

# EU Regional Policy and Tax Competition<sup>1</sup>

by

Johannes Becker\* and Clemens Fuest<sup>‡</sup>

University of Cologne

This version:  
28th April 2008

---

<sup>1</sup>We gratefully acknowledge financial support from the Deutsche Forschungsgemeinschaft (DFG), Grant No. FU 442/3-1.

\*Cologne Center for Public Economics, University of Cologne, Albertus-Magnus-Platz, D-50923 Cologne, Germany. E-Mail: johannes.becker@uni-koeln.de

<sup>‡</sup>Cologne Center for Public Economics, University of Cologne, Albertus-Magnus-Platz, D-50923 Cologne, Germany. E-Mail: clemens.fuest@uni-koeln.de

## **Abstract**

The European Union provides coordination and financing of trans-European transport infrastructures, i.e. roads and railways, which link the EU Member States and reduce the cost of transport and mobility. This raises the question if EU involvement in this area is justified by inefficiencies of national infrastructure policies. Moreover, an often expressed concern is that policies enhancing mobility may boost tax competition. We deal with these questions using a model where union countries and non-union countries compete for the location of profitable firms. We show that a coordination of investment in transport cost reducing infrastructures within union countries enhances welfare and mitigates tax competition. In contrast, with regard to union-periphery infrastructure, the union has an interest in a coordinated reduction of investment expenditures. Here, the effects on tax competition are ambiguous. Our results provide a rationale for EU-level regional policy that supports the development of intra-union infrastructure.

**JEL Codes:** H54, H25, F23

**Keywords:** European Union, Infrastructure, Regional Policy, Tax Competition

# 1 Introduction

The European Union (EU) invests substantial resources in transport infrastructures, i.e. in roads and railways which link the EU member countries to each other. The intended effect is to reduce mobility costs of workers and transport costs for goods and production factors. This reduction of mobility costs is in line with the objective of fostering economic integration in the Common Market. However, from an economic perspective, these policies also raise various concerns. Firstly, the question arises whether EU involvement is necessary, given that member states themselves also have an interest in improving their infrastructure. Secondly, increasing mobility across borders has implications for other policy areas as well, in particular tax policy. As some member states are concerned about tax competition, the question how EU infrastructure policies affect tax competition may be of crucial importance.<sup>1</sup> A widespread view is that increased international mobility leads to more intensive tax competition.

In this paper, we analyze the interaction between regional policies, i.e. public investment in regional infrastructure, and tax competition. We develop a model of open economies competing for foreign direct investment through tax and infrastructure policies. Infrastructure investment leads to the reduction of transport costs of goods across borders. We assume that some countries form a union and are able to coordinate their infrastructure policies but not their tax policies. This reflects the current situation within the European Union, where large infrastructure policies are (co-)financed by the supranational EU-level, while business taxes remain uncoordinated. We ask whether national infrastructure policies are efficient for the union as a whole and how coordination of infrastructure policies affects tax competition, given that the member states retain autonomy in corporate taxation.

Our results show that national governments will invest in infrastructure in order to attract firms and to reduce import prices faced by domestic consumers. However, uncoordinated national infrastructure policies do not lead to efficient

---

<sup>1</sup>For instance, on a visit in Poland after its accession to the EU, on May 26th 2004, the German chancellor Gerhard Schroder argued, with reference to EU regional policies: *“It is certainly unreasonable that we finance an unbridled tax competition among each other via the EU budget”*, cited after Jan Stoyaspal: *Want Lower Taxes? Go East*, TIME Magazine of 11th July 2004.

outcomes for the union as a whole. There is a potential for welfare enhancing coordination of infrastructure policies. These welfare gains arise not only because national infrastructure investment gives rise to spillovers, but also because more infrastructure investment may mitigate tax competition. This is surprising because policies which enhance mobility are usually considered as intensifying tax competition. In our model, this is not the case because more infrastructure reduces transport costs and thus reduces the difference between the prices of imported compared to domestically produced goods faced by consumers. Attracting firms to make them produce close to the consumers becomes less important, so that governments are less willing to cut taxes. We also consider the welfare effects of coordinating infrastructure investment that reduces the transport costs to non-union countries. In this case, the effects on union welfare are ambiguous, as are the effects on tax competition with these countries.

Seen from an empirical point of view, many studies question the existence of measurable positive effects of regional policies on growth, productivity and employment. Boldrin and Canova (2001) show that regions which received EU infrastructure investment support in the past did not perform better than similar regions without investment. Midelfart-Knarvik and Overman (2002) as well as Basile, Castellani and Zanfei (forthcoming) show that these policies effectively lead to firm relocation into the target regions but are nevertheless accompanied with substantial misallocation of resources. Therefore, many authors come to the conclusion that EU regional policy should be considerably revised if not abolished. Our paper offers an alternative rationale for EU regional policy. Of course, infrastructure investment like the trans-European networks may be seen as a rather specific kind of regional policy. However, our argument implies that this kind of EU-level policy is welfare-enhancing even if there is no measurable effect on growth or employment.

The idea that decreasing mobility cost increases tax competition is common sense in the empirical literature on international taxation, see the surveys by Devereux (2007) and Hines (1999). Tax competition is predicted to be strongest between neighboring countries. This prediction is derived from the assumption that capital mobility is higher among countries which are close to one another. Indeed, proximity is a strong determinant for the location of investment by mul-

tinational investors, see e.g. Markusen (2002) or Buch, Kleinert, Lipponer and Toubal (2005). In contrast, the literature dealing with tax competition between countries is somewhat inconclusive. There are only very few papers which set out to measure tax competition directly and, more specifically, there is no unanimous approach towards geographical distance. Whereas Devereux, Lockwood and Redoano (forthcoming) do not account for the impact of distance and find significant evidence for tax competition, Overesch and Rincke (2008) show that the evidence becomes weak when distance is omitted from the regression equation.<sup>2</sup>

Apart from this, our paper is related to several distinct strands of literature. Firstly, next to the empirical work mentioned above there is a theoretical literature dealing with the regional policy of - broadly speaking - the central government, be it the federal government in large federations like the US or the supranational level in communities of countries like the EU. Fuest and Huber (2006) analyze regional policy from a public finance point of view. They argue that a coordination of regional policies helps internalizing positive externalities of national policies. However, in their model, regional policies do not affect transport costs. Ulltveit-Moe (2007) explores whether redistributive goals can be achieved by more efficient instruments than those used by the EU. Behrens, Gaigne, Ottaviano and Thisse (2007) analyse transport-cost reducing regional policies in a 'new economic geography' model. Their focus is on intra- versus interregional agglomeration, though.

Secondly, there is a literature on intergovernmental competition over public spending on infrastructure, see in particular Keen and Marchand (1997). They consider a model where the government provides infrastructure and a public consumption good and show that there is too much infrastructure spending in the uncoordinated equilibrium. Thirdly, several papers analyse partial coordination in the sense that policy coordination agreements cover only a subset of the available policy instruments. This literature shows that partial coordination agreements may fail to be effective because governments react by adjusting other instruments, see Fuest (1995) and Cremer and Gahvari (2000). Fourthly, there is a literature which analyzes interjurisdictional competition for profitable firms.<sup>3</sup> These contri-

---

<sup>2</sup>Further evidence for tax competition is provided in Winner (2005) and Lahrèche-Révil (2006).

<sup>3</sup>See e.g. Black and Hoyt (1989), Haaparanta (1996), Hauffer and Wooton (1999), Fuest (2005) and Hauffer and Wooton (2006)

butions assume that a potential reason why it may be desirable for a country to attract investment is the existence of transport costs. If production takes place close to consumers, consumer prices are lower compared to the case where goods have to be imported. Seen from the firm's perspective, it is desirable to locate where consumers are in order to charge higher prices net of transport costs.<sup>4</sup> A final related strand of literature analyzes the effects of policy coordination in a subset of competing countries.<sup>5</sup> Basically, these papers show that policy coordination may yield welfare gains even if only a subset of countries participates.

The remainder of the paper is organized as follows. Section 2 gives a quick overview on infrastructure expenditures of the European Union. In section 3, the model is presented. Sections 4 and 5 analyze competition and coordination of tax policies and regional infrastructure expenditures. Section 6 discusses the results and concludes.

## **2 Infrastructure expenditure and tax competition within the European Union**

According to the EU, transport infrastructure investments are means to achieve the goal of sustainable growth which is one of the core objectives of EU policies. The Fourth Report on Economic and Social Cohesion by the European Commission (2007b) states: “*An efficient transport system is a key factor underlying regional competitiveness and growth. Accordingly, it is one of the main areas of investment of cohesion policy.*” (p. 100) In the 2008 budget of the European Union, 44,9% of total expenditures are spent for this purpose. This budget share corresponds to 58 billion € of which 46,9 billion € are planned for cohesion policies and 11,1 billion € for the purpose of supporting competitiveness.

Transport infrastructure is just one of the instruments of structural policy which is generally directed at reducing (regional) inequalities within the European

---

<sup>4</sup>In so far, this literature builds on the New Trade Theory or New Economic Geography, see Baldwin and Krugman (2004).

