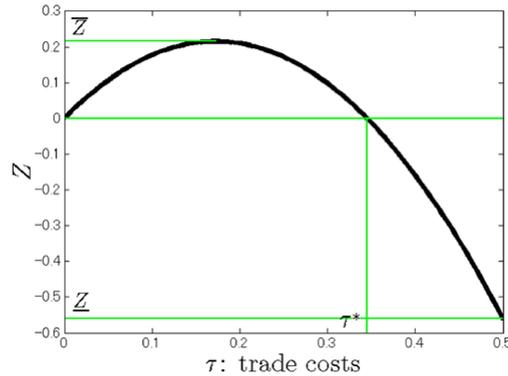


Figure 3.1. Slope of the migration equation Z .

Z captures a firm's incentive to agglomerate (disperse, resp.) if it is positive (negative, resp.). Agglomeration forces reach the peak (\bar{Z}) when trade costs are intermediate ($\tau^*/2$), while they become smallest (\underline{Z}) when trade costs are highest ($\bar{\tau}$). The intuition behind the inverted U-shaped relationship between τ and Z is easy to grasp when considering the two extreme cases.⁸ When

⁸Note that the difference of consumer surplus is increasing in τ as long as Assumption 1 holds: $CS_1(\lambda = 1) - CS_2(\lambda = 1) = K^2\tau(1 - \tau)/2(K + 1)^2$. Note also that the wage gap has an inverted U-shaped relationship in terms of τ

$\tau = \bar{\tau}$ and the costs of shipping industrial goods are prohibitively high, agglomeration of firms in one country is harmful because they earn little from the foreign market and operate solely in the domestic market. However, when $\tau = 0$ and trade is completely free, agglomeration is not necessary because the location choice does not matter. When trade costs are intermediate, agglomeration is profitable. The positive utility difference between the core and periphery ($\Delta u(\lambda = 1) = Z/2$) is the so called “agglomeration rent”.

Following the tradition of the core-periphery model, we consider the myopic behavior of firms. That is, entrepreneurs, the owners of firms, relocate to the country that affords the higher *current* utility. Therefore, the movement of firms is governed by a simple migration equation $\dot{\lambda} \equiv d\lambda/dt = \Delta u(\lambda)$. For now, we simply assume that the motion stops if the economy hits either of the boundaries $\lambda \in \{0, 1\}$. This restriction will be removed in the next section.

When $\tau > \tau^*$, the slope of the migration equation Z is negative and the dispersed distribution $\lambda = 1/2$ is stable, while when $\tau < \tau^*$, the slope is positive and the agglomerated distributions $\lambda \in \{0, 1\}$ are stable. For the dispersed location to emerge, we impose the “no-black-hole” condition:

Assumption 2. $\tau^* < \bar{\tau}$,

$$\Rightarrow K < \frac{1}{8} \left[2L - 5 + \sqrt{(2L - 5)^2 + 32(L - 1)} \right].$$

The condition simply states that, to prevent agglomeration forces from being too strong, the number of entrepreneurs should be small compared to that of workers.

The following lemma is the central finding of the core-periphery model:

Lemma 3.1. *If trade costs are high ($\tau > \tau^*$), the symmetric configuration is the only stable one. If trade costs are low ($\tau < \tau^*$), the core-periphery structure is the only stable one.*

In this linear model, the “break point” at which the symmetric state is no longer stable coincides with the “sustain point” at which the concentrated states become stable.

as long as $L > 1$, Assumption 1 and 2 hold: $w_1(\lambda = 1) - w_2(\lambda = 1) = K\tau[2 - (K + L + 1)\tau]/(K + 1)$.

3.3 Tax Competition over an Infinite Horizon

Having presented the base model, we now introduce taxes and a government for each country that plays tax competition over an infinite time horizon. This section also explains equilibrium concepts in the dynamic game and includes a few additional assumptions.

3.3.1 The Governments' Problem

Following Ludema and Wooton (2000) and Borck and Pflüger (2006), taxes are levied in a lump-sum manner. The government in country $i \in \{1, 2\}$ imposes lump sum taxes on each domestic firm so that the migration equation for firms is modified as follows:

$$\begin{aligned}\dot{\lambda}/\gamma &= (u_1 - T_1) - (u_2 - T_2) \\ &= Z(\lambda - 1/2) - (T_1 - T_2), \quad \lambda \in [0, 1],\end{aligned}$$

where γ is a positive constant that represents the migration speed, and T_i denotes the *taxes* in i if it is positive or *subsidies* if negative. Unlike the previous section, hereafter, we do not require $\dot{\lambda}$ to be zero when λ hits a boundary. The governments redistribute their tax revenues to the domestic immobile workers as numéraire goods so that the governments' budgets are balanced at each point in time.

Taking into account the firms' incentive to relocate, both governments try to maximize the following discounted sum of the instantaneous payoff W_i :

$$\begin{aligned}\max_{\{T_i(t)\}_{t=0}^{\infty}} & \int_0^{\infty} \exp(-\rho t) W_i(\lambda(t), T_i(t)) dt \equiv J_i, \\ \text{s.t.} & \begin{cases} \dot{\lambda}(t)/\gamma = Z[\lambda(t) - 1/2] - [T_1(t) - T_2(t)], \\ \lambda(t) \in [0, 1], \quad \lambda(0) = \lambda_0 \text{ given,} \end{cases}\end{aligned}\tag{5}$$

where $\rho > 0$ is a discount rate. Following Baldwin and Krugman (2004) and Borck and Pflüger (2006), I adopt a simple instantaneous objective function:

$$W_i(\lambda(t), T_i(t)) \equiv K\lambda_i(t)T_i(t) - cT_i^2(t)/2,$$

where $\lambda_1 \equiv \lambda$ and $\lambda_2 \equiv 1 - \lambda$, and $c > 0$ is a parameter. The first term on the right hand side is the total tax revenue for country i and the second term is the quadratic loss from taxation. This simple instantaneous objective function captures the basic conflicts governments face: they seek to raise more tax revenue while maintaining a low tax rate. It is regarded as a reduced-form objective function that either selfish or benevolent governments adopt (Baldwin and Krugman, 2004, Section 5). From a different point of view, the second term can be considered the administrative cost incurred in collecting taxes (see, e.g. Kenny and Winer, 2006 for empirical evidence). The second term may also be interpreted as the smoothing motives of taxes both in a static and a dynamic sense. Without the quadratic term, the instantaneous payoff would be linear with respect to the tax rate so that the governments would tend to choose whether a possible highest tax rate or a possible lowest one. This static behavior would lead to a bang-bang tax control, which seems implausible considering the fact that most countries change corporate tax rates gradually. The quadratic term is necessary from the viewpoint of consistency with the reality.

3.3.2 Equilibrium Concepts: Is Commitment Credible?

This subsection introduces two equilibrium concepts, the open-loop Nash equilibrium (OLNE) and the Markov-perfect Nash equilibrium (MPNE). Intuitively speaking, OLNEs consider situations in which both governments can make a precommitment; they stick to their strategies announced at the beginning of the game. Conversely, MPNEs assume such a precommitment away, so both governments may deviate from their predetermined tax policies. Precommitment to tax schedules is possible in two cases.⁹ One case is that the governments cannot observe the time path of the distribution of firms (except for the initial one) nor the tax path of the rival country. The other case is that the governments can observe the state and other player's actions but they can precommit to their future policies with the aid of commitment device such as national legislations with compelling power. In the context of tax competition, We adopt the latter explanation of why precommitment is possible.¹⁰

⁹The following explanation is based on Reynolds (1987, Section 3).

¹⁰It does not seem plausible that the actual governments adopt the open-loop strategies, but there are some countries that appear to do this. In particular, as discussed in the introduction, Ireland is a good example. A government report released in 2013 (Department of Finance of Ireland, 2013) firmly asserts the commitment toward its tax rate: "Our competitive taxation system is, of course, an element of the Irish package and we remain committed to our competitive 12.5% tax rate."(p.3)

Open-loop Nash Equilibrium

In this model, an open-loop strategy for country i is a tax policy T_i which is a function of time and the boundaries of the state variable $\lambda \in \{0, 1\}$. A pair of open-loop strategies $\{T_1^o(t, \lambda \in \{0, 1\}), T_2^o(t, \lambda \in \{0, 1\})\}$ forms an OLNE such that

$$J_i(T_i^o, T_j^o; \lambda) \geq J_i(T_i, T_j^o; \lambda), \text{ for every open-loop strategy } T_i(t, \lambda \in \{0, 1\}), \quad i, j \in \{1, 2\}; i \neq j,$$

where $J_i(\cdot, \cdot)$ is a maximized value of the objective function defined in (3.5). At an OLNE, the payoffs of both governments are maximized and neither has an incentive to deviate from its open-loop strategies, given the open-loop strategy of the other. To solve for OLNEs, the optimal control method can be applied. We formulate the current-value Hamiltonian for the home government \mathcal{H}_1 and the Lagrangian \mathcal{L}_1 as follows:

$$\mathcal{H}_1 = K\lambda T_1 - cT_1^2/2 + \mu_1\gamma[Z(\lambda - 1/2) - (T_1 - T_2)],$$

and

$$\mathcal{L}_1 = \mathcal{H}_1(\lambda, T_1, T_2) + \nu_1^1\lambda + \nu_1^2(1 - \lambda),$$

where μ_1 is the co-state variable associated with the state variable, and ν_1^1 and ν_1^2 are the Lagrange multipliers on the boundaries of the state variable. The optimal control problem here is somewhat different from the standard problem in that the state variable λ should lie in between $[0, 1]$. In order to deal with the state variable constraints, we employ ‘‘informal theorem’’ 4.1 in Hartl et al. (1995) (see, e.g., Oyama, 2009b for an application in economics).¹¹ Given an open-loop strategy of the foreign government T_2 , an open-loop strategy of the home government T_1 is characterized by the

¹¹Although the necessary conditions of the optimal control problem with state and control constraints have not been fully characterized, those of the problem we are considering (no mixed constraints on state and control variables) have been formally proved. See Hartl et al. (1995, p.187).

following necessary conditions for optimality:

$$\lambda/\gamma = Z(\lambda - 1/2) - (T_1 - T_2), \quad \lambda \in [0, 1], \quad (3.61)$$

$$\frac{\partial \mathcal{H}_1}{\partial T_1} = K\lambda - cT_1 - \gamma\mu_1, \quad (3.62)$$

$$\rho\mu_1 - \dot{\mu}_1 = \frac{\partial \mathcal{H}_1}{\partial \lambda} = KT_1 + \gamma Z\mu_1, \quad (3.63)$$

$$\lim_{t \rightarrow \infty} \exp(-\rho t)\mu_1 = 0, \quad (3.64)$$

$$v_1^1(t) \begin{cases} > 0 & \text{if } \lambda(t) = 0 \\ = 0 & \text{if } \lambda(t) > 0 \end{cases}, \quad v_1^2(t) \begin{cases} > 0 & \text{if } \lambda(t) = 1 \\ = 0 & \text{if } \lambda(t) < 1 \end{cases}, \quad (3.65)$$

and for any time z in a boundary interval and for any contact time z ,¹² $\mu_1(\cdot)$ may have a discontinuity governed by the following *jump conditions* :

$$\mu_1(z^-) - \mu_1(z^+) = \eta_1^1(z) - \eta_1^2(z), \quad (3.66)$$

$$\eta_1^1(z) \begin{cases} > 0 & \text{if } \lambda(z) = 0 \\ = 0 & \text{if } \lambda(z) > 0 \end{cases}, \quad \eta_1^2(z) \begin{cases} > 0 & \text{if } \lambda(z) = 1 \\ = 0 & \text{if } \lambda(z) < 1 \end{cases}, \quad (3.67)$$

for some $\eta_1^1(z), \eta_1^2(z)$ for each z , where $\mu_1(z^-) \equiv \lim_{t \rightarrow z^-} \mu_1(t)$ and $\mu_1(z^+) \equiv \lim_{t \rightarrow z^+} \mu_1(t)$. An open-loop strategy of 2, given an open-loop strategy of 1, is derived in a similar manner. We obtain an OLN as a pair of tax policies that simultaneously satisfies both governments' necessary conditions for optimality as just described.

OLNEs assume open-loop strategies, where both players announce the action schedule at the outset of the game and commit themselves to it. Because open-loop strategies depend on time, the government sticks to the original plan even if it is no longer optimal to do so on account of the counterpart's deviations from the original tax policy, or due to shocks that pull the distribution of firms off the predetermined path.¹³ Hence, an OLNE is not robust against any deviations from the

¹²An interval $[t_1, t_2] \subset [0, \infty)$ with $t_1 < t_2$ is said to be a *boundary interval* if $\lambda(t) \in [0, 1]$ for all $t \in [t_1, t_2]$. An interval $(t_1, t_2) \subset [0, \infty)$ with $t_1 < t_2$ is said to be an *interior interval* of $\lambda(\cdot)$ if $\lambda(t) \in (0, 1)$ for all $t \in (t_1, t_2)$. If the trajectory is in the interior interval just before and just after z , z is said to be a *contact time*.

¹³The open-loop strategies we consider are slightly different from the standard one; the former depends both on time and the boundaries of the state variable, whereas the latter depends only on time. However, the argument does not change much.

equilibrium path.

Markov-perfect Nash Equilibrium

A Markov-perfect strategy and a MPNE are defined similarly to the open-loop case. An Markov-perfect strategy for country i is a tax policy T_i which is a function only of the state variable $\lambda \in [0, 1]$. An pair of Markov-perfect strategy $\{T_1^m(\lambda(t)), T_2^m(\lambda(t))\}$ forms an MPNE such that

$$J_i(T_i^m, T_j^m; \lambda) \geq J_i(T_i, T_j^m; \lambda), \text{ for every Markov-perfect strategy } T_i(\lambda(t)), \quad i, j \in \{1, 2\}; i \neq j,$$

As in the open-loop case, we obtain an MPNE as a solution to the two governments' dynamic optimization problems. Necessary conditions for each government's problem here are slightly different from the ones in the open-loop case. Condition (3.63) is replaced with the following condition:

$$\begin{aligned} \rho\mu_1 - \dot{\mu}_1 &= \frac{\partial \mathcal{H}_1}{\partial \lambda} + \frac{\partial \mathcal{H}_1}{\partial T_2} \frac{\partial T_2}{\partial \lambda}, \\ &= KT_1 + \gamma Z\mu_1 + \gamma\mu_1 \frac{\partial T_2}{\partial \lambda}. \end{aligned} \tag{3.7}$$

The necessary conditions from (3.61) to (3.67) other than (3.63) are the same. Symmetric expressions hold for the foreign government.

The second term in the right hand side of (3.7) captures the feedback effect of the counterparts on the change of the state variable. In the Markov-perfect case, the government takes into account how the other government changes its tax policy by responding to the changes of the distribution of firms. In the open-loop case, the government ignores this feedback effect so that the term does not appear.

Since the government utilizes the counterpart's decisions at each point in time, a credible pre-commitment for implementing the tax schedule determined at the beginning of the game is no longer possible. Markov strategies that depend only on the state variable in the game imply that the governments optimally choose their tax schedules at each time instant. Thus, an MPNE is a subgame perfect equilibrium and is robust against any deviations from the equilibrium path.¹⁴

¹⁴Both solution concepts are time consistent, which is a weaker requirement than subgame perfection. See Dockner et al. (2000, Chapter 4).

Assumptions

The subsequent analysis relies on several assumptions. First, to shed light on the dynamic aspect of the analysis, we assume the following:

Assumption 3. ρ/γ is sufficiently close to zero.

The ratio of the governments' discount rates to the migration speed ρ/γ is called the “degree of friction”. The behavior of the dynamics does not depend on ρ or γ independently (see the appendix of the chapter), but on the ratio. This assumes that the governments greatly value the future (small ρ) and/or the firms move quickly when responding to the tax differential (large γ). Thus, when deciding tax policies, the governments put more emphasis on the steady states where movement of firms stops, than on the short term payoffs on the way to the steady states.

Second, we need a criterion to select the resulting outcomes among others because, as will be seen in the analysis, the model has multiple stable steady states:

Assumption 4. Pareto inefficient steady states for governments (if any) are eliminated.

This refinement of the Nash equilibrium is known as “payoff dominance” (without uncertainty). Since the governments focus solely on the steady-state payoffs due to Assumption 3, the resulting outcomes are determined by the steady-state payoffs. If the payoff at a stable steady state dominates the others in a Pareto sense, both governments agree that the economy reaches the state. The Pareto refinement seems to be consistent with sufficiently forward-looking agents who would be able to co-ordinate to avoid the inferior outcomes.

Finally, for analytical convenience, we restrict the range of parameter c , which captures the intensity of loss from an increasing tax or subsidy rate:

Assumption 5. $0 < c < (2 - \sqrt{3})K/\bar{Z} \approx 0.27K/\bar{Z}$,

$$\text{where } \bar{Z} \equiv \max Z = \frac{K(3K + 2)^2}{(K + 1)^2[2K^2 + (2L + 5)K + 2(L + 1)]}.$$

This assumption eliminates the imaginary root in the linear MPNE (see Appendix 3.A.2 for details).

3.4 Results

This section characterizes the resulting industrial location both under OLNE and under MPNE. The time path of the share of industry and taxes are also discussed.

