

COMPETING FOR FOREIGN DIRECT INVESTMENT THROUGH INVESTMENT IN
PUBLIC INFRASTRUCTURE

By

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Summary

In the first essay we examine optimal investment in public infrastructure when used to attract foreign direct investment (FDI). We model a monopolistic multinational firm that wants to establish its production plant in one of two prospective host countries with segmented markets, hence there is no arbitrage between the markets. Preceding the firm's location decision, the government of one of the prospective host countries invests in public infrastructure, while the other prospective host government is policy inactive. We identify country characteristics that make a government more likely to use investment in public infrastructure to attract FDI. We find that countries with a large market size, low social cost of public funds, large direct social benefits and high effectiveness of public infrastructure are most likely to be successful in attracting FDI into their jurisdiction by investing in public infrastructure. We also examine the effect of trade liberalisation between the two markets on optimal investment in public infrastructure. We find that a non-monotonic relationship exists between trade costs and optimal investment in public infrastructure.

In the second essay we use a similar set-up as in the first essay. However, we now explicitly introduce domestic firms into the model. Simultaneously to the MNE's location decision, these firms, also benefiting from the investment in public infrastructure, decide whether to remain producers for the domestic market only or to become exporters instead. We show that, under certain conditions, a government that invests in public infrastructure to attract foreign direct investment through manipulation, may at the same time turn its domestic firms into exporters.

The third essay models a competition - for - FDI game between governments that use different policy instruments: one government invests in public infrastructure, while

the other uses its corporate tax rate to entice foreign firms. We model a monopolistic multinational firm, considering to set up a plant in one of two prospective host countries with segmented markets. Governments set policies before the multinational chooses its production location. Also, the government that invests in public infrastructure determines its policy prior to the other government setting its corporate tax rate. When governments compete, there is likely to be a “race to the bottom” in taxes and a “race to the top” in public infrastructure investment.

In the final essay we set up a two-stage game in which two governments, competing for FDI, both invest in public infrastructure and set corporate tax rates. We investigate how public infrastructural investment affects tax competition. We assume that investment in public infrastructure by one country may generate spillovers - positive or negative - for the other country. When the infrastructure investment implies significantly negative spillovers for competing host countries, the investing government will strategically under-invest to ease tax competition, while it will strategically over-invest when the spillovers are negative but small or when these are positive. We also examine how two different forms of tax harmonisation affect investment in public infrastructure. Tax harmonisation in the form of a minimum tax can eliminate strategic investment in public infrastructure. While tax harmonisation in the form of a cooperative tax will result in higher taxes. Furthermore, the level of investment in public infrastructure will also be higher.

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I dedicate this dissertation to my family and friends.

1. General Introduction

It is well acknowledged that the surge of multinational enterprise (MNE) activity in the form of foreign direct investment (FDI) has grown at a more rapid rate than most other international transactions, such as trade flows between countries.¹ In various ways, MNEs are the control centers for a substantial portion of international transactions other than FDI. For instance, almost half of US imports are intrafirm, i.e., trade within a MNE.² These real-world trends have led international trade economists to explore the fundamental factors that drive FDI behaviour. Dunning (1977) posits that firms undertake FDI in response to competitive advantages: ownership, location and internationalisation.

Apart from academics, policy makers are also interested in acquiring a better understanding of MNE behaviour. One of the reasons for this is simply because foreign-owned MNEs are key employers across the world.³ MNEs contribute to the creation of national wealth: they often bring skills, new technologies and financial resources to the host country. They usually offer working conditions and product qualities that are superior to those offered by indigenous firms.⁴

¹Reported by Blonigen (2005).

²See Bernard *et al.* (2011).

³OECD (2001) *The role of multinationals in OECD economies. Manufacturing and services*. Paris; OECD.

⁴Navaretti and Venables (2004), provide an overview of the benefits MNEs can have on a host country.

Because of these expected benefits from MNEs, most governments have been actively promoting their countries as investment locations to attract foreign capital. Host governments offer numerous forms of investment incentives to encourage foreign investors to locate in their country.⁵ One of the most commonly used and fiercely debated policy instruments to attract FDI is the corporate tax rate. Governments may set a low corporate tax rate in order to attract FDI. Examples of countries that use this type of incentive are Ireland, with a corporate tax rate of 12.5%, Hong Kong, where companies pay 16.5% of their profits in taxes. Other countries that set a high corporate tax rate are Belgium, with a corporate tax rate of 33.99%, France, where the corporate tax rate is set at 33.33% and Germany, where the corporate tax rate is 29.55%.⁶

Of course, in reality, when site selectors advise companies where to set up production, they consider a combination of factors. An important factor that enhances a country's attractiveness for foreign investors is good quality infrastructure. Infrastructure covers many dimensions, ranging from roads, ports, railways, education, telecommunication systems to the institutional features of an economy, such as accounting and legal services. National governments invest in infrastructure to enhance the overall environment of the country, possibly making it more attractive for foreign investors.⁷ It is not by chance that MNEs began to locate in Singapore after huge public investment in telecommunications, or in South Korea after the 1953-1956 Post War Reconstruction. Taiwan also attracted a large amount of foreign firms following government funded research institutes and the construction of industrial parks.⁸

⁵Blomström and Kokko (2003) discuss these incentives. They include fiscal incentives, for instance, grants and preferential loans to MNEs and monopoly rights.

⁶KPMG (2013), Global Corporate Tax Rates.

⁷It has been reported in Silicon Republic (2013) that in the past five years the Irish telecommunications industry invested two and a half billion euro in infrastructure, which has facilitated fifty four billion euro worth of FDI as well as expansion projects for indigenous Irish firms.

⁸See Hobday (1995), and Li (2002) and Kellenberg (2007), respectively.

One of the seminal studies investigating infrastructure as a determinant in firms' international location decisions is Wheeler and Mody (1992). In their study they use an indicator for "infrastructure quality" and find a significant positive effect of high infrastructure quality on FDI. Coughlin *et al.* (1991) find that a more extensive transportation infrastructure was associated with increased FDI. Goodspeed *et al.* (2007) also find a significant positive impact of infrastructure on FDI. Bènassy-Quèrè *et al.* (2007) examine FDI from the United States to 18 EU countries and find a significant positive impact of infrastructure on FDI. Mollick *et al.* (2006) examine the role of transport and telecommunications infrastructure for FDI to Mexico and find a positive impact of both types of infrastructure on FDI. There is also a literature in development economics that examines FDI flows. For instance, Loree and Guisinger (1995), Asiedu (2002) and Dollar *et al.* examine the impact of infrastructure on FDI flows. Dollar *et al.* (2004) uses a firm level data set to study the effect of investment climate indicators on FDI flows. Their findings show that FDI is higher in those countries where these indicators are better. While empirical work strongly suggests the importance of good infrastructure for a country to make it attractive for MNEs, theoretical work examining the link between public infrastructure investment and FDI has been relatively scarce. Exceptions include King *et al.* (1993), who present a model in which public investment is the crucial location determinant when two identical regions compete for FDI. They find that, despite the symmetry between the competing regions, it is efficient for governments to choose different levels of infrastructure. Zissimos and Wooders (2008) and Hindriks *et al.* (2008) have analysed the role of public goods differentiation in a tax competition set-up. Bènassy-Quèrè *et al.* (2007) study competition in taxes and the provision of public goods that enhance consumer's utility and firms' productivity.

Their findings suggest that the amount of public research and development expenditures as a share of GDP and road infrastructure had a positive impact on FDI flowing from the US to European countries in 1994-2003.

The work in this dissertation aims to fill part of the gap in this literature. We focus on a number of specific questions in four essays. In the first essay, we construct a basic theoretical framework to examine how a government can use investment in public infrastructure to attract multinational activity. We identify when a government is more likely to successfully use investment in public infrastructure as a means to attract foreign investors. In addition, we investigate how globalisation, in the form of increasing trade liberalisation, is likely to affect investment in public infrastructure.

Governments can be criticised for implementing policies that are actively favouring foreign investors without entailing a similar level of support for domestic firms. In the second essay, we argue that this does not have to be the case. We show that when a government invests in public infrastructure through manipulation to attract foreign investors, it can, while attracting multinational activity, transform domestic firms into international players.

Of course, in the real world, MNEs do not make their decisions based on local public infrastructure provision alone. Typically, a MNE's location decision is determined by a combination of local advantages and favourable policy packages. Governments often compete with each other to attract foreign investors. In doing so, they implement policies to entice foreign firms to locate in their jurisdiction. Foreign investors are often offered favourable policy packages by countries.

In reality, we observe governments offering subsidies to attract foreign investors. In

1995, Ireland granted employment subsidies to IBM and Citibank and, in 1998, Germany offered investment subsidies to Motorola. In the US, investment subsidies from state governments helped attract Mercedes-Benz to Alabama and BMW to North Carolina.⁹

Many papers focus on the competition between potential host countries for a single MNE. In these models the equilibrium policy generally involves giving a subsidy to the MNE. Haufler and Wooton (1999) introduce a model of regional tax competition. Their study shows that when two countries compete to attract a single foreign firm, differences in the sizes of the countries' home markets affect the equilibrium taxes offered by both countries and the larger country always attracts the foreign investment. Governments want to attract firms for a number of possible reasons: scale economies in the provision of public goods (Black and Hoyt, 1989), employment creation (Barros and Cabral, 2000) or positive spillovers from employment (Haaparanta, 1996; Davies, 2005). Other studies have shown, however, that these results change when countries compete for two mobile firms (Ferrett and Wooton, 2010) or when a domestic firm exists in one of the potential host countries (Bjorvatn and Eckel, 2006).

Many empirical studies have linked tax differentials to FDI flows (e.g., Bénassy-Quéré *et al.* (2005); Kammass (2011)), while other studies have linked the decline in corporate tax rates to tax competition (e.g., Devereux *et al.* (2002),(2008); Redoano (2007); Cassette and Paty (2008) and Davies and Voget (2009)). Of course corporate taxes are not the only factor influencing firms location decisions.

Another strand of literature recognises the importance of backward and forward linkages, and has examined tax competition for international mobile firms in models of

⁹See Hanson (2001).

economic geography. This literature has predicted that in an environment of increasing returns to scale and imperfect trade integration, the most populated countries are able to sustain higher corporate taxes. Since firms located in this country benefit from “agglomeration rent” their sensitivity to countries’ relative corporate tax policies is reduced.¹⁰ Nonetheless, trade integration induces convergence in corporate taxes (at low levels) because the location where production takes place becomes increasingly less relevant. However, tax disparities between countries should persist as soon as there are some frictions to trade. This literature can explain both the convergence to the bottom in corporate taxes and the persistence of tax disparities by the fact that some countries are less exposed to tax competition than others.¹¹

Another reason why some countries can set high taxes and still attract FDI, may lie in the fact that countries differ in the level and quality of public infrastructure. Naturally, foreign investors find some countries (e.g., Germany) particularly attractive because of the high quality of the public infrastructure. Other countries (e.g., Ireland) have managed to attract a lot of FDI because of the lower corporate tax rate. As a first step to incorporating tax policy into our basic framework, we examine a game between two policy active governments of two regions, competing for FDI. The government of one region invests in public infrastructure to attract FDI, whereas the other government sets the corporate tax rate.

¹⁰See, for instance, Ludema and Wooton (2000), Kind *et al.* (2000), Andersson and Forslid (2003), Baldwin and Krugman (2004), Borck and Pflüger (2006). These papers show that agglomeration creates rents for the mobile factor that can be taxed, increasing the equilibrium tax rates. In this framework, the result, according to which the mobile factor may not respond to marginal changes in tax rates, differs from the standard theoretical predictions in tax competition models. These authors show how an agglomerated region can tax more without losing its mobile activities. Firms are willing to bear a higher tax rate in order to benefit from agglomeration and from local public goods. This leads to a “race to the top” instead of the “race to the bottom”, described by the vast body of literature on tax competition.

¹¹See, Ottaviano and van Ypersele (2005), Haufler and Wooton (2010).

Because of its long-run character and its largely irreversible nature, the government choosing public infrastructure investment makes its decision in our model prior to the government setting the corporate tax rate. This analysis allows us to characterise optimal policies when governments compete for FDI, using different policies.

The final essay explores how governments, *both* investing in public infrastructure and subsequently setting corporate tax rates, can influence FDI flows into their country. We also introduce the possibility of interregional spillovers from public infrastructure investment. In the literature, there is a small number of papers that examine the relationship between the provision of public goods and tax competition. Zissimos and Wooders (2008) determine how firms that vary in their requirements for public goods might lead to differences in the levels of public good provision across countries. They find that competition in public goods makes competition in taxes less intense. Hindriks *et al.* (2008) also built a model of tax and public goods competition with perfect capital mobility. This study assumes that regions vary in their attractiveness when one region possesses a better production technology than the other.

Bénassy-Quéré *et al.* (2007) examine competition through taxes and the provision of public goods that raise consumers' utility and firms' productivity. This study suggests that, from 1994 to 2003, the amount of public research and development expenditures as a share of GDP and the road infrastructure had a positive effect on FDI flowing from the United States to European countries.

A distinguishing feature of our model is that we allow for spillovers from investments in public infrastructure to the rival host country. Different types of investments in public infrastructure may have different effects on the FDI flow into rival countries. For instance, public infrastructure investment in one country may directly reduce the

FDI going to the other location, as it potentially makes the rival country less attractive (e.g., public investment in domestic roads). However, when investment in public infrastructure has a positive interregional spillover effect (e.g., investment in interregional transport routes), FDI may increase to both locations. We also examine how two different types of tax harmonisation affects investment in public infrastructure.

2. Investment in Public Infrastructure and Foreign Direct Investment

2.1. Introduction

The infrastructure of a country helps to define its investment environment and hence creates favourable conditions for economic growth. In 2008, the World Bank in its Growth Commission Report states that countries that devote more of GDP to public investment, notably countries in Asia, grow faster than those that invest a little.

Investment in public infrastructure generates positive social benefits. These social benefits typically entail a higher level of well-being for households and increased productivity of firms. For this reason, it is hardly surprising that policies designed towards development in many countries have been based on investments in infrastructure.

Because of the public good nature of public infrastructure, investment in infrastructure has, apart from its obvious benefits to local economic agents, the potential to attract foreign investors.¹ A number of papers has focused on the role of infrastructure in attracting MNEs. Examples are Wheeler and Mody (1992), Loree and Guisinger (1995), Richaud et al. (1999), Morisset (2000) and Asiedu (2002). These studies suggest that

¹Globerman and Sharpiro (2002)

good infrastructure is a necessary condition for foreign firms to be attracted to a region. Infrastructure should enhance the investment climate for FDI by lowering the cost of production, hence, increasing productivity within that country.

As economic globalisation deepens, MNE's have become increasingly footloose. Meanwhile, governments are keen to attract MNEs as they bring various benefits to their host country. It then seems quite natural to suggest that some countries, especially newly emerging economies that are investing heavily in public infrastructure, also use that policy to attract foreign direct investment.

King et al. (1993) present a model in which public investment is the crucial location determinant when two identical regions compete for FDI. In their model governments can build infrastructure first and then bid in an auction for a firm. Our paper differs from their study, we focus on the public good nature of infrastructure. We determine a country's optimal investment in public infrastructure when that investment is not only considered as a policy to attract foreign investment but it also entails direct social benefits. In an empirical study, Bénassy-Quéré et al. (2007) find that road infrastructure had a positive impact on FDI flowing from the US to European countries in 1994-2003.

In this essay we construct a theoretical model in which a monopolistic multinational firm considers establishing a production plant in one of two prospective host countries with segmented markets. We assume only one government invests in infrastructure while the government of the other host country is policy inactive. We identify country characteristics that make a government more likely to invest in infrastructure to attract FDI. We also examine the effect of trade liberalisation between the two prospective host countries on investment in public infrastructure.

In section 2.2, the model is presented. In section 2.3, the optimal level of public infrastructure investment is derived when public infrastructure entails direct social benefits for the local economy, while also increasing the attractiveness of the country for foreign investors. Section 2.4 concludes.

2.2. The Model

An MNE decides to locate in one of two potential host countries, country 1 or country 2. For simplicity, the fixed cost of setting up a plant, F , is assumed to be the same in both countries.² Furthermore, it is also assumed to be large enough for the MNE only to locate in one country. Irrespective of its chosen production location, the MNE will serve customers in each country. When the MNE exports from its chosen production location to the other country, the firm incurs a trade cost per unit of export, τ . We assume the MNE is a monopolist in each host market. The two prospective host countries' markets are segmented. The inverse demand function for country i is given by,

$$P_i = a - b_i Q_i \quad i = 1, 2 \quad (2.1)$$

where P_i denotes the price of the MNE's good in country i and Q_i is the quantity of the MNE's good consumed in country i , with $b_i = \frac{1}{S_i}$ where S_i denotes country i 's market size. We assume country 2's market size is at least as big as country 1's ($S_1 \leq S_2$). Without government intervention, the marginal production cost is the same in both countries and is denoted by c . Hence, without government intervention, the MNE's

²Allowing for different fixed costs across countries results in the country with the lower F to be a relatively more attractive location for the MNE to set up in. However, qualitatively results do not change.

natural location choice is to locate in the country with the larger market, i.e., country 2. Without government intervention, the MNE's profit from locating in the larger market exceeds the profit it would make if it were to locate in the smaller market.

We assume that country 1 has a policy active government. This government invests in public infrastructure, denoted by x , which lowers locally producing firms' marginal cost of production. Public infrastructure is a broad term, which can include physical infrastructure, education and the legal or institutional environment of an economy. One can think of improvements in any of the above mentioned infrastructures as lowering the marginal production cost within that country. So, if it locates in country 1, the MNE's cost function is given by:

$$c_1 = c - \lambda x \quad (2.2)$$

where λ represents the effectiveness of public infrastructure investment. Hence, the MNE's respective profit functions when locating in country 1 and country 2 are given by:

$$\Pi^1 = (P_1 - c + \lambda x)Q_1^1 + (P_2 - c + \lambda x - \tau)Q_2^1 - F \quad (2.3)$$

and

$$\Pi^2 = (P_1 - c - \tau)Q_1^2 + (P_2 - c)Q_2^2 - F \quad (2.4)$$

Subscripts refer to the country of consumption and superscripts refer to the country where the MNE resides (e.g., Q_2^1 is the output for country 2 when the MNE is located in country 1.). As mentioned earlier, determining the marginal cost of production in

country 1 crucially depends on the government's investment in public infrastructure. This is chosen by the government by maximising domestic welfare, which is given by:

$$W = \frac{b_1(Q)^2}{2} + \sigma x - \delta \frac{\gamma(x)^2}{2} \quad (2.5)$$

The first term in expression (2.5) is the consumer surplus generated by consumption of the good produced by the MNE. The second term measures what I will henceforth refer to as the direct social benefit of public infrastructure investment to the economy. Such benefits can include an increase in the productivity of the nation through higher levels of education or through improvements in physical infrastructure. These do not depend on the presence of the MNE. The third term in the welfare function represents the cost of investment in public infrastructure.³ Parameter γ is a positive constant. The weight attached to government expenditure, δ , can be interpreted as the social cost of public funds and can be thought of as reflecting the deadweight loss of raising taxes in the economy to fund public infrastructure investment, $\delta > 1$.⁴

The timing of the game is as follows. In stage 1, the government of country 1 chooses its investment level in public infrastructure. In stage 2, the multinational decides whether to establish its production facility in either country 1 or country 2. In stage 3, the multinational chooses its output levels. The three-stage game is solved by backward induction.

³Following d'Aspremont and Jacquemin (1988), we assume a quadratic cost function.

⁴Neary (1994) introduced the concept of the "social cost of public funds" to the strategic trade literature.

2.2.1 Stage 3: The MNE's outputs

In the final stage of the game, the MNE chooses outputs for each market. If the MNE locates in country 1, the MNE determines optimal outputs for each market by maximising expression (2.3) with respect to public infrastructure, yielding:

$$Q_1^1 = \frac{S_1(A + \lambda x)}{2} \quad (2.6)$$

$$Q_2^1 = \frac{S_2(A + \lambda x - \tau)}{2} \quad (2.7)$$

respectively, where A is defined as $A \equiv a - c$. The larger the market size and the more the government invests in public infrastructure, the larger are the outputs the MNE produces.

If the MNE locates in country 2, the optimal output for each market is obtained by maximising expression (2.4) with respect to public infrastructure investment and is given by:

$$Q_1^2 = \frac{S_1(A - \tau)}{2} \quad (2.8)$$

$$Q_2^2 = \frac{S_2 A}{2} \quad (2.9)$$

Also, exports (Q_2^1 when the MNE is located in country 1 and Q_1^2 when it is located in country 2) fall in the trade cost, τ .