<sup>5</sup>Apart from Haufler and Wooton (2006) who analyze the coordination of tax or subsidy policies within a union of countries, important contributions to this literature are Konrad and Schjelderup (1999) and Sørensen (2004).

Union. Since the establishment of the Structural Funds in the early 1960s, the expenditures for structural policy have grown substantially. Figure 1 depicts the expenditures of structural funds as a fraction of total EU budget (left y-axis) and as a fraction of EU Member States government expenditures as well as EU gross national income (GNI) (both right y-axis).<sup>6</sup> The former two of them have seen a parallel development over time which reflects that the EU budget represented quite a stable fraction of Member States government expenditures in the past. In contrast, growth of structural funds expressed as a fraction of GNI is less steep reflecting that total government expenditures (and the EU budget) as a fraction of GNI has declined over time.

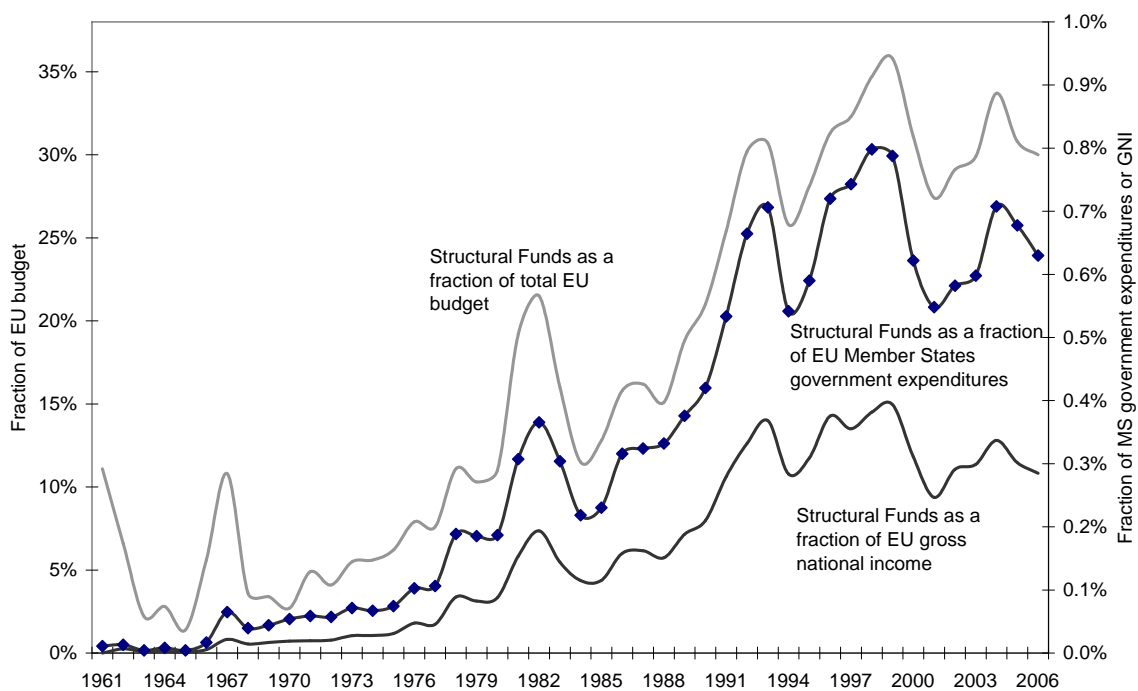


Figure 1: Expenditures of Structural Funds over time.

Since the actual level of transport infrastructure expenditures depends on the projects the member states apply for, it is helpful to take a look at the pattern of expenditures in the past. Financing is mainly provided via the European Regional

<sup>6</sup>All data are taken from European Commission (2007a).

Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF). From 2000 to 2006, the ERDF and the ESF jointly spent 24,9 billion € for transport infrastructures which correspond to 19,2 per cent of the total fund’s budget. In the same period, the Cohesion Fund (CF) invested 16,8 billion € into transport facilities which equals 48,8% of total funds. Figure 2 illustrates the financing of transport infrastructure. Although infrastructure expenditures by ERDF, ESF and CF are mainly targeted at regions which lag behind in terms of growth, employment and productivity, the Trans-European Transport Networks (TEN-T) are supported in virtually all member states and regions. From the perspective of this paper, they play a special role. These transport networks include motorways, railways, airports, and ports as well as traffic management and navigation systems (e.g. satellite programs). In its decision 884/2004/EC<sup>7</sup>, the European Parliament and the European Council name thirty priority projects which are part of the TEN-T. The selection is based on the following analysis: *“Growth in traffic, in particular due to the growing share of heavy goods vehicles, has resulted in increased congestion and bottlenecks on international transport corridors. In order to ensure international mobility of goods and passengers, it is therefore necessary to optimise the capacity of the trans-European transport network.”* (p. 1).

According to a memo of the European Commission (2003), “[by] 2020 the total cost of the trans-European network [...] will amount to € 600 billion” (p. 8), 20% of which are to be financed by the private sector and up to 30% by the European Union. These figures show that transport infrastructure is effectively a core objective of EU policies.

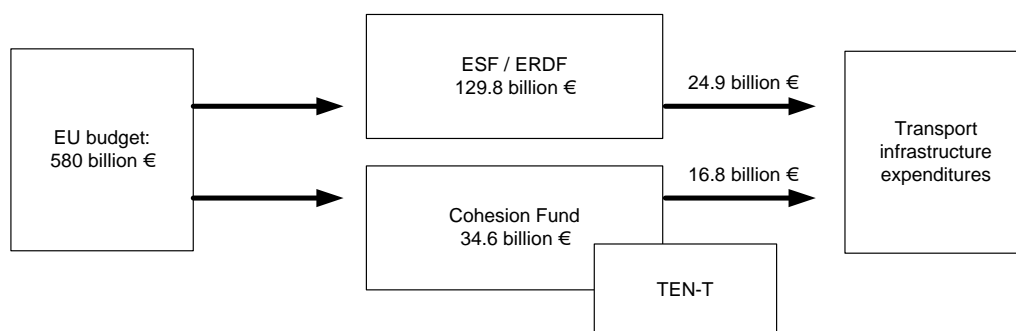


Figure 2: Financing transport infrastructures (2000-2006).

<sup>7</sup>[http://ec.europa.eu/ten/transport/legislation/doc/2004\\_0884\\_en.pdf](http://ec.europa.eu/ten/transport/legislation/doc/2004_0884_en.pdf)

Four questions arise, though. Firstly, one may ask whether these policies achieve their goals. Based on a simulation study which predicts growth effects of infrastructure on productivity and welfare until 2031, the Commission memo optimistically claims that investments in transport infrastructures should “*improve welfare which may lead to a boost in economic growth of 0.23% of GDP*” (p. 8). However, the Cohesion report says that “[*since*] *the gains in terms of GDP growth and accessibility tend to be relatively evenly spread across regions, the contribution to reducing regional disparities is often modest.*” (p. 102)<sup>8</sup> And: “*The effect, however, tends to be larger in smaller countries, especially if the investment serves to improve connections to the economic core of Europe.*” (p. 102)

Secondly, the question arises why the European Union should implement these policies and not the member states themselves. The Commission states that there is a “*case for European involvement in spending. Indeed, many of the projects would not be economic if considered purely in terms of the returns to the Member State commissioning them but have a high return to the EU as a whole.*” (p. 102) In other words, the Commission seems to believe in positive external effects of infrastructure investments leading to underinvestment if national policies are uncoordinated. If this view is correct, a coordination of infrastructure policies on the EU-level policy is welfare-enhancing because it accounts for these externalities, an argument derived in Fuest and Huber (2006).

Thirdly, critics may argue that some of the implemented policies are not precise in their effects. For example, many of the priority projects enlisted in the framework of the TEN-T policy do not aim at connecting the European periphery to the core, but strengthen the ties between core countries. This may effectively reinforce the core countries’ advantage in accessibility and growth potential. A closer look at the project list shows that, indeed, many of the projects are realized in countries which are not target regions of the cohesion policies. E.g. project no. 1 is a rail axis between Berlin, Munich and Milano, i.e. cities which are certainly not located in peripheral regions. Project no. 2 is a rail axis between Paris and London via Bruxelles and Cologne. For the whole list, see European Commission (2005). Thus, the EU seems to believe in the beneficial effect of infrastructure not

---

<sup>8</sup>This would explain why the evidence reported in some studies discussed in Boldrin and Canova (2001) is rather pessimistic about the effects of regional policy on convergence.

only in the case where the periphery is connected to the core.

Fourthly, as discussed above, it is an often expressed concern that increasing mobility undermines the national governments' ability to levy tax revenue necessary to fund the provision of public goods. Thus, a potential consequence of transport cost cutting infrastructure investment may be that tax competition among countries within the EU is fiercer than competition between countries from distinct regions.