3.4.1 Open-loop Case: Both Governments Fully Commit to Their Tax Schedules

We illustrate OLNEs by resorting to intuitive arguments, which are verified by the formal proof in Appendix 3.A.1. The present model is somewhat complicated because the economy by nature may have multiple steady states, the symmetric state $\lambda = 1/2$ and the concentrated states $\lambda \in \{0, 1\}$.¹⁵ However, since the future is sufficiently important for the governments by Assumption 3, the governments are concerned mainly with the steady-state payoffs when choosing equilibrium paths. Assumption 4 requires that the steady state configurations which bring higher payoffs to both governments than others are realized in equilibrium. By comparing the payoffs between the symmetric state and the concentrated states, the resulting steady states can be found. The stability of the states are proved in Appendix 3.A.1.

First, we look at the symmetric steady state, which can be obtained by making $\dot{\lambda} = \dot{\mu}_1 = \dot{\mu}_2 = 0$ and $\nu_1^1 = \nu_1^2 = \nu_2^1 = \nu_2^2 = 0$ in the necessary conditions. Since both governments have an equal share of firms at the steady state, the tax rate will be equalized as a result of dynamic competition:

$$T_1^o(\lambda^o = 1/2) = T_2^o(\lambda^o = 1/2) = \frac{K(\rho - \gamma Z)}{2[c\rho + \gamma(K - cZ)]}.$$

The expression is simplified by Assumption 3 that the degree of friction ρ/γ is sufficiently close to zero:

$$T_1^o(\lambda^o = 1/2) = T_2^o(\lambda^o = 1/2) = \frac{KZ}{2(cZ - K)} \begin{cases} \geq 0 & \text{if } Z \leq 0 \\ < 0 & \text{if } Z > 0 \end{cases}.$$

Note that, by Assumption 5, c is small enough for the denominator to always be negative. The

¹⁵Since the migration equation is linear with respect to λ , the interior points, other than the symmetric state, cannot be steady states.

inverted U-shaped relationship between the slope of the migration equation Z and trade costs τ (Figure 3.1) implies that positive (negative, resp.) Z equals high trade costs $\tau > \tau^*$ (low trade costs $\tau < \tau^*$, resp.).

It can be easily verified that if trade costs are high ($\tau > \tau^*$), making the dis-intensive to agglomerate strong ($Z < 0$), the tax rate is positive and both governments earn positive payoffs at the symmetric steady state. On the other hand, if trade costs are low ($\tau < \tau^*$), making the incentive to agglomerate strong ($Z > 0$), the tax rate is negative and both governments incur loss by providing subsidies to keep the symmetric location stable.

To see why the tax rate responds to trade costs as such, consider the motives of firms. High trade costs lessen the profitability of exports and make the domestic competition among firms tougher, so that firms try to avoid a country with many competitors. Because of the firms' preference for diversified distribution, the governments can impose a positive tax. Conversely, low trade costs reverse the outcome: since low trade costs makes exports more profitable, firms try to locate in a country with many rivals in order to exploit scale economies. The governments need to subsidize the domestic firms to prevent them from moving away. This is reminiscent of the "race to the bottom" result. Strong incentives for firms to gather make the symmetric configuration unattractive for both governments.

Next, we look at the steady state with full agglomeration in the home country ($\lambda = 1$). For the concentrated configuration to be stable, the tax differential should be determined in such a way that the motion of firms $\dot{\lambda}$ evaluated at $\lambda = 1$ is equal to zero and $T_1 - T_2 = Z/2$. Evidently, the optimal tax rate for country 2 is zero and it has zero payoff. Therefore, the core country will set its tax rate at $Z/2$:

$$T_1^o(\lambda^o = 1) = Z/2,$$

$$T_2^o(\lambda^o = 1) = 0.$$

Both the tax rate and the payoff of country 1 at the steady state are negative under low agglomeration incentive $Z < 0$ and equivalently high trade costs $\tau > \tau^*$, whereas they are positive under high agglomeration incentive $Z > 0$ and low trade costs $\tau < \tau^*$.

The same reasoning for the symmetric case applies here. High trade costs strengthen the in-

centive for firms to diversify so that the core country has to subsidize them to maintain clustering. Under low trade costs, however, the incentive to concentrate is so strong that the core earns the taxable agglomeration rent.

Figure 3.2-(a) shows the tax rate of 1 at each steady state for a various level of trade costs.¹⁶ The instantaneous payoff of 1 also exhibits a similar shape as in Figure 3.2-(b). Parameter values are $K = 1$, $L = 5$, and $d = 1$. By the symmetry of the model, it holds that $T_1^o(\lambda^o = 1) = T_2^o(\lambda^o = 0)$, $T_1^o(\lambda^o = 0) = T_2^o(\lambda^o = 1)$ and $T_1^o(\lambda^o = 1/2) = T_2^o(\lambda^o = 1/2)$. The same relations hold for the payoffs of country 2.

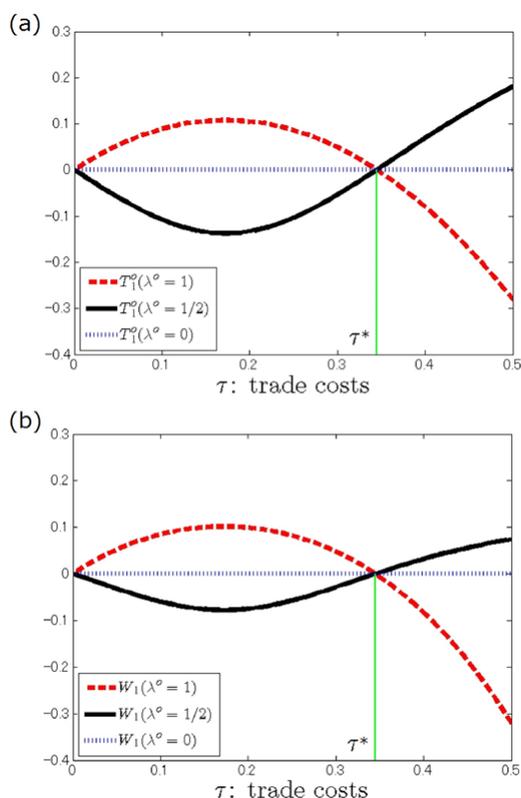


Figure 3.2. Country 1's (a) tax rates and (b) payoffs at the steady states under OLNE.

To sum up, high trade costs bring the dispersed equilibrium $\lambda = 1/2$, while low trade costs bring the agglomerated equilibrium $\lambda \in \{0, 1\}$. When trade costs are high ($Z < 0$), the governments

¹⁶Hauffer and Wooton (2010) study a static tax game in a location model (“footloose capital model”) which is similar to the present model. Their model also obtains a U-shaped relationship with the tax rate and trade costs in the symmetric equilibrium. But their paper and this paper are quite different in that their model exhibits weaker agglomeration forces and their focus is only on interior equilibria.

share an equal number of firms while setting a positive tax rate by taking advantage of the firms' anti-agglomeration motive. Since the governments have to provide subsidies to keep all the firms in their country, neither of them tries to achieve agglomeration. In contrast, when trade costs are low ($Z > 0$), the governments have to set negative tax rates to maintain the symmetric configuration because of the firms' agglomeration motive and instead they try to become the core. In this case, the governments face a "battle of the sexes" situation. Although both governments prefer the core-periphery patterns to the dispersed one, they have a conflict of interest over which of them attains agglomeration. As in the battle of the sexes game, the winner of tax competition cannot be determined in the model. These findings reveal that the result of tax competition dramatically changes below and above the threshold, which is called the "bifurcation of tax competition".¹⁷ The diversified distribution of firms emerges when $\tau > \tau^*$, and the concentrated distribution emerges when $\tau < \tau^*$. Thus, we obtain the following proposition:^{18 19}

Proposition 3.1. *The OLNEs are characterized in the following way (except for the non-generic case: $\tau = \tau^*$ or $Z = 0$)*

(i) *If trade costs are high ($\tau > \tau^*$ or $Z < 0$), the symmetric configuration is the only stable steady state and the tax rates at the steady state are given by*

$$T_1^o(\lambda^o = 1/2) = T_2^o(\lambda^o = 1/2) = \frac{KZ}{2(cZ - K)}.$$

(ii) *If trade costs are low ($\tau < \tau^*$ or $Z > 0$), the only stable steady states are in the core-periphery*

¹⁷The author is grateful to Richard Baldwin for naming this.

¹⁸If trade costs happen to be the critical value τ^* , the slope of the migration equation Z equals zero and any distribution is stable. But this particular case is unimportant.

¹⁹If the governments' payoffs include the consumer surpluses of their immobile residents ($CS_i L/2$), the tax rate at the symmetric configuration is modified as $\tilde{T}^o(\lambda^o = 1/2) = [KZ + d\tau(2 - \tau)]/[2(cZ - K)]$, where d is a positive constant. We can confirm that caring consumer surpluses pushes the tax rate downward: $\tilde{T}^o < T^o = KZ/[2(cZ - K)]$. Since the expansion of firm share benefits consumers by lowering domestic price, the governments try to attract firms by reducing taxes. Although the bifurcation of tax competition under this modified problem is different from that under the problem discussed in the text, the qualitative properties of OLNEs remain unchanged.

configuration and the tax rates at the steady states are given by

$$\text{Case } \lambda^o = 0 : T_1^o(\lambda^o = 0) = 0, \quad T_2^o(\lambda^o = 0) = Z/2,$$

or

$$\text{Case } \lambda^o = 1 : T_1^o(\lambda^o = 1) = Z/2, \quad T_2^o(\lambda^o = 1) = 0.$$

Proof. See Appendix 3.A.1.

It can be readily verified that the static analysis in the same setting mimics the results in Proposition 3.1 (see Section 3.4.3).

Proposition 3.1 confirms the “race to the top” result from Baldwin and Krugman (2004) in a dynamic context. When trade costs are low, the core country eventually hosts all the firms while setting a positive tax rate. The tax gap between the core and periphery ($T_1^o(\lambda^o = 1) - T_2^o(\lambda^o = 1) = Z/2$) exhibits an inverted U-shaped curve as in the dashed line in Figure 3.2-(a). In contrast to the sequential move game, any initial location is allowed and the initial advantage would disappear in the dynamic model. The country that becomes the core is determined by the “expectations” of *governments*, not by the “history” of industrial locations. An analogous argument can be found in the studies on the forward-looking behavior of *entrepreneurs* in the core-periphery model (Baldwin, 2001; Ottaviano, 2001; Ottaviano et al., 2002, Section 6).²⁰ Consider why the peripheral country fails to attract firms even when competition lasts an infinite time. Even if the peripheral country, say 2, took back all the firms and achieved the core position ($\lambda = 0, T_1 = 0$ and $T_2 = Z/2$), it could not commit itself to keep its tax rate low enough to make the distribution of firms stable. 2 would have an incentive to increase its tax rate after catching all the firms. Thus, it could not stop firms from relocating to the other country.²¹

²⁰Oyama (2009a,b) also examine the forward-looking expectations of entrepreneurs. In contrast to the three papers cited in the text, these two papers obtain the uniqueness of stable steady state in a more general core-periphery model with asymmetries of market size and trade costs.

²¹Mathematically, the discussion here corresponds to the choice of the Lagrange multipliers ν_i^1 and ν_i^2 on the boundaries of the state variable. In steady states, the state and co-state (or control) variables are constant over time ($\dot{\lambda} = \dot{\mu}_1 = \dot{\mu}_2 = 0$). The multipliers are uniquely determined so as to attain a steady state. Since the multipliers cannot be chosen in such a way that both the two concentrated states are steady states at the same time, either one of the steady

Figure 3.3 shows the transition path from the initial state to the steady state with high trade costs ($\tau = 0.2$ in Figure 3.3-(a)) and low trade costs ($\tau = 0.4$ in Figure 3.3-(b)). Initial distributions of firms are $\lambda_0 = 0.7$ in (a) and $\lambda_0 = 0.3$ in (b), Other parameter values are $K = 1$, $L = 5$, $d = 1$ and $\rho/\gamma = 0$. In Figure 3.3-(a), trade costs are higher than the bifurcation of tax competition ($\tau = 0.4 > 0.3448 = \tau^*$). Country 1, which has more firms at the beginning, will decrease its tax rate gradually, while country 2, which has fewer firms, will behave in the opposite way. In Figure 3.3-(b) where trade costs are low enough ($\tau = 0.2 < 0.3448 = \tau^*$), a more spectacular change is observed. The prospective core country, 1, reduces taxes excessively at the outset and raises taxes as more firms relocate in 1.

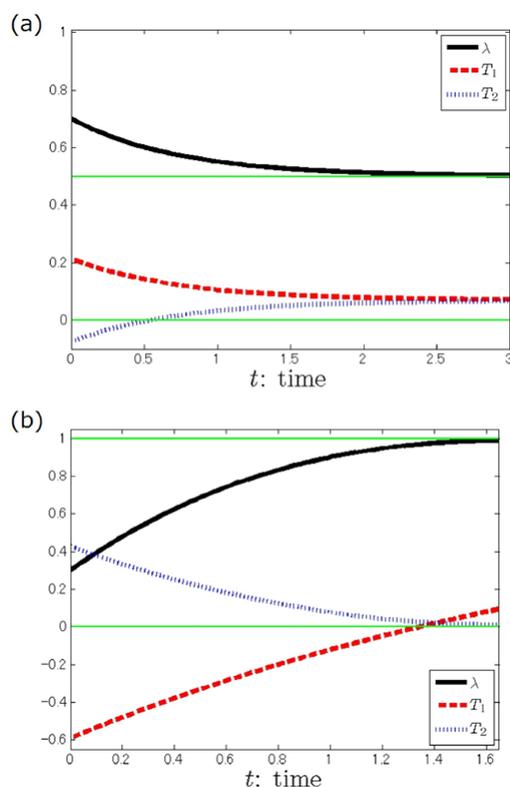


Figure 3.3. Transition paths under OLNE with (a) high trade costs and (b) low trade costs.

It is worthwhile to mention the limitation of OLNE. An OLNE is not subgame perfect and is fragile to any unexpected events. Suppose that unanticipated shocks happen at a point in time and thereby alter the path of λ from that time onwards which both governments have expected at first. Although the original tax schedule that both governments announced at the initial stage of the game

states is achieved.

is no longer optimal, they will stick to the original tax schedules. In the case of Ireland discussed in the introduction, its aggressive tax policies have been effective for attracting FDI at the expense of flexibility.

3.4.2 Markov-perfect Case: Neither Government Commits to Its Tax Schedule

We turn to the analysis of MPNE. Only the symmetric linear strategy with respect to the state variable is considered:²²

$$T_1(\lambda) = A\lambda + B_1,$$

$$T_2(\lambda) = A(1 - \lambda) + B_2,$$

where A , B_1 and B_2 are constants that are determined in equilibrium.

As in the preceding analysis, consider the tax rate and payoff both at the symmetric and concentrated steady states. In the later case, the tax rate is determined so as to keep the core-periphery structure stable: the core country sets its rate at $Z/2$, while the peripheral country sets at zero. Since the smaller Z makes the tax rate lower, the concentrated steady states cannot be realized as long as $Z < 0$ or $\tau > \tau^*$.

The tax rates at the symmetric steady state are calculated as follows:

$$T_1^m \left(\lambda^m = \frac{1}{2} \right) = \frac{K \left(Z - \frac{\partial T_2}{\partial (1-\lambda)} \right)}{2 \left[c \left(Z - \frac{\partial T_2}{\partial (1-\lambda)} \right) - K \right]},$$

$$T_2^m \left(\lambda^m = \frac{1}{2} \right) = \frac{K \left(Z - \frac{\partial T_1}{\partial \lambda} \right)}{2 \left[c \left(Z - \frac{\partial T_2}{\partial \lambda} \right) - K \right]}$$

Unlike the open-loop case, the tax rates reflect the feedback of the rival country ($\partial T_1/\partial \lambda$ and $\partial T_2/\partial (1 - \lambda)$) because each government considers how its counterpart changes its tax rate in response to changes in the distribution of firms. If these feedback terms were zero, the tax rates would

²²Linear Markov-perfect strategies give sharp predictions and are frequently used in the literature (Dockner et al., 2000; Long, 2010). It is known that, if instead non-linear strategies are adopted, a continuum of equilibria emerges (see e.g., Tsutsui and Mino, 1990) as in the repeated games, in which case it seems hard to map theoretical results into context in the real world.

be the same as those under the open-loop case (see Proposition 3.1-(i)). It is verified in Appendix 3.A.2 that the feedback effect ($\partial T_1/\partial \lambda = \partial T_2/\partial(1 - \lambda) = A$) is positive. This means that the tax rate of a country should be directly proportional to the share of firms in that country.

The tax rates at the symmetric steady state in the Markov-perfect case is higher than that in the open-loop case.²³ To see why, consider the situation where both countries stick to their open-loop tax schedules predetermined at the beginning until some point in time and country 1 deviates from the schedule by increasing its tax rate. The tax increase of 1 will cause some firms to move away from there to 2. Under full commitment, country 2 will continue to stick to the predetermined schedule so that such deviation of 1 will never improve its payoff. In the absence of commitments, however, 2 believes that 2 will respond to this expansion of tax base by raising its tax rate according to the linear strategy. This consideration is captured by the feedback effect in the tax rates. The loss of firms in 1 by raising its tax rate will be mitigated to some extent by the reaction of 2. Thus, 1's deviation from the open-loop schedule will increase its overall payoff. If 2 anticipates this, it is also desirable for 2 to deviate from the open-loop schedule.