2.2.2 Stage 2: MNE's location decision

In the second stage, the monopolist MNE selects the country in which to locate. The firm's maximised profits when it locates in country 1 and country 2 are, respectively, given by:

$$\Pi^1 = b_1(Q_1^1)^2 + b_2(Q_2^1)^2 - F \quad (2.10)$$

and

$$\Pi^2 = b_1(Q_1^2)^2 + b_2(Q_2^2)^2 - F \quad (2.11)$$

At $x = 0$, $\Pi^1(x) < \Pi^2$ since country 2 has a larger market size and at $x = 0$, the marginal cost of production in each country is the same. There is a critical level of public infrastructure investment at which the MNE is indifferent between locating in country 1 and country 2, denoted by \underline{x} . Formally, we have $\Pi^1(\underline{x}) = \Pi^2$. Using expressions (2.10) and (2.11), the value of this critical x threshold is equal to:

$$\underline{x} = \frac{\tau(S_2 - S_1)}{\lambda(S_1 + S_2)} \quad (2.12)$$

The above expression can be rewritten as:

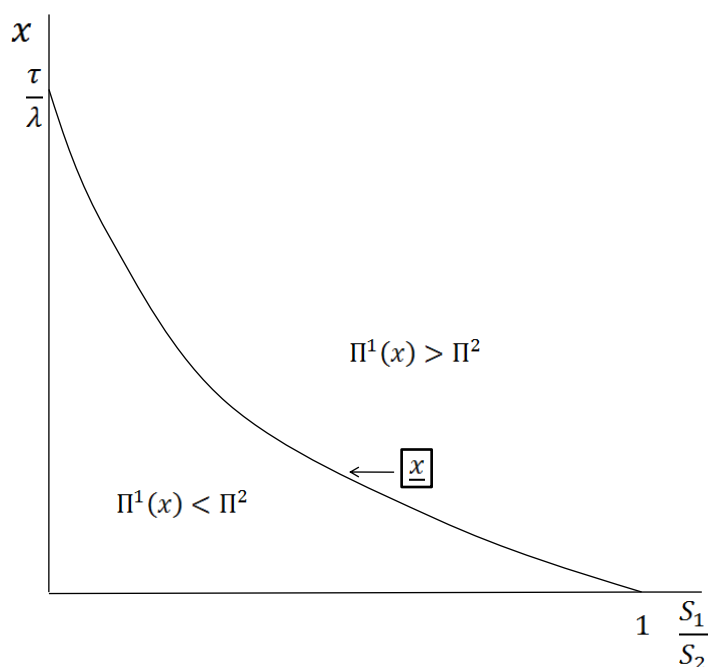
$$\lambda \underline{x}(S_1 + S_2) = \tau(S_2 - S_1) \quad (2.13)$$

The left hand side of equation (2.13) represents the MNE's relative advantage if it resides in country 1, which is increasing in the effectiveness of public infrastructure

(λ) and the sum of the two market sizes $(S_1 + S_2)$; locating in country 1 gives a cost advantage of $\lambda \underline{x}$ per unit of production, on outputs derived for both markets. The right hand side of equation (2.13) refers to the relative disadvantage of locating in country 1, which is increasing in the per unit trade cost (τ) and the difference in market sizes $(S_2 - S_1)$; locating in country 1 implies a higher trade cost as the export market is larger than the market in which the MNE is located $(S_2 \geq S_1)$. Hence, the critical level of public infrastructure investment at which the MNE is indifferent between both locations, (\underline{x}) , is decreasing in the features which make country 1 more attractive for the MNE, i.e., the effectiveness of public infrastructure (λ) and the sum of the two market sizes $(S_1 + S_2)$. While \underline{x} is increasing in the parameters which make country 1 less attractive for the MNE, i.e., the per unit trade cost (τ) and the difference in market sizes $(S_2 - S_1)$.

Figure 2.1 depicts \underline{x} as a function of the relative market size of country 1.

FIGURE 2.1: The MNE's location indifference locus



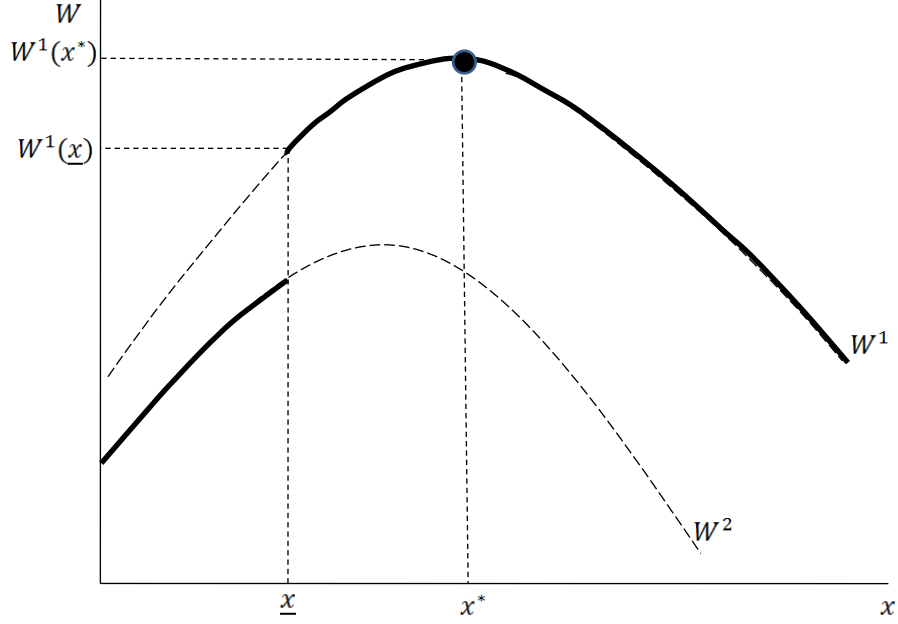
To the left of the firm's location-indifference locus, the firm decides to invest in country 2. To the right of the locus the firm invests in country 1.

2.2.3 Stage 1: Optimal Investment in Public Infrastructure

Having determined the critical threshold at which the MNE is indifferent between the two prospective host countries, we now discuss the optimal investment level in public infrastructure the government should choose. There are three possible qualitatively different outcomes. We will first discuss and illustrate each of them graphically. Subsequently, in section (2.3), we will explore how changes in the values of our model parameters affect the optimal public infrastructure level.

Note, first of all, that given x , the welfare in country 1 is higher when the MNE locates in country 1 than when it locates in country 2 ($W^1 > W^2$). Figure 2.2 traces out welfare levels (in bold) for different values of x for the first possible scenario. For $x < \underline{x}$, the MNE locates in country 2, hence $W = W^2$. For $x > \underline{x}$, the MNE locates in country 1, hence $W = W^1$. The welfare function exhibits a kink at \underline{x} , the level of public infrastructure at which the MNE is indifferent between locating in country 1 and country 2.

FIGURE 2.2: Optimal investment in public infrastructure when $\underline{x} \leq x^*$



In this case, it is clear that the government maximises welfare at x^* , and at x^* the MNE will locate in country 1. The optimal public infrastructure investment, x^* is obtained by maximising welfare $W^1(x, Q_1^1(x))$ and yields the following first-order condition:

$$\frac{dW^1}{dx} = W_x^1 + W_{Q_1^1}^1 \frac{dQ_1^1}{dx} = 0 \quad (2.14)$$

where subscripted variables refer to partial derivatives and with $W_x^1 = \sigma - \delta\gamma x$ and $W_{Q_1^1}^1 \frac{dQ_1^1}{dx} = \frac{\lambda(A+\lambda x)}{4b_1}$. In this case, the optimal investment level in public infrastructure is given by:

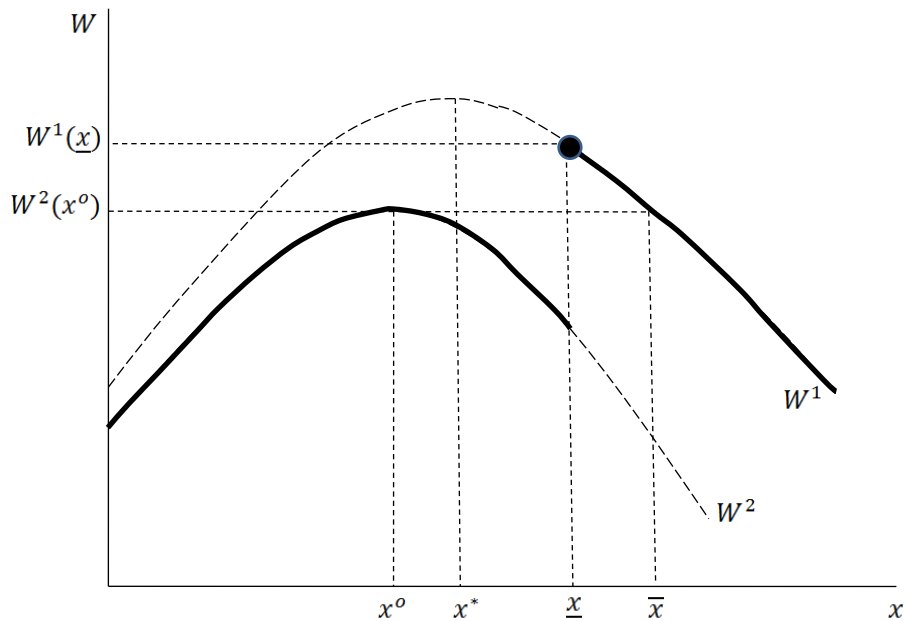
$$x^* = \frac{A\lambda + 4b_1\sigma}{4b_1\delta\gamma - \lambda^2} \quad (2.15)$$

This case most likely arises when the difference between markets sizes ($S_2 - S_1$) is low,

the value of the per unit trade cost (τ) is low, the effectiveness of public infrastructure (λ) is high, the sum of the two market sizes ($S_1 + S_2$) are large, the direct marginal social benefit of public infrastructure (σ) is large and the social cost of public funds (δ) is low.

Two other possible outcomes arise if the investment level x^* is lower than the MNE's location-indifference level of investment, i.e., $x^* < \underline{x}$. The second possible outcome is depicted in figure 2.3. Because the policy active government moves prior to when the MNE makes its location choice, it can induce the MNE to locate in its country by investing slightly above \underline{x} . In fact, since welfare is clearly highest at \underline{x} , the government will attract the MNE, manipulating its location decision by choosing a level of public infrastructure slightly higher than \underline{x} and hence attracting the MNE ($W^1(\underline{x}) \geq W^2(x^o)$).

FIGURE 2.3: Optimal investment in public infrastructure when $\underline{x} > x^*$ and $W^1(\underline{x}) \geq W^2(x^o)$



This case is likely to emerge for intermediate values of; the per unit trade cost (τ), the

effectiveness of public infrastructure (λ), the direct marginal social benefit of public infrastructure (σ) and the social cost of public funds (δ).

However, since deviating away from x^* is costly, as it involves deviating from the unconstrained optimum, the government may not wish to do this. In fact, there is a threshold of investment in public infrastructure, above which the government is no longer willing to attract the MNE and simply prefers to import the good produced by the MNE in country 2, denoted by \bar{x} . Note that, at \bar{x} $W^1(\bar{x}) = W^2(x^o)$; in other words \bar{x} denotes the maximum x the government is willing to invest in order to attract the MNE.⁵

The third possible scenario is depicted in figure 2.4. Like in the previous case, $\underline{x} > x^*$, but now the government attains a higher welfare by importing the good than by attracting the MNE ($W^1(\underline{x}) < W^2(x^o)$ or $\underline{x} > \bar{x}$). When the government of country 1 imports the MNE's good it attains a welfare level, $W^2(x^o)$. At x^o , the government maximises $W^2(x, Q_1^2)$ (see expression (2.5)). The first order condition is then given by:

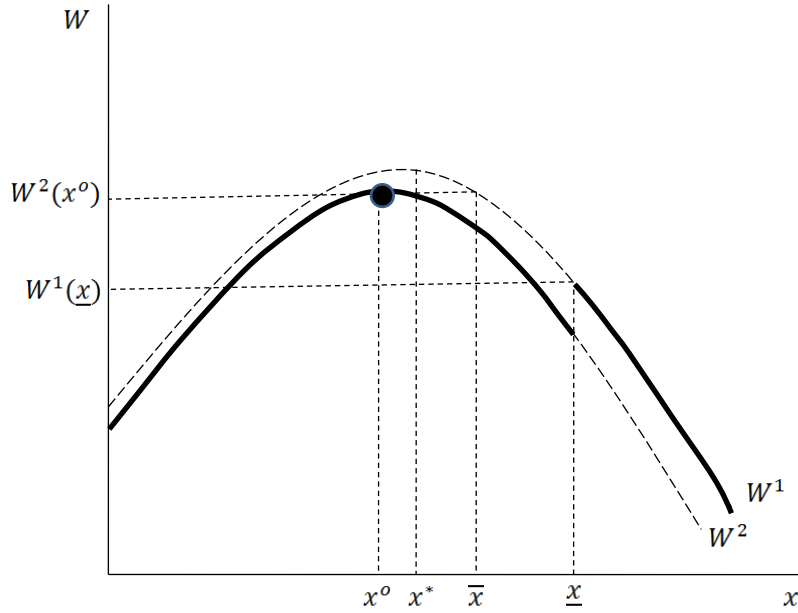
$$\frac{dW^2}{dx} = W_x^2 = 0 \quad (2.16)$$

with $W_x^2 = \sigma - \delta\gamma x$ and hence the optimal level of public infrastructure investment is given by:

$$x^o = \frac{\sigma}{\delta\gamma} \quad (2.17)$$

⁵The expression for \bar{x} is reported in the Appendix.

FIGURE 2.4: Optimal investment in public infrastructure when $W^1(\bar{x}) \leq W^2(x^o)$



Hence, the highest attainable welfare is reached when the government of country 1 imports the good produced by the MNE from country 2 and $x = x^o$. This scenario most likely occurs when the difference between markets sizes ($S_2 - S_1$) is high, the value of the per unit trade cost (τ) is high, the effectiveness of public infrastructure (λ) is low, the sum of the two market sizes ($S_1 + S_2$) are small, the direct marginal social benefit of public infrastructure (σ) is small and the social cost of public funds (δ) is high.

Summarising, if the unconstrained optimal investment in public infrastructure is higher than what is required to attract the MNE ($x^* > \underline{x}$), then the government will choose to invest x^* and the MNE will locate in country 1. However, if the unconstrained welfare maximum is unattainable because the level of public infrastructure is not high enough to attract the MNE ($x^* < \underline{x}$), then the government will invest slightly more

than \underline{x} to attract the MNE, provided that this yields higher welfare than it can obtain by importing the good from the MNE when the latter is located in country 2. This case involves the government of country 1 manipulating the MNE's location decision through its choice of public infrastructure investment. Only when this manipulation becomes too costly, the government will choose a discretely lower level of public infrastructure investment, let the MNE locate in country 2 and import the good.

2.3. Determinants of optimal public infrastructure investment and welfare

In this section we respectively investigate how a change in the social cost of public funds, the direct marginal social benefit of public infrastructure and trade liberalisation affect optimal infrastructure investments. For each possible combination of parameter values, one of the three outcomes, sketched in the previous section, will prevail.

2.3.1 Social cost of public funds

The bold curves in figure 2.5 and 2.6 respectively depict optimal investment in public infrastructure and welfare levels as the social cost of public funds change (holding all other parameter values constant at intermediate values).

The government is able to choose its optimal unconstrained level of public infrastructure investment (as was the case in figure 2.2) when this exceeds the level of investment required by the MNE to reside in country 1 ($x^* > \underline{x}$); this will prevail when the social cost of public funds is low ($\delta \leq \delta_L$). The government invests x^* and attracts the MNE. The welfare in country 1 is given by, $W^1(x^*)$.

The level of public infrastructure the MNE requires to produce in country 1 is higher than x^* ($x^* < \underline{x}$) for intermediate values of δ ($\delta_L < \delta \leq \delta_H$). As δ rises, it becomes more costly for the government to fund its public infrastructure projects, x^* falls and so does welfare. Nevertheless, the government still wants to actively attract FDI since it is willing to invest more than \underline{x} to attract the MNE, ($\bar{x} > \underline{x}$) (see the case in figure 2.3). Thus the government invests slightly more than \underline{x} to entice the MNE to locate on its territory.

The government is not willing to invest in public infrastructure to attract the MNE by manipulation ($\bar{x} < \underline{x}$) (as was the case in figure 2.4) for high values of δ ($\delta \geq \delta_H$). As δ rises beyond δ_H , the deadweight loss of raising taxes in the economy is too high to fund investments to attract the MNE. Hence, the government prefers to import the MNE's product from country 2, it invests x^o and reaches the welfare level $W^2(x^o)$.

Thus, the lower the social cost of public funds, the more likely the government will use investment in public infrastructure to attract FDI and the more likely the government will succeed in attracting the MNE.

FIGURE 2.5: Social cost of funds and optimal public infrastructure

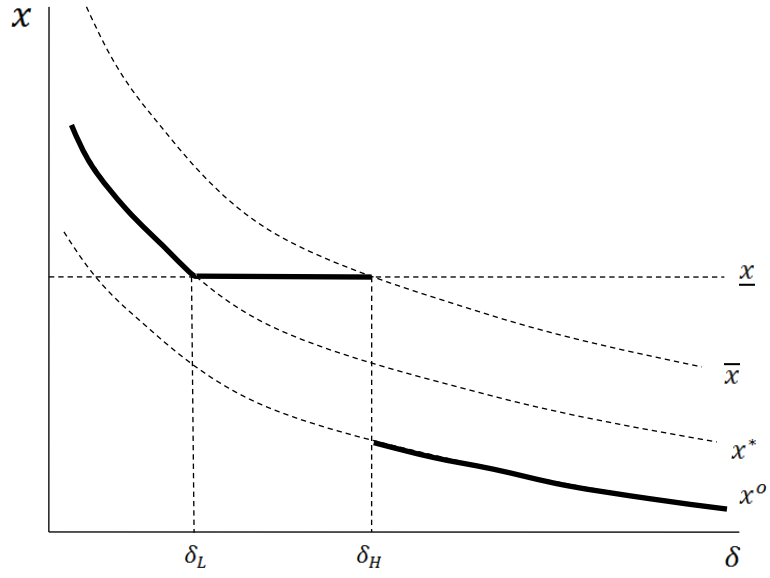
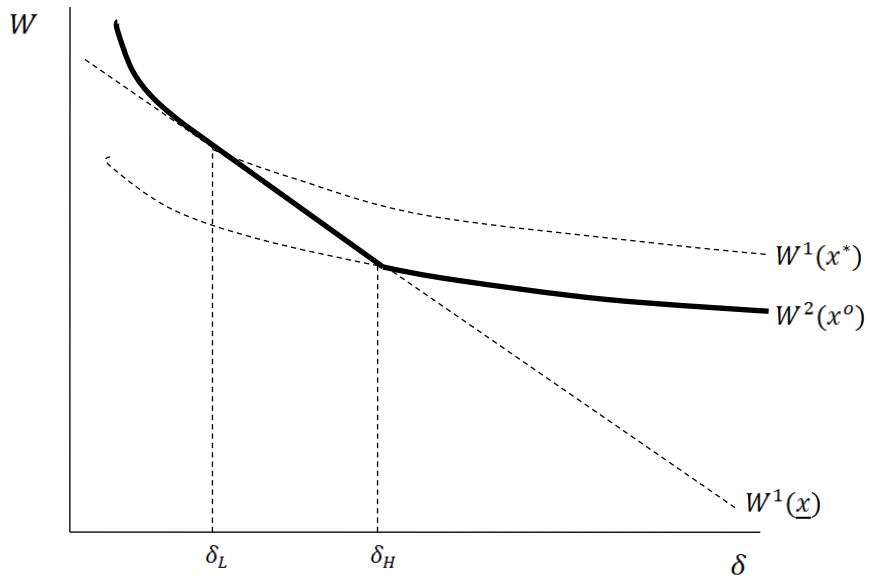


FIGURE 2.6: Social cost of funds and welfare



2.3.2 Direct marginal social benefit of public infrastructure

The bold curves in figures 2.7 and 2.8 respectively illustrate the optimal investment in public infrastructure and welfare levels for country 1 as the direct marginal social benefit from public infrastructure investment increase (holding all other parameter values constant at intermediate values).

The MNE requires higher levels of infrastructure than the government is willing to invest ($\bar{x} < \underline{x}$) when the direct marginal social benefit from investment in public infrastructure is low, ($\sigma \leq \sigma_L$). It is in the government's best interest to import the MNE's product from country 2, hence, it invests x^o and welfare in country 1 is given by $W^2(x^o)$.

However, it is optimal for the government to increase investment in public infrastructure to actively attract FDI ($\bar{x} > \underline{x}$) as the direct marginal social benefit of having infrastructure in the economy increase to intermediate levels, ($\sigma_L < \sigma \leq \sigma_H$). The government increases investment levels slightly above what the MNE requires, \underline{x} , and welfare levels continue to rise to $W^1(\underline{x})$.

The government increases public infrastructure investment even further than what is required by the MNE ($x^* > \underline{x}$) as investment in public infrastructure lead to even higher direct marginal social benefits, ($\sigma > \sigma_H$). The government invests x^* and attracts FDI. As a result, the welfare level in country 1 increases to $W^1(x^*)$.