To sum up, the EU claims that infrastructure policies are beneficial and that there is a need for coordinating such policies. The actual policy implementation seems to suggest that there is not only a benefit from infrastructure linking the periphery to the core but also from infrastructure between different core regions. Fiercer tax competition may be an undesirable by-product of these investments. In the next section, we present a model in which these issues can be tackled.

### 3 The model

Consider a region with three countries called  $A$ ,  $B$  and  $C$ . Countries  $A$  and  $B$  form a union. This means that a supranational government exists which is able to coordinate national infrastructure policies. There are investor firms from the rest of the world who consider setting up factories in the region to serve the three markets in the three countries. In the base version of our model, we assume that only countries  $A$  and  $B$  are considered as investment locations, either because  $C$  is too small or because production costs in country  $C$  are too high. We also assume that  $C$  is passive, i.e. its infrastructure expenditure is given and does not adjust in response to tax or infrastructure changes in countries  $A$  and  $B$ . This implies a focus on intra-union tax and infrastructure competition. In section 5, we consider the case where one of the union countries (country  $A$ ) and country  $C$  compete for foreign direct investment.

#### 3.1 Households

Consumers in all countries are identical. Their number is  $n_A = 1$  in country  $A$ ,  $n_B$  in country  $B$  and  $n_C$  in country  $C$ . The representative household consumes a

numeraire good denoted by  $z$  and a continuum of other differentiated goods  $x(s)$ , where  $s$  is an index of differentiation which is uniformly distributed between 0 and 1, with density  $\zeta(s)$  and a distribution function  $\Psi(s)$ . The household has quadratic, quasi-linear preferences:

$$u_i = \int_0^1 \left[ \alpha x_i(s) - \frac{1}{2} \beta x_i(s)^2 \right] \zeta(s) ds + z_i \quad \text{for } i \in \{A, B, C\} \quad (1)$$

where  $\alpha$  and  $\beta$  are preference parameters. Each household inelastically supplies one unit of labor, and the wage rate is given by  $w_i$ . The representative household's budget constraint in country  $i$  is

$$w_i + \frac{T_i}{n_i} = z_i + \int_0^1 p_i(s) x_i(s) \zeta(s) ds \quad (2)$$

Product prices in country  $i$  are unity for good  $z_i$  and  $p_i(s)$  for good  $x_i(s)$ .  $T_i/n_i$  is a per-capita lump sum transfer from the government (or a lump sum tax if  $T_i$  is negative). The firms producing the differentiated good are owned by households residing outside the region. Replacing  $z_i$  in (1) yields

$$u_i = \int_0^1 \left[ \alpha - \frac{1}{2} \beta x_i(s) - p_i(s) \right] x_i(s) \zeta(s) ds + w_i + \frac{T_i}{n_i} \quad (3)$$

Utility maximizing choice of  $x_i(s)$ , denoted by  $\hat{x}_i(s)$  implies

$$\hat{x}_i(s) = \frac{\alpha - p_i(s)}{\beta} \quad \forall s \quad (4)$$

and aggregate demand in country  $i$  is given by

$$n_i \hat{x}_i(s) = n_i \left( \frac{\alpha - p_i(s)}{\beta} \right) \quad (5)$$

## 3.2 Firms

Assume that all goods,  $z$  and  $x(s)$ , are produced with linear production technology where the only input is labor. Production technologies do not differ across countries. The numeraire good  $z$  is produced by perfectly competitive firms with

zero profits. As good  $z_i$  is freely traded without any trade costs, wage costs are equalised across countries.<sup>9</sup>

The goods  $x(s)$  are produced under imperfect competition and increasing returns to scale. Goods can be shipped across borders, but there is a transport cost  $k$  between each pair of countries which is denoted by  $k_{ij}$  between countries  $i$  and  $j$ . Each variety  $s$  is produced by a monopolist firm which considers investment, due to large fix costs, in just one of the three countries. Firms differ in location specific fixed costs. The fixed cost for all firms in country  $A$  is normalized to  $F_A$ . The fixed cost in country  $B$  is equal to  $F_A + \Delta(s)$ , where  $\Delta(s)$  denotes the location-specific fixed cost disadvantage (or advantage in case of negative values) of country  $B$ , which differs across varieties  $s$ . We assume that  $s$  can be continuously mapped to  $\Delta(s)$  with  $\Delta(0) = \Delta^-$ ,  $\Delta(1) = \Delta^+$  and  $\partial\Delta/\partial s = \gamma$ , where  $\gamma$  is a constant.

In this section, we assume further that fixed production costs in country  $C$  are prohibitive, so that there is no production of  $x(s)$  in country  $C$ . Consequently, our analysis focuses on intra-union tax and infrastructure competition.

### 3.3 National governments and the union

In each country, a benevolent government maximizes the representative household's utility. There are two policy instruments, a lump-sum tax (or subsidy)  $t_i$ ,  $i \in \{A, B, C\}$  and infrastructure expenditures  $\theta_i^{ij}$ . Infrastructure investment  $\theta_i^{ij}$  reduces trade costs  $k_{ij}$ . We assume  $k_{ij} = k_{ij}(\theta_i^{ij}, \theta_j^{ij})$  with  $k_{\theta_i} < 0$ ,  $k_{\theta_i\theta_i} > 0$ . For simplicity, we assume that  $k_{\theta_i\theta_j} = 0$ .

The public sector budget constraint is given by

$$T_i = t_i m_i - \sum_j \theta_i^{ij} \quad (6)$$

where  $m_i$  is the number of firms located in country  $i$  and  $\theta_i^{ij}$  is country  $i$ 's expenditure on infrastructure between  $i$  and  $j$ .

---

<sup>9</sup>Thus, firm location has no impact on wages.

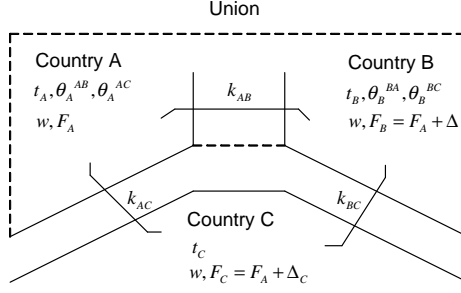


Figure 3: Illustration of the model.

Figure 3 summarizes and illustrates the model. The firms decide between the two locations  $A$  and  $B$  and take into account the market access via exports to the other country and country  $C$ .

### 3.4 Equilibrium

The timing of decisions is as follows: At the first stage, countries simultaneously set  $\theta_i$  and tax rates. At the second stage, the firms choose their location. At stage three, they choose their quantities. As usual, we derive the equilibrium by backward induction, beginning with stage three. At this stage, the location of the firms is given, and the firm set their quantities to maximize profits. Let  $\pi_{ij}$  be the profits in country  $i$  if the firm locates in  $j$ . Then overall profits before taxes and firm specific fixed costs are given by

$$\Pi_j = \sum_i \pi_{ij} = \sum_i (p_{ij} - c_{ij}) n_i x_{ij} \quad (7)$$

Using  $x_i(s) = n_i \left( \frac{\alpha - p_i(s)}{\beta} \right)$ , the profit-maximizing quantities imply

$$x_{ij} = n_i \frac{\alpha - c_{ij}}{2\beta} \quad (8)$$

and equilibrium prices are  $p_{ij} = \frac{\alpha + c_{ij}}{2}$ . Marginal costs are  $c_{ij} = w + k_{ij}$  with  $k_{ii} = 0$  and  $k_{ij} = k_{ji}$ .

Next, consider stage 2, where the firm chooses its location. If the firm locates

in country A, its profits are

$$\Pi_A = \frac{1}{4\beta} (\alpha - w)^2 + \frac{n_B}{4\beta} (\alpha - w - k_{AB})^2 + \frac{n_C}{4\beta} (\alpha - w - k_{AC})^2 - F_A - t_A \quad (9)$$

Note that, in country A, all sectors  $s$  have the same after-tax profits. In contrast, due to sector-specific location costs, profits in case of location in B depend on  $s$  and are given by

$$\Pi_B(s) = \frac{1}{4\beta} (\alpha - w - k_{BA})^2 + \frac{n_B}{4\beta} (\alpha - w)^2 + \frac{n_C}{4\beta} (\alpha - w - k_{BC})^2 - F_A - \Delta(s) - t_B \quad (10)$$

The heterogeneity in location-specific fixed costs gives rise to an equilibrium where each of the two countries hosts some firms. If we assume that firms weakly prefer country A, firms will locate in this country if  $\Pi_A \geq \Pi_B$ . Let  $s^*$  denote the sector which is just indifferent between the two production locations, i.e.  $\Pi_A = \Pi_B$ , and  $\Delta^* \equiv \Delta(s^*)$  the corresponding fixed cost. Firms with a fixed cost above  $\Delta^*$  will prefer country A over country B, and vice versa, where  $\Delta^*$  is given by

$$\Delta^* = \frac{n_B - 1}{4\beta} [2k_{AB}(\alpha - w) - k_{AB}^2] + (k_{AC} - k_{BC}) \frac{n_C}{4\beta} [2(\alpha - w) - (k_{AC} + k_{BC})] + t_A - t_B \quad (11)$$

Note that if both countries are of equal size,  $n_B = 1$ , and the transport costs from the two countries to country C are identical,  $k_{AC} = k_{BC}$ , then the marginal difference in fixed costs is equal to the difference in tax rates:  $\Delta^* = t_A - t_B$ .