In the open-loop case, when trade costs are low and the firms' incentive to agglomerate is strong, the tax rates at the symmetric state are negative so that both governments agree on the core-periphery outcomes. In the Markov-perfect case, however, competition becomes less severe because of the lack of commitment and the tax rates at the symmetric state may bring a higher payoff to both governments than those at the position of the core even when agglomeration forces are strong. The Pareto criterion of Assumption 4 implies that the dispersed configuration emerges in a wider range of trade costs.

Figures 3.4 and 3.5 graphically illustrate the above discussions. Parameter values are $K = 1$, $L = 5$, $c = 0.5$ in Figure 3.4 and $c = 1$ in Figure 3.5. The tax and payoff of country 2 have a mirror image. When parameter c is small and thus tax adjustment costs ($-cT_i^2/2$) are less severe, the tax rate and the tax revenue ($K\lambda_i T_i$) at the symmetric state become higher.²⁴ In this case, the symmetric state generates a higher payoff than the agglomeration rent (Figure 3.4-(b)) and emerges in equilibrium whatever trade costs may be by Assumption 4. When c becomes larger and the motive of tax smoothing is strong, the tax rate and the tax revenue become lower. The symmetric

²³Note that $T_i^m(\lambda^m = 1/2) - T_i^o(\lambda^o = 1/2) = K^2 A / [2(K - cZ)\{L + c(A - Z)\}] > 0$ as long as $A > 0$ and Assumption 5 holds.

²⁴It can be checked that $d(a_2^m)/dc < 0$ and $d[T_i^m(\lambda^m = 1/2)]/dc < 0$.

state may become less desirable than the concentrated states (Figure 3.5-(b)). The core-periphery patterns are observed in equilibrium when trade costs are in between the two bifurcations of tax competition ($\tau \in (\underline{\tau}^m, \bar{\tau}^m)$) where the agglomeration rent is large. At the expense of firms, the governments' payoff at the symmetric state under MPNE is higher than that under OLNE.²⁵

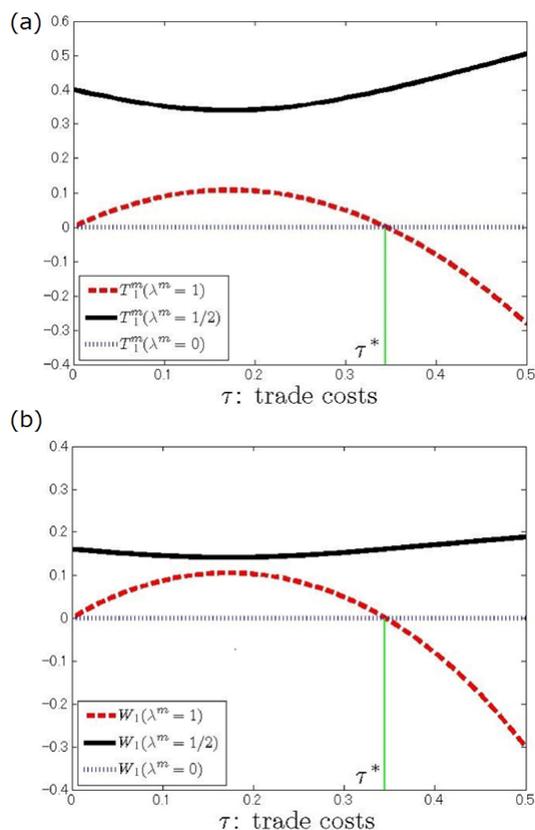


Figure 3.4. Country 1's (a) tax rates and (b) payoffs at the steady states under MPNE with small c .

²⁵At the symmetric state, the instantaneous payoff is maximized at $T(\lambda) = K\lambda/c$. Noting that the payoff is quadratic and $T^o(\lambda^o = 1/2) < T^m(\lambda^m = 1/2) < T(\lambda = 1/2)$ holds (see footnote 23), we have $W^o(\lambda^o = 1/2) < W^m(\lambda^m = 1/2) < W(\lambda = 1/2)$.

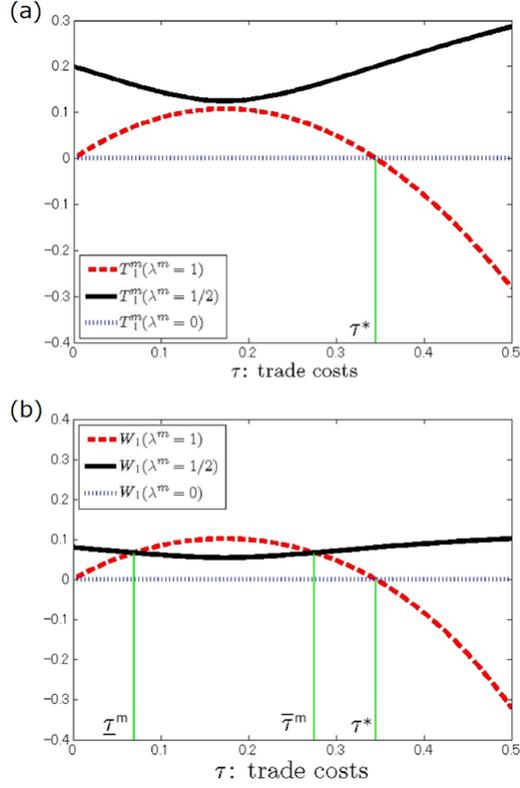


Figure 3.5. Country 1's (a) tax rates and (b) payoffs at the steady states under MPNE with large c .

Therefore, the following proposition is obtained:

Proposition 3.2. *The MPNEs are characterized in the following way (except for the non-generic cases: $\tau = \tau^*$ or $Z = 0$).*

(i) *If $0 < c \leq (2 - \sqrt{2}\sqrt[4]{3})K/\bar{Z} \approx 0.14K/\bar{Z}$, the symmetric configuration is the only stable steady state no matter what trade costs may be. The tax rates at the steady state are given by*

$$T_1^m\left(\lambda^m = \frac{1}{2}\right) = T_2^m\left(\lambda^m = \frac{1}{2}\right) = \frac{K(Z - A_2^m)}{2[c(Z - A_2^m) - K]},$$

where

$$A_2^m = \frac{1}{3c} \left[K + cZ + \sqrt{(K + cZ)^2 - 6cKL} \right] > 0.$$

(ii) *If $(2 - \sqrt{2}\sqrt[4]{3})K/\bar{Z} < c < (2 - \sqrt{3})K/\bar{Z}$, there are two cases:*

(ii-i) *If trade costs are sufficiently high ($\tau \geq \tau\text{-bar}^m$) or sufficiently low ($\tau \leq \tau^m$), the symmetric*

configuration is the only stable steady state and the tax rates at the steady state are given by

$$T_h^m \left(\lambda^m = \frac{1}{2} \right) = T_f^m \left(\lambda^m = \frac{1}{2} \right) = \frac{K(Z - A_2^m)}{2[c(Z - A_2^m) - K]}.$$

(ii-ii) If trade costs are intermediate ($\underline{\tau}^m < \tau < \bar{\tau}^m$), both the symmetric and concentrated configurations are stable steady states and the tax rates at each steady state are given by

$$\begin{aligned} \text{Case } \lambda^m = 0 : T_1^m(\lambda^m = 0) &= 0, \quad T_2^m(\lambda^m = 0) = \frac{Z}{2}, \\ \text{Case } \lambda^m = \frac{1}{2} : T_1^m \left(\lambda^m = \frac{1}{2} \right) &= T_2^m \left(\lambda^m = \frac{1}{2} \right) = \frac{K(Z - A_2^m)}{2[c(Z - A_2^m) - K]}, \end{aligned}$$

or

$$\text{Case } \lambda^m = 1 : T_1^m(\lambda^m = 1) = \frac{Z}{2}, \quad T_2^m(\lambda^m = 1) = 0,$$

where $\underline{\tau}^m$ and $\bar{\tau}^m$ are the solutions of $Z = (2 - \sqrt{2}\sqrt[4]{3})K/c$.

Proof. See Appendix 3.A.2.

Dynamic tax competition between governments that have no commitment leads to increases in their taxes at the symmetric state and thereby acts as a dispersion force. Especially when the adjustment of tax is not so costly (small c), sharing firms between countries is more desirable than collecting all the firms even when trade costs are intermediate and the agglomeration rent is large. This result is in stark contrast to the results from OLNE and from the existing literature that obtain the superiority of the core in a static setting (Baldwin and Krugman, 2004; Borck and Pflüger, 2006). In the fully dynamic model, the credibility of policies significantly changes the result of tax competition.

The implication of MPNE that the lack of commitment gives governments a higher tax rate may explain the recent corporate tax policies of France. France has been one of the highest-corporate-tax countries in the EU since the mid-2000s, while at the same time it has been one of the most strong opponent of the world's lowest corporate tax rate of Ireland and has also been one of the biggest supporters of tax harmonization in the EU (see, e.g., Mitchell, 2009; Stewart, 2011). Part of the reason for the high tax in France may be that France has urged other countries to increase

their tax rate and thereby expected to lessen losses from the relocation of domestic firms to low-tax countries. It is also worth noting that the direction of tax policies in France is sometimes subject to change (e.g., the regime change in 2012), which indicates that commitment is not so stringent. This story follows exactly what happens in MPNE.

Not only at the steady state, but also in the interim, the tax rate at the symmetric state under MPNE is higher than that under OLNE. Figure 3.6 shows the transition paths with the same trade costs $\tau = 0.4$ as in Figure 3.3-(a). Initial conditions and other parameter values are also the same: $\lambda_0 = 0.7$, $K = 1$, $K = 5$, $c = 1$, and $\rho/\gamma = 0$. Unlike the open-loop case, the core-periphery patterns exhibit no transition dynamics (see Appendix 3.A.2 for details). Because of the subgame perfectness of MPNE, even amidst unexpected shocks, governments optimally alter their taxes according to the linear Markov-perfect strategies.

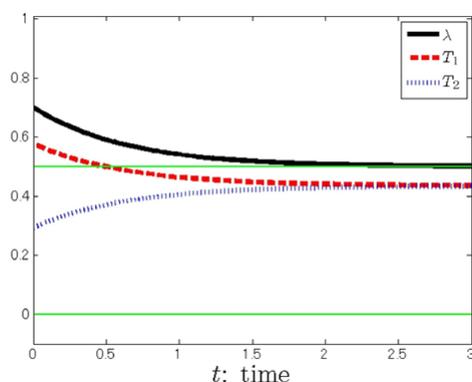


Figure 3.6. Transition paths under MPNE.

3.4.3 Discussion: What If Firms Are Forward Looking?

The analysis has so far dealt with the situation where firms choose their location by looking at their current payoffs (the migration equation (3.6.1)). This subsection briefly argues that the main results would remain unchanged if firms are forward looking. Though a full characterization of far-sighted firms is the outside scope of the present analysis, we can examine some stylized cases.

The forward-looking behavior of firms is already reflected to some degree in the migration equation. The speed of adjustment γ captures to what extent firms value their future payoffs because the larger γ helps firms reach the stable steady state more quickly and thus makes firms focus only

on the long-run outcome.²⁶ With this interpretation in mind, two cases are examined: in the one case firms are very far-sighted ($\gamma = \infty$) and in the other case they discount their future payoffs to a certain extent ($\gamma \in (0, \infty)$).²⁷

The Case of $\gamma = \infty$. In this case, the firms reach the stable steady state in a moment and therefore the governments also care solely about it regardless of their discount rate ρ . The dynamic tax game reduces to the static game.²⁸ This means that the governments choose their tax rate once and it does not matter whether or not they commit. As shown in the formal analysis in Appendix 3.A.3, the results are summarized as follows. When trade costs are high, the dispersed configuration is the equilibrium one. When trade costs are low, however, the core-periphery pattern is the equilibrium one where the country that has more firms at the beginning of the game becomes the core. Since there is no transition path, what matters here is in which state the game starts. In this sense, the initial state acts as an equilibrium selection device. These location patterns are the same as those in the open-loop case discussed in Section 3.4.1 except for the role of the initial state and are also consistent with many of the existing studies on agglomeration and tax competition (e.g., Baldwin and Krugman, 2004; Borck and Pflüger, 2006).

The case of $\gamma \in (0, \infty)$. If the governments are very far-sighted ($\rho \simeq 0$), the degree of friction ρ/γ is sufficiently close to zero as in Assumption 3 and the results of the main analysis hold. Consider the situation where the degree of friction is not so small. In this case, it is expected that the analysis yields similar results to those under the sufficiently small degree of frictions. It can be verified that the Markov-perfect strategies gives the governments a larger incentive to tax at the symmetric steady state than the open-loop strategies.²⁹ Therefore, the dispersed configuration may arise in a wider range of trade costs in the Markov-perfect equilibrium than in the open-loop equilibrium as in Propositions 1 and 2.³⁰ The main results under Assumption 3 ($\rho/\gamma \simeq 0$), in

²⁶The formal dynamic analysis of the new economic geography model by Oyama (2009b) shows that a sufficiently high speed of adjustment and a sufficiently low future discount rate of *firms* give the same result.

²⁷The very myopic firms, which values today's payoff most, can be represented as an almost zero speed of adjustments $\gamma = 0$, in which case the firms stay in the initial state. The governments set their tax rate by considering only the initial location of firms.

²⁸At the steady state, condition (3.6.3) for the optimality of the open-loop strategies (or (3.7) for the optimality of the Markov-perfect strategies) becomes: $(\rho/\gamma - Z)\mu_1 = (K/\gamma)T_1$. When $\gamma = \infty$, the condition holds for $\mu_1 = 0$. The zero co-state variable means that the current strategies of agents do not affect future payoffs and makes the analysis static.

²⁹See footnote 23.

³⁰Unlike the case of $\rho/\gamma \simeq 0$, since the governments put emphasis on the way to the steady state, the initial state would starts to matter in determining which country will be the core.

particular, the importance of commitment aspect, would carry over to a more general case ($\rho/\gamma \in (0, \infty)$).

In a complete dynamic analysis which rigorously considers forward-looking behavior of governments and firms, government commitment toward both rival governments and firms can be important. Since the expectations of both sides interact, multiple equilibria may occur for a broad range of parameters. Commitment aspect as well as initial conditions may be crucial in equilibrium selection. One possible way to deal with such indeterminacy is to introduce asymmetries of market size and trade costs and utilize “potential methods” as in Oyama (2009a). Further research is needed in this area.

3.5 Conclusion

Previous studies on agglomeration and tax competition deal mainly with static situations that imply that the initial industrial location matters and the core maintains its initially advantageous status. This chapter contributes to this literature by introducing fully dynamic strategic interactions between governments.

This chapter has considered OLNE and MPNE, contrasting equilibrium concepts in the sense that the former presumes full commitment of governments and the latter does not. As a result of tax competition under open-loop strategies, a dispersed spatial configuration emerges when trade costs are high, while when they are low, an agglomerated configuration appears. However, if the governments adopt Markov-perfect strategies, the dispersed configuration may be observed regardless of trade costs (note that the agglomerated configuration may also happen under low trade costs). The conclusion of the superiority of the core in the existing literature still holds in the dynamic model when the governments have full commitment, but the initial position is no longer important. Instead, the expectations of governments are essential in determining the core. The result that Markov-perfect strategies insulate the industrial firms from locating together especially when agglomeration tendencies are prevailing is simply because a lack of government commitment to their tax policies induces the governments to raise their tax rate, while an enormous decrease in tax is needed to convince firms to relocate.

These results suggest that, to become the winner of tax competition, it is necessary for a gov-

ernment to make foreign rivals expect that it is committed to its tax policies. This may explain why Ireland has succeeded in hosting large multinational enterprises. However, fully credible policies are not free from problems; they do not guarantee optimality once any unexpected events strike the economy. As an example, it may have been desirable if Ireland had modified its tax schedule when it faced financial collapse in 2010.

3.A Appendix

3.A.1 Proof of Proposition 1

First, we derive the system of differential equations that characterize the economy. Then, we confirm that the symmetric state is the saddle stable when trade costs are high, and that the concentrated states are stable when trade costs are low.