FIGURE 2.7: Direct marginal social benefit and optimal public infrastructure

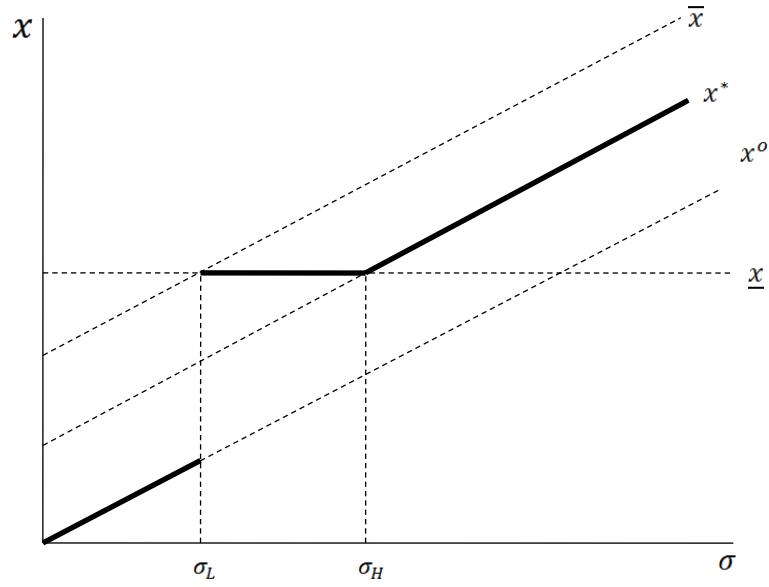
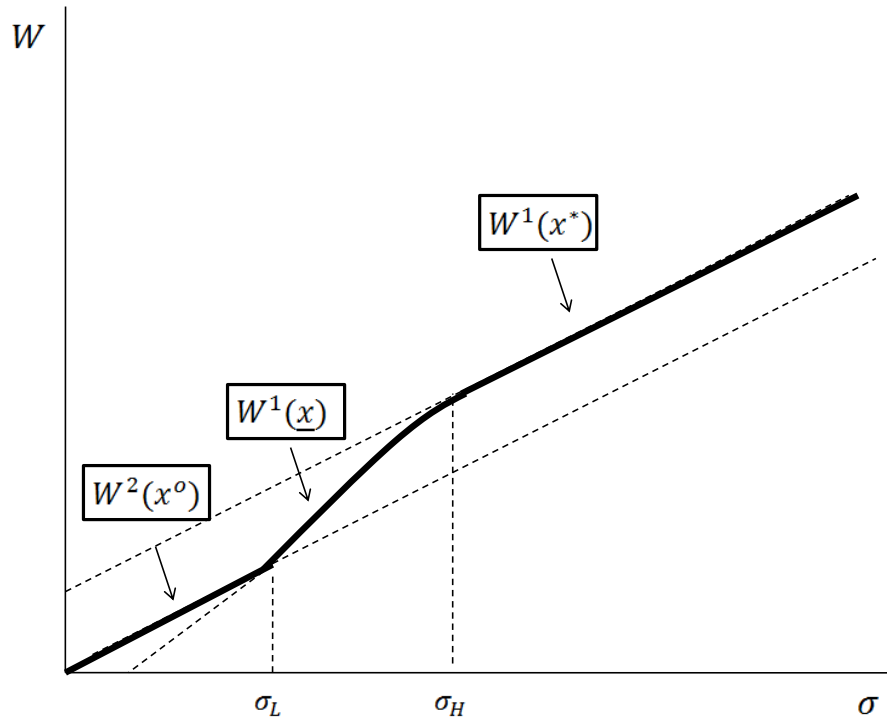


FIGURE 2.8: Direct marginal social benefit and welfare



As there are more greater direct marginal social benefits in the economy from having public infrastructure, the government invests more in public infrastructure, has a higher willingness to attract FDI and is more likely to be successful in attracting the MNE.

2.3.3 Trade liberalisation

The bold curve in figure 2.9 illustrates the relationship between trade liberalisation and optimal investment. While the bold curve in figure 2.10 shows the welfare level for country 1 as a function of trade costs (holding all other parameter values constant at intermediate values).

The government is not willing to invest in public infrastructure to actively attract FDI ($\underline{x} > \bar{x}$) when trade costs are high, ($\tau > \tau_H$). The MNE requires very high levels of public infrastructure to be compensated for locating in the smaller country and so the government decides instead to import the MNE's product from country 2. Its optimal investment in public infrastructure is given by x^o and welfare in country 1 is given by $W^2(x^o)$. As the trade cost falls and approaches τ_H , the firm exports more to country 1 and thereby increases country 1's welfare through increased consumer surplus.

It is optimal for the government to invest in public infrastructure to actively attract FDI, ($\bar{x} > \underline{x}$) for intermediate trade costs, ($\tau_L < \tau \leq \tau_H$). Hence, there is a discrete increase in investment levels. The government invests slightly above \underline{x} to entice the MNE to locate on its territory.

The government does not need to compensate the MNE with as much public infrastructure to tempt it to locate in country 1 as the two countries become more integrated

and τ approaches τ_L . The amount of investment the MNE requires (\underline{x}) is falling as τ falls. Thus welfare levels continue to rise.

The optimal public infrastructure is x^* and welfare is $W_1^1(x^*)$, ($x^* > \underline{x}$) as trade costs continue to fall to really low levels, ($0 < \tau < \tau_L$). The welfare level remains the same for low values of τ ($0 < \tau \leq \tau_L$), as the firm is now located in country 1, therefore the trade cost does not affect how much the MNE will produce to serve the host market.

In summary, the effect of increasing trade liberalisation on public infrastructure investment depends on the level of trade liberalisation that already exists. When trade costs are high, a small degree of trade liberalisation has the potential to immediately increase optimal investment in infrastructure. However, when trade costs are relatively low, trade liberalisation may reduce optimal public infrastructure investment. The optimal investment level in public infrastructure is thus non-monotonic in τ .

FIGURE 2.9: Trade liberalisation and optimal public infrastructure ($S_1 = S_2$)

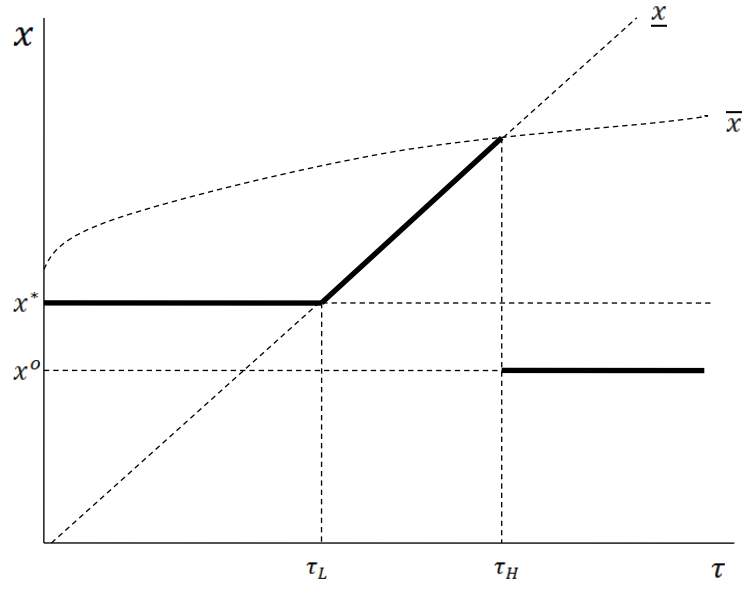
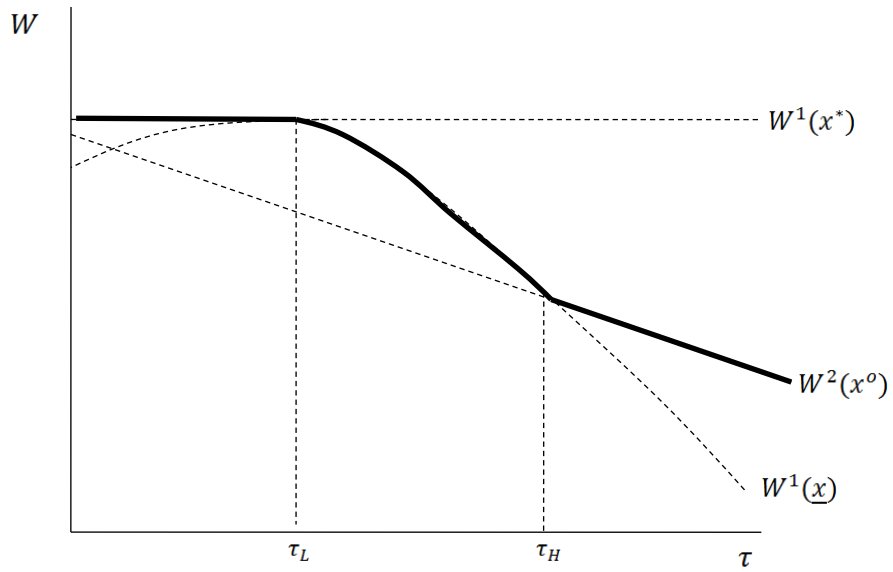


FIGURE 2.10: Trade liberalisation and welfare ($S_1 = S_2$)



2.4. Conclusion

In this essay we examine a government's optimal investment policy in public infrastructure when used to attract foreign capital. When considering whether to attract FDI through manipulation, a government must outweigh the benefits associated with attracting foreign firms against the costs of infrastructure projects. Countries with a large market size, low social cost of public funds, large direct social benefits and high effectiveness of public infrastructure are more likely to invest in infrastructure projects to attract FDI. Hence, a country with these characteristics using public infrastructure to attract FDI increase the likelihood that multinationals will locate in its territory.

We examined how trade liberalisation affects optimal investment in public infrastructure and found that a non-monotonic relationship exists between trade liberalisation and optimal investment. When trade costs are high, a small degree of trade liberalisation has the potential to cause a discrete increase in optimal investment in infrastructure. However, when trade costs are low, trade liberalisation will reduce optimal public infrastructure investment.

Our framework enables us to answer more complex questions. In the next essay, we will extend our analysis by introducing domestic firms. Given the public good nature of public infrastructure, they - like a MNE - also benefit from investment in public infrastructure. We explore how investment in public infrastructure impacts foreign firms' location choice as well as domestic firms' exporting decisions.

2.5. Appendix

\bar{x} is the maximum level of investment the government is prepared to invest in order to attract the MNE ($W^1(\bar{x}) = W^2(x^o)$) ; it is given by:

$$\bar{x} = \frac{-(2A\lambda + 8b_1\sigma) - \sqrt{(2A\lambda + 8b_1\sigma)^2 - 4(\lambda^2 - 4b_1\delta\gamma)(2A\tau - \tau^2 - 8b_1\sigma x^o + 4b_1\delta\gamma(x^o)^2)}}{2(\lambda^2 - 4b_1\delta\gamma)} \quad (2.18)$$

3. Investment in Public Infrastructure: Boosting Exports through Attracting Foreign Direct Investment

3.1. Introduction

Governments' FDI policies often involve manipulating multinational firms' location decisions by making their country sufficiently attractive to firms to produce there. In fact, some governments have been using policies that are effectively discriminatory, actively favouring foreign firms without entailing a similar level of support for domestic firms. For instance, foreign investors are often offered substantial investment incentives by host countries. Bond and Samuelson (1986), provide examples of the types of subsidies offered by host countries to foreign investors. Examples include reduced tax rates in the early years of operation, labour training grants, and cash grants.

In this paper, we argue that this does not need to be the case and show that public infrastructure investment initiatives have the potential to attract MNEs, while at the same time propelling domestic firms into international markets. We show this, constructing a framework in which a government manipulates multinational firms to locate on its territory through investment in public infrastructure. Local firms in the MNE's potential host country are, by assumption, not competing with the MNE and *ex ante* serve the domestic market only. We demonstrate that, thanks to the public good nature of public infrastructure, government investment to attract foreign direct

investment through manipulation may, under certain conditions, also transform their own domestic firms into international players. In other words, the domestic sector of the host country gets internationalised precisely because the host country's government public infrastructure investment strategy, aims to capture multinational activity. Other studies such as King et al. (1993) Zissimos and Wooders (2008), Hindriks et al. (2008), Benassy-Quere et al. (2007) emphasise the importance of investment in public infrastructure in attracting FDI. Our paper contributes to the literature by taking into account the public good nature of investment in public infrastructure and how this policy not only has the potential to attract FDI but it also has the potential to enable domestic firms into becoming exporters.

More specifically, we develop a theoretical three-stage model. In the first stage, the government of one of the two prospective host countries for a multinational firm chooses its level of investment in public infrastructure. The government of the other country is assumed to be policy inactive. We assume the respective markets of the prospective host countries are segmented. In the second stage, firms make their decisions: the multinational firm decides in what country to produce, whereas domestic firms in the country that invest in public infrastructure decide whether to export or not. In the third stage, all firms choose their outputs.

In section 3.2, we present and solve the model. In section 3.3 we briefly discuss a number of possible extensions. First, we discuss the effects of introducing heterogeneity among domestic firms, which allows us to examine what type of domestic firms are most likely to become exporters. Second, we briefly sketch some of the potential outcomes of the model when we allow for competition between the multinational enterprise and the domestic sector. Section 3.4 concludes.

3.2. The Model

A multinational enterprise decides to locate in one of two potential host countries, country 1 or country 2, aiming to serve both markets. The MNE will be a monopolist in each host market. The two markets are segmented. When exporting from its chosen production location to the other country, the firm incurs a trade cost, τ . The inverse demand function for country i is given by:

$$P_i = a - b_i Q_i \tag{3.1}$$

with $b_i = \frac{1}{S_i}$, S_i denoting country i 's market size. We assume country 2's market size is at least as big as country 1's ($S_1 \leq S_2$). The fixed cost, F , of setting up a plant abroad is assumed to be identical in both locations. F is assumed to be large enough so that the MNE will locate in one country only. Without government intervention, the marginal production cost is the same in both countries and is denoted by c . Hence, the MNE's natural location choice is to locate in the country with the larger market, i.e., country 2.

We assume that country 1 has a policy active government. This government invests in public infrastructure, denoted by x , which lowers locally producing firms' marginal cost of production. The types of investment which lower local firms' marginal cost of production include public education, physical infrastructure, or the creation of strong legal institutions. Therefore, if the MNE locates in country 1, its cost function is given by:

$$c_1 = c - \lambda x \tag{3.2}$$

where λ represents the effectiveness of public infrastructure, the degree to which an investment in public infrastructure leads to a reduction in the cost of the firm. Hence, the MNE's profit functions from locating in country 1 and country 2 are respectively given by,

$$\Pi^1 = (P_1 - c + \lambda x)Q_1^1 + (P_2 - c + \lambda x - \tau)Q_2^1 - F \quad (3.3)$$

and

$$\Pi^2 = (P_1 - c - \tau)Q_1^2 + (P_2 - c)Q_2^2 - F \quad (3.4)$$

The subscript refers to the country of consumption and the superscript stands for the country the MNE sets up production. For instance, Q_2^1 is the output the MNE produces in country 1 and exports to country 2.

It is assumed there are domestic firms in country 1, which do not compete with the MNE, i.e., the MNE is a monopolist in both markets. For simplicity, I assume that there are n symmetric domestic monopolist firms in country 1.¹ Domestic firms also benefit from investment in public infrastructure. Again, to keep things simple, it is assumed that public infrastructure lowers the marginal cost of production for domestic firms to the same extent as the MNE's.² Domestic firms either serve the domestic market only or produce for the domestic market and export to the foreign market. We assume the location of domestic firms is fixed. We will use lower case variables to refer to a typical domestic firm. The inverse demand function for a representative domestic

¹In an extension we introduce heterogeneity among domestic firms.

²If we allow for λ to differ across firms, an investment in public infrastructure would still benefit all firms. However, some firms would benefit to a larger extent than others. Qualitatively, results do not change if λ differs across firms.

firm in country i is given by,

$$p_i = \alpha - b_i q_i \quad (i = 1, 2) \quad (3.5)$$

The profit functions of a representative domestic firm serving the domestic (π^D) and the international markets (π^E) are respectively given by:

$$\pi^D = (p_1 - c + \lambda x)q_1 \quad (3.6)$$

and

$$\pi^E = (p_1 - c + \lambda x)q_1 + (p_2 - c + \lambda x - \tau)q_2 - f \quad (3.7)$$

Again, subscripts denote the country of consumption and superscripts refer to the domestic firms market serving decision. When domestic firms export, they incur a fixed cost of exporting, denoted by f .

The government of country 1 chooses its investment in public infrastructure by maximising domestic welfare, which is given by:

$$W = \frac{b_1(Q)^2}{2} + \frac{nb_1(q_1)^2}{2} + n\pi - \delta \frac{\gamma(x)^2}{2}, \quad \delta \geq 1 \quad (3.8)$$

The first and second term in expression (3.8) represent the consumer surplus generated by consumption of the product produced by the MNE and domestic firms, respectively. The third term stands for domestic industry profits. The fourth term represents the cost of investment in public infrastructure. Parameter γ is a positive constant. The weight attached to government expenditure, δ , can be interpreted as the social cost

of public funds, reflecting the deadweight loss of raising taxes in the economy to fund public infrastructure investment.

The timing of the game is as follows. In stage 1, the government of country 1 chooses its investment level in public infrastructure. In stage 2, the MNE decides whether to establish its production facility in either country 1 or country 2 and, simultaneously to that decision, domestic firms decide to export or not. In stage 3, the MNE and domestic firms choose their levels of output for each market. The three-stage game is solved by backward induction.

3.2.1 Stage 3: Outputs

In the final stage of the game, the MNE and domestic firms choose their output levels. If the MNE locates in country 1, the MNE determines optimal outputs for each market by maximising expression (3.3), yielding:

$$Q_1^1 = S_1\left(\frac{A + \lambda x}{2}\right) \quad (3.9)$$

$$Q_2^1 = S_2\left(\frac{A + \lambda x - \tau}{2}\right) \quad (3.10)$$

where A is defined as $A \equiv a - c$. If the MNE locates in country 2, the optimal output for each market is obtained by maximising expression (3.4) and given by:

$$Q_1^2 = S_1\left(\frac{A - \tau}{2}\right) \quad (3.11)$$

$$Q_2^2 = \frac{S_2 A}{2} \quad (3.12)$$

In terms of the output decision of the domestic firms, we first look at the case in which domestic firms serve the domestic market only. Each monopolist domestic firm determines its optimal output by maximising expression (3.6), which yields:

$$q_1 = S_1 \left(\frac{H + \lambda x}{2} \right) \quad (3.13)$$

where H is defined as $H \equiv \alpha - c$. If a domestic firm serves both the domestic and the international market, the optimal export quantity for country 2 is given by:

$$q_2 = S_2 \left(\frac{H + \lambda x - \tau}{2} \right) \quad (3.14)$$

Note that, the policy tool used by the government of country 1, i.e., investment in public infrastructure, increases the output produced by all firms producing in country 1. Also, exports Q_2^1 when the MNE is located in country 1, Q_1^2 when it is located in country 2 and q_2 when the domestic firm exports, fall in the trade cost, τ .

3.2.2 Stage 2: The MNE's location and domestic firms' exporting decisions

In the second stage, the monopolist MNE selects the country in which to locate and domestic firms decide whether or not to export to country 2. It is assumed that the MNE and domestic firms operate in different industries and hence do not compete with each other.

We first turn to the location decision of the MNE. The MNE's maximised profits when it locates in country 1 and country 2 are, respectively, given by:

$$\Pi^1(x) = b_1[Q_1^1(x)]^2 + b_2[Q_2^1(x)]^2 - F \quad (3.15)$$

and

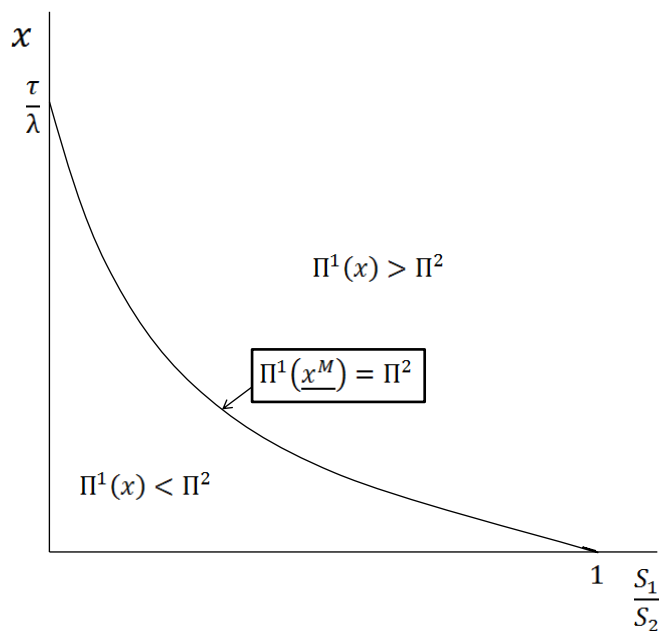
$$\Pi^2 = b_1(Q_1^2)^2 + b_2(Q_2^2)^2 - F \quad (3.16)$$

At $x = 0$, $\Pi^1(x) < \Pi^2$ since country 2 has a larger market size. In fact, there is a critical level of investment in public infrastructure at which the MNE is indifferent between locating in country 1 and country 2, denoted by \underline{x}^M , with $\Pi^1(\underline{x}^M) = \Pi^2$. Using expressions (3.15) and (3.16), the value of this critical x threshold is:

$$\underline{x}^M = \frac{\tau(S_2 - S_1)}{\lambda(S_1 + S_2)} \quad (3.17)$$

The critical level of public infrastructure investment at which the MNE is indifferent between both locations, (\underline{x}^M) , is decreasing in the effectiveness of public infrastructure (λ) and the sum of the two market sizes ($S_1 + S_2$), while \underline{x}^M is increasing in the parameters which make country 1 less attractive for the MNE, i.e., the per unit trade cost (τ) and the difference in market sizes ($S_2 - S_1$). Figure 3.1 illustrates this critical x threshold as a function of the relative market size of country 1, $(\frac{S_1}{S_2})$.