Figure 4 illustrates the firm allocation across countries. Firm varieties are indexed by  $s \in \{0, 1\}$  where firms with a low index have low costs of locating in B, denoted by  $\Delta$ , and vice versa. The firm with the index  $s^*$  is just indifferent between the two locations, see (11), which implies that all firms above  $s^*$  locate in country A and all firms beneath  $s^*$  in country B. Policy measures which increase  $\Delta^*$  decrease the number of firms in country A. The size of this effect depends crucially on the parameter  $\gamma$  which can be interpreted as a determinant of firm mobility. An increase of  $\Delta^*$  by one unit translates into firm relocation  $ds$  of  $1/\gamma$ . The lower  $\gamma$ , the larger the elasticity of firm relocation with respect to policy changes.

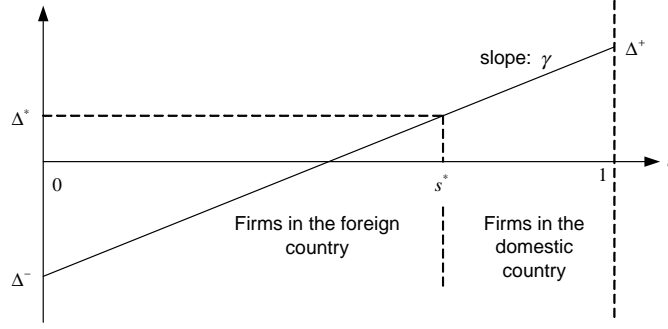


Figure 4: Firm allocation across countries.

Equation (11) implicitly defines a function  $\Delta^* = \Delta^*(t_A, t_B, \theta_A^{AB}, \theta_B^{AB}, \theta_A^{AC}, \theta_B^{BC})$ . Not surprisingly, an increase in the tax differential  $t_A - t_B$  induces more firms to locate in  $B$ :  $\frac{\partial \Delta^*}{\partial t_A} = 1 = -\frac{\partial \Delta^*}{\partial t_B}$ . More infrastructure between countries  $A$  and  $B$  will induce more firms to locate in  $B$  if country  $B$  is smaller than  $A$  (and vice versa):

$$\frac{\partial \Delta^*}{\partial \theta_i^{AB}} = (n_B - 1) \frac{(\alpha - w - k_{AB})}{2\beta} \frac{\partial k_{AB}}{\partial \theta_i^{AB}} \quad i = A, B \quad (12)$$

This happens for the following reason. Assume for the sake of the argument that taxes and transport costs to  $C$  are the same in countries  $A$  and  $B$ . Since country  $B$  offers a smaller local market for consumer goods ( $n_B < 1$ ), it is only attractive as a location for firms if it offers a cost advantage, i.e.  $\Delta^* < 0$ . This cost advantage compensates firms for the transport cost of exporting to the larger market of country  $A$ . Note that firms located in  $A$  also have to bear transport costs for selling in  $B$ . But the quantities of the differentiated good exported from  $A$  to  $B$  are smaller than the quantities exported from  $B$  to  $A$ , so that transport costs are less important for firms located in  $A$ . If infrastructure between  $A$  and  $B$  is improved, this transport cost disadvantage becomes smaller, but the fixed cost advantage does not change. As a result, more firms will locate in country  $B$ .

Expenditure on infrastructure between  $A$  and  $C$  will attract more firms to  $A$  because better access to country  $C$  consumers increases profits:

$$\frac{\partial \Delta^*}{\partial \theta_A^{AC}} = n_C \frac{(\alpha - w - k_{AC})}{2\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} < 0 \quad (13)$$

For the same reason, an improved infrastructure between  $B$  and  $C$  will attract

more firms to country B:

$$\frac{\partial \Delta^*}{\partial \theta_B^{BC}} = -n_C \frac{(\alpha - w - k_{BC})}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} > 0 \quad (14)$$

In the next section, we analyze tax and infrastructure competition between union countries.

## 4 Tax and infrastructure competition between union countries

Governments of all countries set their tax policy to maximize the utility of the representative citizen while the tax policy of the other country as given. The objective function of the government of country  $A$  is thus given by

$$u_A = \int_{s^*}^1 \frac{\alpha - w}{8\beta} \zeta(s) ds + \int_0^{s^*} \frac{\alpha - w - k_{AB}}{8\beta} \zeta(s) ds + w_A + \int_{s^*}^1 t_A \zeta(s) ds - \sum_k \theta_A^k \quad (15)$$

The first term on the right hand side (r.h.s.) is the consumer surplus from all goods produced in country  $A$ , the second term represents the surplus from consumption of goods imported from country  $B$ . This surplus is a function of the transport cost  $k_{AB}$ . The fourth term is tax revenue from all firms located in country  $A$ , net of infrastructure expenditure.

Equivalently, the representative household's utility level in country  $B$  is equal to

$$u_B = \int_{s^*}^1 \frac{\alpha - w - k_{AB}}{8\beta} \zeta(s) ds + \int_0^{s^*} \frac{\alpha - w}{8\beta} \zeta(s) ds + w_B + \int_0^{s^*} \frac{t_B}{n_B} \zeta(s) ds - \sum_k \frac{\theta_B^k}{n_B} \quad (16)$$

## 4.1 Optimal tax and intra-union infrastructure policies

What are the forces driving tax policy in this model? The first order condition for the optimal tax rate of country  $A$  is given by

$$\frac{\partial u_A}{\partial t_A} = \int_{s^*}^1 \zeta(s) ds - \left( \frac{k_{AB}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} = 0 \quad (17)$$

where we use  $\partial s^*/\partial t_A = 1/\gamma$ . The first term on the r.h.s. is the gain in tax revenue for a given tax base, the second term represents the cost of the decline in the tax base caused by a tax increase,  $t_A \zeta(\Delta^*)$ , and the decline in consumer surplus  $\frac{k_{AB}}{8\beta} \zeta(\Delta^*)$ , which occurs as firms relocate to country  $B$  and offer their goods in country  $A$  at higher prices. Accordingly, the first order condition for the optimal tax rate of country  $B$  is given by

$$\frac{\partial u_B}{\partial t_B} = \frac{1}{n_B} \int_0^{s^*} \zeta(s) ds - \left( \frac{k_{AB}}{8\beta} + \frac{t_B}{n_B} \right) \frac{\zeta(s^*)}{\gamma} = 0 \quad (18)$$

where we used  $\partial s^*/\partial t_B = -1/\gamma$ .

The first order condition for the optimal infrastructure expenditure of country  $A$ ,  $\theta_A^{AB}$ , is given by

$$\frac{\partial u_A}{\partial \theta_A^{AB}} = -1 - \left[ \frac{1}{8\beta} \int_0^{s^*} \zeta(s) ds + \left( \frac{k_{AB}}{8\beta} + t_A \right) (n_B - 1) \frac{\alpha - w - k_{AB} \zeta(s^*)}{2\beta} \frac{\zeta(s^*)}{\gamma} \right] \frac{\partial k_{AB}}{\partial \theta_A^{AB}} \quad (19)$$

The first term on the r.h.s. is the pecuniary cost of infrastructure expenditure. The first term in square brackets is the gain due to lower transport costs which translates into lower consumer prices of products imported from  $B$ . The second term in square brackets captures the firm relocation effect caused by a change in infrastructure expenditure. It is equal to zero if countries  $A$  and  $B$  are of equal size. The first order condition for the optimal investment of country  $B$  is

$$\frac{\partial u_B}{\partial \theta_B^{AB}} = -\frac{1}{n_B} - \left[ \frac{1}{8\beta} \int_{s^*}^1 \zeta(s) ds - \left( \frac{k_{AB}}{8\beta} + \frac{t_B}{n_B} \right) (n_B - 1) \frac{\alpha - w - k_{AB} \zeta(s^*)}{2\beta} \frac{\zeta(s^*)}{\gamma} \right] \frac{\partial k_{AB}}{\partial \theta_B^{AB}} \quad (20)$$

which can be interpreted similarly.