By combining the necessary conditions for 1, (3.6.1), (3.6.2) and (3.6.3) with the corresponding conditions for 2, the dynamic system is obtained as follows:

$$\begin{aligned}\frac{\dot{\lambda}}{\gamma} &= Z\left(\lambda - \frac{1}{2}\right) - (T_1 - T_2), \\ c\dot{T}_1 &= L(2\gamma Z - \rho)\lambda + c(\rho - \gamma Z)T_1 + \gamma KT_2 - \frac{\gamma KZ}{2} + \gamma(v_1^1 - v_1^2), \\ c\dot{T}_2 &= K(\rho - 2\gamma Z)\lambda + \gamma KT_1 + c(\rho - \gamma Z)T_2 + K\left(\frac{3\gamma Z}{2} - \rho\right) - \gamma(v_2^1 - v_2^2).\end{aligned}$$

To verify that the system depends only on a ratio between ρ and γ , we apply the change of variables: $\lambda'(t) = \lambda(t/\gamma)$, $T'_1(t) = T_1(t/\gamma)$ and $T'_2(t) = T_2(t/\gamma)$. The system can be rewritten as the following:

$$\begin{aligned}\lambda' &= Z\left(\lambda' - \frac{1}{2}\right) - (T'_1 - T'_2), \\ c\dot{T}'_1 &= K\left(2Z - \frac{\rho}{\gamma}\right)\lambda' + c\left(\frac{\rho}{\gamma} - Z\right)T'_1 + KT'_2 - \frac{KZ}{2} + (v_1^1 - v_1^2), \\ k\dot{T}'_2 &= L\left(\frac{\rho}{\gamma} - 2Z\right)\lambda' + KT'_1 + c\left(\frac{\rho}{\gamma} - Z\right)T'_2 + L\left(\frac{3Z}{2} - \frac{\rho}{\gamma}\right) - (v_2^1 - v_2^2).\end{aligned}$$

Assumption 5 requires that the ratio (the degree of friction) is sufficiently close to zero:

$$\lambda' = Z\left(\lambda' - \frac{1}{2}\right) - (T'_1 - T'_2), \tag{3.A.1.1}$$

$$c\dot{T}'_1 = 2KZ\lambda' - kZT'_1 + LT'_2 + (v_1^1 - v_1^2) - \frac{LZ}{2}, \tag{3.A.1.11}$$

$$c\dot{T}'_2 = -2KZ\lambda' + KT'_1 - cZT'_2 - (v_2^1 - v_2^2) + \frac{3KZ}{2}. \tag{3.A.1.12}$$

When Trade Costs Are High: $\tau > \tau^*$ or $Z < 0$. In this case, as was discussed in Section 3.4.1, the tax rate and the instantaneous payoff of both countries at the symmetric steady state are positive and those at the concentrated steady state are non-positive. Thus, only the symmetric state is achieved in equilibrium. At the

interior equilibrium, it holds that $v_1^1 = v_1^2 = v_2^1 = v_2^2 = 0$. The system can be rewritten in matrix form:

$$\begin{bmatrix} \dot{\lambda}' \\ \dot{T}'_1 \\ \dot{T}'_2 \end{bmatrix} = \begin{bmatrix} Z & -1 & 1 \\ 2KZ/c & -Z & K/c \\ -2KZ/c & K/c & -Z \end{bmatrix} \begin{bmatrix} \lambda' - 1/2 \\ T'_1 - T^o(\lambda^o = 1/2) \\ T'_2 - T^o(\lambda^o = 1/2) \end{bmatrix},$$

where the tax rate at the steady state is given by

$$T^o\left(\lambda^o = \frac{1}{2}\right) = \frac{KZ}{2(cZ - K)} > 0.$$

To examine the stability, we check the determinant of the coefficient matrix.

$$\begin{vmatrix} Z & -1 & 1 \\ 2KZ/c & -Z & K/c \\ -2KZ/c & K/c & -Z \end{vmatrix} = \frac{Z(3K - cZ)(K - cZ)}{c^2}.$$

Under Assumption 5 that c is positive but small enough, the determinant is negative. This ensures that the matrix has one negative eigenvalue and two positive eigenvalues. Since the system has one state variable λ' and two control variables T'_1 and T'_2 , the negative determinant implies the steady state is saddle stable. The transversality conditions $\lim_{t \rightarrow \infty} \exp(-\rho t)\mu_1 = \lim_{t \rightarrow \infty} \exp(-\rho t)\mu_2 = 0$ hold by construction. Since the trajectories of the variables continuously approach the steady state, the jump conditions have no relevance here. \square

When Trade Costs Are Low: $\tau < \tau^*$ or $Z > 0$. In this case, only the concentrated steady states are possible because the payoff for both countries at the symmetric steady state is negative. The proof of the stability is in two steps. First we show that the co-state variables $\mu'_1(t) = \mu_1(t/\gamma)$ and $\mu'_2(t) = \mu_2(t/\gamma)$ satisfy the jump conditions (3.6.6), (3.6.7) for 1 and their correspondents for 2 for some η . Then we confirm the existence of the Lagrange multipliers for the boundary conditions, v_1^1, v_1^2, v_2^1 and v_2^2 .

By using the necessary conditions, the migration equation can be written as a function of the co-state variables:

$$\dot{\lambda}' = \left(Z - \frac{2K}{c}\right)\left(\lambda' - \frac{1}{2}\right) + \frac{\gamma}{c}(\mu'_1 + \mu'_2).$$

Suppose that s is the time when the economy hits $\lambda' = 1$. The payoff at the symmetric steady state is negative;

therefore, after the economy hits the boundary, it is optimal for both countries to keep their position. Thus, we obtain the following:

$$\begin{aligned}\dot{\lambda}'(s^-) &= \frac{1}{2} \left(Z - \frac{2K}{c} \right) + \frac{\gamma}{k} [\mu'_1(s^-) + \mu'_f(s^-)] \geq 0, \\ \dot{\lambda}'(s^+) &= \frac{1}{2} \left(Z - \frac{2K}{c} \right) + \frac{\gamma}{c} [\mu'_1(s^+) + \mu'_f(s^+)] = 0.\end{aligned}$$

The jump conditions require that $\eta_1^1(s) = \eta_2^1(s) = 0$, $\mu_1(s^-) - \mu_1'(s^+) = -\eta_1^2(s)$ and $\mu_2(s^-) - \mu_2'(s^+) = -\eta_2^2(s)$.

The difference of these equations becomes:

$$\begin{aligned}0 \leq \dot{\lambda}'(s^-) - \dot{\lambda}'(s^+) &= \frac{\gamma}{c} [\mu'_1(s^-) - \mu'_1(s^+) + \mu'_2(s^-) - \mu'_2(s^+)] \\ &= -\frac{\gamma}{k} [\eta_1^2(s) + \eta_2^2(s)].\end{aligned}$$

Since η is non-negative, only $\eta_1^2(s) = \eta_2^2(s) = 0$ satisfies the above condition. Thus, the jump conditions hold for $\eta_1^1(s) = \eta_2^1(s) = \eta_1^2(s) = \eta_2^2(s) = 0$. $\dot{\lambda}'(s^-) = \dot{\lambda}'(s^+) = 0$ implies that λ continuously reaches the boundary and remains there. The co-state variables will not change once the economy hits the boundary, so that the transversality conditions also hold.

From time s onwards, the tax rate is determined so as to satisfy $\dot{\lambda}' = Z(1 - 1/2) - (T'_1 - T'_2) = 0$. Country 2, which has no firms, chooses $T_2^o(\lambda^o = 1) = 0$. Thus country 1 sets a positive tax rate $T_1^o(\lambda^o = 1) = Z/2$.

Finally, we check that the Lagrange multipliers ν satisfy the conditions. The multipliers for the left boundary are not binding so that we obtain $\nu_1^1 = \nu_2^1 = 0$. Those for the right boundary ν_1^2 and ν_2^2 can be obtained by making $\dot{T}'_1 = \dot{T}'_2 = 0$ and substituting the steady state values into (3.A.1.11) and (3.A.1.12):

$$\begin{aligned}0 = c\dot{T}'_1 &= 2KZ \cdot 1 - cZ \cdot \frac{Z}{2} + K \cdot 0 + (0 - \nu_1^2) - \frac{KZ}{2}, \\ \Rightarrow \nu_1^2 &= \frac{Z(3K - cZ)}{2}, \\ 0 = c\dot{T}'_2 &= -2KZ \cdot 1 + K \cdot \frac{Z}{2} - cZ \cdot 0 - (0 - \nu_2^2) + \frac{3KZ}{2}, \\ \Rightarrow \nu_2^2 &= 0.\end{aligned}$$

ν_1^2 is positive as long as Assumption 5 holds. □

3.A.2 Proof of Proposition 2

First, we solve for the parameters in the linear Markov strategy, A and B . Second, we compare the payoff at the three steady states for different levels of trade costs and eliminate Pareto inefficient states (if any) by Assumption 4. Finally, we confirm the stability of the selected steady states.

Derivation of the Parameters A and B in Equilibrium As in Appendix 3.A.1, from the necessary conditions both for 1 and 2, the dynamics of the tax rate of 1 is characterized as follows:

$$c\dot{T}_1 = K \left[\gamma \left(2Z + \frac{\partial T_2}{\partial \lambda} \right) - \rho \right] \lambda + c \left[\rho - \gamma \left(Z + \frac{\partial T_2}{\partial \lambda} \right) \right] T_1 + \gamma K T_2 - \frac{\gamma K Z}{2} + \gamma (v_1^1 - v_1^2).$$

We apply the change of variables: $\lambda(t) = \lambda'(t/\gamma)$, $T_1(t) = T_1'(t/\gamma)$ and $T_2(t) = T_2'(t/\gamma)$, and let ρ/γ close to zero:

$$c\dot{T}'_1 = K \left(2Z + \frac{\partial T'_2}{\partial \lambda'} \right) \lambda' - c \left(Z + \frac{\partial T'_2}{\partial \lambda'} \right) T'_1 + K T'_2 - \frac{KZ}{2} + v_1^1 - v_1^2.$$

Imposing the linear specification of the strategies $T'_1 = A\lambda' + B_1$ and $T'_2 = A(1 - \lambda') + B_2$ yields

$$k\dot{T}'_1 = K(2Z - A)\lambda' - c(Z - A)(A\lambda' + B_1) + K[A(1 - \lambda') + B_2] - \frac{KZ}{2} + v_1^1 - v_1^2. \quad (3.A.3.1)$$

The motion of T'_1 can be written in a different way:

$$\dot{T}'_1 = \frac{\partial T'_1}{\partial \lambda'} \frac{d\lambda}{dt} = A \left[Z \left(\lambda' - \frac{1}{2} \right) - (A\lambda' + B_1) + \{A(1 - \lambda') + B_2\} \right]. \quad (3.A.3.2)$$

Combining (3.A.3.1) with (3.A.3.2) yields:

$$\left[3cA^2 - 2(K + cZ)A + 2LZ \right] \lambda' - cA^2 + \left[K + c \left(\frac{Z}{2} + 2B_1 - B_2 \right) \right] A + KB_2 - cZB_1 - \frac{KZ}{2} + v_1^1 - v_1^2 = 0, \quad (3.A.3.31)$$

which is an identity with respect to $\lambda \in [0, 1]$. For f , an analogous expression can be obtained:

$$\left[3cA^2 - 2(K + cZ)A + 2KZ \right] \lambda' - 2cA^2 + \left[K + c \left(\frac{Z}{2} + 2B_1 - 2B_2 \right) \right] A - KB_1 + cB_2Z - 3KZ + v_2^1 - v_2^2 = 0. \quad (3.A.3.31)$$

We solve for A by making the coefficient of λ' zero:

$$3cA^2 - 2(K + cZ)A + 2KZ = 0,$$

$$\Rightarrow A_1^m = \frac{1}{3c} \left[K + cZ - \sqrt{(K + cZ)^2 - 6cKZ} \right], \quad A_2^m = \frac{1}{3c} \left[K + cZ + \sqrt{(K + cZ)^2 - 6cKZ} \right].$$

Assumption 5 suggests that both roots are real. I then derive the tax rates at each steady state. At the symmetric state, it holds that $v_1^1 = v_1^2 = 0$ and $B_1 = B_2 = B$ by the symmetry of the system. From the identity (3.A.3.3), we can solve for B :

$$-c(A^m)^2 + \left[K + k \left(\frac{Z}{2} + 2B - B \right) \right] a^m - \frac{KZ}{2} + KB - cZB = 0,$$

$$\Rightarrow B^m = \frac{KZ - (cZ - 2K)A^m}{6[c(Z - A^m) - K]}.$$

Thus

$$T_1^m \left(\lambda^m = \frac{1}{2} \right) = T_2^m \left(\lambda^m = \frac{1}{2} \right) = A^m \cdot \frac{1}{2} + B^m = \frac{K(Z - A^m)}{2[c(Z - A^m) - K]}.$$

As for the right boundary state, 2 has no tax base and sets its tax rate at zero. Then, 2 chooses its tax rate so as to keep the distribution stable ($\dot{\lambda}' = Z(1 - 1/2) - (T_1' - 0) = Z/2 - T_1' = 0$). Parameter B associated with the tax rate at the left boundary are determined in the following way:

$$T_1^m(\lambda^m = 1) = A^m \cdot 1 + B_c^m = \frac{Z}{2} \quad \Rightarrow \quad B_c^m = \frac{Z}{2} - A^m.$$

$$T_2^m(\lambda^m = 1) = A^m \cdot 0 + B_p^m = 0 \quad \Rightarrow \quad B_p^m = 0.$$

□

Ranking of Payoffs at the Steady States Next, I compare the payoff at the symmetric state with the state at the right boundary. It is easy to check that the tax rate at $\lambda^m = 1/2$ for A_2^m is higher than that for A_1^m and it is smaller than the unconstrained tax rate ($0 < T_i^m(\lambda^m = 1/2; A_1^m) < T_i^m(\lambda^m = 1/2; A_2^m) < K/c = \text{argmax} W_i(\lambda = 1/2)$). Thus A_2^m always gives the higher payoff than A_1^m does. Assumption 4 suggests that A_2^m should be adopted when the symmetric equilibrium emerges. Denote $W_h(\lambda^m = 1/2) \equiv KT_1(\lambda^m =$

$1/2; A_2^m)/2 - c[T_1(\lambda^m = 1/2; A_2^m)]^2/2$ and $W_1(\lambda^m = 1) \equiv KZ/2 - cZ^2/4$. A tedious calculation reveals³¹

$$Z \leq \frac{(2 - \sqrt{2}\sqrt[4]{3})K}{c} \Rightarrow W_1(\lambda^m = 1) \leq W_1\left(\lambda^m = \frac{1}{2}\right),$$

$$\frac{(2 - \sqrt{2}\sqrt[4]{3})K}{c} < Z < \frac{(2 - \sqrt{3})K}{c} \Rightarrow W_1\left(\lambda^m = \frac{1}{2}\right) < W_1(\lambda^m = 1).$$

Remembering $W_1(\lambda^m = 0) = 0$, when $0 < c \leq (2 - \sqrt{2}\sqrt[4]{3})K/\bar{Z}$, it follows that:

$$\text{If } 0 < \tau < \bar{\tau} \Rightarrow W_1(\lambda^m = 0) < W_1\left(\lambda^m = \frac{1}{2}\right), \quad W_1(\lambda^m = 1) \leq W_1\left(\lambda^m = \frac{1}{2}\right).$$

And when $(2 - \sqrt{2}\sqrt[4]{3})K/\bar{Z} < c < (2 - \sqrt{3})K/\bar{Z}$, it follows that:

$$\text{If } 0 < \tau \leq \underline{\tau}^m \Rightarrow W_1(\lambda^m = 0) < W_1(\lambda^m = 1) \leq W_1\left(\lambda^m = \frac{1}{2}\right),$$

$$\text{If } \underline{\tau}^m < \tau < \bar{\tau}^m \Rightarrow W_1(\lambda^m = 0) < W_1\left(\lambda^m = \frac{1}{2}\right) < W_1(\lambda^m = 1),$$

$$\text{If } \bar{\tau}^m \leq \tau < \bar{\tau} \Rightarrow W_1(\lambda^m = 0) < W_1\left(\lambda^m = \frac{1}{2}\right), \quad W_1(\lambda^m = 1) \leq W_1\left(\lambda^m = \frac{1}{2}\right).$$

The solution of $W_1(\lambda^m = 1/2) - W_1(\lambda^m = 1) = 0$ which lies in $\tau \in (0, \bar{\tau})$ is $Z = (2 - \sqrt{2}\sqrt[4]{3})K/c$. Solving this equation for τ gives $\underline{\tau}^m$ and $\bar{\tau}^m$. $\bar{\tau}^m (> \underline{\tau}^m)$ is smaller than τ^* , which is the positive solution of $Z = 0$. \square

Stability of the Symmetric State. The boundary conditions are not binding so that we have $v_1^1 = v_1^2 = v_2^1 = v_2^2 = 0$. To see that A_2^m guarantees the stability of the symmetric state, we look at the slope of the migration equation:

$$\lambda' = Z\left(\lambda' - \frac{1}{2}\right) - (T_1' - T_2') = (Z - 2A^m)\lambda' + A^m - \frac{Z}{2}.$$

$Z - 2A_2^m$ is negative regardless of Z or τ , which ensures stability. The fact that the state variable converges to a finite value implies that the co-state variables also do so. Thus the transversality conditions also hold. The jump conditions trivially holds for $\eta_1^1 = \eta_1^2 = \eta_2^1 = \eta_2^2 = 0$. \square

³¹Note that

$$W_h\left(\lambda^m = \frac{1}{2}\right) - W_1(\lambda^m = 1) = \frac{(cZ - 2K)[5c^3Z^3 - 2c^2(15K + 2\sqrt{D})Z^2 + 2cK(21K + 8\sqrt{D})Z - 4K^2(K + \sqrt{D})]}{8c[5c^2Z^2 - 4c(5K + \sqrt{D})Z + K(17K + 8\sqrt{D})]},$$

where $D \equiv (K + cZ)^2 - 6cKZ$. The solutions of $W_1(\lambda^m = 1/2) - W_1(\lambda^m = 1) = 0$ are $Z = (2 \pm \sqrt{2}\sqrt[4]{3})2K/c, 2K/c$ and $4K/c$.