FIGURE 3.1: The MNE's location indifference locus



To the left of the MNE's location-indifference locus, the firm decides to invest in country 2, to the right of the locus the firm decides to invest in country 1.

Now we turn to the domestic firms' decision whether or not to serve the export market. A representative domestic firm's maximised profits when it serves the domestic and the international market are, respectively, given by:

$$\pi^D(x) = b_1[q_1(x)]^2 \quad (3.18)$$

and

$$\pi^E(x) = b_1[q_1(x)]^2 + b_2[q_2(x)]^2 - f \quad (3.19)$$

There is a critical level of investment in public infrastructure at which a domestic

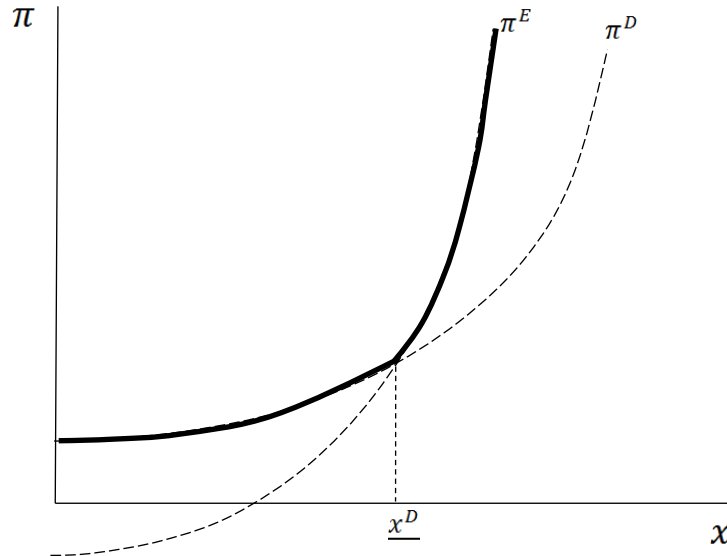
firm is indifferent between exporting or not, denoted by \underline{x}^D . In other words, we have $\pi^D(\underline{x}^D) = \pi^E(\underline{x}^D)$, with \underline{x}^D equal to:

$$\underline{x}^D = \frac{\tau - H + 2\sqrt{\frac{f}{S_2}}}{\lambda} \quad (3.20)$$

At \underline{x}^D , the operating profit from exporting equals the fixed cost of exporting, f . For values of x lower than \underline{x}^D , it is optimal for a domestic firm to serve the domestic market only. For values of x higher than \underline{x}^D , it is optimal to export. Domestic firms' operating profit from exporting increases in the size of the export market (S_2), the effectiveness of public infrastructure (λ), and in H ; it decreases in the trade cost (τ). Hence, the critical level of public infrastructure investment at which domestic firms are indifferent between exporting and not (\underline{x}^D) is decreasing in the parameters which increase the operating profit from exporting, i.e., the size of the export market (S_2), the effectiveness of public infrastructure (λ) and H . While \underline{x}^D is increasing in the costs from exporting - the trade cost (τ) and the fixed cost of exporting (f).

The bold line in figure 3.2 illustrates a representative domestic firm's profit for different values of x , taking into account its market serving decision. This figure depicts the profit functions for a value of f for which the "export-or-not" decision is not trivial.

FIGURE 3.2: A domestic firm's profit functions



When a domestic firm serves the international market it must incur an additional cost, f , hence the profit functions have different intercepts. Nevertheless, there are greater gains from public infrastructure for firms serving the international market rather than the domestic market as they produce more when they export. For this reason the profit functions have different slopes.

Firms' decisions in stage 2 lead to four possible outcome combinations: the MNE locates in country 2 and domestic firms serve the domestic market only, denoted by (2,D); the MNE locates in country 2 and the domestic firms export, denoted by (2,E); the MNE locates in country 1 and the domestic firms serve the domestic market only, (1,D) and the MNE locates in country 1 and the domestic firms export, (1,E).

3.2.3 Stage 1: Optimal investment in public infrastructure

Welfare for country 1, given in expression (3.8), can be rewritten as a function of the MNE's and domestic firms' optimal outputs:

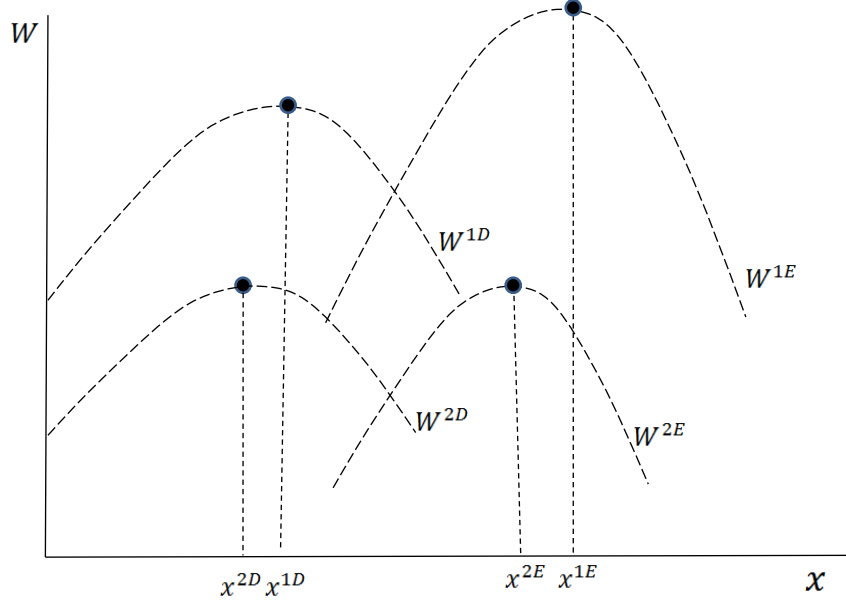
$$W = \frac{b_1(Q)^2}{2} + \frac{3nb_1(q_1)^2}{2} + nb_2(q_2)^2 - nf - \delta \frac{\gamma(x)^2}{2} \quad (3.21)$$

with $Q = Q(x)$ if the MNE locates in country 1, $q_1 = q_1(x)$ and $q_2 = q_2(x)$. It will prove useful to first examine optimal public infrastructure for each of the firms' decision combinations, (see subsection 3.2.3.1). Subsequently, we will show that the government does not have an incentive to manipulate domestic firms' exporting decision, (see subsection 3.2.3.2). However, we do show that, when the government wants to manipulate the MNE's location decision, domestic firms may become exporters, whereas they would have been active in the domestic market only if the government did not manipulate the MNE's location decision (see subsection 3.2.3.3).

3.2.3.1 Optimal public infrastructure for each of the firms' decision combinations

Naturally, *given* each of the possible second-stage outcome combinations, the optimal investment level of public infrastructure will differ. The welfare functions for each of the possible firms' decision combinations are depicted in figure 3.3 denoted by W^{2D} , W^{2E} , W^{1D} and W^{1E} . In each of these possible outcomes, (2,D),(2,E),(1,D) and (1,E), the government chooses the level of public infrastructure which maximises welfare. These optimal levels are denoted by x^{2D} , x^{2E} , x^{1D} , and x^{1E} , respectively, and we will now calculate each of these.

FIGURE 3.3: Optimal levels of public infrastructure investment *given* each of the decision combinations of the firms



In all cases, the first-order condition for optimal investment in public infrastructure is:

$$\frac{dW}{dx} = W_x + W_Q \frac{dQ}{dx} + W_{q_1} \frac{dq_1}{dx} + W_{q_2} \frac{dq_2}{dx} = 0 \quad (3.22)$$

Subscripts denote partial derivatives, where $W_x = -\delta\gamma x$, $W_Q = b_1 Q$, $\frac{dQ}{dx} = \frac{\lambda}{2b_1}$ when the MNE locates in country 1 but equals zero otherwise, $W_{q_1} = 3nb_1 q_1$, $\frac{dq_1}{dx} = \frac{\lambda}{2b_1}$, $W_{q_2} = 2nb_2 q_2$ when domestic firms export but equals zero if they do not, and $\frac{dq_2}{dx} = \frac{\lambda}{2b_2}$.

When the MNE sets up production in country 2 and domestic firms serve the domestic market, (2,D), optimal public infrastructure is given by:

$$x^{2D} = \frac{3\lambda n H}{4b_1 \gamma \delta - 3\lambda^2 n} \quad (3.23)$$

Now suppose the domestic firms export to country 2 and the MNE locates in country 2 (2,E). Then optimal public infrastructure is given by:

$$x^{2E} = \frac{n\lambda(3b_2H + 2b_1(H - \tau))}{4b_1b_2\gamma\delta - n\lambda^2(3b_2 + 2b_1)} \quad (3.24)$$

If the MNE locates in country 1 and domestic firms serve the domestic market, (1,D), optimal public infrastructure is given by:

$$x^{1D} = \frac{\lambda(A + 3nH)}{4b_1\gamma\delta - \lambda^2(1 + 3n)} \quad (3.25)$$

If domestic firms decide to serve the international market and the MNE decides to locate in country 1, (1,E), optimal public infrastructure is given by:

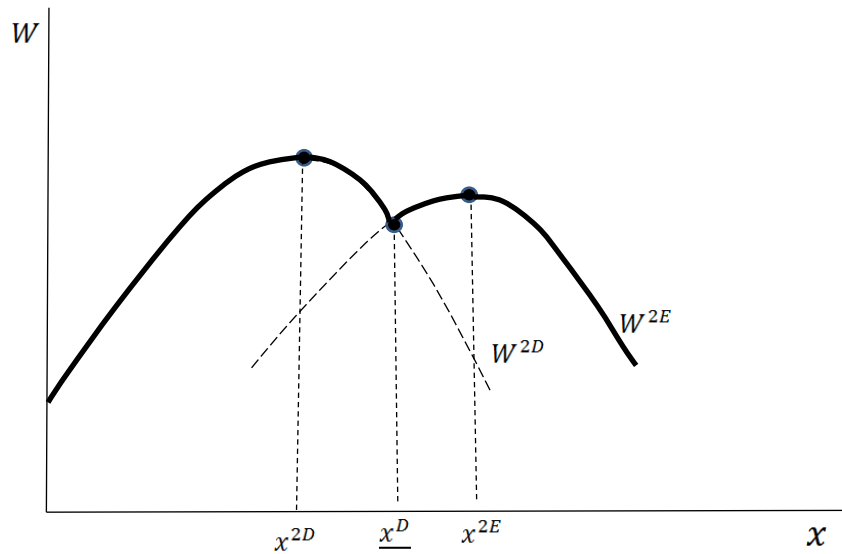
$$x^{1E} = \frac{\lambda(b_2(A + 3nH) + 2b_1n(H - \tau))}{4b_1b_2\gamma\delta - \lambda^2(b_2 + 3b_2n + 2b_1n)} \quad (3.26)$$

Let us compare the optimal public infrastructure levels in the four possible firm decision combinations. *Given* the MNE's location decision, the government invests more in public infrastructure when domestic firms export than when they are serving the domestic market only ($x^{2E} > x^{2D}$ and $x^{1E} > x^{1D}$). Since domestic firms produce more output when exporting, there are greater gains from an investment in public infrastructure when domestic firms are exporting relative to the case in which they only serve country 1. Also, *given* the domestic firms' decision, there are greater gains - in the form of consumer surplus - from an investment in public infrastructure when the MNE locates in country 1 relative to the case when the MNE locates in country 2. Hence, $x^{1D} > x^{2D}$ and $x^{1E} > x^{2E}$.

3.2.3.2 Investment in public infrastructure to manipulate domestic firms

Since the government of country 1 determines x in stage 1, that is, before firms have made their decisions, it is in a position to manipulate their decisions. In this subsection we determine whether welfare can be improved by manipulating domestic firms' decision whether or not to export. To examine this, we assume first, that the MNE locates in country 2. Figure 3.4 depicts the welfare functions W^{2D} and W^{2E} . For $x < \underline{x}^D$, domestic firms serve the domestic market only, hence welfare is given by W^{2D} . For $x > \underline{x}^D$, domestic firms export to country 2, hence welfare is given by W^{2E} .

FIGURE 3.4: The government neither induces domestic firms to nor deters them from exporting



At \underline{x}^D , the critical x level at which domestic firms are indifferent between exporting or not ($\pi^{2D}(\underline{x}^D) = \pi^{2E}(\underline{x}^D)$) is the same critical x level at which the welfare level from exporting also equals the welfare level when domestic firms do not export ($W^{2D}(\underline{x}^D) = W^{2E}(\underline{x}^D)$). The reason why this is the case lies in the fact that, at \underline{x}^D , consumer surplus

in (2,D) is equal to the consumer surplus in (2,E). The same is true for the cost of investment in public infrastructure. Hence, at \underline{x}^D , $W^{2D} = W^{2E}$ reduces to $\pi^{2D} = \pi^{2E}$, which holds by definition, at $x = \underline{x}^D$.

So, what level of public infrastructure will the government choose given that the MNE locates in country 2? When the MNE locates in country 2, the government will choose x^{2D} when $\max W^{2D} > \max W^{2E}$ and the government will choose x^{2E} when $\max W^{2D} < \max W^{2E}$.

In figure 3.4, welfare is highest if domestic firms do not export ($\max W^{2D} > \max W^{2E}$). Hence, the government will invest x^{2D} and since $x^{2D} < \underline{x}^D$, domestic firms do not export. The case in which $\max W^{2D} > \max W^{2E}$ will occur if the fixed cost of exporting (f) is above a critical level, \tilde{f} , with ($\max W^{2D}(\tilde{f}) = \max W^{2E}(\tilde{f})$). This implies that, for values of f greater than \tilde{f} ($f > \tilde{f}$), welfare is higher when domestic firms do not export ($W^{2E}(x^{2E}) < W^{2D}(x^{2D})$).

If, however $f < \tilde{f}$ welfare is higher when domestic firms export ($\max W^{2E}(x^{2E}) > \max W^{2D}(x^{2D})$). In this case, (not depicted) the government will invest x^{2E} and domestic firms will export since $x^{2E} > \underline{x}^D$. In neither case, welfare is maximised by choosing \underline{x}^D , the x level that would be chosen to manipulate domestic firms. Thus, the government will not need to manipulate domestic firms' export decision by choosing $x = \underline{x}^D$. Note that, there is a similar reasoning when the MNE locates in country 1, that is, even when the MNE locates in country 1, the government will not reach a higher welfare level by manipulating the export decision of its domestic firms. By contrast, there are cases in which the government wants to manipulate the MNE's location decision. We will turn to this in the next subsection.

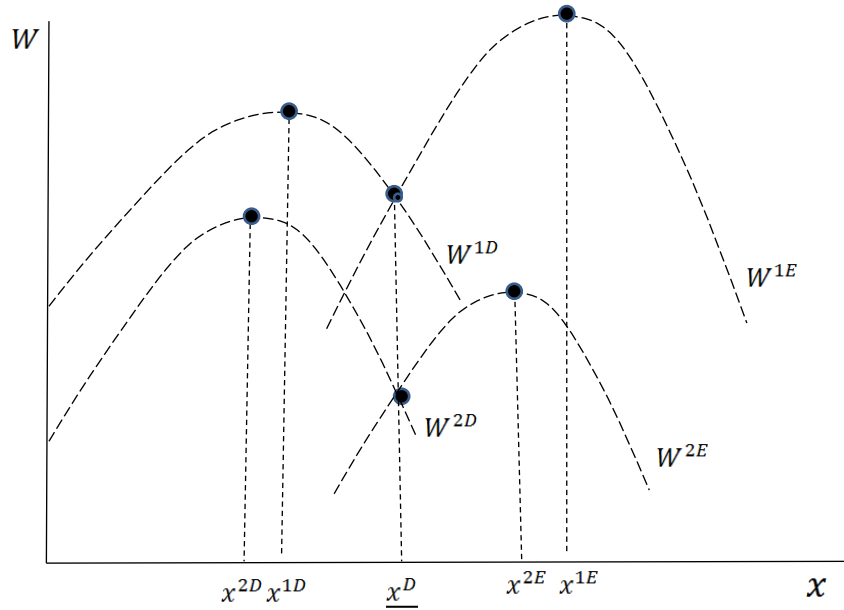
3.2.3.3 Investment in public infrastructure to attract the MNE

Having derived the optimal public infrastructure levels given firms' decisions (in subsection 3.2.3.1) and having established that the government will not manipulate the exporting decision of its domestic firm. We now show that attracting the MNE through manipulation, the government choosing the level of public infrastructure, can potentially allow domestic firms to become exporters. We first restrict the parameter space to allow for this scenario and subsequently specify when this is likely to happen.

In order to make our point, we focus on the case in which, if the MNE locates in country 2, maximum welfare, given the MNE's location, is attained by choosing x^{2D} (i.e., $W^{2D}(x^{2D}) > W^{2E}(x^{2E})$), whereas, if the MNE locates in country 1, maximum welfare, given this location decision, is achieved at x^{1E} (i.e., $W^{1E}(x^{1E}) > W^{1D}(x^{1D})$). This case will prevail when the fixed cost of exporting is intermediate. In our model, this implies $\tilde{f} < f < \hat{f}$ with $W^{2E}(x^{2E}, \tilde{f}) = W^{2D}(x^{2D})$ and $W^{1E}(x^{1E}, \hat{f}) = W^{1D}(x^{1D})$. In words, the fixed cost of exporting are high enough for the domestic firms not to export when the MNE does not produce locally in country 1 (i.e., $W^{2D}(x^{2D}) > W^{2E}(x^{2E}, f)$), but low enough for the domestic firms to export when the MNE does produce in country 1 (i.e., $W^{1D}(x^{1D}) < W^{1E}(x^{1E}, f)$).³ Figure 3.5 depicts this situation.

³There exists such a range of f since the welfare difference between domestic firms exporting and serving the domestic market only, increases in the local presence of the MNE.

FIGURE 3.5: Welfare for all possible firm decision combinations ($\tilde{f} < f < \hat{f}$)

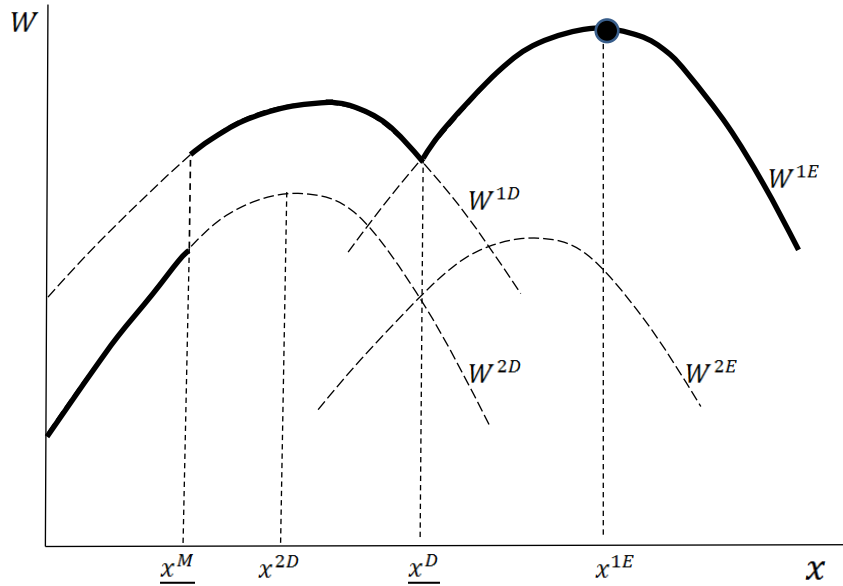


We now determine - when in this range of intermediate fixed cost of exporting - the government manipulating the MNE into producing in its territory, and when it takes the MNE's decision as given. Depending on the critical level of investment the MNE requires to produce in country 1, (\underline{x}^M) - there are three possible qualitatively different outcomes. We discuss each of these outcomes consecutively. Figures 3.6, 3.7 and 3.8 illustrate each of these cases. The bold curves trace out welfare levels for different values of x .

The first case is illustrated in figure 3.6, and arises when the the level of investment required by the MNE to produce in country 1 (\underline{x}^M) is relatively low. For $x < \underline{x}^M$, the MNE produces in country 2 and, since $\underline{x}^M < \underline{x}^D$, domestic firms do not export. The relevant welfare curve in this x range is thus W^{2D} . For $x > \underline{x}^M$ but $x < \underline{x}^D$, the MNE produces in country 1, and domestic firms remain active in the domestic market only.