## 4.2 Tax and infrastructure policy coordination

Our main focus is to investigate whether there is scope for welfare enhancing policy coordination and how tax and infrastructure policies interact. We begin by considering tax and infrastructure coordination separately. Consider the following experiment: departing from the equilibrium without coordination, countries  $A$  and  $B$  simultaneously increase their taxes by a small amount  $dt_A = dt_B = dt$ , holding all other policy variables constant. The impact of this coordinated tax change on country  $A$  is given by

$$du_A = \frac{\partial u_A}{\partial t_A} dt_A + \frac{\partial u_A}{\partial t_B} dt_B \quad (21)$$

Since  $\frac{\partial u_A}{\partial t_A} = 0$  holds in the uncoordinated equilibrium, we can express the welfare effect as

$$\frac{du_A}{dt} = \frac{\partial u_A}{\partial t_B} = \left( \frac{k_{AB}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} > 0 \quad (22)$$

In the same way, we can derive the effect on the welfare of country  $B$  as:

$$\frac{du_B}{dt} = \frac{\partial u_B}{\partial t_A} = \left( \frac{k_{AB}}{8\beta} + t_B \right) \frac{\zeta(s^*)}{\gamma} > 0 \quad (23)$$

Tax competition leads to tax rates which are too low from the perspective of the union as a whole. The reason is that the tax increase of one country gives rise to a positive fiscal externality, i.e. it increases the welfare of the other country, because the tax increase induces firms to invest in the other country. The other country benefits from this through, firstly, higher tax revenue and, secondly, lower consumer prices. This implies that tax competition in this model is indeed harmful in that it leads to a 'race to the bottom'.

Consider next a coordination of intra-union infrastructure expenditure by  $d\theta_A^{AB} = d\theta_B^{AB} = d\theta^{AB}$ , assuming that all other policy instruments including tax rates are held constant. The welfare effect is now given by

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} = -\frac{\partial k_{AB}}{\partial \theta_B^{AB}} \left[ \frac{1}{8\beta} \int_0^{s^*} \zeta(s) ds + \left( \frac{k_{AB}}{8\beta} + t_A \right) (n_B - 1) \frac{\alpha - w - k_{AB}}{2\beta} \frac{\zeta(s^*)}{\gamma} \right] \quad (24)$$

Using equation (19) and  $\frac{\partial k_{AB}}{\partial \theta_B^{AB}} = \frac{\partial k_{AB}}{\partial \theta_A^{AB}}$ , this can be reduced to  $\frac{du_A}{d\theta^{AB}} = 1$ . For country  $B$ , it is straightforward to show that  $\frac{du_B}{d\theta^{AB}} = \frac{1}{n_B}$ . Uncoordinated infra-

structure expenditure is inefficiently low because national governments neglect that foreign consumers benefit from an improvement of the infrastructure between the two countries. These findings may be summarized as

**Proposition 1** *i) Departing from the uncoordinated equilibrium and holding constant all other policy instruments, a coordinated increase in corporate taxes increases the welfare of all member states of the union. ii) Departing from the uncoordinated equilibrium and holding constant all other policy instruments, a coordinated increase in intra-union infrastructure expenditure increases the welfare of all member states of the union.*

The results in proposition 1 have been derived under the assumption that coordination in one policy field does not affect the way in which policies are set in other fields. However, as discussed in the introduction, there are concerns that policy coordination in the field of infrastructure provision may affect policies pursued by countries in the field of tax policy, where they are not bound by coordination agreements. We therefore consider the following policy experiment: There is a coordinated change in infrastructure expenditure by  $d\theta_A^{AB} = d\theta_B^{AB} = d\theta^{AB}$ , but national governments may react to this coordination by adjusting their tax policies as they like. The effect of infrastructure coordination on the welfare of the representative household residing in country  $A$  is now given by

$$du_A = \frac{\partial u_A}{\partial \theta_A^{AB}} d\theta_A^{AB} + \frac{\partial u_A}{\partial \theta_B^{AB}} d\theta_B^{AB} + \frac{\partial u_A}{\partial t_A} dt_A + \frac{\partial u_A}{\partial t_B} dt_B \quad (25)$$

Since  $\frac{\partial u_A}{\partial \theta_A^{AB}} = \frac{\partial u_A}{\partial t_A} = 0$  holds in the uncoordinated equilibrium, we can rewrite the above equation as:

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} + \frac{\partial u_A}{\partial t_B} \frac{dt_B}{d\theta^{AB}} \quad (26)$$

Total differentiation of (17) and (18) yields

$$\frac{dt_A}{d\theta^{AB}} = \frac{2}{3} \left[ - (n_B - 1) \frac{(\alpha - w - k_{AB})}{2\beta} - \frac{2 + n_B}{8\beta} \right] \frac{\partial k_{AB}}{\partial \theta^{AB}} \quad (27)$$

$$\frac{dt_B}{d\theta^{AB}} = \frac{2}{3} \left[ (n_B - 1) \frac{(\alpha - w - k_{AB})}{2\beta} - \frac{1 + 2n_B}{8\beta} \right] \frac{\partial k_{AB}}{\partial \theta^{AB}} \quad (28)$$

For the case of symmetric countries, we get  $\frac{dt_A}{d\theta^{AB}} = \frac{dt_B}{d\theta^{AB}} = -\frac{1}{8\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0$ . Here, an increase in  $\theta^{AB}$  decreases equilibrium tax rates. Thus, we can rewrite equation (26) as

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} - \frac{\partial u_A}{\partial t_B} \frac{1}{8\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \quad (29)$$

where  $\frac{\partial u_A}{\partial \theta_B^{AB}}, \frac{\partial u_A}{\partial t_B} > 0$  has been demonstrated above and  $\frac{\partial k_{AB}}{\partial \theta^{AB}} < 0$ . For country B, we get, accordingly,

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_B}{\partial \theta_A^{AB}} - \frac{\partial u_B}{\partial t_A} \frac{1}{8\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \quad (30)$$

We may thus state

**Proposition 2** *A coordinated increase in intra-union infrastructure expenditure, departing from the uncoordinated equilibrium, mitigates tax competition and unambiguously increases welfare if countries A and B are of equal size.*

The explanation for the result in proposition 1 is as follows: One reason to cut taxes in this model is that attracting production plants reduces consumer prices in the country. However, this benefit declines if the infrastructure improves and transport costs are smaller. Therefore countries increase taxes when the infrastructure is improves.

What happens if countries A and B are asymmetric? If  $n_B$  is sufficiently small, the term in square brackets in (27) may become positive, so that the r.h.s. of this equation becomes negative. This is given at

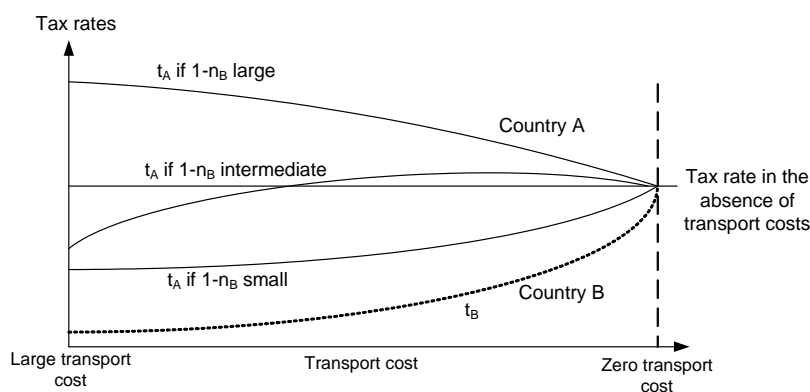
$$n_B < 1 - \frac{1}{2(\alpha - w - k_{AB}) + \frac{1}{2}} \quad (31)$$

In this case, country A reacts by reducing its tax rate while B increases it. This may be stated as

**Proposition 3** *If country B is sufficiently small relative to A, a coordinated increase in intra-union infrastructure expenditure, departing from the uncoordinated equilibrium, induces country A to reduce its tax rate whereas B increases its tax rate.*

The explanation for this asymmetric reaction is the following. As discussed above, a reduction in transport costs has two effects: Firstly, it reduces the cost of not attracting the firm, i.e. reduces the country's willingness to pay for the marginal firm. This c.p. increases tax rates. Secondly, the reduction in transport costs reduces the location advantage of the large country relative to the small country and, thus, the firms' willingness to pay for the proximity to consumers. Accordingly, if  $A$  is much larger than  $B$ , the increase in infrastructure induces firms to relocate from country  $A$  to country  $B$ . This implies that the corporate tax base in  $A$  declines whereas it increases in  $B$ . If this effect overcompensates the first one, country  $A$  reacts to the decline in transport costs by cutting its tax rate, and country  $B$  does the opposite.

As equation (31) shows, the cut-off level of  $n_B$ , at which the large country's tax rate declines in response to decreasing transport costs, depends negatively on the transport cost  $k_{AB}$  itself. This implies that there is a range of values of  $n_B$  for which taxes are increased at high levels of transport costs and reduced for low levels of  $k_{AB}$ . Figure 5 illustrates the tax rate responses to decreasing transport cost. For all levels of  $n_B$  country  $B$ 's tax rate is increased.<sup>10</sup> If  $n_B < 1$ , the tax rate of country  $A$  is larger than the tax rate of country  $B$ . If the difference in population size is small, decreasing transport costs increase the tax rate  $t_A$  (lower curve). If  $n_B$  is much lower than unity,  $t_A$  decreases if  $k_{AB}$  is reduced. If  $n_B$  is in the above mentioned intermediate range,  $t_A$  increases for large levels of  $k_{AB}$  and is decreased thereafter.



<sup>10</sup>Of course, for changing values of  $n_B$  the response function changes its shape, but has always a positive slope. For purpose of presentation, only one response curve is depicted.