Stability of the Boundary States. We focus on the situation where the economy hits the right boundary. We can show that jump conditions are satisfied in the same manner as in Appendix 3.A.1. Consider the smaller root A_1^m first. At $\lambda = 1$, the conditions for the left boundary are not binding so that I obtain $v_1^1 = v_2^1 = 0$. Substituting A_1^m , B_c^m , B_p^m into (3.A.3.31), We can derive the Lagrange multiplier of h for the right boundary:

$$\begin{aligned} & -c(A_1^m)^2 + \left[K + c \left(\frac{Z}{2} + 2B_c^m - B_p^m \right) \right] A_1^m + KB_p^m - kZb_c^m - \frac{KZ}{2} - v_1^2 = 0 \\ \Rightarrow v_1^2 & = \left(\frac{cZ}{2} - K \right) A_1^m + \frac{Z(3K - cZ)}{2}. \end{aligned}$$

which is positive as long as $Z > 0$ or $\tau < \tau^*$ and Assumption 5 holds. The multiplier of 2 for the right boundary is derived from (3.A.3.32):

$$\begin{aligned} & -2c(A_1^m)^2 + \left[K + c \left(\frac{3Z}{2} + B_c^m - 2B_p^m \right) \right] A_1^m - KB_c^m + cB_p^m Z - 3KZ - v_2^2 = 0 \\ \Rightarrow v_2^2 & = 0. \end{aligned}$$

A_1^m brings the negative slope of the migration equation ($Z - 2A_1^m < 0$) so that there are no transition paths and the economy reaches the boundary in a moment. The transversality conditions trivially hold.

If the larger root A_2^m is chosen, v_1^2 turns out to be negative so that the agglomerated distributions, as well as the dispersed distribution, are never achieved in equilibrium. Therefore, when the core-periphery patterns emerge in equilibrium, the smaller root A_1^m and the associated B_c^m and B_p^m should be adopted. \square

3.A.3 Analysis Under Very Far-sighted Firms

We consider the situation where the migration speed is infinitely high ($\gamma = \infty$), i.e., firms care only about the long-run payoff. As mentioned in the text, the problem now reduces to an one-shot simultaneous game as in the literature. The game proceeds as follows. First, each government announces an tax rate simultaneously and non-cooperatively. Then, firms relocate to the country that affords a higher payoff in the steady states. The game should be solved backward. That is, the governments choose their tax rate to maximize their one-shot payoff while taking into account the steady-state distribution of firms. The economy without governments has two stable steady states, the dispersed state when trade costs are high and the agglomerated state when they are low (see Lemma 3.1). We treat these cases separately.

When Trade Costs Are High: $\tau > \tau^*$ or $Z < 0$. In this case, the stable steady state will be λ that satisfies

$\lambda/\gamma = 0$:

$$\begin{aligned}\frac{\dot{\lambda}}{\gamma} &= Z\left(\lambda - \frac{1}{2}\right) - (T_1 - T_2) = 0, \\ \Rightarrow \lambda &= \frac{1}{2} + \frac{T_1 - T_2}{Z}.\end{aligned}$$

By substituting this into the one-shot payoff of each government ($W_i = K\lambda_i T_i - cT_i^2/2$, $i \in \{1, 2\}$) and differentiating it with respect to its tax rate, we can obtain the response function of each government (1 and 2 respectively):

$$\begin{aligned}\left(\frac{2K}{Z} - c\right)T_1 + K\left(\frac{1}{2} - \frac{T_2}{Z}\right) &= 0, \\ \left(\frac{2K}{Z} - c\right)T_2 + K\left(\frac{1}{2} - \frac{T_1}{Z}\right) &= 0.\end{aligned}$$

We solve these equations and obtain the Nash equilibrium tax rates and the eventual share of firms.

$$T_1^s = T_2^s = \frac{KZ}{2(cZ - K)}, \quad \lambda^s = \frac{1}{2}.$$

These are the same as in the open-loop case (Proposition 3.1-(i)).

When Trade Costs Are Low: $\tau < \tau^*$ or $Z > 0$. In this case, the stable steady state will be either $\lambda = 0$ or $\lambda = 1$. Suppose that $\Delta u(\lambda_0) = Z(\lambda_0 - 1/2) - (T_1 - T_2) \geq 0$ holds given the rival's tax rate and the initial state and country 1 will achieve an agglomeration. Then 1 will set its tax rate to the level where firms' delocation never occurs, i.e., T_1 that satisfies $\Delta u(\lambda_0) = 0$, or it will attain the unconstrained maximum by choosing $T_1 = \operatorname{argmax}[KT_1 - cT_1^2/2] = K/2$. Similar reasoning applies to the case of country 2. The best response function of each government becomes:

$$\begin{aligned}T_1 &= \begin{cases} \min\{K/c, Z(\lambda_0 - 1/2) + T_2\}, & Z(\lambda_0 - 1/2) - (T_1 - T_2) \geq 0, \\ 0, & Z(\lambda_0 - 1/2) - (T_1 - T_2) \leq -\varepsilon. \end{cases} \\ T_2 &= \begin{cases} \min\{K/c, Z(1/2 - \lambda_0) + T_1\}, & Z(\lambda_0 - 1/2) - (T_1 - T_2) \leq -\varepsilon, \\ 0, & Z(\lambda_0 - 1/2) - (T_1 - T_2) \geq 0. \end{cases}\end{aligned}$$

where ε is a sufficiently small positive constant, which excludes the indeterminacy of equilibrium tax rate. Since it always holds that $K/c > Z(\lambda_0 - 1/2)$ under Assumption 5, the Nash equilibrium tax rates are given

by

$$T_1^s = Z \left(\lambda_0 - \frac{1}{2} \right), \quad T_2^s = 0, \quad \lambda^s = 1.$$

It is worth noting that the tax rate of the core country T_1^s is inverted U-shaped in trade costs τ (see the definition of Z in Section 3.2.4). The result is the so called “race to the top”(Baldwin and Krugman, 2004; Borck and Pflüger, 2006).

Chapter 4

Trade Liberalization, Foreign Direct Investment and Industrial Development

This chapter is based on a joint work with Ryo Makioka (Department of Economics, Pennsylvania State University) and Toshihiro Okubo (Faculty of Economics, Keio University).

4.1 Introduction

Does increasing openness of an economy, i.e., liberalizing trade and hosting foreign direct investment (FDI), promote its economic transition from traditional sectors such as agriculture and resource intensive industries to modern sectors like high-tech manufacturing and sophisticated service? Despite some skepticism and counter-evidences, it is widely believed that more openness leads to higher economic performance (Frankel and Romer, 1999).¹ However, if a liberalizing economy is associated with productive traditional sectors, the answer to this question would be more complex. The entry of multinational manufacturing firms into developing countries is likely to contribute to local traditional sectors, say, agriculture, by accelerating the improvement of farm management and technology of intermediate inputs such as fertilizer. The increased productivity in

¹See Rodriguez and Rodrik (2001) for a critical view.

agriculture allows the sector to produce with fewer employment than before, thus shifting labor to manufacturing. On the other hand, it might be the case that high productive agricultural sector gains comparative advantage over manufacturing sectors and absorbs a large portion of the workforce, hindering industrialization.

The objective of this chapter is to understand how liberalizing trade of the modern sector affects economic development by focusing on the openness of traditional sectors. Specifically, in a two-country spatial model with a constant-returns traditional sector and an increasing-returns modern sector, we allow the two countries to have different productivity in their traditional sectors and investigate how trade liberalization in the modern sector affects industrial location. To describe the process of economic development, we assume non-homothetic preferences to replicate the Engel's law where the income elasticity of demand for the traditional good is less than unity. This assumption implies that a one percent increase in income expands demand for the traditional good by less than one percent, inducing consumers to spend more on the modern goods and causing the modern sector to expand.

We show that if the traditional good is not traded, the country with more productive traditional sector gets industrialized as trade in the modern sector becomes perfectly free. That is, it gains a larger industry share in perfect free trade compared to the share before opening the industry. The better traditional technology in a country pushes down the price of the traditional good there and allows consumers to spend more on the modern products under the less-than-unity income elasticity, resulting the expansion of the modern sector in the country.

The impact of gradual trade liberalization, however, is not monotonic. When trade costs in the modern sector are high, modern firms try to save these costs and seek a richer demand (this is the so-called *home market effect*; Helpman and Krugman, 1985) so that they are willing to locate in the country with better traditional technology. This expansion of the modern sector pushes upward labor demand and wages in the country and raises marginal costs. As trade costs get smaller, reducing marginal costs, rather than saving trade costs does matter in firms' location choice. Modern firms prefer lower wages in the less technologically advanced country. Thus, the industry share of a country with better traditional technology first increases, and then decreases responding to continuing trade liberalization.

We also find that if the traditional good is traded, on the other hand, industrialization process

in the technologically advanced country fails to get on track; the country will lose all modern firms in perfect free trade. As a result of the free trade of the traditional good, its price is equal to a common world price so that a better traditional technology brings higher wages, rather than lower prices. The productive country with higher wages demands more modern goods than the unproductive country. When trade costs are high, the productive country attracts more firms that seek a richer demand. Further reductions in trade costs, however, help the productive traditional sector expand its production for export and contract the modern sector. Since both sectors engage in international trade, forces of comparative advantage are so pronounced that at the end of the liberalizing process the two countries will fully specialize in their production of goods they are relatively good at.

In sum, whether or not the traditional sector is open to international trade, the country with more productivity traditional sector hosts more modern firms than the other country when the trade impediments on the modern goods are high. When the impediments are low, however, the openness of the traditional sector makes a difference; if the traditional good is internationally traded, the productive country may lose its modern industry whereas it can maintain if the good is not traded.

These findings help understand the consequences of having productive traditional sectors. Our results suggest that the closedness of traditional sectors is effective for industrialization. In Thailand, for example, agricultural production and productivity (rice, in particular) have grown significantly since the government's efforts on infrastructure and land reforms started from the 1960s (Gypmantasiri et al., 2001; Choeun et al., 2006). The Thai government imposed taxes on exports of rice in the 1950s to the late 1980s, which contributed to keep the domestic price of rice and wages. The export restrictions on agricultural goods, combined with the export promotion of manufactured products, helped shift labor to manufacturing and accelerates economic growth (Siriprachai, 1998). The Thailand's experience seems consistent with our story.

Our results also suggest that the openness of traditional sectors prevents an economy from expanding modern sectors when the modern sectors are sufficiently open to the world market. We view this finding to explain the experiences of Latin American countries in 1990s. Since 1980s, they turned their development strategy based on import substitution to the one emphasizing outward orientation. In contrast to East Asian countries, the effectiveness of such policies was in general unsatisfactory (Narula, 2002; Shafaeddin, 2005; Duran et al., 2008). Shafaeddin (2005) reports

that since the early 1980s, Latin American countries have expanded exports mainly in resource based industries and the labor intensive stage of production. Rodrik (1996) points out that in the Latin American countries extensive and deep liberalization reforms in trade and finance were implemented in a shorter period than in the East Asian countries. Uniform reductions in trade barriers in Latin America may help the region specialize traditional economic activities and prevent from modernizing its industrial structure.

4.2 Contribution to the Literature

Structural change of industries is extensively studied in the literature on economic growth.² Among many others, this chapter is most closely related to Matsuyama (1992). He constructs a two-sector model of endogenous growth and shows that in the closed economy case, higher agricultural productivity promotes industrialization while in the small open economy case, it shrinks and eventually collapses the manufacturing sector.³ By interpreting the results in our static model as the steady states of a genuine dynamic model, Matsuyama's findings are similar to ours. Unlike his analysis, however, we also examine the effects of gradual trade liberalization as well as the comparison between closed and open economies. This is far from a minor modification. In his model, the engine of manufacturing growth is learning-by-doing while in our model, the expansion of the manufacturing sector is caused by geographical agglomeration of firms. Thus, changes in trade costs affect location incentives of firms, giving richer implications such as the non-monotonic pattern of industrial development.

In the literature on new economic geography, Puga and Venables (1996, 1999) analyze economic development in a multi-country, multi-sector model with vertical linkages between sectors. They demonstrate that industrialization spreads from the core country to other peripheral countries under the assumption that agricultural products are freely traded. Considering the case of non-tradable agricultural goods, which is not addressed by them, we find a contrastive result that industries remain in the core country.

In terms of modeling costly trade of the homogeneous good sector, we follow approaches taken by Davis (1998) and Takatsuka and Zeng (2012a). They examine the robustness of the home

²See Acemoglu (2008, Chapters 20 and 21).

³Young (1991) also highlights the adverse impact of opening up to international trade on economic growth.

market effect, which means that the larger country in size hosts a more-than-proportional share of modern firms. Their models focus on market size difference and thus abstract away from the role of productivity of traditional sector.

The rest of the chapter proceeds as follows. The next section presents our base model with non-homothetic preferences. Sections 4.3 and 4.4 characterize equilibrium industry location patterns if the traditional sector is non-tradable and those patterns if it is tradable, respectively. Final section concludes.

4.3 The Model

We develop a model of location and trade based on the footloose capital model by Martin and Rogers (1995), which is characterized by internationally mobile capital and immobile workers (see Chapter 1 for more details).

The economy consists of two countries, indexed by 1 and 2, with two industries, called the modern sector and the traditional one. There are two factors of production, capital specific to the modern sector, and labor used in both sectors. The traditional sector produces a homogeneous good using a constant-returns-to-scale technology and it is subject to perfect competition. We will consider two polar cases of the openness of the sector; the sector is either closed or fully open to international markets. The modern sector produces differentiated goods, which are internationally traded with transportation costs, and is monopolistically competitive.

The total amounts of two factors in the world are expressed as L (labor) and K (capital) and both countries are endowed with the same amounts of labor and capital: $L_1 = L_2 = L$ and $K_1 = K_2 = K$. To highlight the role of the traditional sector, the two countries are symmetric except for the productivity of the sector; we assume that country 1 has a better technology than country 2.

Each resident provides one unit of labor service with the industry where she is employed. Since there is no barrier to labor movement between sectors, the adjustment lasts until the sectoral wages are equalized. She also owns K/L units of capital and invests it in modern firms generating the highest return. Capital or modern firms move to a country that affords the highest (operating) profits so that the share of capital employed in country 1, denoting this as $\lambda \in [0, 1]$ (the mass λK), is in general different from the endowment share: $\lambda \neq 1/2$.

In the following, we will mainly focus on the variables of country 1 unless otherwise noted, but the analogous expressions hold for country 2.

4.3.1 Demand Side

All residents in country 1 share the identical preferences given by

$$u_1 = Q_1^\mu (\tilde{q}_{01} - e_0)^{1-\mu},$$

$$\text{where } Q_1 = \left[\int_{\omega \in \Omega_1} q_{11}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega + \int_{\omega \in \Omega_2} q_{21}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}},$$

and where $\mu \in (0, 1)$ is the expenditure share on the industrial goods, $\sigma > 1$ is the elasticity of substitution between the varieties of the modern goods. ω indicates a brand of the differentiated products and Ω represents the set of consumed varieties. \tilde{q}_0 is the consumption of the traditional good. q_{ij} is the quantity of a variety produced in i consumed in j for $i, j \in \{1, 2\}$, Q is the real consumption index for the modern goods. The parameter $e_0 > 0$ is the subsistence consumption level of the traditional good and is assumed to be small enough to make sure the positive consumption of modern goods as will be discussed in Section 4.3.3. This specification of non-homothetic preferences are also adopted in Matsuyama (1992) and Puga and Venables (1996, 1999).

From the FOCs, the aggregate demand for each differentiated variety is represented by

$$q_{i1}(\omega) = \frac{p_{i1}(\omega)^{-\sigma}}{P_1^{1-\sigma}} \mu (Y_1 - p_{01} e_0 L_1),$$

$$\text{where } P_1 = \left[\int_{\omega \in \Omega_1} p_{11}(\omega)^{1-\sigma} d\omega + \int_{\omega \in \Omega_2} p_{21}(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}},$$

and where Y_1 is national income, p_{ij} is the price of a variety produced in i consumed in j and P represents the price index for the modern goods. Hereafter, the index of each brand will be suppressed.

The aggregate demand for the traditional good is given by

$$q_{01} = L_1 \tilde{q}_{01} = \frac{(1-\mu)(Y_1 - p_{01} e_0 L_1)}{p_{01}} + e_0 L_1, \quad (4.1)$$

where p_{01} is the price of the good.

4.3.2 Supply Side

Traditional Sector. The traditional sector uses only labor as a variable input: we denote by a_{0i} the unit labor requirement in country $i \in \{1, 2\}$. The price of the good is determined so as to make excess profits zero, implying $p_{0i} = w_{0i}a_{0i}$. The price in country 2 is normalized to unity: $p_{02} = 1$, so the wage in 2 is pinned down in a way that $w_{02} = 1/a_{02}$. We assume that country 1 has a better technology, i.e., $a_{01} < a_{02}$ and this is the only asymmetry of countries in our model.