Hence, the relevant welfare function in this range is W^{1D} . For $x > \underline{x}^D$, domestic firms export, implying that for this range of x values, the relevant welfare function is W^{1E} . Having traced out relevant welfare levels for each x level, it is clear from the graph that in this case the government chooses its unconstrained level of public infrastructure investment (x^{1E}). Hence, the government invests $x = x^{1E}$, the MNE locates in country 1 and domestic firms export.

FIGURE 3.6: Optimal investment in public infrastructure when $\underline{x}^M < x^{1E}$ ($\tilde{f} < f < \hat{f}$)



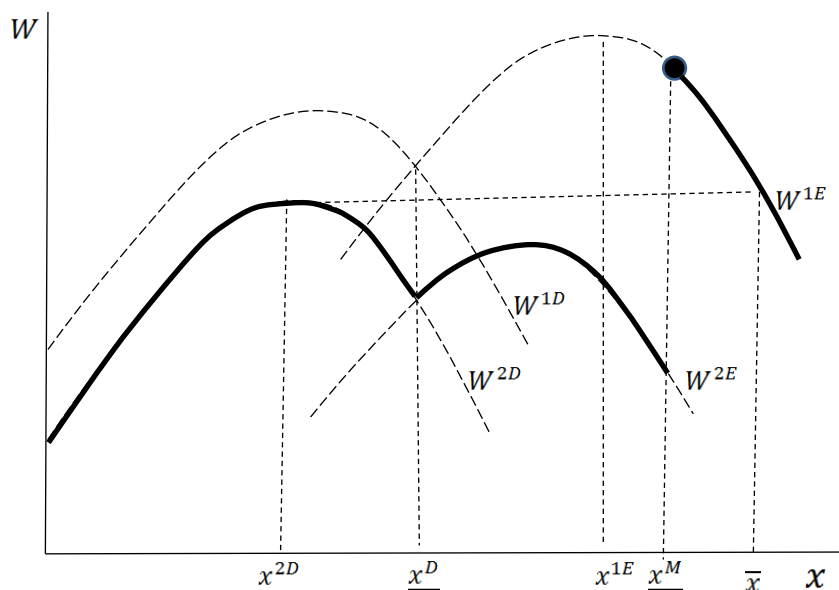
This case will prevail when the trade cost (τ) is relatively low, the effectiveness of public infrastructure (λ) is relatively high, the sum of the two market sizes ($S_1 + S_2$) is relatively large and the difference in market sizes ($S_2 - S_1$) is relatively small.

Two other possible outcomes arise if the investment level x^{1E} is lower than the MNE's location-indifference level of investment, i.e., $x^{1E} < \underline{x}^M$. The first one is illustrated in figure 3.7. For $x < \underline{x}^D$, domestic firms do not export and since $\underline{x}^D < \underline{x}^M$ the MNE

produces in country 2. Hence, W^{2D} is the relevant welfare level. For $x > \underline{x}^D$ but $x < \underline{x}^M$, domestic firms export, while the MNE locates in country 2; welfare is given by W^{2E} . When $x > \underline{x}^M$, the MNE locates in country 1 and welfare is given by W^{1E} . So, now the MNE will not locate in country 1 unless the policy active government manipulates the MNE, which it can do by investing slightly above \underline{x}^M .

In fact, since welfare is clearly highest at \underline{x}^M in figure 3.7, the government will attract the MNE, manipulating its location decision by picking a level of public infrastructure slightly higher than \underline{x}^M and hence attracting the MNE.

FIGURE 3.7: Optimal investment in public infrastructure when $\underline{x}^M > x^{1E}$ and $W^{1E}(\underline{x}^M) \geq \max W^{2D}$ ($\tilde{f} < f < \hat{f}$)



Importantly, by manipulating the MNE's location decision through investment in public infrastructure, the government has also transformed domestic firms into international players: since $\underline{x}^M > \underline{x}^D$, domestic firms are now exporters. Hence, investment

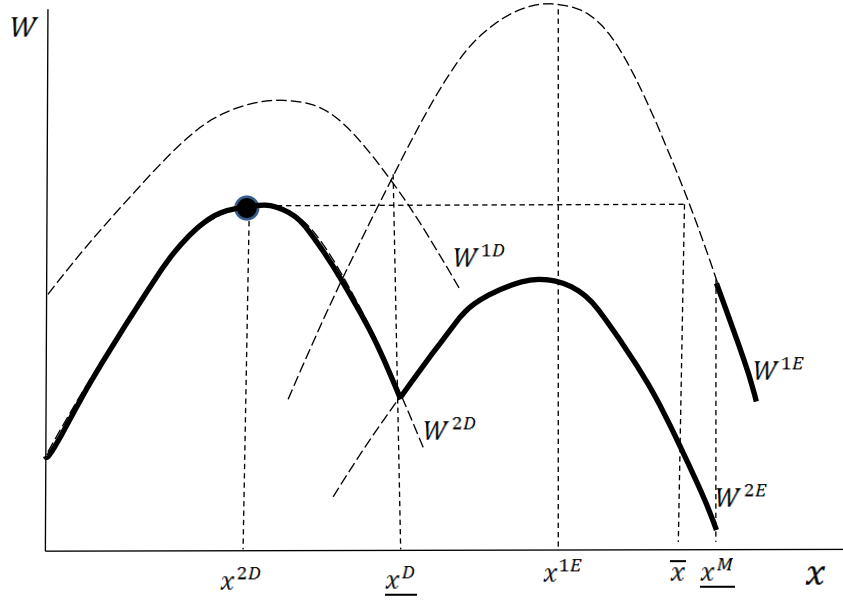
in public infrastructure that manipulates MNEs location decisions will not only capture FDI but also catapults domestic firms into international markets. This scenario is likely to occur for intermediate values of trade cost (τ) and effectiveness of public infrastructure (λ).

However, since it is costly for the government to invest \underline{x}^M , to the extent that it involves deviating away from the unconstrained optimal level of public infrastructure x^{1E} , it is not always willing to do this. In fact, the government has a threshold of investment in public infrastructure (\bar{x}) above which, it is no longer worthwhile trying to attract FDI. This threshold is determined by considering the welfare level that can be attained without attracting the MNE, i.e., $W^{2D}(x^{2D})$. Hence, we have $W^{1E}(\bar{x}) = W^{2D}(x^{2D})$.⁴

When the maximum level the government is willing to invest to attract the MNE is lower than what the MNE requires to produce in country 1 ($\bar{x} < \underline{x}^M$), the government maximises welfare by investing x^{2D} , the MNE produces in country 2 and domestic firms of country 1 do not export. This case is illustrated in figure 3.8.

⁴The expression for \bar{x} is in the appendix

FIGURE 3.8: Optimal investment in public infrastructure when $\underline{x}^M > x^{1E}$ and $W^{1E}(\underline{x}^M) < \max W^{2D}$



This last case will prevail when the trade cost (τ) is relatively high, the effectiveness of public infrastructure (λ) is relatively low, the sum of the two market sizes ($S_1 + S_2$) is relatively small and the difference in market sizes ($S_2 - S_1$) is relatively large.

Note that, when the fixed costs of exporting are very high ($f > \hat{f}$), domestic firms will never export, even if the government manipulates the MNE's location decision. Also, if fixed costs of exporting are very low ($f < \tilde{f}$), domestic firms will always export, regardless of whether the government manipulates the MNE's location decision or not.

What we showed is that there is an intermediate range of fixed exporting costs, where investment in public infrastructure which manipulates the MNE's location decision has the potential to internationalise domestic firms.

3.3. Extensions

In the following two sections we discuss two extensions of the basic model. First, we will briefly discuss how an investment in public infrastructure can affect domestic firms' exporting choices differently when we allow for firm heterogeneity. Secondly, we sketch to what extent the results of the model qualitatively change when we introduce competition between the MNE and a local firm.

3.3.1 Heterogeneous Domestic Firms

In our model, we assume for simplicity that domestic firms are identical. Due to increased availability of micro-level data on trade, we know, however, that real-world firms are far from symmetric. In fact, firms are typically heterogeneous in nature. In this section, we sketch how our results need to be qualified when one takes firm heterogeneity into account. We consider firms with different productivity levels. We will give a stylised sketch of what type of firms are most likely to benefit from public infrastructure investment.

To keep things simple, suppose three types of domestic firms exist. Type 1 firms are very productive. Type 2 firms are less efficient and have average productivity and the least productive firms will be labelled as type 3. When the government invests in public infrastructure, all firms will benefit but only one group is likely to change its export status.

Since type 1 firms are highly efficient, the governments increased investment in public infrastructure is unlikely to affect its exporting decision as these firms are likely to be

able to cover the fixed cost of exporting regardless of the governments increased investment in public infrastructure. Naturally, investment in public infrastructure lowers their cost of production further, making them even more productive than before and allowing them to supply more of their product to both the domestic and international markets.

Type 3 firms are the least efficient firms. When the government invests more in public infrastructure to attract FDI, these firms become more efficient but they remain unlikely to be able to cover the fixed costs of exporting. They simply continue to only serve the domestic market, albeit at a lower marginal cost of production.

Now we consider the effect of investment in public infrastructure on type 2 firms, those with average productivity. These firms are on the cusp of becoming exporters. It is precisely these firms that are likely to overcome impediments to export from increased investment in public infrastructure. Type 2 firms most probably benefit the most from increased investment in public infrastructure. They will become more productive than before, enabling them to overcome the fixed cost of exporting and allowing them to supply more of their product to the domestic market and also serve the international markets at a lower cost.⁵

3.3.2 Competition between the MNE and the domestic sector

In our model, we assume the MNE and domestic firms all operate in different sectors.

In this section, we sketch how our results may change if we allow the MNE to compete

à la Cournot with one or more of the domestic firms.

⁵Another way firms can differ is in the extent to which they benefit from increased investment in public infrastructure. Firms that gain most from the policy will be incited into exporting sooner than another firm which benefits less from the governments increased investment.

In the main model, the government may manipulate the MNE's location decision by investing more in public infrastructure. High degrees of competition can alter this result. When competition between the MNE and the domestic sector is fierce, welfare received from attracting the MNE may be lower than the welfare that would be received from importing its product. This is due to the fact that attracting the MNE would harm the domestic sector. Hence, if this case arises the government may want to import the MNE's product from country 2 instead of attracting it. Since the government moves prior to the MNE, the government may want to invest less in public infrastructure to deter the MNE from locating in its country.

In the main model, the government does not need to influence the domestic firms exporting decisions since the domestic firms export exactly when the government wants them to. However, if the MNE locates in country 2 and the MNE and the domestic sector compete, the government of country 1 can give the domestic firms a strategic advantage by investing in public infrastructure. By lowering the domestic firms' cost through increased investment in public infrastructure, profits in the export market will shift towards the domestic firms, hence raising welfare. In that case, the government induces domestic firms to export. However, as the number of domestic firms in the same sector increase, there will be a negative terms of trade effect, which will dominate the positive profit shifting effect if, the number of domestic firms is relatively high. In that case, welfare may be higher if the government deters domestic firms from exporting by keeping its level of public infrastructure investment low.⁶

⁶Of course, allowing for competition between the MNE and domestic firms within the framework of this paper would lead to added complexity. It is possible there would be cases in which there exists multiple equilibria.

3.4. Conclusion

In policy debates, governments are often criticised for implementing policies aimed towards attracting FDI and not towards developing local firms. The aim of this paper is to show that policies geared to attract MNEs can in certain conditions change the character of domestic firms. In particular, we show that governments, investing in public infrastructure to attract FDI through manipulation, may, due to the public good nature of this policy, not only capture FDI but also enable domestic firms to break through on international markets. This is likely to happen for intermediate values of the fixed cost of exporting, the trade cost and effectiveness of public infrastructure investment.

We introduced heterogeneity among domestic firms, which allowed us to examine what type of domestic firms are most likely to become exporters. We found that, the degree to which firms benefit from investment in infrastructure varies. Firms with average productivity are mostly likely to benefit the most from increased investment in public infrastructure. These firms are on the cusp of becoming exporters. When governments increase investment in public infrastructure, domestic firms that are close to becoming exporters, are likely to be able to lower their variable cost by enough to actually overcome fixed costs of exporting and hence become active in international markets.

As we introduced competition among the firms, other scenarios may appear. When domestic firms and the MNE operate in similar industries, hence, compete with each other for market shares, the government may try to manipulate the domestic firms' decisions and also invest in public infrastructure to deter the MNE.

3.5. Appendix

The maximum level of public infrastructure the government is willing to invest (\bar{x}) to try attract the MNE ($W^{1E}(\bar{x}) = W^{2D}(x^{2D})$) is given by:

$$\bar{x} = \frac{-\hat{b} - \sqrt{\hat{b}^2 - 4\hat{a}\hat{c}}}{2\hat{a}} \quad (3.27)$$

where $\hat{b} = 2\lambda[b_2(A + 3nH) + 2b_1n(H - \tau)]$, $\hat{a} = \lambda^2[b_2(1 + 3n) + 2b_1n] - 4b_1b_2\delta\gamma$, and $\hat{c} = b_2(A^2 + 3nH^2 + 2b_1n(H^2 - 2H\tau + \tau^2) - 8b_1b_2(nf + W^{2D}(x^{2D}))$

4. Competing for Foreign Direct Investment: Taxes versus Infrastructure

4.1. Introduction

It is a well known fact that countries commonly use low tax rates to attract FDI. Several papers in the literature on tax competition maintain that such tax competition games typically lead to a “race to the bottom”. Seminal papers in the tax competition literature are Wilson (1986) and Zodrow and Mieszkowski (1986), where the local governments finance their expenditures using a capital tax, and the result is a reduction of tax rates that lead to the underprovision of public goods. The baseline model has been extended in a number of ways. Differences in country size significantly change the predictions of the baseline model. See for instance Bucovetsky (1991), Wilson (1991), Kanburi and Keen (1993), Haufler and Wooton (1999). See also Wilson and Wildasin (2004) and Dembour (2008) for literature surveys on tax competition. Other studies focusing on international competition for FDI include Haaland and Wooton (1999), Fumagalli (2003), Olsen and Osmundsen (2003) and Ferrett and Wooton (2010). Overesch and Rincke (2011) argue that the recent decline in corporate taxes is a result of tax competition. Fearing this outcome, policy makers are concerned that tax rates will lose their potential to extract rent from MNEs. In addition, there is, particularly in Europe, a concern that intense tax competition will ultimately lead to the erosion of

the welfare state. As a result, proposals for tax harmonisation, especially within the European Union (EU), never seem to disappear from the EU's political agenda.¹

However, there is other work that argues that competition for FDI does not need to imply a “race to the bottom”. For instance, Baldwin and Krugman (2004) suggest that, while a race to the bottom is likely to prevail between the peripheral member states of the EU, the EU's core countries seem to be able to charge significantly higher tax rates without losing their attractiveness as host locations for MNEs. This paper shows that while European integration deepened, taxes in the core countries – Benelux, France and Germany - rose. There has been no race to the bottom. Our paper differs from Baldwin and Krugman (2004), our paper suggests that one of the reasons why taxes in the core countries rose, may lie in the fact that investment in public infrastructure in the core economies has been and continues to be much higher than in the EU periphery. Other studies in the economic geography literature suggesting that tax competition may even trigger ‘a race to the top’ in the core countries, include, Ludema and Wooton (2000), Anderson and Forslid (2003), Kind *et al.* (2000), and Forslid (2005). These papers find that regions with agglomeration rents are able to set higher taxes and still be successful in attracting foreign capital. Another distinction of our paper is that we examine governments using different policy tools to attract FDI, resulting in policies being strategic substitutes instead of strategic complements as modelled in the vast tax competition literature.

In this paper, we construct a theoretical model in which the government of two prospective host countries compete for FDI, using different policy instruments: one government uses its corporate tax rate, whereas the other invests in public infrastructure. Public

¹See, for instance “Tax torment”, *The Economist*, 17 March 2011. “EU tax harmonisation back on agenda”, *The Irish Examiner*, 30 November 2011.

infrastructure is typically a medium or long term instrument that is - to a large extent - irreversible. We capture this feature by assuming the government investing in public infrastructure moves first, after which the other government sets its corporate tax rate, taking the level of public infrastructure in the rival host country as given. Subsequently, a monopolist MNE chooses in which of the two prospective host countries to set up a plant. We also examine how optimal investment in public infrastructure is affected when the country setting the corporate tax rate is restricted by a minimum tax.

4.2. The Model

A MNE decides to locate in one of two potential host countries, country 1 or country 2. The fixed cost of setting up a plant abroad, F , is assumed to be identical in both locations and sufficiently large for the MNE only to locate in one country. The MNE intends to serve consumers in country 1 and country 2. We assume these two markets are segmented. When exporting from its chosen production location to the other country, the firm incurs a trade cost, τ .

The inverse demand function for the MNE's good in country i is given by,

$$P_i = a - b_i Q_i \quad i = 1, 2 \quad (4.1)$$

where P_i denotes the price of the MNE's good in country i , Q_i is the quantity of the MNE's good in country i and $b_i = \frac{1}{S_i}$, S_i denoting country i 's market size. The marginal cost of production without government intervention, c , is constant and the same in both countries. However, the governments of both countries are policy active,

and are concerned with attracting the MNE. Both countries benefit from increased consumer surplus if they attract the MNE.

The governments of countries 1 and 2 use different policy instruments to attract the MNE. The government in country 2 sets its corporate tax rate, denoted by t , to try attract the MNE. The government in country 1 uses an alternative policy to try attract the MNE; it invests in public infrastructure, denoted by x . With public infrastructure in country 1, the marginal cost of production in country 1 is equal to:

$$c_1 = c - \lambda x \tag{4.2}$$

where λ represents the effectiveness of public infrastructure in lowering locally producing firms' marginal cost.

Optimal government variables are determined by maximising welfare. Welfare in country 1, is given by:

$$W_1(x) = \frac{b_1(Q)^2}{2} + \sigma x - \delta \frac{\gamma(x)^2}{2} \tag{4.3}$$

The first term in expression (4.3) denotes the consumer surplus generated by consumption of the good produced by the MNE. The second term represents the direct social benefit associated with investments in public infrastructure. Such benefits can include an increase in the productivity of the nation through higher levels of education or through improvements in transport infrastructure. We assume these benefits do not depend on the presence of the MNE. The last term refers to the cost of investment in public infrastructure. Parameter γ is a positive constant. The weight attached to government expenditure, $\delta > 1$, can be interpreted as the social cost of public funds

and can be thought of as reflecting the deadweight loss of raising taxes in the economy to fund public infrastructure investment.

Welfare in country 2 is given by:

$$W_2(t) = \frac{b_2(Q)^2}{2} + t\Pi \quad (4.4)$$

The first term in expression (4.4) is the consumer surplus generated by consumption of the product produced by the MNE. The second term represents the tax revenues. If the MNE locates in country 1, welfare in country 2 is simply equal to consumer surplus.

The MNE's profit function depends on where it chooses to locate. If the MNE locates in country 1 its profit function is given by:

$$\Pi^1 = (P_1 - c + \lambda x)Q_1^1 + (P_2 - c + \lambda x - \tau)Q_2^1 - F \quad (4.5)$$

The subscript denotes the country of consumption and the superscript refers to the country of production. For instance, Q_2^1 is the MNE's output exported to country 2 when located in country 1.

The MNE's net profit function from locating in country 2 is given by:

$$\Pi^2 = (1 - t)[(P_2 - c)Q_2^2 + (P_1 - c - \tau)Q_1^2 - F] \quad (4.6)$$

The timing of the game is as follows. The sequence of moves is determined by the relative commitment power of the variables. In stage 1, the government of country 1 invests in public infrastructure. As public infrastructure investment typically is

a relatively long-run decision and is to a large extent irreversible, and therefore it entails a stronger commitment than a tax rate. Hence, the government of country 1 determines its investment in public infrastructure first and subsequently in stage 2 the government of country 2 sets its corporate tax rate. In stage 3, the MNE decides whether to establish its production facility in either country 1 or country 2. In stage 4, the MNE chooses output levels. The four-stage game is solved by backward induction.

4.3. Taxes versus Investments in Public Infrastructure: Outcomes of the game

In this section we solve the model by backward induction. We firstly solve for the MNE's optimal output levels. Subsequently, we determine the MNE's location decision. Then, we derive the government of country 2's optimal tax policy. Lastly we derive the government of country 1's optimal investment in public infrastructure.

4.3.1 Stage 4: Outputs

In the final stage of the game, firms choose their output levels. Since the marginal cost of production depends on government policy - more specifically the investment in public infrastructure in country 1 - outputs will depend on the MNE's production location.

If the MNE locates in country 1, it determines optimal outputs for each market by maximising expression (4.5), yielding:

$$Q_1^1 = \frac{S_1(A + \lambda x)}{2} \quad (4.7)$$

$$Q_2^1 = \frac{S_2(A + \lambda x - \tau)}{2} \quad (4.8)$$

with $A \equiv a - c$. The subscript denotes the country of consumption and the superscript refers to the country of production. Note that the policy instrument used by the government of country 1, i.e., investment in public infrastructure, raises the output produced by firms in country 1.