Figure 5: Convergence pattern of tax rates.

If the transport cost is zero, country size does not play a role for tax policy. The cut-off level  $\Delta^*$  is reduced to  $\Delta^* = t_A - t_B$ , and tax rates are given by  $t_A = \frac{\gamma}{\zeta(s^*)} \int_{s^*}^1 \zeta(s) ds$  and  $t_B = \frac{\gamma}{\zeta(s^*)} \int_0^{s^*} \zeta(s) ds$ . Therefore, if the shape of the fixed cost function is symmetric, then both countries have equal tax rates although they are of different size (see figure 5). Thus, we may state

**Proposition 4** *Decreasing transport costs lead to tax policy convergence rather than a race to the bottom.*

This result is interesting from a policy point of view. Recalling the 'Schröder hypothesis' (see introduction), it is true that, in the asymmetric scenario, firms relocate to the small country in response to a coordinated increase in infrastructure provision. However, both countries' tax policy reactions mitigate the extent of firm relocation, rather than reinforcing it. In other words, providing Poland with the opportunity to react to improved infrastructure will not increase the pressure on German tax rates, but reduce it.

### 4.3 Optimal union-periphery infrastructure policies

Now, consider the expenditures for infrastructure which links union countries  $A$  and  $B$  to the peripheral country  $C$ . Optimal infrastructure expenditures  $\theta_A^{AC}$  are

$$\frac{\partial u_A}{\partial \theta_A^{AC}} = -1 - \left( \frac{k_{AB}}{8\beta} + t_A \right) n_C \frac{\alpha - w - k_{AC}}{2\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \frac{\zeta(s^*)}{\gamma} = 0 \quad (32)$$

Equivalently, optimal infrastructure expenditures  $\theta_B^{BC}$  are given by

$$\frac{\partial u_B}{\partial \theta_B^{BC}} = -\frac{1}{n_B} - \left( \frac{k_{AB}}{8\beta} + t_B \right) n_C \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \frac{\zeta(s^*)}{\gamma} = 0 \quad (33)$$

Again, we start by considering the effect of a coordinated increase in infrastructure expenditure, holding all other policy variables constant. With  $\frac{\partial u_A}{\partial \theta_A^{AC}} = 0$

and  $d\theta_A^{AC} = d\theta_B^{BC} = d\theta^C$ , the welfare change for country  $A$  is determined by the derivative

$$\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial \theta_B^{BC}} = \left( \frac{k_{AB}}{8\beta} + t_A \right) n_C \frac{\alpha - w - k_{BC}}{2\beta} \frac{\zeta(s^*)}{\gamma} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} < 0. \quad (34)$$

This implies that a coordinated increase in infrastructure expenditures towards country  $C$  reduces the welfare of country  $A$ . The same result can be derived for  $B$ . There is overspending on infrastructure because an individual country does not take into account that spending more on infrastructure to country  $C$  attracts firms from the other member country and thus negatively affects this country, as does a tax cut.

Taking into account an adjustment of tax rates, the overall welfare change can be expressed as

$$\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial \theta_B^{BC}} + \frac{\partial u_A}{\partial t_B} \frac{dt_B}{d\theta^C} \quad (35)$$

Following the same procedure as before, we can derive

$$\frac{dt_A}{d\theta^C} = \frac{n_C}{6\beta} \left( (\alpha - w - k_{BC}) \frac{\partial k_{BC}}{\partial \theta_B^{BC}} - (\alpha - w - k_{AC}) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \right) \quad (36)$$

$$\frac{dt_B}{d\theta^C} = -\frac{n_C}{6\beta} \left( (\alpha - w - k_{BC}) \frac{\partial k_{BC}}{\partial \theta_B^{BC}} - (\alpha - w - k_{AC}) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \right) \quad (37)$$

Under perfect symmetry, variations in  $\theta_A^{AC}$  and  $\theta_B^{BC}$  have no impact on the equilibrium tax rates. Thus, equation (35) can be rewritten as

$$\frac{du_A}{d\theta^C} = \left[ \frac{2}{3} (\alpha - w - k_{BC}) \frac{\partial k_{BC}}{\partial \theta_B^{BC}} + \frac{1}{3} (\alpha - w - k_{AC}) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \right] \left( \frac{k_{AB}}{8\beta} + t_A \right) \frac{n_C \zeta(s^*)}{2\beta \gamma} < 0 \quad (38)$$

Note, that under perfect symmetry, this equation boils down to the expression in (34). Equivalently, we can derive the welfare effect for country  $B$ :

$$\frac{du_B}{d\theta^C} = \left[ \frac{2}{3} (\alpha - w - k_{AC}) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} + \frac{1}{3} (\alpha - w - k_{BC}) \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \right] \left( \frac{k_{AB}}{8\beta} + \frac{t_B}{n_B} \right) \frac{n_C \zeta(s^*)}{2\beta \gamma} < 0 \quad (39)$$

We summarize this in

**Proposition 5** *A coordinated increase of expenditures in infrastructure which links the union with the periphery unambiguously decreases welfare. Under perfect symmetry, tax competition is not affected, though.*

So far, we have assumed that competition takes place between the two union countries. We now turn to the analysis of competition between a union country and the non-union country  $C$ .

## 5 Tax and infrastructure competition between union and non-union countries

The analysis in the preceding section shows that transport-cost reducing investment in infrastructure may mitigate tax competition *within* the union. However, competition for foreign direct investment may also occur between union countries and non-union countries. In this section, we explore if accounting for competition between union and non-union countries changes our results. Therefore, we now assume that country  $A$  and the non-union country  $C$  compete for firms. This is the case if, for all  $s$ , the location-specific profits are higher in either of the two countries than in country  $B$ , which may be due to high transport costs, a low number of inhabitants or low location-specific cost disadvantages  $\Delta$ . The results apply, however, equally for competition between  $B$  and  $C$ .

Therefore, replace (10) by

$$\Pi_C(s) = \frac{1}{4\beta} (\alpha - w - k_{AC})^2 + \frac{n_B}{4\beta} (\alpha - w - k_{BC})^2 + \frac{n_C}{4\beta} (\alpha - w)^2 - F_A - \Delta_C(s) - t_A \quad (40)$$

where  $\Delta_C$  is the additional fixed cost in country  $C$ , and (11) by

$$\Delta_C^* = \frac{n_C - 1}{4\beta} [2k_{AC}(\alpha - w) - k_{AC}^2] + (k_{AB} - k_{BC}) \frac{n_B}{4\beta} [2(\alpha - w) - (k_{AB} + k_{BC})] + t_A - t_C \quad (41)$$

Thus, an individual firm prefers  $A$  to  $C$  if  $\Pi_A > \Pi_C$  or if  $\Delta_C > \Delta_C^*$ .

The utility of the representative household in country  $A$  is given by

$$u_A = \int_{s^*}^1 \frac{\alpha - w}{8\beta} \zeta(s) ds + \int_0^{s^*} \frac{\alpha - w - k_{AC}}{8\beta} \zeta(s) ds + w_A + t_A \int_0^{s^*} \zeta(s) ds - \sum_k \theta_A^k \quad (42)$$

The only change compared to the case considered in the preceding section is that consumer surplus is now reduced by the transport costs  $k_{AC}$  instead of  $k_{AB}$ .

The representative household's utility level in country  $B$  is equal to

$$u_B = \int_{s^*}^1 \frac{\alpha - w - k_{AB}}{8\beta} \zeta(s) ds + \int_0^{s^*} \frac{\alpha - w - k_{BC}}{8\beta} \zeta(s) ds + w_B - \sum_k \frac{\theta_B^k}{n_B} \quad (43)$$

Households in country  $B$  are indifferent between importing goods from  $A$  and  $C$  as long as the transport costs  $k_{AB}$  and  $k_{BC}$  are equal.

Finally, consider the the representative household in country  $C$  whose utility is given by

$$u_C = \int_{s^*}^1 \frac{\alpha - w - k_{AC}}{8\beta} \zeta(s) ds + \int_0^{s^*} \frac{\alpha - w}{8\beta} \zeta(s) ds + w_A + \int_0^{s^*} \frac{t_C}{n_C} \zeta(s) ds. \quad (44)$$

In the uncoordinated equilibrium, countries  $A$  and  $C$  will set tax rates according to  $\frac{\partial u_A}{\partial t_A} = 0$  and  $\frac{\partial u_C}{\partial t_C} = 0$ , and the union countries will determine their infrastructure expenditures according to  $\frac{\partial u_A}{\partial \theta^{AB}} = 0$  and  $\frac{\partial u_B}{\partial \theta^{AB}} = 0$ . It is straightforward to show that  $\frac{du_A}{d\theta^{AB}} = \frac{du_B}{d\theta^{AB}} = 1$  and  $\frac{\partial u_A}{\partial \theta^{AB}} = \frac{\partial u_B}{\partial \theta^{AB}} = \frac{1}{n_B}$ , if tax rates are held constant. This implies that coordination in intra-union infrastructure has unambiguously positive welfare effects. What is the welfare effect of a coordinated increase in  $\theta_A^{AB}$  and  $\theta_B^{AB}$  if tax rates in countries  $A$  and  $C$  are allowed to adjust?