Modern Sector. In the modern sector, the market structure is monopolistically competitive. Firms use labor as a variable input and require one unit of capital as a fixed input. Some fraction of goods melts away during shipping: that is, firms have to export $\tau \geq 1$ units of a brand to sell one unit of it in the foreign market. An individual firm operating in country 1 with its unit labor requirement being a produces a brand of the modern goods and earns operating profits π_1 such as

$$\begin{aligned}\pi_1 &= R_1 - w_1 n_1 \\ &= (p_{11}q_{11} + p_{12}q_{12}) - w_1 a(q_{11} + \tau q_{12}),\end{aligned}$$

where R_1 represents the total revenue, w_1 is the wage rate for workers employed in the sector and n_1 is the mass of workers hired by the firm. The above operating profit goes to capital owners so that it becomes the return to one unit of capital.

Profit maximization of firms yields the constant mark up price over the marginal cost:

$$p_{11} = p_1, \quad p_{12} = \tau p_1, \quad \text{where } p_1 = \frac{\sigma w_1 a}{\sigma - 1}.$$

Substituting these equilibrium prices into the operating profit and the price indexes gives

$$\begin{aligned}\pi_1 &= (\mu\psi/\sigma)(w_1a)^{1-\sigma} \left[(Y_1 - p_{01}e_0L_1)P_1^{\sigma-1} + \phi(Y_2 - p_{02}e_0L_2)P_2^{\sigma-1} \right], \\ P_1^{\sigma-1} &= \left[\psi K \left\{ (w_1a)^{1-\sigma} \lambda + \phi(w_2a)^{1-\sigma} (1-\lambda) \right\} \right]^{-1}, \\ P_2^{\sigma-1} &= \left[\psi K \left\{ \phi(w_1a)^{1-\sigma} \lambda + (w_2a)^{1-\sigma} (1-\lambda) \right\} \right]^{-1}, \\ \text{where } \psi &= \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma}, \quad \phi = \tau^{1-\sigma} \in [0, 1],\end{aligned}$$

and where $(w_1a)^{1-\sigma}$ is the inverse measure of marginal costs⁴ and ϕ is the trade freeness where a higher value means higher freeness.

4.3.3 Location Equilibrium

In location equilibrium where firms relocation stops, the operating profits in two countries are equalized at an interior point of λ , otherwise firms would fully agglomerate in either of the countries. At interior spatial configurations, both countries engage in traditional and modern economic activities so that the free movement of workers between the two sectors equalizes sectoral wages: $w_{01} = w_1$.

The national income consists of labor income and capital reward. From this fact and the equalized wages between sectors, the national income in country 1 now becomes $Y_1 = w_1L_1 + \pi K_1 = s(w_1L + \pi K)$. To make sure the consumption of modern goods, the “disposal income”, $Y_i - p_{0i}e_0L_i$, must be positive. This requires the subsistence level e_0 to be sufficiently small: $e_0 < \min\{1/a_{01}, 1/a_{02}\}$.⁵

To see the equalized capital reward $\pi_1 = \pi_2 = \pi$, we look at the clearing condition for the modern goods market in the world:

$$\mu(Y_1 - p_{01}e_0L_1) + \mu(Y_2 - p_{02}e_0L_2) = K(R_1 + R_2),$$

where the left hand side is the world expenditure on the goods and the right hand side is the global revenue of modern firms. Using the fact that $R_i = \sigma\pi_i$ for $i \in \{1, 2\}$, we rearrange the clearing

⁴To produce one unit of a modern variety, a firm has to hire a workers and thus incurs w_1a for hiring costs.

⁵To see this, the disposal income is $Y_i - p_{0i}e_0L_i = w_iL_i + \pi_iK_i - p_{0i}e_0L_i = w_i(1 - a_{0i}e_0)L_i + \pi_iK_i$. The condition $1 - a_{0i}e_0 > 0$ ensures a positive disposal income.

condition to get

$$\pi = \mu \frac{\sum_{i=1}^2 (w_i - p_{0i}e_0)L_i}{(\sigma - \mu)K}.$$

4.4 Non-tradable Traditional Sector

We first consider the case where the traditional good is solely consumed by domestic residents, whereas international trade of the modern goods and movement of capital are allowed.⁶ The crucial difference between the non-tradable case and the tradable case is how wages are determined. In the non-tradable case, as we will see shortly, the labor demand curve in the traditional sector is downward-sloping. In the tradable case, on the other hand, due to the international equalization of the price of the traditional good, it is flat at a certain wage rate.

Let us look at labor markets. In the traditional sector, since the good's demand is q_{01} , the sector needs $N_{01}^D = a_{01}q_{01}$ workers. The labor supply in the modern sector is therefore

$$N_1^S = L_1 - N_{01}^D = L_1 - [(1 - \mu)(Y_1 - p_{01}e_0L_1)/w_1 + a_{01}e_0L_1].$$

where we use q_{01} defined in (4.1) and $p_{01} = w_1a_{01}$. The productivity growth in the traditional sector saves workforce there (small $a_{01}e_0L_1$) and increases the labor supply in the modern sector. It is worth stressing that this productivity effect never emerges when the subsistence level e_0 is zero. If the subsistence level is zero, the Cobb-Douglas preferences imply a constant allocation of consumption and employment between the two sectors and thus the employment level in the traditional sector independent of its productivity. Under a positive subsistence level, on the other hand, the income elasticity of demand for the traditional good is less than unity so that people spends more on modern goods than before as their income rises. This implies that the productivity improvement enables the traditional sector to release its workforce to the modern sector.

As we have seen in the previous section, an individual modern firm needs $n_1 = a(q_{11} + \tau q_{12})$

⁶Considering only two extreme cases (non-traded and perfectly freely traded) facilitates a clear analysis and singles out the role of the openness of the traditional sector. But it is of course a stark assumption. We conjecture that the results under positive but finite trade costs of the traditional sector are in the middle between the two polar cases. In fact, by using the two factor spatial model with footloose capital as in our model, Takatsuka and Zeng (2012a) shows that introducing positive trade costs of the homogeneous sector does not change the qualitative results.

workers so that aggregate labor demand in the sector becomes $N_1^D = (\lambda K)n_1$ workers, which can be calculated as⁷

$$N_1^D = (\sigma - 1)\pi_1\lambda K/w_1.$$

For given wages, the expansion of the industry share (larger λ) increases the labor demand. Noting that the wage rate (and the price of the traditional good) is endogenously determined by the labor market clearing condition, this increased labor demand tends to push the equilibrium wage rate upward.

The market clearing wage rate must equate the labor demand and supply: $N_1^D = N_1^S$ to get

$$w_1 = \frac{(1 - a_{02}e_0)[2\lambda(\sigma - 1) + (1 - \mu)]}{a_{02}(1 - a_{01}e_0)[2\{\sigma - \mu - \lambda(\sigma - 1)\} - (1 - \mu)]}. \quad (4.2)$$

As for country 2, since p_{02} is normalized to one, it holds that $w_2 = 1/a_{02}$. The positive relationship with the wage rate in country 1 and the size of modern firms there implies that wages act as a dispersion force. Consider the situation where $\pi_1 > \pi_2$, then relocation occurs from country 2 to country 1. The influx of the modern firms pushes the labor demand in the sector and drives up wages in both sectors. This increases the marginal cost, which may hurt the profit of modern firms in 1 and thus prevents a further relocation. The mechanism plays a vital role in the subsequent analysis.

4.4.1 The Effect of Liberalizing Trade of Modern Goods

We characterize how a fall in trade costs τ (or an increase in the trade freeness ϕ) affects the equilibrium share of modern firms, wages and welfare.

No Trade Versus Perfect Free Trade

Although it is hard to obtain the closed form solution of λ satisfying $\pi_1 - \pi_2 = 0$, we can easily find out it at the two extreme points, that is, the case of prohibitive trade costs and the case of perfect free trade.

⁷Note that $q_{11} + \tau q_{12} = (\sigma - 1)R_1/(\sigma w_1 a)$ and $R_1 = \sigma\pi_1$.

In the no-trade case where $\phi = 0$ holds, the equilibrium share of modern firms in each country turns out to be the same as the share of capital endowment: $\lambda|_{\phi=0} = 1/2$. Suppose that the factor prices were equal between the two countries, then country 1 could produce the traditional good with fewer workers than country 2. Since both countries have the same market size and there is no international trade of the traditional good, the price of the traditional good in 1 must be lower than in 2 to meet the domestic demand. Holding factor prices constant, this lower price leads to a larger disposal income ($Y_1 - p_{01}e_0L_1$) and consumers spend more on the modern goods. The productive traditional sector needs fewer workers (fewer labor demand), but at the same time the sector has to compete in hiring workers with the expanding modern sector (fewer labor supply). In equilibrium where the labor market clears, the former effect exceeds the latter and the wage rate gets lower than country 2. The lower price of the traditional good expands the demand for the modern goods. This expanded demand, however, is exactly canceled out by the reduced income due to the lower wage. As a consequence, modern firms find both countries equally profitable and never move.

In the perfect free trade case where $\phi = 1$ holds, the equilibrium share is determined so as to equate the marginal costs in the two countries; $(w_1a)^{1-\sigma} = (w_2a)^{1-\sigma}$ or $w_1 = w_2$. This is because the difference of marginal costs, rather than that of market size (as measured by the expenditure on modern goods $\mu(Y_i - p_{0i}e_0L_i)$), matters for firms' location decision. In the fully integrated world where there is no point for modern firms to agglomerate in a particular country to save trade costs, firms move to the country where they can produce goods at lower costs.

We can analytically compute the equilibrium firm share and confirm that $\lambda|_{\phi=1} > 1/2$. Since the non-homothetic preference in our model allows workers in the traditional sector to move to the modern one as the traditional productivity grows, country 1 with a better technology expands employment more in the modern sector than country 2. The expanded modern sector in turn increases its labor demand and pushes wages upward. The inflow of firms into 1 continues to the point where the wage rates between the countries are equalized.

To summarize

Proposition 4.1 (non-tradable traditional sector). *Consider the case where the traditional sector is non-tradable. Assume that country 1 has a better technology in the traditional sector ($a_{01} < a_{02}$).*

If trade costs on modern goods are prohibitively high, the share of modern firms in 1 is equal to the endowment share: $\lambda|_{\phi=0} = 1/2$. If trade costs are zero, it exceeds the endowment share: $\lambda|_{\phi=1} > s$.

Proof. See Appendix 4.A.2.

Gradual Trade Liberalization

Turning to the analysis of gradual trade liberalization, we are forced to rely on numerical simulation. Figure 4.1 shows how the firm share (the left panel) and the individual welfare (the right panel), computed as $v_i = [(Y_i - p_{0i}e_0L_i)/L_i]P_i^{\mu-1}p_{0i}^{-\mu}$, respond to the exogenous change in the trade freeness (see also Appendix 4.A.4 for more simulation results). The parameter values are given in Appendix 4.A.1. As we have discussed, the firm share coincides with the endowment share at $\phi = 0$ and exceeds it at $\phi = 1$. A notable feature is that the industry share reaches the peak at an intermediate trade openness. This inverted U-shape reflects nothing but the home market effect, meaning that firms are clustered in one place to save costs of transporting goods. Considering the fact that sufficiently high trade costs make exporting unprofitable while at sufficiently low trade costs larger demand does not matter for firms' location decision, the agglomeration tendency gets higher when trade openness takes intermediate values.

The evolution of welfare in the right panel of figure 4.1 can be understood with the help of the evolution of country's industry share. In country 1 with a larger industry share, its residents can enjoy lower the price index for the modern goods as well as the lower price of traditional good so that the individual welfare level in 1 always exceeds that in 2. Since the industrial configuration becomes the most unequal in intermediate levels of trade openness, the welfare gap between countries also seems to be the largest in this range. At $\phi = 1$ where wages are internationally equalized, the welfare gap results from the difference of the traditional good's price.⁸

We emphasize that these location patterns appear because of the non-homothetic preference. If the subsistence level were zero ($e_0 = 0$), then the difference of traditional productivity would not affect the labor demand in the sector (noting that $a_{01}q_{01} = (1 - \mu)Y_1/w_1$). In such a case, it would hold that $\lambda = 1/2$ for $\phi \in [0, 1]$.

⁸See Figure 4.A.1 in Appendix 4.A.4.

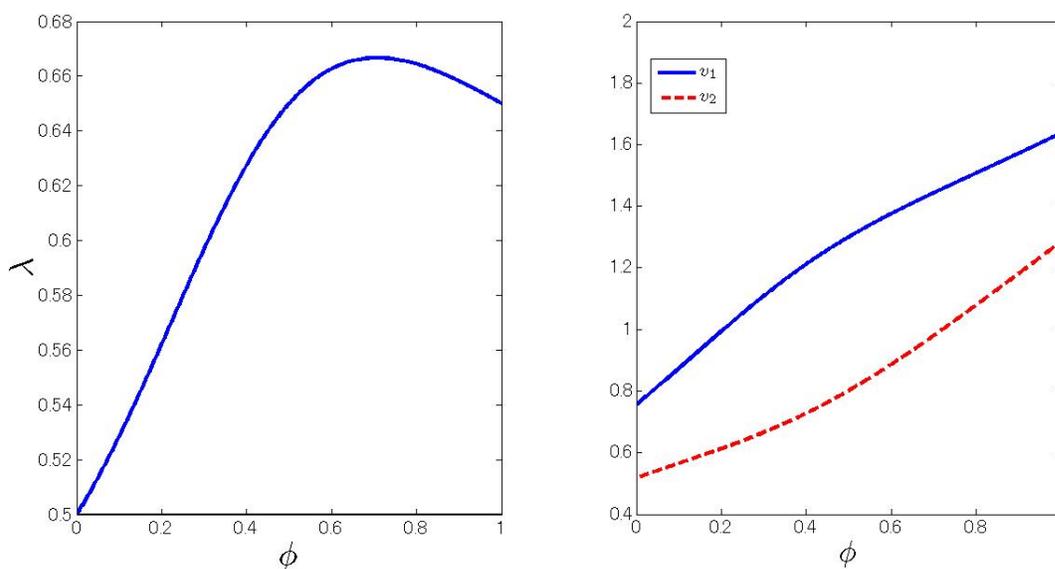


Figure 4.1. The effect of trade liberalization in the modern sector on location pattern (left): and welfare (right).

4.5 Tradable Traditional Sector

Let us turn to the case where the traditional good is internationally traded without any trade costs. In contrast to the non-tradable case, costless trade of the traditional good equalizes prices internationally: $p_{01} = p_{02} = 1$. The traditional sector has now a flat labor demand curve; it demands labor perfectly elastically at wage $w_i = w_{0i} = 1/a_{0i}$ for $i \in \{1, 2\}$.⁹

4.5.1 The Effect of Liberalizing Trade of Modern Goods

No Trade Versus Perfect Free Trade

As in the previous section, we first look at the two endpoints. In the infinite-trade-costs case with $\phi = 0$, the equilibrium industry share exceeds the endowments share: $\lambda|_{\phi=0} > 1/2$. Unlike the non-tradable case, the traditional good producers in country 1 does not have to lower the price because they can export at an international price. The efficient technology is reflected only in a higher wage (noting that $1 = p_{01} = w_1 a_{01}$ or $w_1 = 1/a_{01}$). The higher wage in turn raises the disposal income

⁹This is true under the situation where both sectors are active.

spent on modern goods ($\mu(Y_1 - p_{01}e_0L_1)$) and this larger demand in country 1 are attractive for modern firms. In this case, country 1 imports capital and exports the traditional good to country 2.

In the perfect-free-trade case with $\phi = 1$, modern firms decide their location with a view to reducing hiring costs, rather than seeking larger markets. Since marginal costs are higher in country 1 than in country 2 ($w_1a = a/a_{01} > a/a_{02} = w_2a$), all modern firms agglomerate in 2. The relocation occurs because country 1 has a comparative advantage in the traditional sector. In perfect free trade, the more productive traditional sector prevents industrialization.

These results are summarized in

Proposition 4.2 (tradable traditional sector). *Consider the case where the traditional sector is tradable. Assume that country 1 has a better technology in the traditional sector ($a_{01} < a_{02}$). If trade costs on modern goods are prohibitively high, the share of modern firms in 1 exceeds the endowment share: $\lambda|_{\phi=0} > 1/2$. If trade costs are zero, all the modern firms are agglomerated in 2: $\lambda|_{\phi=1} = 0$.*

Proof. See Appendix 4.A.3.

Gradual Trade Liberalization

We have seen that market size determines location patterns in the no trade case whereas marginal costs do so in the perfect free trade case. When considering the equilibrium location patterns within positive but finite trade costs, it is expected that, as in the previous analysis, we observe a bell-shaped relationship between the industry share and the trade openness. Our numerical simulations reveal that this conjecture is not necessarily true (see also Appendix 4.A.4 for the robustness of simulation results): namely, a bell-shaped relationship emerges only when the elasticity of substitution σ is low, as shown in Figure 4.2. A higher degree of product differentiation (lower σ) allows firms to charge a higher mark-up, thereby reducing competitive pressure of being placed in a country with more firms. In this case, the incentive of locating in a richer country to save trade costs is so strong that a bell-shaped curve emerges.¹⁰

¹⁰As discussed in the previous section, this agglomeration force becomes the largest at an intermediate degree of the trade openness.

When σ is high, on the other hand, the industry share in country 1 monotonically decreases, as illustrated in Figure 4.3. Since a low degree of product differentiation (higher σ) leads to a tougher competition, firms do not find it attractive enough to locate in a richer market. As trade gets liberalized and firms in country 1 have to compete with those in country 2 with lower marginal costs, they are ready to move to the low-cost country 2.