If the MNE locates in country 2, the optimal output for each market is obtained by maximising expression (4.6) and given by:

$$Q_1^2 = \frac{S_1(A - \tau)}{2} \quad (4.9)$$

$$Q_2^2 = \frac{S_2 A}{2} \quad (4.10)$$

The government policy of country 2, the corporate tax rate, does not affect the output produced by firms in country 2.

4.3.2 Stage 3: The MNE's location decision

After having derived firms' outputs, we now turn to the MNE's location decision in stage 3. At this stage, government policies are *given*. The MNE is indifferent between locations when $\Pi^1(x) = \Pi^2(t)$. *Given* the level of x in country 1, the locus determines the corporate tax rate in country 2 at which the MNE is indifferent between the two locations.

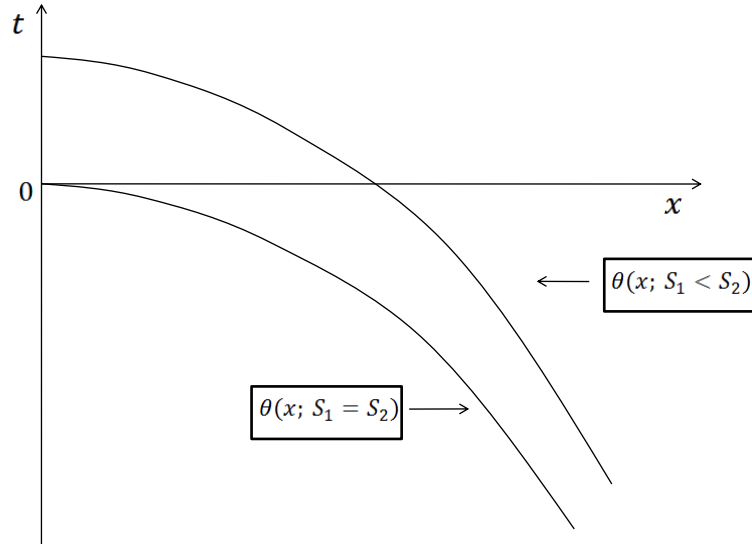
In fact, it will prove useful to define this particular tax level as the maximum tax rate the government of country 2 can set, *given* the level of x in country 1, in order to make the MNE indifferent between locating in either country. We will refer to this tax level as $\theta(x)$. It is given by:

$$\theta(x) = 1 - \frac{S_1(A + \lambda x)^2 + S_2(A + \lambda x - \tau)^2 - 4F}{S_1(A - \tau)^2 + S_2A^2 - 4F} \quad (4.11)$$

This critical threshold level is depicted in figure 4.1. The higher the level of public infrastructure in country 1, the lower is this maximum tax rate the government of country 2 can set to keep the MNE indifferent between locations ($\theta(x)$). If the government of country 2 sets a tax rate higher than $\theta(x)$ ($t > \theta(x)$), the MNE locates in country 1. If, by contrast it sets its tax rate below $\theta(x)$ ($t < \theta(x)$), the MNE locates in country 2.

The locus shifts when there is a change in relative market sizes. If $S_2 > S_1$, the locus will shift up, as illustrated by figure 4.1.

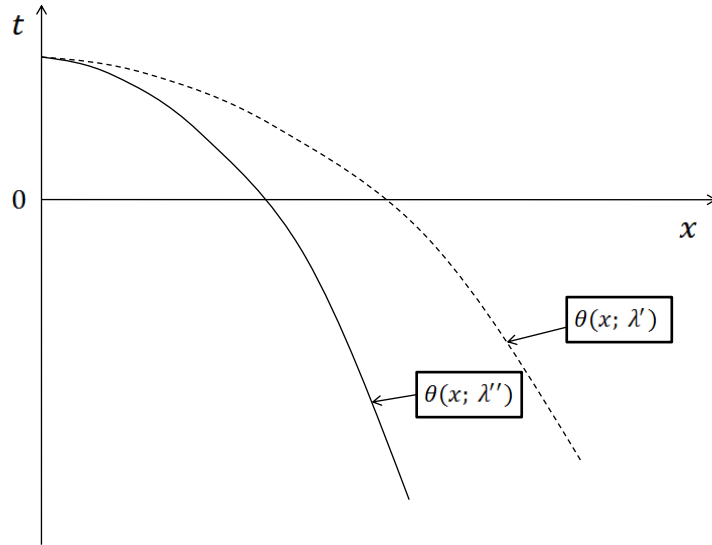
FIGURE 4.1: The MNE's location choice



The MNE finds the country with a larger market size naturally more attractive to locate in. Hence, even if the government of country 1 does not invest in any public infrastructure ($x = 0$), the government of country 2 can set a positive tax and keep the MNE indifferent between either location. The slope of the locus is also affected by changes in relative market sizes. As illustrated in figure 4.1, the gains from locating in the larger country are significantly higher for lower levels of public infrastructure.

The slope of the locus is also affected as λ changes. Figure 4.2 illustrates what happens to the $\theta(x)$ locus when public infrastructure becomes more effective (i.e., when λ increases from λ' to λ'').

FIGURE 4.2: The MNE's indifference locus when λ increases ($\lambda' < \lambda''$)



For a *given* tax rate, the MNE now needs to be compensated with less public infrastructure to locate in country 1. Hence, the locus becomes steeper.

4.3.3 Stage 2: Country 2's optimal tax rate

Suppose the MNE decides to locate in country 2. *Given* that decision of the MNE, the optimal corporate tax rate set by the government of country 2 will be denoted by t^* , where $t^* = 1$. This would imply that $\Pi^2 = 0$. We assume for simplicity that the only other option for the MNE is to produce in country 1. So if the MNE chooses to locate in country 2 in spite of the 100% tax rate, it implies $\Pi^1 < 0$. Note that we implicitly assume here that exporting from the MNE's home location to country 2 is not profitable. If it was, t^* would be set in such a way that $\Pi^2(t^*)$ would be equal to the

profit from exporting from the MNE's home location, implying $t^* < 1$. Qualitatively, our results would, however, not be affected by this.

Of course, the government of country 2 does not need to take the location of the MNE as given since it is in a position to strategically manipulate it. If t^* is higher than the corporate tax rate that leaves the MNE indifferent between the two locations, ($t^* > \theta(x)$), the government of country 2 can still attract the MNE by setting the tax rate slightly lower than $\theta(x)$ and attain a welfare level of W_2^2 where the subscript refers to the country and the superscript stands for the country where the MNE resides. However, since the MNE requires a lower tax rate than t^* to be indifferent between the two locations ($\theta(x) < t^*$), this policy is costly in terms of welfare and will only be chosen if it yields a welfare level that is at least as high as the welfare attained when country 2 imports the good from the MNE, located in country 1. When importing the good, country 2 receives a welfare level W_2^1 .

For the government in country 2, there is a minimum tax level, \underline{t} , below which the government of country 2 is not willing to lower its tax to attract the MNE, with $W_2^2(\underline{t}) = W_2^1$; this critical t level is equal to:

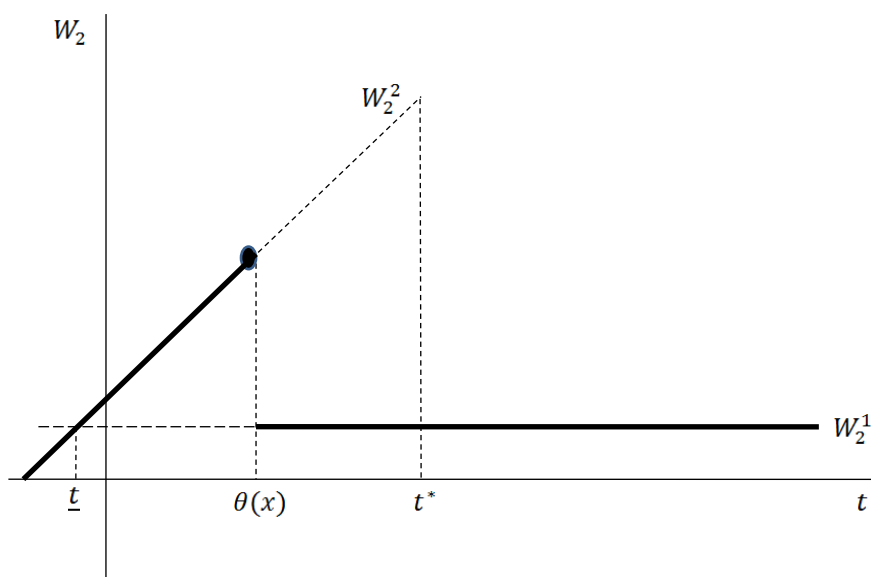
$$\underline{t} = \frac{S_2(A + \lambda x - \tau)^2 - 8S_2A^2}{16S_2A^2 + 16S_1(A - \tau)^2 - 64F} \quad (4.12)$$

For values of the tax rate less than \underline{t} , welfare for country 2 is higher if it imports the MNE's good from country 1 instead of attracting the MNE ($W_2^1 > W_2^2$) and hence, the government of country 2 will not compete for the MNE. Note that $W_2^1 = W_2^1(x)$ and the higher the level of public infrastructure within country 1, the higher the welfare for country 2 if it imports the MNE's good from country 1. Also, $W_2^2 = W_2^2(\theta(x))$ when country 2 competes for the MNE. Since $\theta(x)$ falls in x and hence W_2^2 falls in x , higher

levels of public infrastructure investment in country 1 reduces country 2's willingness to compete for the MNE, implying that \underline{t} increases in x .

So, what tax rate will the government of country 2 set, given the level of public infrastructure investment that the government of country 1 has to set in stage 1? We assume $t^* > \theta(x)$, to avoid the case in which country 2 does not have to compete for the MNE. Figures 4.3 and 4.4 depict W_2 for different values of t . There are two qualitatively different outcomes. The first case prevails, when the government of country 2 is willing to set a lower tax rate than the MNE requires to be indifferent between both locations ($\underline{t} < \theta(x)$) and is depicted in figure 4.3. For tax rates less than the critical tax rate that leaves the MNE indifferent between both locations ($t < \theta(x)$), the MNE locates in country 2 and hence $W_2 = W_2^2$; for tax rates greater than $\theta(x)$ ($t > \theta(x)$), the MNE locates in country 1 and hence $W_2 = W_2^1$

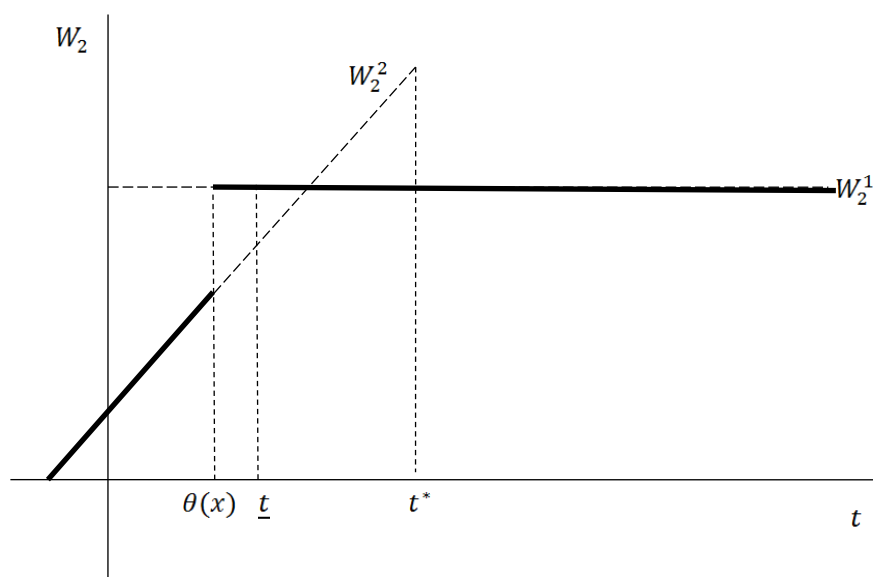
FIGURE 4.3: Welfare of country 2 when $\theta(x) > \underline{t}$



Clearly in figure 4.3, the government will set the tax rate slightly lower than $\theta(x)$ and the MNE locates in country 2. This case will occur when \underline{t} is relatively low and $\theta(x)$ is relatively high ($\underline{t} < \theta(x)$). Since \underline{t} increases in x and $\theta(x)$ falls in x , this outcome will prevail for relatively low levels of public infrastructure investment.

The second case prevails when the MNE requires a lower tax rate than the government of country 2 is willing to set ($\underline{t} > \theta(x)$) and is depicted in figure 4.4. In this case, the government will choose not to attract the MNE.

FIGURE 4.4: Welfare of country 2 when $\theta(x) < \underline{t}$

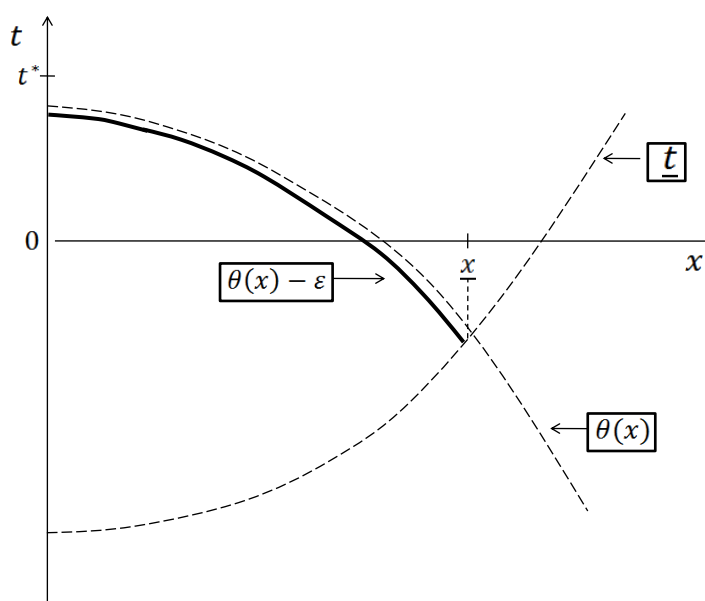


This case will occur when the level of public infrastructure investment in country 1 is relatively high.

We will now trace out the tax best response function of the government of country 2 in figure 4.5 (using figures 4.3 and 4.4). First define \underline{x} as the x level at which the government of country 2's best response, $\theta(x)$, is equal to the minimum tax rate

the government of country 2 is willing to set, or $\theta(x) = \underline{t}$. Alternatively, at \underline{x} , the government of country 2 is indifferent between attracting the MNE and importing the MNE's good from country 1 ($W_2^1 = W_2^2$). Hence, \underline{x} is the minimum level of public infrastructure investment the government of country 1 should invest, *given* the tax rate in country 2, in order to make the MNE indifferent between either location.

FIGURE 4.5: Country 2's tax reaction function



For values of x less than \underline{x} , the government of country 2 receives a higher welfare level if it attracts the MNE than when it does not ($W_2^2 > W_2^1$), since the government of country 2 is willing to set a tax rate lower than what the MNE requires ($\underline{t} < \theta(x)$) (this was the case in figure 4.3). So, for $x \leq \underline{x}$, the government will set the tax rate slightly less than $\theta(x)$ to attract the MNE. For levels of x greater than \underline{x} , the MNE requires a lower tax rate than the government of country 2 is willing to set, $\theta(x) < \underline{t}$. Hence, the government of country 2 achieves a higher welfare level if it does not attract the MNE ($W_2^2 < W_2^1$) (this was the case in figure 4.4). For $x > \underline{x}$, it is too costly for the

government of country 2 to attract FDI and its reaction function is truncated at this point.

4.3.4 Stage 1: The government of country 1 chooses public infrastructure investment

The government of country 1 can choose its investment level in public infrastructure prior to the government of country 2 setting its tax rate. Since the government of country 1 moves first, it will pick the point on country 2's tax reaction function that yields the highest welfare. Let us first briefly discuss the case in which the government of country 1 attracts the MNE without manipulating the latter's location decision. In that case, the government of country 1 is not constrained in the level of public infrastructure it sets, hence, sets its investment level by maximising $W_1^1(x, Q_1^1(x))$ with respect to public infrastructure. The first order condition is given by:

$$\frac{dW_1^1}{dx} = \frac{\partial W_1^1}{\partial x} + \frac{\partial W_1^1}{\partial Q_1^1} \frac{dQ_1^1}{dx} = 0 \quad (4.13)$$

Subscripts denote partial derivatives, where $\frac{\partial W_1^1}{\partial x} = \sigma - \delta\gamma x$, $\frac{\partial W_1^1}{\partial Q_1^1} = b_1 Q_1^1$ and $\frac{dQ_1^1}{dx} = \frac{\lambda}{2b_1}$. Hence, the optimal infrastructure is given by:

$$x^* = \frac{A\lambda + 4b_1\sigma}{4b_1\delta\gamma - \lambda^2} \quad (4.14)$$

If this level of public infrastructure investment is higher than what is required to make the MNE indifferent between the two locations ($x^* > \underline{x}$) then the government of country 1 will choose x^* .

There is effective competition between the two countries when x^* is lower than the level of public infrastructure investment required to keep the MNE indifferent between country 1 and country 2 ($x^* < \underline{x}$). We then distinguish between two cases. The first case will be presented in figures 4.6 and 4.7. For values of x less than the level that makes the MNE indifferent between locations ($x < \underline{x}$), the MNE locates in country 2, hence welfare in country 1 is given given by W_1^2 . For values of x higher than \underline{x} ($x > \underline{x}$), country 1's welfare is given by W_1^1 , as for those levels of public infrastructure investment, the MNE locates in country 1. In this case, the government of country 1 chooses an investment level in public infrastructure that is slightly higher than \underline{x} , thus guaranteeing that the MNE locates in country 1. This subgame perfect Nash equilibrium is at point E in figure 4.7. The larger the direct marginal social benefit of public infrastructure investment (σ) and the higher the relative effectiveness of public infrastructure investment, the more likely country 1 will become host to the MNE. An increase in the relative effectiveness of public infrastructure investment can occur due to an increase in λ or a decrease in γ .

FIGURE 4.6: Welfare of country 1 with $\underline{x} < \bar{x}$

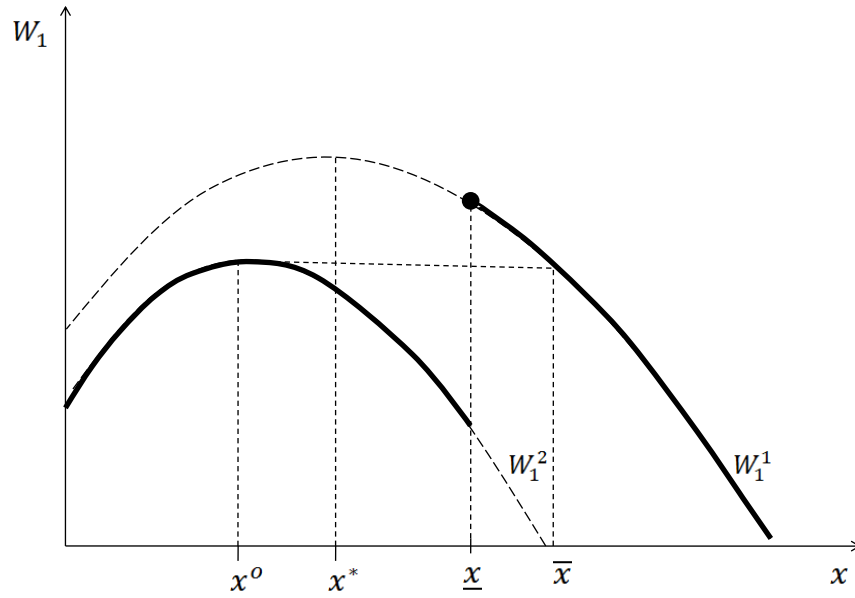
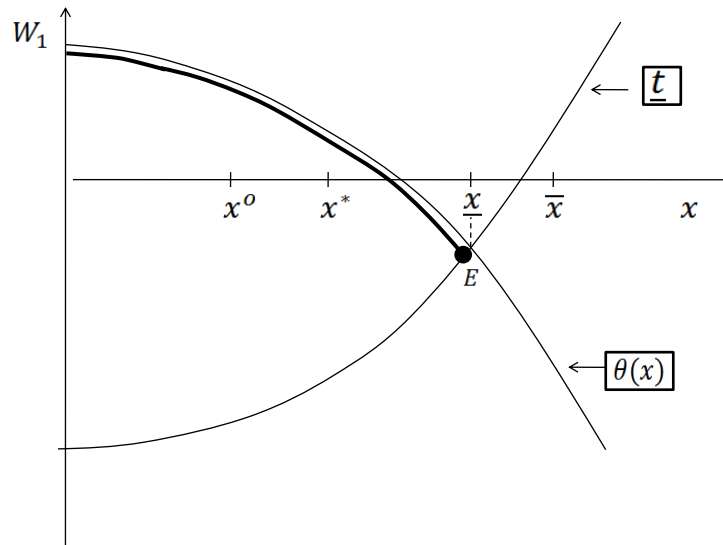


FIGURE 4.7: Subgame perfect Nash equilibrium when the government of country 1 attracts the MNE



The government will choose this policy provided that \underline{x} is smaller than the maximum

level of public infrastructure investment the government of country 1 is willing to set to attract the MNE, denoted by \bar{x} .² At \bar{x} , welfare when attracting the MNE is equal to the welfare level that is attained by importing the MNE's good from country 2. Or, $W_1^1(\bar{x}) = W_1^2(x^o)$, where x^o is the level of public infrastructure that maximises welfare of country 1 when the MNE produces in country 2 and is given by:

$$x^o = \frac{\sigma}{\delta\gamma} \quad (4.15)$$

Note that $x^o < x^*$.³ When the MNE requires more public infrastructure investment than the government of country 1 is willing to invest ($x > \bar{x}$) another outcome prevails, depicted in figures 4.8 and 4.9. Now, attracting the MNE yields a lower welfare level for country 1 than importing the MNE's product from country 2 ($W_1^1(x) < W_1^2(x^o)$), and hence the government of country 1 chooses the level of public infrastructure investment that maximises welfare (x^o) and the government of country 2 sets its tax rate slightly below $\theta(x)$. In this case the MNE resides in country 2. The subgame perfect Nash equilibrium is graphically shown by point E in figure 4.9.