Consider firstly country  $A$ . The effect of a coordinated increase in  $\theta_A^{AB}$  and  $\theta_B^{AB}$  on its welfare is given by

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta^{AB}} + \frac{\partial u_A}{\partial t_C} \frac{dt_C}{d\theta^{AB}} \quad (45)$$

The appendix shows that coordination in  $\theta^{AB}$  affects tax rates asymmetrically:

$$\frac{dt_A}{d\theta^{AB}} = -\frac{2}{3} \frac{\partial \Delta^*}{\partial \theta^{AB}} = -\frac{2}{3} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \quad (46)$$

$$\frac{dt_C}{d\theta^{AB}} = \frac{2}{3} \frac{\partial \Delta^*}{\partial \theta^{AB}} = \frac{2}{3} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} < 0 \quad (47)$$

Whereas country  $A$  increases its tax rate in response to the coordinated increase in  $\theta^{AB}$ , country  $C$  lowers its tax rate. This result can be explained as follows. The increase in intra-union infrastructure expenditure makes country  $A$  a more attractive location because access to the market of  $B$  is improved. Country  $C$  becomes less attractive. This is why  $A$  increases its tax rate and  $C$  reduces it. With  $\frac{\partial u_A}{\partial t_C} = \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma}$ , it follows:

$$\frac{du_A}{d\theta^{AB}} = -\frac{1}{3} \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \quad (48)$$

which is unambiguously positive. Equivalently, we can derive  $\frac{du_B}{d\theta^{AB}} = \frac{\partial u_B}{\partial \theta^{AB}} + \frac{\partial u_B}{\partial t_A} \frac{dt_A}{d\theta^{AB}} + \frac{\partial u_B}{\partial t_C} \frac{dt_C}{d\theta^{AB}}$  with  $\frac{\partial u_B}{\partial t_A} = \frac{k_{AB} - k_{BC}}{8\beta} \frac{\zeta(s^*)}{\gamma} = -\frac{\partial u_B}{\partial t_C}$ :

$$\frac{du_B}{d\theta^{AB}} = -\frac{1}{8\beta} \int_{s^*}^1 \frac{\partial k_{AB}}{\partial \theta^{AB}} \zeta(s) ds - \frac{1}{3} \frac{\zeta(s^*)}{\gamma} \frac{k_{AB} - k_{BC}}{8\beta} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} \quad (49)$$

which is positive as long as  $k_{BC}$  is not too large in comparison to  $k_{AB}$ . We may summarize this in

**Proposition 6** *A coordinated increase in intra-union infrastructure expenditures unambiguously increases the welfare of country  $A$ . If  $k_{AB}$  is not too small compared to  $k_{BC}$ , then country  $B$  gains as well. Coordination increases the optimal tax rate in country  $A$  and decreases the optimal tax rate in  $C$ .*

Consider now the expenditures for infrastructure which links the union countries  $A$  and  $B$  to the peripheral country  $C$ . We analyze a small increase in  $\theta_A^{AC}$  in  $\theta_B^{BC}$  with  $d\theta_A^{AC} = d\theta_B^{BC} = d\theta^C$ . The appendix shows that this coordinated increase

has the following effects on tax rates:

$$\frac{dt_A}{d\theta^C} = -\frac{1}{8\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} + \frac{1}{3} n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} - \frac{1}{3} (n_C - 1) \left( \frac{\alpha - w - k_{AC}}{2\beta} + \frac{1}{8\beta} \right) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \quad (50)$$

and

$$\frac{dt_C}{d\theta^C} = -\frac{n_C}{8\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} - \frac{1}{3} n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} + \frac{1}{3} (n_C - 1) \left( \frac{\alpha - w - k_{AC}}{2\beta} + \frac{1}{8\beta} \right) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \quad (51)$$

The first terms on the r.h.s. of (50) and (51) are positive and reflect that the gain in consumer surplus from attracting additional firms declines as transport costs decline. This drives up tax rates. Secondly, the reduction in transport costs between country  $B$  and country  $C$  makes country  $C$  more attractive as a location for production, relative to  $A$ . As a result,  $C$  increases its tax rate and  $A$  reduces it. This is captured by the second terms on the r.h.s. of (50) and (51). Finally, if there are size differences,  $n_C \neq 1$ , tax rates are again asymmetrically affected by investment in  $\theta_A^{AC}$ .

Thus, the coordinated increase in union-periphery infrastructure investment affects the representative household's utility in  $A$  as follows  $\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial \theta_B^{BC}} + \frac{\partial u_A}{\partial t_C} \frac{dt_C}{d\theta^C}$  or

$$\begin{aligned} \frac{du_A}{d\theta^C} = & -\left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} \left[ \frac{n_C}{8\beta} - \frac{1}{3} (n_C - 1) \left( \frac{\alpha - w - k_{AC}}{2\beta} + \frac{1}{8\beta} \right) \right] \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \\ & + \frac{2}{3} \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \end{aligned} \quad (52)$$

The representative household's utility in country  $A$  is affected by the reduction in transport cost between  $A$  and  $C$ ,  $k_{AC}$ , and by lower transport costs between  $B$  and  $C$ ,  $k_{BC}$ . The former has a positive impact through higher tax rates in  $A$ . This is captured by the first term in square brackets, the second term corrects for size asymmetries. Lower levels of  $k_{BC}$ , in contrast, reduce the number of firms in country  $A$ . This is only partly compensated by higher tax rates in  $C$ . Thus, the overall effect is ambiguous, if both expenditure levels,  $\theta_A^{AC}$  and  $\theta_B^{BC}$ , are increased. If, however, the union countries agree on increasing  $\theta_A^{AC}$  and decreasing  $\theta_B^{BC}$  (or leaving  $\theta_B^{BC}$  unaffected), the welfare effect on country  $A$  is positive, at least for

$n_C \approx 1$ .

Country  $B$  is affected by the coordinated policies through reduced transport costs for imported goods from country  $C$  and price changes due to firm relocation between the competing countries.

$$\frac{du_B}{d\theta^C} = \frac{k_{AB} - k_{BC}}{8\beta} \frac{\zeta(s^*)}{\gamma} \frac{1}{3} \left[ (n_C - 1) \left( \frac{\alpha - w - k_{AC}}{2\beta} + \frac{1}{8\beta} \right) \frac{\partial k_{AC}}{\partial \theta_A^{AC}} - n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \right] \quad (53)$$

If transport costs  $k_{AB}$  and  $k_{BC}$  are equal, then the coordinated increase does not affect the welfare in country  $B$ . If these transport costs differ, the change in welfare of country  $B$  is also ambiguous. This may be summarized as

**Proposition 7** *A coordinated increase of investment in infrastructure which links the union with the periphery has an ambiguous impact on both welfare and tax rates.*

## 6 Discussion and concluding remarks

The analysis in this paper starts from the observation that the European Union supports investment in infrastructure which reduces the cost of transport between the member states. Our theoretical analysis has led to several results which require some discussion.

Firstly, the model shows that the member countries do have incentives to invest in infrastructure because this allows them to attract investment or improves the access of local consumers to goods produced in other countries. However, the uncoordinated interaction of national tax and infrastructure policies will lead to outcomes which are suboptimal for the union as a whole, as has already been stressed by Fuest and Huber (2006) and Behrens, Gaigne, Ottaviano and Thisse (2007) in the context of different models. In particular, national expenditures on intra-union infrastructure tend to be inefficiently low whereas expenditures on infrastructure linking the union countries with the periphery is likely to be inefficiently high. By increasing or decreasing the expenditure levels under consideration, the union corrects for spillovers of these policies.<sup>11</sup>

---

<sup>11</sup>Keen and Marchand (1997) argue in a different framework that countries will tend to spend

Secondly, and perhaps surprisingly, the reduction in mobility cost induced by more infrastructure investment mitigates tax competition in our model. Thus, the widespread view that tax competition is intensified as mobility costs decline may have to be qualified. Most importantly, the type of mobility matters. In the model, different types of mobility are at play. The parameter  $k_{AB}$  (as well as  $k_{AC}$  and  $k_{BC}$ ) denote mobility costs of goods, as opposed to the mobility costs of firms. The latter is implicitly captured by the parameter  $\gamma$ . As indicated above,  $\gamma$  determines how elastically firms react to policy changes, e.g.  $\partial s^*/\partial t_A = 1/\gamma$ . Here, if  $\gamma$  is large, tax rate changes only have a small effect on  $s^*$ , i.e. the number of firms leaving a country in response to a given tax increase is small. Of course, a reduction in  $\gamma$  has implications for tax competition.<sup>12</sup> However, as this paper's focus is on regional policy directed at reducing trade costs, we do not analyze the effects of variations in  $\gamma$  in greater detail. For a given level of firm mobility, though, an decrease in transport costs mitigates tax competition.<sup>13</sup> The reason is that part of the cost of a tax increase - the reduction in consumer surplus due to firm relocation - becomes smaller as transport costs decline.