The location patterns are directly related to the patterns of welfare; the welfare level evolves in the same way as the industry share in both figures until full specialization occurs. In the fully integrated world with $\phi = 1$, free movement of capital makes wages and price indices equalized so that residents achieve the same level of welfare regardless of their location. A notable point is that country 1 may worsen its welfare on account of increase in price index for modern products. Reductions in trade costs benefit consumers by lowering the prices of foreign modern goods, but at the same time they induce relocation of domestic firms and make consumers dependent on imported varieties. It may be the case that the latter negative effect exceeds the former positive effect and liberalizing trade does harm to country 1. After full agglomeration occurs, trade liberalization benefits more country 1 relying entirely on imported modern products.

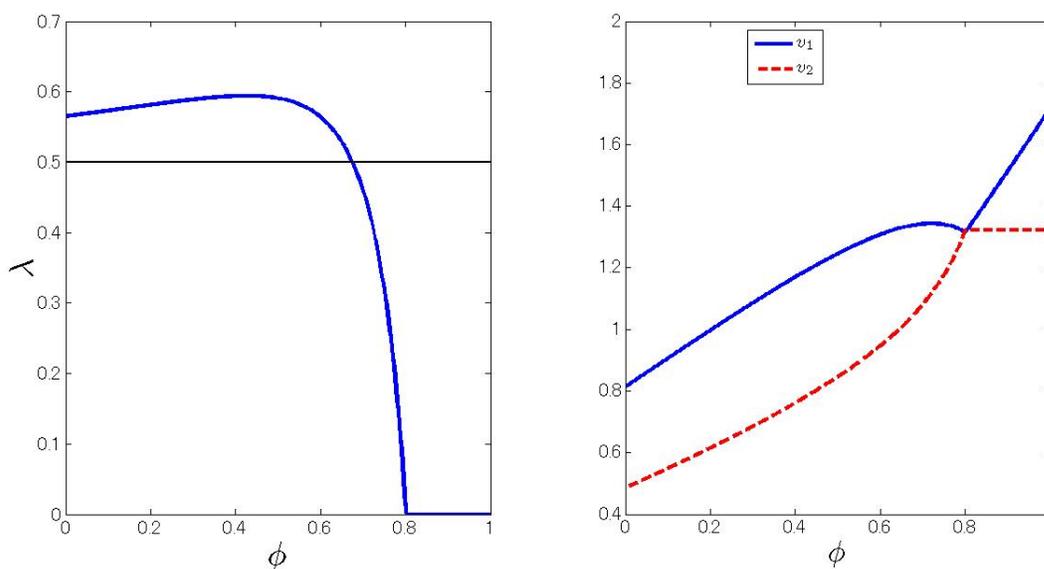


Figure 4.2. The effect of trade liberalization in the modern sector on location pattern (left): and welfare (right) when σ is low.

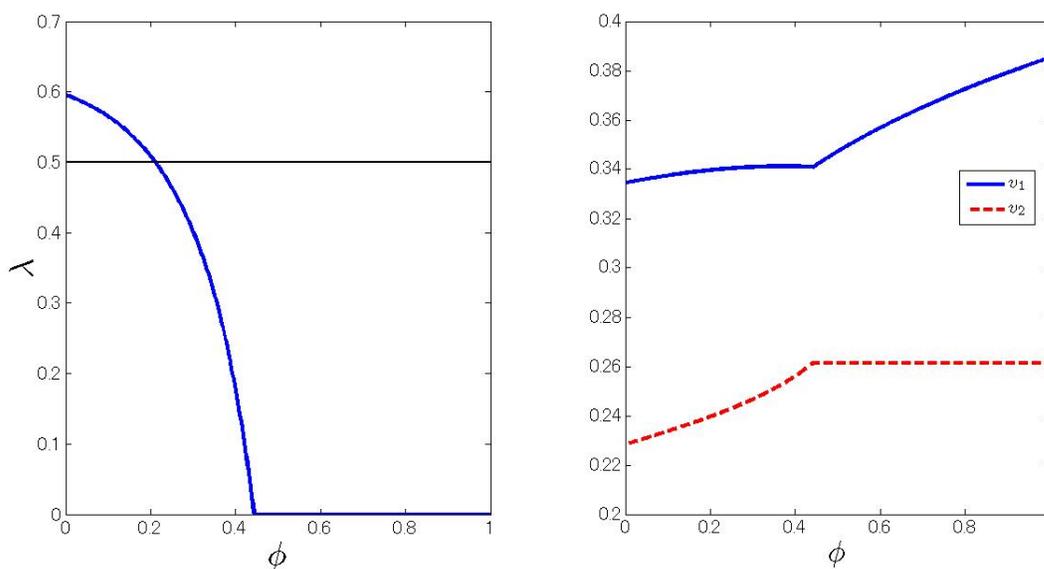


Figure 4.3. The effect of trade liberalization in the modern sector on location pattern (left): and welfare (right) when σ is high.

4.6 Conclusion

We have analyzed a model of trade and geography by shedding light on the traditional sector. It is shown that if the sector is not traded, the country with more productive traditional sector gains a more industry share in free trade than in no trade. Declining trade costs first expands, then shrinks its industry so that the industrialization takes a bell-shaped path. If the traditional good is freely traded, on the other hand, the productive country has a smaller industry share in free trade than in no trade. The process of declining in industry share can be either monotonic or non-monotonic responding to continuing trade liberalization and the productive country may worse off during the process. Our analysis tells that the effectiveness of outward-oriented strategies depends on the openness of traditional sectors. To avoid getting stuck in traditional economic activities, we may conclude that it could be better to liberalize modern sectors first, rather than undertake uniform liberalization across sectors.

4.A Appendix

4.A.1 Parameter Values

The simulations use the following parameter values:

In Figures 4.1 and 4.2: $\sigma = 1.5$, $s = 0.5$, $\mu = 0.6$, $e_0 = 0.8$, $K = 5$, $L = 10$, $a = 1$, $a_{01} = 0.9$, $a_{02} = 1$.

In Figure 4.3: $\sigma = 5$, $s = 0.5$, $\mu = 0.6$, $e_0 = 0.8$, $K = 5$, $L = 10$, $a = 1$, $a_0 = 0.9$, $a_{02} = 1$.

4.A.2 Proof of Proposition 4.1

The operating profits are given by

$$\pi_1 = \frac{\mu B_1}{\sigma K} \left[\frac{Y_1 - p_{01} e_0 L_1}{B_1 \lambda + \phi B_2 (1 - \lambda)} + \frac{\phi (Y_2 - p_{02} e_0 L_2)}{\phi B_1 \lambda + B_2 (1 - \lambda)} \right], \quad (4.A.2.11)$$

$$\pi_2 = \frac{\mu B_2}{\sigma K} \left[\frac{\phi (Y_1 - p_{01} e_0 L_1)}{B_1 \lambda + \phi B_2 (1 - \lambda)} + \frac{Y_2 - p_{02} e_0 L_2}{\phi B_1 \lambda + B_2 (1 - \lambda)} \right], \quad (4.A.2.12)$$

where $B_i = (w_i a)^{1-\sigma}$, $Y_i = w_i L_i + \pi_i K_i$ for $i \in \{0, 1\}$.

In the case of the non-tradable traditional sector, w_1 is defined in (4.2) and $w_2 = 1/a_{02}$.

If $\phi = 0$, the profit gap becomes

$$\pi_1 - \pi_2 = \frac{\mu}{\sigma K} \left[\frac{Y_1 - p_{01} e_0 L_1}{\lambda} - \frac{Y_2 - p_{02} e_0 L_2}{1 - \lambda} \right], \quad (4.A.2.2)$$

which is independent of the marginal cost terms B_i . The gap equals to zero at $\lambda = 1/2$.

If $\phi = 1$, the profit gap becomes

$$\pi_1 - \pi_2 = \frac{\mu(B_1 - B_2)}{\sigma K} \left[\frac{Y_1 - p_{01} e_0 L_1}{B_1 \lambda + B_2 (1 - \lambda)} + \frac{Y_2 - p_{02} e_0 L_2}{B_1 \lambda + B_2 (1 - \lambda)} \right], \quad (4.A.2.3)$$

where the marginal cost terms determine the sign. The gap disappears if $B_1 - B_2 = 0$ or $w_1 - w_2 = 0$. We solve this equation for λ :

$$\lambda = \frac{1}{2} - \frac{e_0(\sigma - \mu)(a_{01} - a_{02})}{2(\sigma - 1)[2 - e_0(a_{01} + a_{02})]}.$$

Since we assume that $a_{01} < a_{02}$, $\sigma > \mu$ and $1 - a_{0i} e_0 > 0$, the second term (including the minus sign) is positive. We confirm $\lambda > 1/2$ at $\phi = 1$.

4.A.3 Proof of Proposition 4.2

In the case of the tradable traditional sector, the operating profits are the same as (4.A.2.11) and (4.A.2.12). The differences are in the prices of the traditional good and the wages: $p_{0i} = 1$ and $w_i = 1/a_{0i}$ for $i \in \{1, 2\}$.

If $\phi = 0$, we make the profit gap (4.A.2.2) zero and solve for λ :

$$\lambda = \frac{1}{2} - \frac{(\sigma - \mu)(a_{01} - a_{02})}{2\sigma[a_{01} + a_{02} - 2a_{01}a_{02}e_0]}.$$

By assumptions we make, the second term (including the minus signs) is positive. We have $\lambda > 1/2$ at $\phi = 0$.

If $\phi = 1$, as can be seen in (4.A.2.3), the marginal cost is higher in country 1 than that in country 2 so that country 2 is always more profitable for an arbitrary industry share. All modern firms are thus located in country 2 ($\lambda = 0$).

4.A.4 Simulations on Gradual Trade Liberalization

The evolutions of key variables along with trade liberalization are shown in Figures 4.A.1 to 4.A.3.

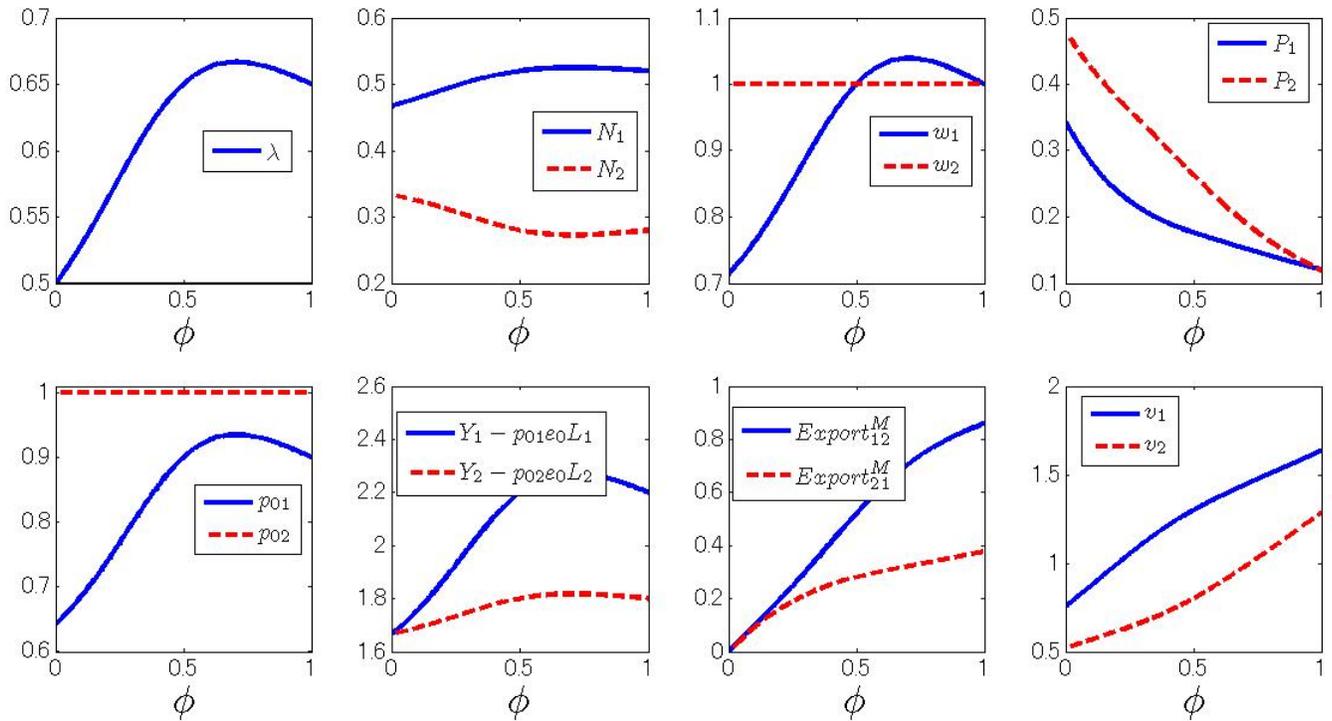


Figure 4.A.1. Equilibrium path corresponding to Figure 4.1.

Note: From left to right in the upper row, the industry share, the employment share, the wage rate and the

price index. From left to right in the lower row, the price of the traditional good, the disposal income, the export value of the modern sector and the individual welfare.

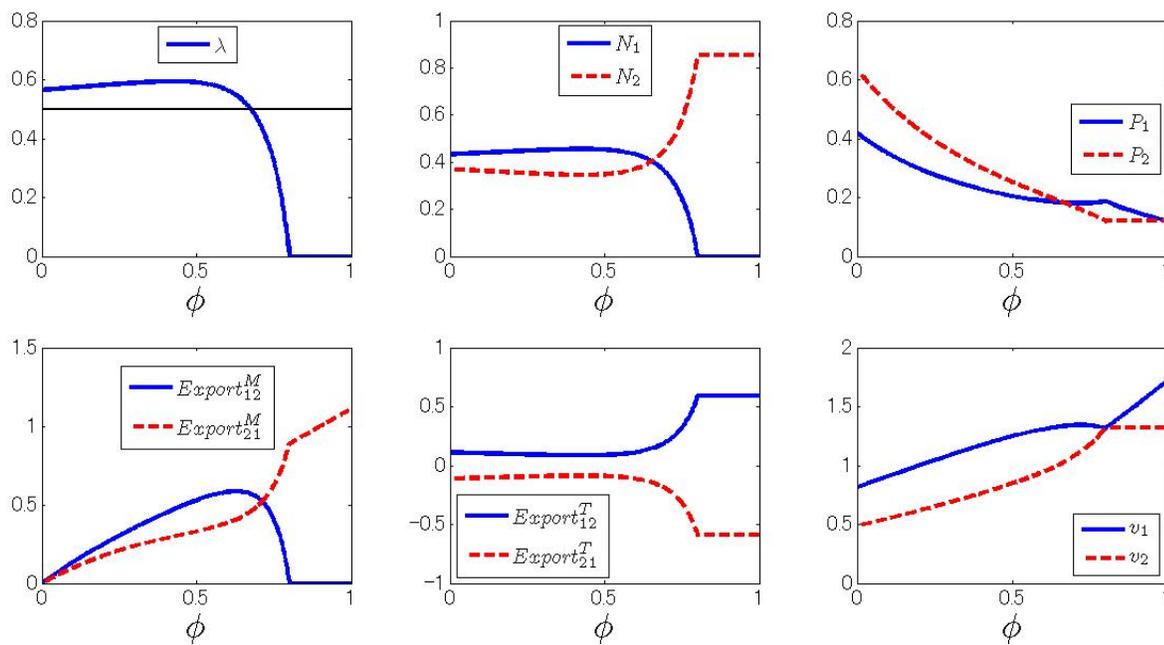


Figure 4.A.2. Equilibrium path corresponding to Figure 4.2.

Note: From left to right in the upper row, the industry share, the employment share and the price index. From left to right in the lower row, the export value of the modern sector, the export value of the traditional sector and the individual welfare.

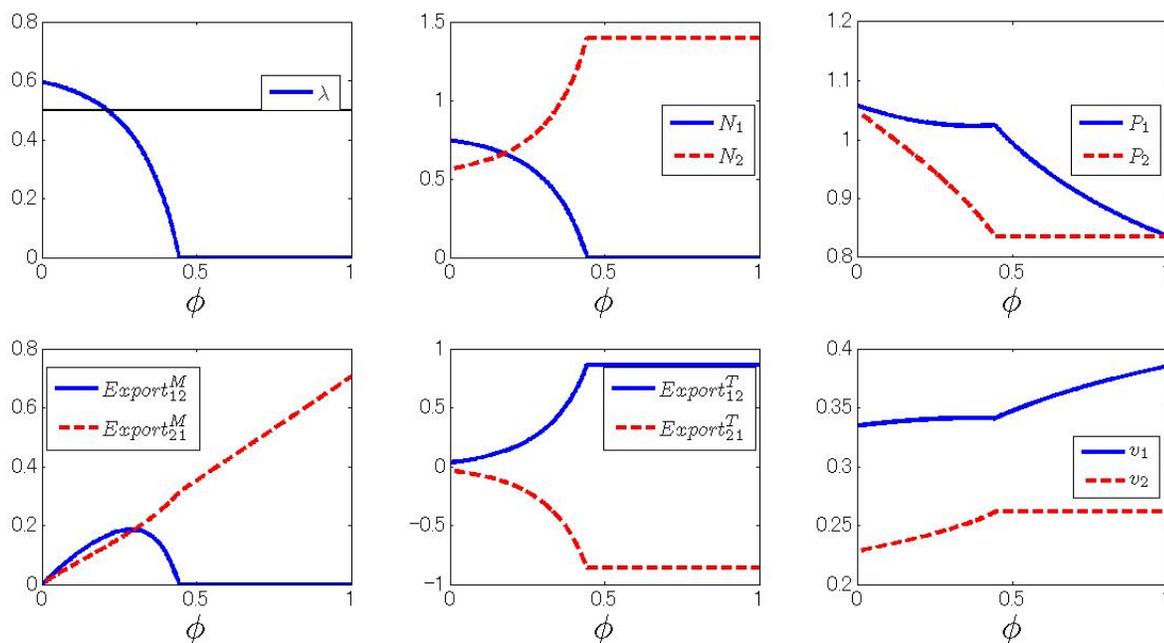


Figure 4.A.3 Equilibrium path corresponding to Figure 4.3.