²The expression for \bar{x} is reported in the Appendix.

³There are greater returns from investments in public infrastructure when the MNE produces in country 1 rather than producing in country 2. These greater returns are in the form of consumer surplus.

FIGURE 4.8: Welfare in country 1 when $\bar{x} > \underline{x}$

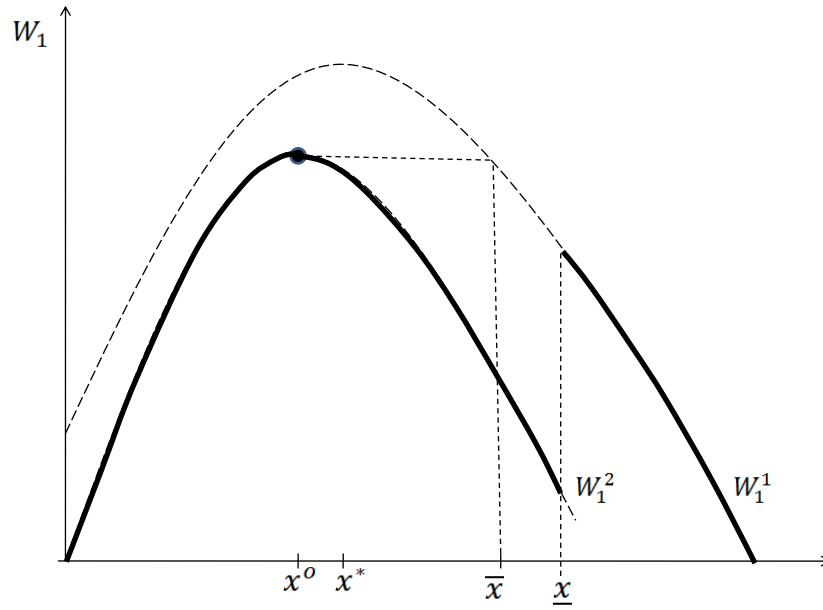
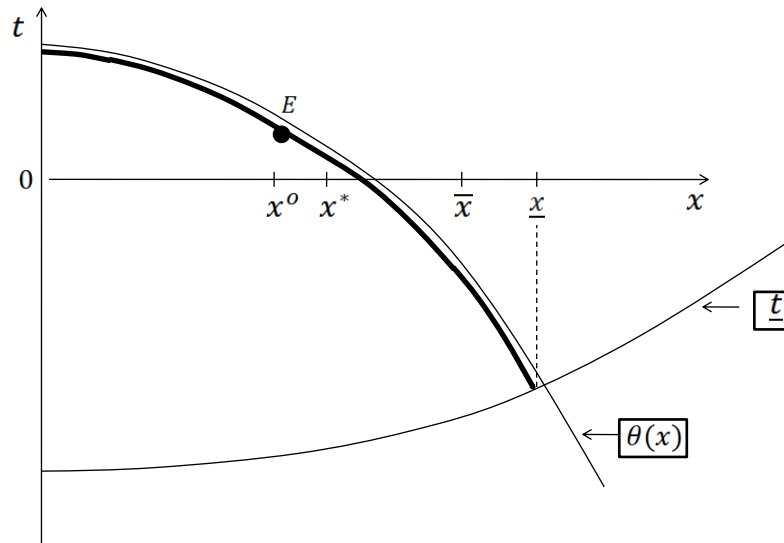


FIGURE 4.9: Subgame perfect Nash equilibrium when the government of country 2 attracts the MNE

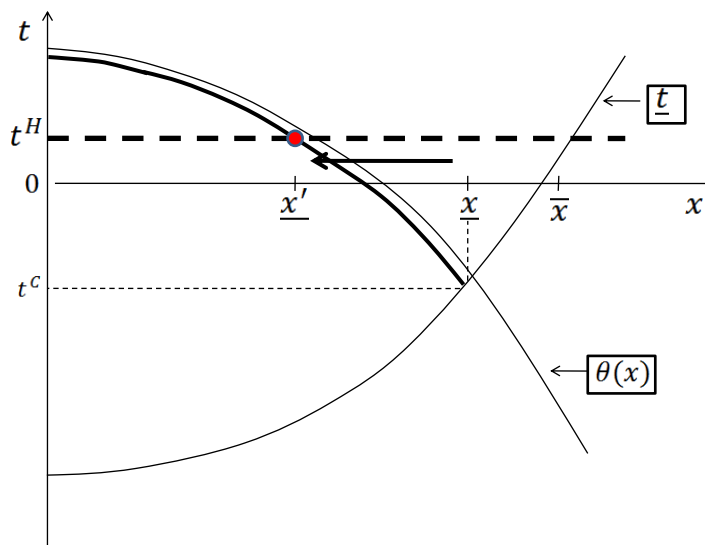


4.4. The government of country 2 subjected to a minimum tax

In this section, we consider the case when the government of country 2 is subjected to a minimum tax, denoted by t^H . Clearly, if the minimum tax rate is set below the critical tax level country 2 sets when competing for FDI, ($t^H < t^c$), the equilibrium outcome in our model is not affected.

However, if the minimum tax rate is set above the critical tax level country 2 sets when competing for FDI, $t^H > t^c$, there will be welfare implications for each country. In this case, the minimum tax restricts the extent to which the government of country 2 can use its tax policy to compete for FDI. The government of country 1, using the alternative policy instrument, investing in public infrastructure can exploit this and can essentially cut back on investment in public infrastructure and still attract FDI. Figure 4.10 depicts the potential effect of the minimum tax has on governments competing for FDI.

FIGURE 4.10: Effect of the minimum tax on public infrastructure investment



The government of country 2 is now restricted in using its tax policy, thus, can no longer compete for FDI by setting tax rates below t^H . As a result the equilibrium investment level in public infrastructure chosen by the government of country 1 is also affected: it no longer has to invest slightly more than \bar{x} to attract the MNE, but instead only needs to invest slightly more than x' . Hence, welfare of country 1 increases as a result of the minimum tax, but this comes at the expense of welfare in country 2. Given that the minimum tax has the potential to curb investment in public infrastructure, consumer surplus in both countries is lower and the MNE's profits are lower than before the policy agreement was introduced.

4.5. Conclusion

In this paper we have developed a theoretical model in which countries compete for FDI, using different policy instruments. More specifically, the government of one of

the potential host countries determines its investment in infrastructure first and, subsequently, the government of the other country sets its corporate tax rate. The government of country 1 moves first since investment in public infrastructure is a relatively long-run decision and is to a large extent irreversible. Thus, it entails a stronger commitment than a tax rate. The government of country 1 has the advantage of picking a point on the government of country 2's tax reaction function. However, the government of country 2 has the advantage of being able to "out bid" country 1 by setting a tax rate that is just low enough to attract the MNE.

We established when the government that uses public infrastructure to attract FDI is more likely to win the competition for FDI when the direct social benefit of public infrastructure are greater and when the relative effectiveness of public infrastructure is higher.

We also looked at the case if the government of country 2 is subjected to a minimum tax. Since, in our framework, taxes and public infrastructure investment are strategic substitutes, the minimum tax rate, since it eases competition, may result in cutbacks in public infrastructure investment in countries that use public infrastructure as a means to attract FDI.

4.6. Appendix

The critical level of public infrastructure, \bar{x} , above which the government of country 1 is not willing to invest any more in public infrastructure to attract the MNE, $W_1^1(\bar{x}) = W_1^2(x^o)$.

$$\bar{x} = \frac{-2S_1\delta\gamma A\lambda - 8\delta\gamma\sigma - \sqrt{(2S_1\delta\gamma A\lambda + 8\delta\gamma\sigma)^2 - 4(S_1\delta\gamma\lambda^2 - 4\delta^2\gamma^2)(S_1\delta\gamma\tau(2A - \tau) - 4\sigma^2)}}{2(S_1\delta\gamma\lambda^2 - (2\delta\gamma)^2)} \quad (4.16)$$

5. Tax Competition and Public Infrastructure with Interregional Spillovers

5.1. Introduction

As economic globalisation deepens, countries tend to compete fiercely with each other to attract foreign direct investment (FDI). Often countries use tax rates to compete for multinational investment. This is not only suggested by the vast literature on tax competition but also corroborated by the often heated political debate on corporate taxes.¹ An important determinant of multinationals' responsiveness to a particular location's fall in tax rate depends on the market potential of that location (see Davies and Voget (2009)). Here, market potential encompasses how profitable the location is. For instance, large countries tend to be profitable since they have many consumers that can be served locally, thereby avoiding trade costs. The higher the location's market potential, the more likely it is that multinationals will respond by locating there. One way to increase a location's market potential is investment in local public infrastructure. Public infrastructure is a wide concept, which we will interpret as any government investment that increases locally producing firms' productivity.² We consider investment in public infrastructure that enhances the region's attractiveness to foreign firms.

¹Recent surveys on tax competition include Zodrow (2010) and Baskaran and Lopes da Fonseca (2013).

²Among many others, Pieretti and Zanaj (2011) use a similar interpretation.

In this essay we model how investment in public infrastructure affects tax competition. The relationship between public infrastructure and tax competition has been previously addressed in the literature. Notable examples are Baldwin et al (2003), Baldwin and Krugman (2004), Zissimos and Wooders (2008) and Pieretti and Zanaj (2011). The last two papers examine the link between public infrastructure and tax competition in a two-stage game in a Hotelling set-up.

Our paper differs from previous work in important ways. First, we use a more general framework that encompasses the results obtained from a Hotelling model. Second, we focus on the public good nature of infrastructure and allow for the possibility of interregional spillovers. Martin and Rogers (1995) distinguish between a country's investment in domestic and international infrastructure in a theoretical model that examines firm location and integration (without tax competition) and emphasise the different effects of the two types of public infrastructure for agglomeration. In an empirical study for the US, Cohen and Morrison Paul (2004) present evidence of spatial spillovers of public infrastructure between states.

In our model, two jurisdictions, "Home" and "Foreign", choose public infrastructure independently and also have capital tax raising power. The level of FDI to the countries depends negatively on local taxes, but positively on local public infrastructure. Jurisdictions play a two-stage game: they commit to public infrastructure levels in stage one and compete for FDI with taxes on capital in stage two.

In our model, public infrastructure investment in one country may directly reduce the FDI going to the other location, as it potentially makes the rival location relatively less attractive (e.g., public investment in domestic roads). However, when investment in public infrastructure has a positive interregional spillover effect (e.g., investment in

interregional transport routes), FDI to both locations may increase. We examine how these interregional or international spillovers affect the tax competition game between jurisdictions. Finally, we examine how tax harmonisation in the form of a minimum tax and tax cooperation, affects governments' optimal choice of public infrastructure.

In section 5.2, we set up the model. We examine how tax harmonisation affects investment in public infrastructure in section 5.3 and section 5.4 concludes.

5.2. The model

Consider two countries, “Home” and “Foreign”, which are both host locations for multinational firms from other countries. The governments of both countries independently choose taxes and investment levels in public infrastructure. The supply of FDI in Home is denoted by k while k^* represents the supply of FDI in Foreign. We assume that k and k^* respond to corporate tax rates in each location, with t and t^* denoting the respective tax rates per unit of capital in Home and Foreign. Multinational capital also responds to investments in public infrastructure in each country, where x and x^* denote investment levels in public infrastructure for Home and Foreign respectively. Hence, the aggregate supply function of FDI, coming from other countries, into Home and Foreign are respectively given by:

$$k = \alpha - \beta(t - \varepsilon t^*) + \gamma(x + \lambda x^*) \quad (5.1)$$

and

$$k^* = \alpha^* - \beta^*(t^* - \varepsilon^* t) + \gamma^*(x^* + \lambda^* x) \quad (5.2)$$

We impose $0 < \varepsilon < 1$ and $-1 < \lambda < 1$. Assume $\alpha = \alpha^* > 0$, $\beta = \beta^* > 0$, $\gamma = \gamma^* \geq 0$, $\varepsilon = \varepsilon^*$ and $\lambda = \lambda^*$ where α and α^* respectively represent the level of FDI into Home and Foreign, regardless of the policies the governments choose. Both countries' flow of FDI are decreasing in their own tax rate but increasing in their rival's tax rate. β represents the own marginal tax effect on a region's FDI, whereas $\beta\varepsilon$ represents the cross marginal tax effect. The marginal own effect of an investment in public infrastructure on the flow of FDI into Home and Foreign are positive and represented by γ and γ^* , respectively. However, the marginal cross public infrastructure effect, represented by $\gamma\lambda$, can be positive or negative. Depending on the type of infrastructure a government invests in, the rival host country will benefit from ($\lambda > 0$) or be harmed by ($\lambda < 0$) public infrastructure investment. The welfare functions in Home and Foreign are respectively given by:

$$W = tk - \delta \frac{x^2}{2} \quad (5.3)$$

and

$$W^* = t^*k^* - \delta^* \frac{x^{*2}}{2} \quad (5.4)$$

with the cost of investment in public infrastructure captured by the last term in the welfare function, where δ represents a positive constant for Home ($\delta > 0$) and δ^* for Foreign, ($\delta^* > 0$). Governments want to maximise their tax revenue, tk for Home and t^*k^* for Foreign, net of the public investment cost.

Governments of the two countries play a two-period game. In the first period, they simultaneously choose investment levels in public infrastructure and subsequently, in

the second period, simultaneously set corporate tax rates. We solve the game by backward induction.

5.2.1 Stage 2: Optimal taxes

Governments simultaneously choose taxes, given x and x^* , to maximise domestic welfare. The first-order conditions for Home and Foreign are, respectively, given by:

$$\frac{dW}{dt} = tk_t + k = 0 \quad (5.5)$$

and

$$\frac{dW^*}{dt^*} = t^*k_{t^*}^* + k^* = 0 \quad (5.6)$$

Subscripts denote partial derivatives, where $k_t = -\beta$ and $k_{t^*}^* = -\beta^*$. The tax reaction function for the Home and Foreign governments are respectively given by:

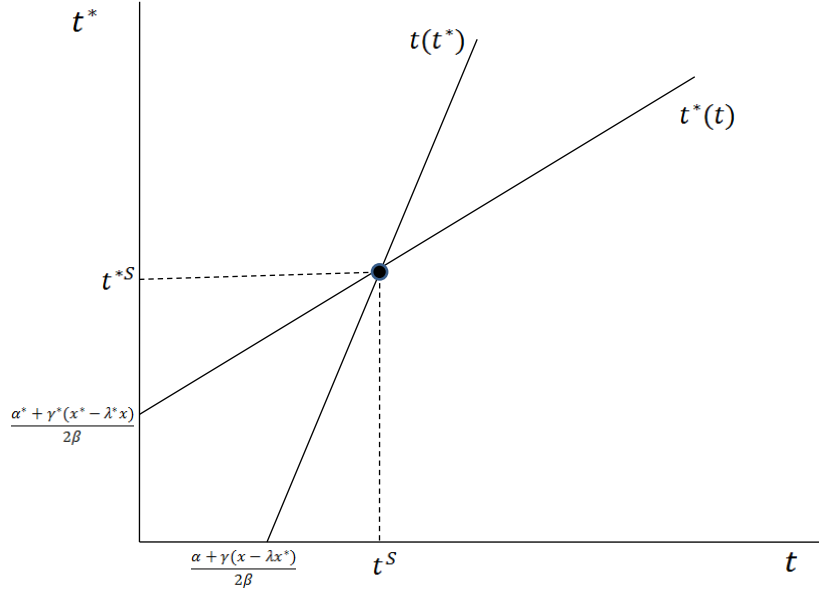
$$t = \frac{\alpha + \gamma(x + \lambda x^*)}{2\beta} + \frac{\varepsilon}{2}t^* \quad (5.7)$$

and

$$t^* = \frac{\alpha^* + \gamma^*(x^* + \lambda^* x)}{2\beta^*} + \frac{\varepsilon^*}{2}t \quad (5.8)$$

So, the taxes in the Home and Foreign country are strategic complements ($\frac{dt}{dt^*} = \frac{dt^*}{dt} = \frac{\varepsilon}{2} > 0$). Reaction functions are shown in figure 5.1.

FIGURE 5.1: Tax reaction functions



Solving for the Nash equilibrium tax rates we obtain:

$$t^S = \frac{\alpha(2 + \varepsilon) + \gamma(2\lambda + \varepsilon)x^* + \gamma(2 + \lambda\varepsilon)x}{\beta(4 - \varepsilon^2)} \quad (5.9)$$

$$t^{*S} = \frac{\alpha(2 + \varepsilon) + \gamma(2 + \lambda\varepsilon)x^* + \gamma(2\lambda + \varepsilon)x}{\beta(4 - \varepsilon^2)} \quad (5.10)$$

Superscripts stand for the Nash equilibrium levels. Using (5.9) and (5.10) we calculate the effect of a country's own investment in public infrastructure on its tax rate.

$$\frac{dt^S}{dx} = \frac{\gamma(2 + \lambda\varepsilon)}{\beta(4 - \varepsilon^2)} > 0 \quad (5.11)$$

Clearly, investment in public infrastructure increases the investing country's tax rate.

Now we derive the effect of a country's investment in public infrastructure on the rival host country's tax rate.

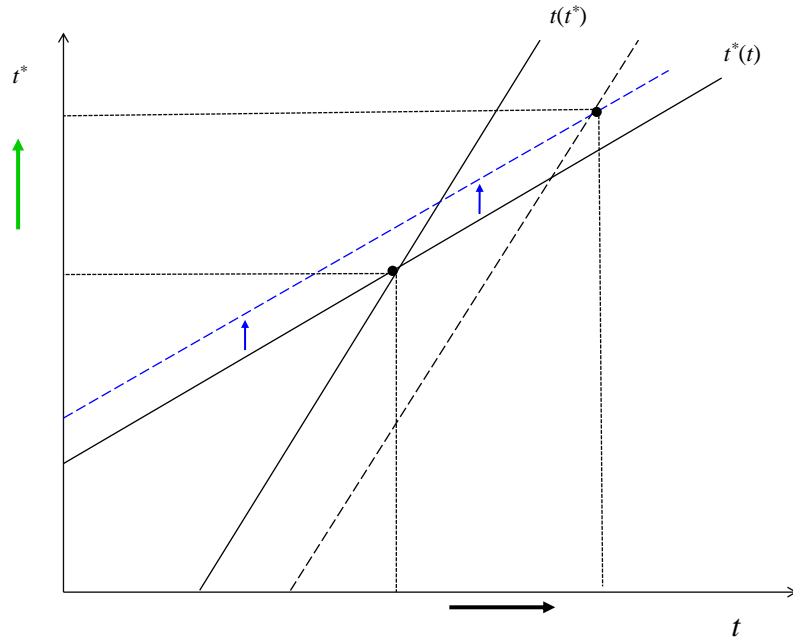
$$\frac{dt^{*S}}{dx} = \frac{\gamma(2\lambda + \varepsilon)}{\beta(4 - \varepsilon)^2} \quad (5.12)$$

An increase in x will shift the Home government's reaction function to the right. However, it may shift the Foreign government's reaction function to the left or to the right, depending on the spillover of x to the Foreign country. The effect of an increase in x on the Foreign tax rate depends on whether λ is above or below a critical level, denoted by $\bar{\lambda}$, which is given by:

$$\bar{\lambda} = \frac{-\varepsilon}{2} \quad (5.13)$$

We investigate the effect of Home's investment on the countries' tax reaction functions. The case in which Home's investment in public infrastructure generates a positive spillover on the Foreign country ($\lambda > 0$) is depicted in figure 5.2. We assume that the Foreign country does not invest ($x^* = 0$).

FIGURE 5.2: Effect of an increase in x on the tax Nash equilibrium when $\lambda > 0$



An increase in Home's public infrastructure investment shifts the Home tax reaction function out and the Foreign tax reaction function up ($\frac{dt^*S}{dx} > 0$). As a result, tax rates in both countries increase.