Note: See the note in Figure 4.A.2.

We conduct simulations with different parameter values of the elasticity of substitution σ and the productivity level in the traditional sector a_{01} .

When the traditional sector is non-tradable, we confirm from Figures 4.A.4 and 4.A.5 that (i) the industry share is inverted U-shaped, (ii) the welfare levels in both countries are increasing.

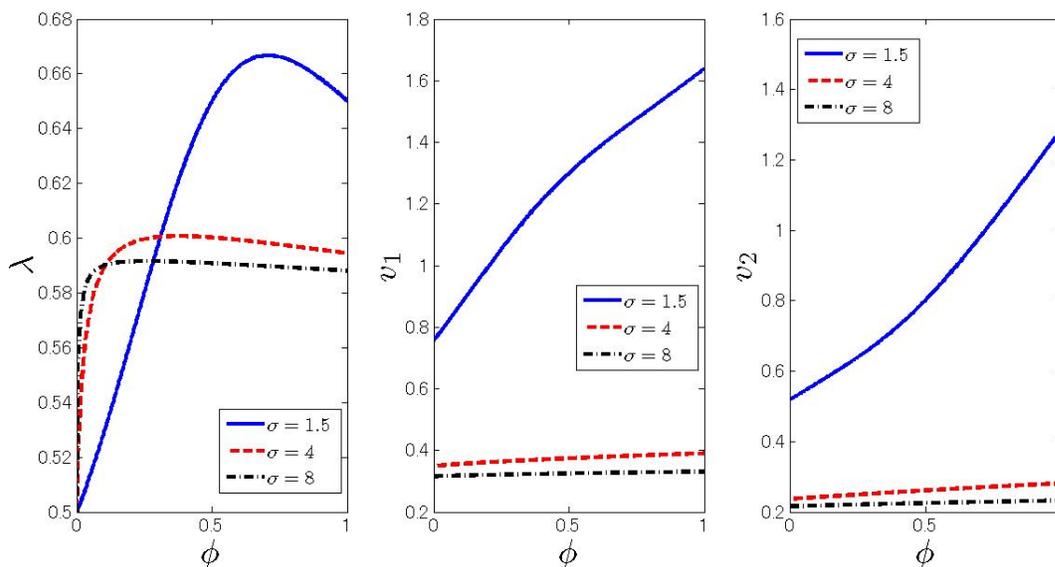


Figure 4.A.4. Location pattern (left), welfare in country 1 (middle) and welfare in country 2 (right) when the traditional sector is non-tradable under $a_{01} = 0.9$.

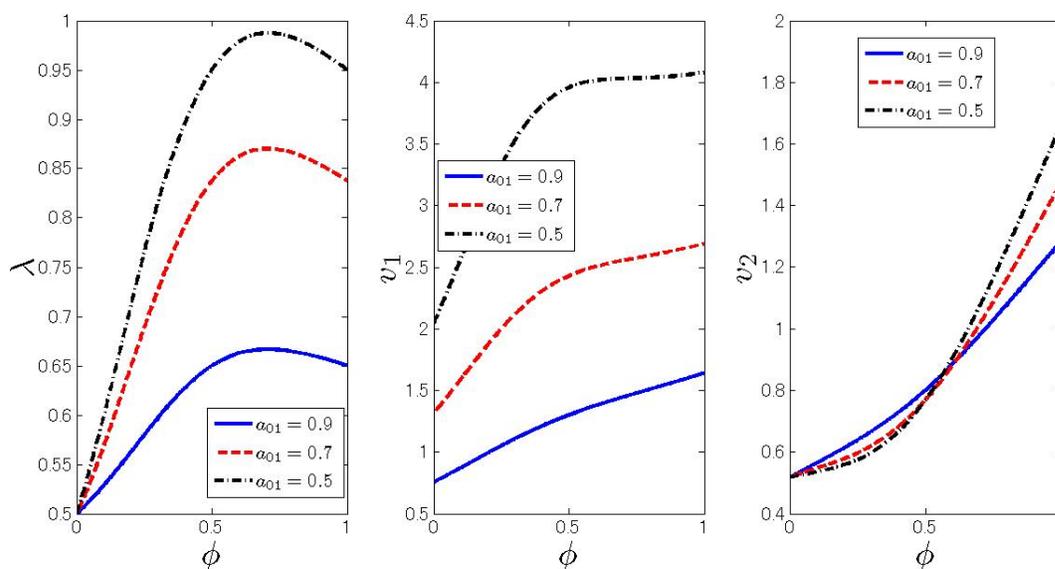


Figure 4.A.5. Location pattern (left), welfare in country 1 (middle) and welfare in country 2 (right) when the traditional sector is non-tradable under $\sigma = 1.5$.

When the traditional sector is tradable, we confirm from Figures 4.A.6 and 4.A.7 that (i) the industry share is inverted U-shaped under low σ , (ii) it is monotonically decreasing under high σ , (iii) the welfare level in country 1 may be worse off and (iv) the welfare level in country 2 is weakly increasing.

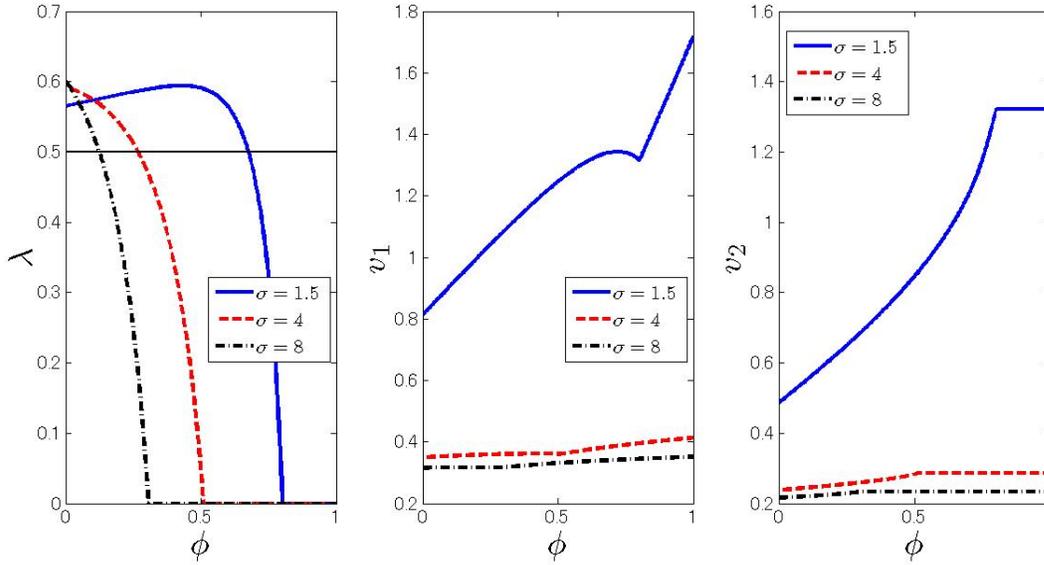


Figure 4.A.6. Location pattern (left), welfare in country 1 (middle) and welfare in country 2 (right) when the traditional sector is tradable under $a_{01} = 0.9$.

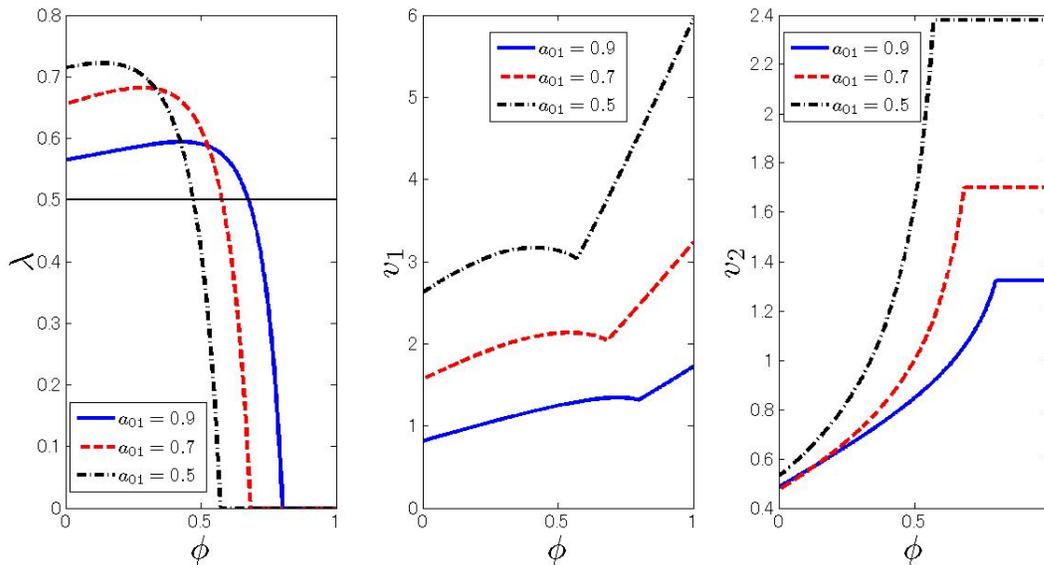


Figure 4.A.7. Location pattern (left), welfare in country 1 (middle) and welfare in country 2 (right) when the traditional sector is tradable under $\sigma = 1.5$.

Other parameter values are $s = 0.5$, $\mu = 0.3$, $e_0 = 0.8$, $K = 5$, $L = 10$, $a = 1$, $a_{02} = 1$.

Chapter 5

General Conclusion

Economic geography models emphasize the importance of being big. If countries are endowed with a large size of production factors or they are lucky to have industrial clustering in their early years for historical accidents or other reasons, they will get more industrialized and enjoy richer varieties of products. One can easily argue counterexamples that put emphasis on being small by relying on different stories. According to the comparative advantage theory, for example, smaller countries gain the most because they face a drastic change of relative prices after opening up to trade. The central message of this dissertation is, however, that the importance of being big does not necessarily hold even within economic geography models. This closing chapter summarizes the insights that have been illustrated in the previous three chapters and provides directions for future research. To be systematic, we look over each chapter.

Summary and Directions for Future Research of Chapter 2

This chapter is motivated by the successful examples of small countries in international tax competition. Thanks partly to their low corporate tax rates, countries like Singapore, Ireland and Estonia have attracted a massive inflow of export-oriented foreign direct investment. The research question in the chapter is why some small countries choose low tax rates and can host investment from abroad.

The reason we argue is that governments are politically biased and implement policies in favor of lobbying groups. Capital owners as interest groups contribute political donations to their domestic governments with a view to raising after-tax profits of firms. An increase in the tax rate in general reduces after-tax profits and this negative impact varies between the asymmetric coun-

tries. A higher tax rate is a direct burden on net profit income, but at the same time it tends to mitigate domestic competition and raise gross profits. This reducing-competition effect of taxes is less significant for firms in the small country than for those in the large country because the relative importance of domestic profits as compared with export profits is lower for small-country firms than for those in large-country firms. Thus capital owners in the small country favor lower taxes more than those in the large country. As a result of contributions based on these considerations, when trade costs are small and the governments care about contributions heavily, the small country chooses a lower rate and host a more-than-proportionate share of firms.

International Political Donations. Our analysis is based on the assumption that interest groups contribute to their local government. However, this is not satisfactory when considering the reality. While there are some countries banning donations from foreign people and/or capital like the US, the UK and Japan, other countries allow their domestic political parties to accept foreign donations. One can easily find in the news media that large multinational enterprises contribute money to politicians in order to extract favorable policies.

Despite its importance in the real world, there are few studies addressing cross-border political donations (not just in the literature on tax competition). This seems to stem from the difficulty of theoretical treatment. We do not have a solid conjecture on how cross-border donations affect our results, but the Pareto-efficient result in the context of tariff competition obtained by Endoh (2012) would be a reference point in this line of reasoning.

Summary and Directions for Future Research of Chapter 3

This chapter shares the same interests and background as in Chapter 2, i.e., some small countries attracting a large amount of foreign capital. Some successful countries are different from many others not just in size, but also in attitudes toward their tax policies. In Ireland, for example, the government has kept announcing that it is committed to its world's lowest corporate tax rate. Singapore has a fairly stable political system allowing its government to have long-term economic plans, including keeping its tax rate low. Chapter 3 studies the role of governments' commitment to their tax schedule on the result of tax competition. To do so, it abstracts away from the difference of market size and focuses on dynamic strategic interactions between governments.

We show that if governments are fully committed to their predetermined tax schedule, either

of the two countries will become the core nation with full agglomeration of firms when trade costs are low enough to generate agglomeration tendencies. If commitment is impossible, both countries may end up with sharing an equal number of firms even when trade costs are low, The results suggest the effectiveness of consistent policies in Ireland and Singapore.

Forward-looking Firms. We notice in the chapter repeatedly that one of the shortcomings in our analysis is the assumption of myopic firms. One can naturally think that if multinationals find a country's policy incredible, they never build a plant there. Consistency of governments' policies is crucial especially for developing countries. Multinationals based in developed countries try to reduce the risk of political uncertainty, so that they care about the credibility of policies the most among other factors when deciding locations. Considering the fact that attracting foreign investment is an engine for the growth of developing countries, it is essential for them to build a good reputation and maintain consistent policies.

As noted in the chapter, one way to deal with full-fledged dynamic analysis is to take approaches by Oyama (2009a,b). Another way to go is to focus on tax policies of one national government and analyze dynamic interactions between the government and firms. This is of course no longer the analysis of tax competition, but still captures strategic aspects. Given the fact that the (statutory) corporate tax rate is higher and a bit more stable in larger countries than smaller ones, we may assume that one large country sets a constant tax rate over time and the other small country can flexibly change its rate to attract forward-looking firms. This "small open economy" setup should be a milestone for further full-fledged dynamic analysis. In this line of reasoning, the studies on dynamic infant-industry protection give us helpful insights and research tools. Miravete (2003) is particularly noteworthy; he examines the infant-industry argument using differential game theory (as in our analysis) in an imperfectly competitive trade model.

Summary and Directions for Future Research of Chapter 4

Chapter 4 turns our attention to the specific development strategy, namely, increasing openness by liberalizing trade and hosting foreign direct investment. This chapter is motivated by the fact that outward-oriented strategies worked well in East Asia while they did not in Latin America. The four Asian tigers are a notable example of export-led growth models. In Latin America, however, accepting the comprehensive liberalization package in the 1990s ("Washington Consensus")

have resulted in expanding exports of primary goods and (seemingly) hindering modernization of economies. Chapter 4 attempts to explain this contrasting performances of industrialization focusing on the openness of traditional sectors.

According to our analysis, the effects of liberalizing trade of the modern sector on industrialization depend on whether or not the traditional sector is open to international markets. If the traditional sector is not traded, trade liberalization induces a disproportionate share of modern firms to locate in the country with a more productive traditional sector, whereas if the traditional sector is traded, liberalization may cause industry delocation from the productive country to the unproductive country. Our results are supported to some extent by the fact that the East Asian countries have liberalized trade in manufacturing goods more extensively than other traditional sectors, while the Latin American countries have undertaken the comprehensive liberalization across all sectors (Urata et al., 2005).

Multi-country Analysis. As many other economic geography models, we confine our analysis to the two-country case. We believe in many cases that having two countries is enough to give us helpful insights, but we need at least three countries when considering the “middle income trap” phenomena. It is now widely recognized that the transition of economy is far from easy from a middle income level to a high income level; the stagnation or decline of growth in middle income countries are known as the middle income trap (Gill et al., 2007).¹ Latin American countries, for example, expanded their manufacturing sector by protecting it from their foreign competitors and attained the middle level of per-capita income in the 1960s and 70s. Since the 1980s, however, their economies have experienced a slowdown or even a decline of growth. Malaysia and Vietnam are recent (potential) examples of middle income countries failing to improve their living standards (Ohno, 2009).

Our modeling developed in the chapter is so tractable that it gives analytical solutions for the equilibrium industry share at the two polar cases (no trade $\phi = 0$ and free trade $\phi = 1$) even in multi-country analysis. Although there are many difficulties in multi-country analysis such as how to define the home market effect and comparative advantage, we hope that our setting can be

¹Here the measure of per-capita income levels is defined in a relative sense: that is, a country is called a middle income one if its per-capita income level is around the mean or median of the world income distribution. The World Bank defines the measure of income level in an absolute sense. See <http://data.worldbank.org/about/country-and-lending-groups>.

extended to at least three-country case and be a useful vehicle for studying the middle income trap.

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