When the spillover from Home's public infrastructure is negative ($\lambda < 0$), the effect on the Foreign tax rate is ambiguous. While an increase in Home's public infrastructure investment shifts the Home reaction function out, the Foreign tax reaction function now shifts down. Figure 5.3 depicts the case in which the negative spillover is relatively small ($|\lambda| < |\bar{\lambda}|$); then, because the shift in the Foreign tax reaction function is relatively small, the Foreign tax rate still goes up after an increase in Home's public infrastructure investment ($\frac{dt^*S}{dx} > 0$).

FIGURE 5.3: The effect of an increase in x on the tax Nash equilibrium when $\lambda < 0$ and $|\lambda| < |\bar{\lambda}|$

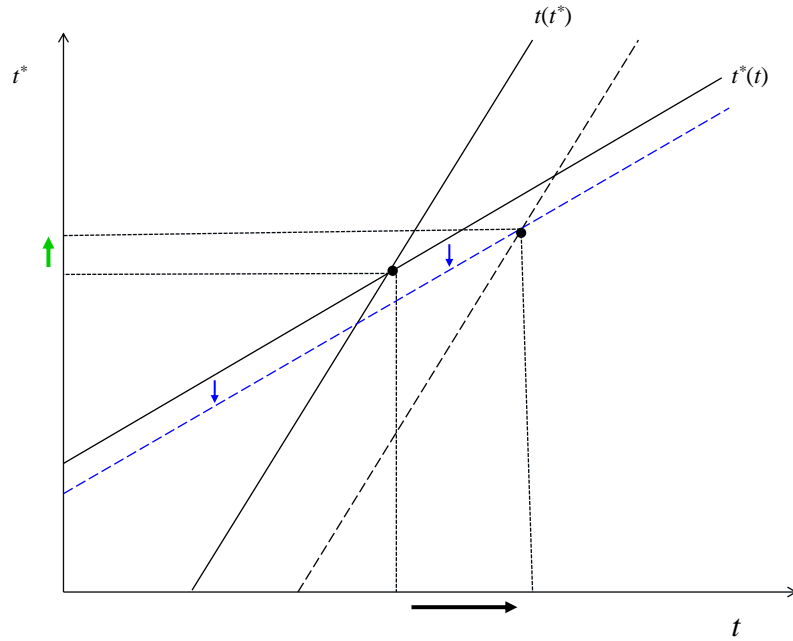
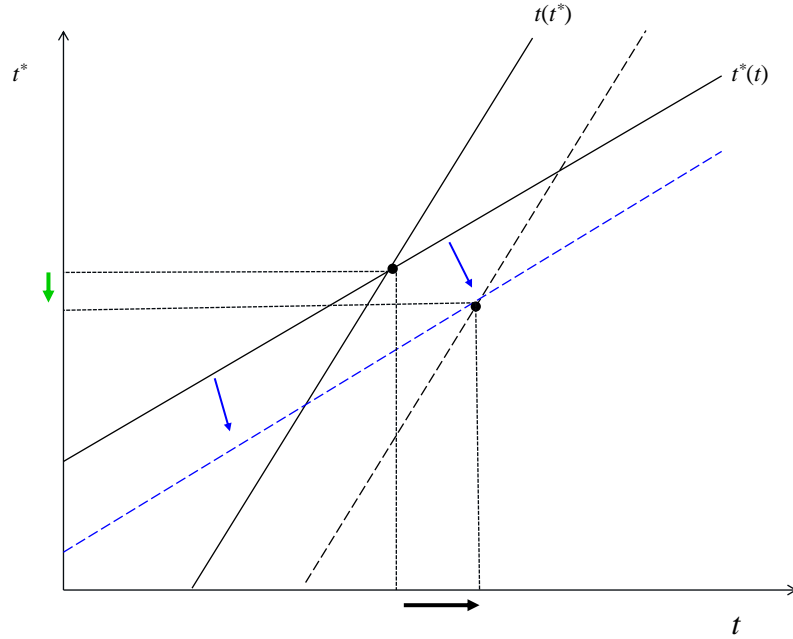


Figure 5.4 depicts the scenario for which the negative spillover is relatively large ($|\lambda| > |\bar{\lambda}|$). In this case, the Foreign tax reaction function now shifts down enough to end up with a lower Foreign tax rate ($\frac{dt^*S}{dx} < 0$). Again, in figures 5.3 and 5.4 we assume that the Foreign country does not invest in infrastructure ($x^* = 0$).

FIGURE 5.4: The effect of an increase in x on the tax Nash equilibrium when $\lambda < 0$ and $|\lambda| > |\bar{\lambda}|$



Note, that the Home corporate tax rate increases in Home's investment in public infrastructure in all cases. Given symmetry, both governments will invest in public infrastructure. We now turn to optimal investment in the next section.

5.2.2 Stage 1: Optimal infrastructure investment

It will prove useful to firstly discuss the case when governments choose both of their policies simultaneously. We will refer to this as the *non-strategic benchmark* case. In this non-strategic benchmark case, the first order condition for the Home government is simply given by:

$$\frac{dW}{dx} = W_x = 0 \quad (5.14)$$

The non-strategic benchmark level of public infrastructure investment is therefore given by:

$$x = \frac{t\gamma}{\delta} \quad (5.15)$$

Now we return to the sequential-move game of our model, in which governments can choose investment in public infrastructure to manipulate the tax competition stage of the game. In stage 1, governments simultaneously invest in public infrastructure, now taking into account the effect of this investment on their own and rival's tax rates. The first order condition for the Home government is given by:

$$\frac{dW}{dx} = W_x + W_t \frac{dt}{dx} + W_{t^*} \frac{dt^*}{dx} = 0 \quad (5.16)$$

where $W_x = t\gamma - \delta x$, $W_t = 0$ from the second stage, $W_{t^*} = \beta\epsilon t$, and $\frac{dt^*}{dx} = \frac{\gamma(2\lambda+\epsilon)}{\beta(4-\epsilon^2)}$. After some manipulation and using $\bar{\lambda} \equiv \frac{\epsilon}{2}$, the infrastructure investment reaction function for Home, reduces to:

$$x = \frac{(2+\epsilon)\alpha}{G} + \frac{(\lambda-\bar{\lambda})2\gamma}{G}x^* \quad (5.17)$$

with $G \equiv \frac{\beta\delta(4-\epsilon^2)^2-2(2+\epsilon\lambda)^2\gamma^2}{2\gamma(2+\epsilon\lambda)}$ and $G > 0$ from the second-order conditions. When $\lambda > \bar{\lambda}$, investments in public infrastructure are strategic complements. In this case, each government will strategically over-invest in public infrastructure relative to the non-strategic benchmark case, thereby driving up the tax rate set by the rival government. When $\lambda < \bar{\lambda}$ investments in public infrastructure are strategic substitutes. In this case, each government will strategically under-invest in public infrastructure, relative to the non-strategic benchmark case. As governments want to drive up the tax

rate in the competing host region and given that its investment in public infrastructure dramatically damages the rival country's ability to attract FDI, it wants to hold back from investment in public infrastructure in this case. So, here this government strategically under invests in the first stage.

The optimal level of investment in public infrastructure in both countries is given by:

$$x^S = \frac{(2 + \varepsilon)\alpha}{G - (\lambda - \bar{\lambda})2\gamma} = x^{*S} \quad (5.18)$$

We now examine how a change in the spillover parameter affects equilibrium corporate tax rates and public infrastructure investment levels. Let $M \equiv G - (\lambda - \bar{\lambda})2\gamma$ with $\frac{dG}{d\lambda} < 0$ and hence $\frac{dM}{d\lambda} < 0$. Therefore, we have $\frac{dx^S}{d\lambda} = \frac{dx^{*S}}{d\lambda} > 0$ (from expression 5.18). As the spillover effect of public infrastructure investment increases, the Nash equilibrium investment levels in public infrastructure also increase. Since an increase in λ increases the investment level in public infrastructure, it is clear from expressions (5.9) and (5.10) that equilibrium corporate tax rates also increase in λ .

5.3. Optimal public infrastructure investment with tax harmonisation

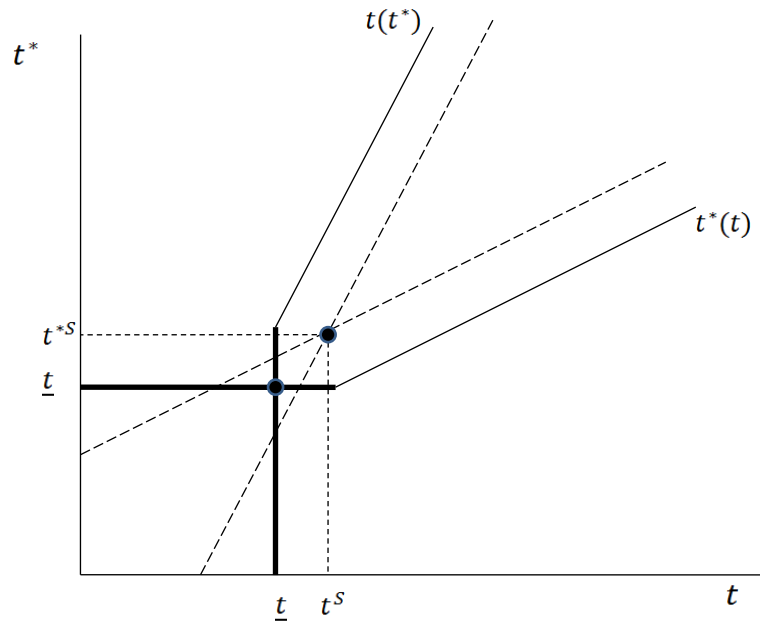
In this section we will examine how public infrastructure investment is affected by two different forms of tax harmonisation. The first takes the form of a minimum tax. Second, we will investigate how tax harmonisation in the form of tax coordination affects optimal investment in public infrastructure.

5.3.1 Minimum tax

Suppose an international tax harmonisation agreement is imposed among the Home and Foreign country, which takes the form of a minimum tax, \underline{t} . Figures 5.5 and 5.6 illustrate the effect of a minimum tax on public infrastructure investment, where t^S and t^{*S} represent the equilibrium tax rates when governments choose public infrastructure investment levels strategically (prior to the minimum tax).

Naturally, if this new harmonised tax is set sufficiently low, i.e., $\underline{t} < t^S$, equilibrium taxes remain t^S and t^{*S} and investment levels in public infrastructure are not affected by the minimum tax rate. This case is illustrated in figure 5.5.

FIGURE 5.5: The effect of tax harmonisation - A minimum tax when $\underline{t} < t^S$



When the minimum tax rate imposed is set higher than the tax rate chosen strategically i.e., $\underline{t} > t^S$, the equilibrium tax rate in both countries is \underline{t} . This case is depicted in figure 5.6.

5.3.2 Cooperative harmonised tax

Now we suppose the Home and Foreign countries cooperatively set a common tax rate in stage 2, denoted by t^c . We therefore rewrite expressions (5.1) and (5.2) as:

$$k = \alpha - \beta(1 - \varepsilon)t^c + \gamma(x + \lambda x^*) \quad (5.19)$$

and

$$k^* = \alpha^* - \beta(1 - \varepsilon)t^c + \gamma(x^* + \lambda x) \quad (5.20)$$

Governments choose t^c to maximise joint welfare $W + W^*$.³ The first order condition is given by:

$$\frac{d(W + W^*)}{dt^c} = W_{t^c} + W_{t^c}^* = 0 \quad (5.21)$$

The cooperative corporate tax rate is given by:

$$t^c = \frac{2\alpha + \gamma(1 + \lambda)(x + x^*)}{4\beta(1 - \varepsilon)} \quad (5.22)$$

Turning to stage 1 of the game, the Home government chooses the level of public infrastructure that maximises Home welfare. The first order condition is given by:

$$\frac{dW}{dx} = W_x + W_{t^c} \frac{dt^c}{dx} = 0 \quad (5.23)$$

³In stage 1 countries will continue to choose investment levels in public infrastructure non-cooperatively.

Assuming symmetry, we can rewrite the first order condition in stage 2 (expression 5.21) as $2W_{t^c} = 0$, which implies that the strategic term in expression (5.23) is zero. Thus, with *symmetry*, strategic investment behaviour by governments vanishes with tax cooperation. Optimal public infrastructure investment levels are now given by:

$$x^c = \frac{\alpha\gamma}{2\beta(1-\varepsilon)\delta - \gamma^2(1+\lambda)} \quad (5.24)$$

Next, we compare equilibrium investment levels in public infrastructure with and without tax cooperation (see expressions 5.18 and 5.24). We can show that investment in public infrastructure under tax cooperation is higher than under non-cooperation provided that $2(1-\varepsilon)\frac{2\lambda+\varepsilon}{4-\varepsilon^2} \leq 1$ holds. Since $0 < \varepsilon < 1$ and $-1 < \lambda < 1$, this condition always holds. Therefore, when governments cooperate in corporate tax setting, the level of investment in public infrastructure is always higher ($x^c > x^S$).

With symmetry, the first-order conditions for taxes when governments choose taxes strategically (expressions (5.9) and (5.10)) and when they choose the tax cooperatively (expression 5.22) can be respectively, rewritten as:

$$t^S = \frac{\alpha + \gamma(1+\lambda)x}{\beta(2-\varepsilon)} \quad (5.25)$$

and

$$t^c = \frac{\alpha + \gamma(1+\lambda)x}{2\beta(1-\varepsilon)} \quad (5.26)$$

Given x , the equilibrium tax under cooperation is higher than when governments choose taxes strategically ($t^c > t^S$). Since governments invest more in public infrastructure

when they choose taxes cooperatively rather than choosing them strategically ($x^c > x^S$), $t^c > t^S$.

Figure 5.7 illustrates the effect of tax cooperation on equilibrium taxes and public infrastructure investment when spillovers from public infrastructure investments are positive or not too negative ($\lambda > \bar{\lambda}$). The solid lines represent the first order conditions when governments choose taxes strategically and point S depicts the governments optimal policy choices for this case. The dashed lines represent the first order conditions when governments choose taxes cooperatively and point C depicts the governments optimal policy choices for this case. Clearly, taxes are higher when governments cooperate in taxes relative to the case when they choose tax rates independently. As mentioned earlier, when governments choose taxes strategically, governments strategically over invest in public infrastructure when $\lambda > \bar{\lambda}$. When governments cooperatively set taxes, strategic investment disappears; hence, $x^c(t^c)$ lies to the left of $x^S(t)$ but the level of investment in public infrastructure is higher at point C than at point S.

FIGURE 5.7: The effect of tax harmonisation - Cooperative harmonised tax when $\lambda > \bar{\lambda}$

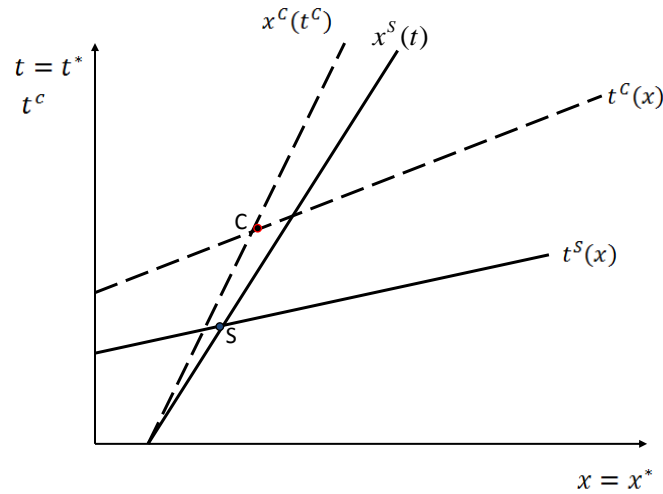
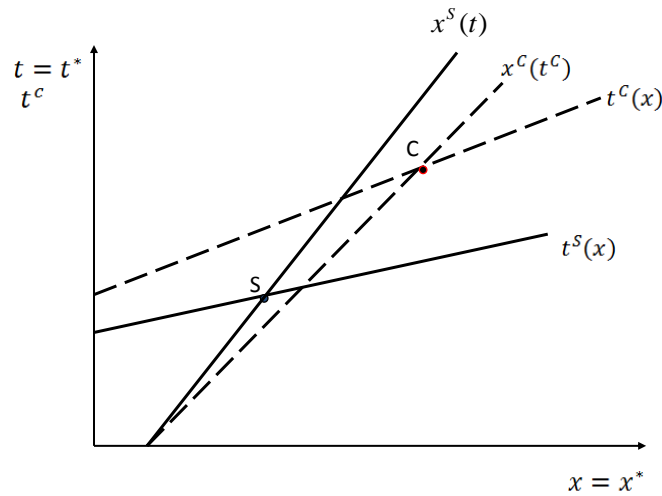


Figure 5.8 depicts the effect of tax cooperation when the spillovers from public infrastructure investments are significantly negative ($\lambda < \bar{\lambda}$).

Again, taxes are higher when governments set taxes cooperatively relative to the case when they choose taxes independently. When governments choose taxes non-cooperatively governments strategically under-invest in public infrastructure when $\lambda < \bar{\lambda}$. However, when governments cooperatively set taxes strategic investment no longer exists; hence $x^c(t^c)$ lies to the right of $x^s(t)$. At point C the government invests more in public infrastructure and, importantly, equilibrium taxes are also higher at point C than at point S even though at point S governments strategically under-invest to push up the rival country's tax. The equilibrium tax rates and the level of investment in public infrastructure is higher at point C than at point S.

FIGURE 5.8: The effect of tax harmonisation - Cooperative harmonised tax when $\lambda < \bar{\lambda}$



5.4. Conclusion

This essay examined how investment in public infrastructure affects tax competition between countries that are potential host countries for multinational firms. We consider investment in public infrastructure that enhances the investing region's attractiveness to foreign firms. When investments in public infrastructure in one country is sufficiently harmful to the other country (by reducing the latter's inward FDI at constant tax levels), the investment lowers the tax rate in the other country. In that case, as tax rates are strategic complements, the government of the investing country *strategically under-invests* in public infrastructure, thereby softening the behaviour of the rival government in the subsequent tax game. However, when the investment in public infrastructure has a positive (or a sufficiently small negative) spillover effect, an increase

in a country's investments in public infrastructure leads the rival host country to raise its capital taxes. In that case, governments will *strategically over-invest* in public infrastructure to soften the behaviour of the rival jurisdiction in the tax game.

We examined how public infrastructure investment is affected by two forms of tax harmonisation, i.e., a minimum tax rate and tax cooperation. When public infrastructure investment attracts FDI and has positive (or not too negative) interregional spillovers, a minimum tax can - if effective - be expected to curtail investment in public infrastructure. However, one can expect a minimum tax- again if effective- to increase investment in public infrastructure when the latter attracts FDI and has sufficiently negative interregional spillovers. When governments cooperate in corporate tax setting, taxes will be higher than under non-cooperation. With symmetry, strategic investment behaviour by governments is eliminated with tax cooperation. Furthermore, the level of investment in public infrastructure will be higher when governments set taxes cooperatively rather than choosing taxes strategically.

6. General Conclusion

Throughout this dissertation we explored the role of investment in public infrastructure in attracting foreign investment. What are the policy lessons one should draw from our study? First, our model suggests that countries with a large market size, low social cost of public funds, large direct social benefits and high effectiveness of public infrastructure are most likely to be successful in attracting FDI into their jurisdiction by investing strategically in public infrastructure.

Second, the effect of increasing trade liberalisation on investment in public infrastructure depends on the level of trade liberalisation that already exists. When trade costs are high, a small degree of trade liberalisation has the potential to dramatically increase optimal investment in infrastructure. However, when trade costs are low, trade liberalisation may reduce optimal public infrastructure investment.

Third, often governments are criticised for implementing policies aimed towards attracting foreign firms and not towards supporting indigenous firms. We show that this does not have to be the case. While governments may want to strategically invest in public infrastructure with the aim of attracting foreign investors, this policy tool may due to the public good nature of public infrastructure investment, at the same time enable indigenous firms to break through on international markets.

Fourth, in practice, different countries have managed to attract FDI using different policy instruments. More specifically, taxes and investment in public infrastructure. These policies are very different. Investment in public infrastructure is irreversible and is typically a relatively long term policy. Thus, it entails a stronger commitment than a tax rate. When governments compete, there is likely to be a “race to the bottom” in taxes and a “race to the top” in public infrastructure investment. The government that uses public infrastructure to attract FDI is more likely to win the competition for FDI when the direct social benefit of public infrastructure are greater and when the relative effectiveness of public infrastructure is higher.

Fifth, public infrastructure investment in one country can potentially affect the level of FDI going to other countries. This policy may directly reduce the FDI going to other locations, if so, the government of the investing country *strategically under invests* in public infrastructure, thereby softening the behaviour of the rival government in the subsequent tax game. However, if FDI increases to both locations due to public infrastructure investment, then the government will *strategically over invest* in public infrastructure to soften the behaviour of the rival jurisdiction in the tax game.

Lastly, we showed that a minimum tax can eliminate strategic investment in public infrastructure. We also showed that cooperation in tax setting, will result in higher taxes than under non-cooperation. Furthermore, the level of investment in public infrastructure will also be higher.

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