Thirdly, the implication of coordinating infrastructure expenditures may be a kind of fortress building policy. As the theoretical model shows, a coordinated reduction in expenditures for infrastructure that links the union to non-union countries may be welfare-increasing. Section 5 even describes a case where expenditure reduction (by country  $B$ ) mitigates tax competition between ( $A$  and  $C$ ). The reason is that coordinated action of union countries is capable of reducing the attractiveness of the non-union country as a production location.

Fourthly, an overall conclusion from this analysis could be that certain types of EU regional policies may be justifiable from an economic point of view even

---

too much on infrastructure and too little on public consumption goods. The difference in results is due to the fact that there are no direct spillovers from infrastructure provision in their model, and tax rates are assumed to be held constant when infrastructure expenditure is coordinated.

<sup>12</sup>E.g., assuming symmetry, total differentiation of (17) yields  $dt_A/d\gamma = -\left(\frac{k_{AB}}{8\beta} + t_A\right) \frac{\zeta(s^*)}{\gamma^2} / \frac{\partial^2 u_A}{\partial t_A^2} > 0$ , which implies that a decline in firm mobility increases equilibrium tax rates, as one would expect.

<sup>13</sup>The idea that increasing mobility reduces tax competition is not completely new in the literature. Kessler, Luelfsmann and Myers (2002) show that, starting from a situation with integrated capital markets, an increasing integration of labor markets across borders may mitigate corporate tax competition.

if they have no measurable effect on growth or economic convergence. In our model, a coordinated increase of intra-union infrastructure may be beneficial for country  $B$  even though no (additional) firm locates there. The surplus of such policy measures is due to lower prices and/or higher tax rates (depending on the scenario). Taking into account the fortress building outcomes of policy coordination (see above), these benefits may come at the cost of decreasing welfare in non-EU countries, though.

## References

- Baldwin, R. E. and Krugman, P. (2004). Agglomeration, Integration and Tax Harmonisation, *European Economic Review* **48**(1): 1–23.
- Basile, R., Castellani, D. and Zanfei, A. (forthcoming). Location Choices of Multinational Firms in Europe: The Role of Cohesion Policy, *Journal of International Economics* .
- Behrens, K., Gaigne, C., Ottaviano, G. and Thisse, J.-F. (2007). Countries, Regions and Trade: On the Welfare Impacts of Economic Integration, *European Economic Review* **51**(5): 1277–1301.
- Black, D. A. and Hoyt, W. H. (1989). Bidding for Firms, *American Economic Review* **79**(5): 1249–1256.
- Boldrin, M. and Canova, F. (2001). Inequality and Convergence in Europe’s Regions: Reconsidering European Regional Policies, *Economic Policy* **32**: 205–45.
- Buch, C. M., Kleinert, J., Lipponer, A. and Toubal, F. (2005). Determinants and Effects of Foreign Direct Investment: Evidence from German Firm-Level Data, *Economic Policy* **41**: 51–98.
- Cremer, H. and Gahvari, F. (2000). Tax Evasion, Fiscal Competition and Economic Integration, *European Economic Review* **44**(9): 1633–1657.

- Devereux, M. P. (2007). The Impact of Taxation on the Location of Capital, Firms and Profit: A Survey of Empirical Evidence, *Oxford University Centre for Business Taxation Working Paper Series No. 07/2* .
- Devereux, M. P., Lockwood, B. and Redoano, M. (forthcoming). Do Countries Compete over Corporate Tax Rates?, *Journal of Public Economics* .
- European Commission (2003). *The Trans-European Transport Network: New Guidelines and Financial Rules - The Commission's Proposals*, Bruxelles.
- European Commission (2005). *Trans-European Transport Network - TEN-T Priority Axes and Projects*, Bruxelles.
- European Commission (2007a). *EU Budget 2006 Financial Report*, Bruxelles.
- European Commission (2007b). *Growing Regions, Growing Europe - Fourth Report on Economic and Social Cohesion*, Bruxelles.
- Fuest, C. (1995). Interjurisdictional Competition and Public Expenditure: Is Tax Co-ordination Counterproductive?, *FinanzArchiv* **52**(4): 478–96.
- Fuest, C. (2005). Economic Integration and Tax Policy with Endogenous Foreign Firm Ownership, *Journal of Public Economics* **89**(9-10): 1823–1840.
- Fuest, C. and Huber, B. (2006). Can Regional Policy in a Federation Improve Economic Efficiency?, *Journal of Public Economics* **90**(3): 499–511.
- Haaparanta, P. (1996). Competition for Foreign Direct Investments, *Journal of Public Economics* **63**(1): 141–153.
- Haufler, A. and Wooton, I. (1999). Country Size and Tax Competition for Foreign Direct Investment, *Journal of Public Economics* **71**(1): 121–139.
- Haufler, A. and Wooton, I. (2006). The Effects of Regional Tax and Subsidy Coordination on Foreign Direct Investment, *European Economic Review* **50**(2): 285–305.
- Hines, J. R. (1999). Lessons from Behavioral Responses to International Taxation, *National Tax Journal* **52**(2): 305–322.

- Keen, M. and Marchand, M. (1997). Fiscal Competition and the Pattern of Public Spending, *Journal of Public Economics* **66**(1): 33–53.
- Kessler, A. S., Luelfesmann, C. and Myers, G. M. (2002). Redistribution, Fiscal Competition, and the Politics of Economic Integration, *Review of Economic Studies* **69**(4): 899–923.
- Konrad, K. A. and Schjelderup, G. (1999). Fortress Building in Global Tax Competition, *Journal of Urban Economics* **46**(1): 156–167.
- Lahrèche-Révil, A. (2006). Who’s Afraid of Tax Competition? Harmless Tax Competition from the New European Member States, *CEPII Working Papers 2006-11*.
- Markusen, J. R. (2002). *Multinational Firms and the Theory of International Trade*, Massachusetts Institute of Technology, Cambridge, USA.
- Midelfart-Knarvik, K. H. and Overman, H. G. (2002). Delocation and European Integration: Is Structural Spending Justified?, *Economic Policy: A European Forum* **35**: 321–51.
- Overesch, M. and Rincke, J. (2008). Tax Competition in Europe 1980-2007 - Evidence from Dynamic Panel Data Estimation, *Working Paper*.
- Sørensen, P. B. (2004). International Tax Coordination: Regionalism versus Globalism, *Journal of Public Economics* **88**(6): 1187–1214.
- Ulltveit-Moe, K. H. (2007). Regional Policy Design: An Analysis of Relocation, Efficiency and Equity, *European Economic Review* **51**(6): 1443–67.
- Winner, H. (2005). Has Tax Competition Emerged in OECD Countries? Evidence from Panel Data, *International Tax and Public Finance* **12**(5): 667–687.

## 7 Appendix

This appendix prepares the results presented in section 5. Infrastructure investment has the following effect on firm location. Whereas reducing  $k_{AB}$  ( $k_{BC}$ ) increases (decreases) the number of firms in country A,  $\frac{\partial \Delta_C^*}{\partial \theta^{AB}} = n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}}$  and

$\frac{\partial \Delta_C^*}{\partial \theta_B^{BC}} = -n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}}$ , cost reducing investment  $\theta_A^{AC}$  only affect firm allocation if countries  $A$  and  $C$  differ in size,  $\frac{\partial \Delta_C^*}{\partial \theta_A^{AC}} = (n_C - 1) \frac{\alpha - w - k_{AC}}{2\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}}$ .

Tax effects on firm allocation are given by  $\frac{\partial s_{AC}^*}{\partial t_A} = \frac{1}{\gamma}$  and  $\frac{\partial s_{AC}^*}{\partial t_C} = -\frac{1}{\gamma}$ , see equation (41). Optimal tax policy strategies of countries  $A$  and  $C$  are implied by<sup>14</sup>

$$\begin{aligned} \frac{\partial u_A}{\partial t_A} &= \int_{s^*}^1 \zeta(s) ds - \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} = 0 \\ \frac{\partial u_C}{\partial t_C} &= \frac{1}{n_C} \int_0^{s^*} \zeta(\Delta) d\Delta - \left( \frac{k_{AC}}{8\beta} + \frac{t_C}{n_C} \right) \frac{\zeta(s^*)}{\gamma} = 0. \end{aligned}$$

Optimal intra-union infrastructure expenditures are given by

$$\begin{aligned} \frac{\partial u_A}{\partial \theta_A^{AB}} &= -1 - \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta_A^{AB}} = 0 \\ \frac{\partial u_B}{\partial \theta_B^{AB}} &= -\frac{1}{n_B} - \frac{1}{8\beta} \int_{s^*}^1 \frac{\partial k_{AB}}{\partial \theta_B^{AB}} \zeta(\Delta) d\Delta - \frac{k_{BC} - k_{AB}}{8\beta} \frac{\zeta(s^*)}{\gamma} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta_B^{AB}} = 0 \end{aligned}$$

Finally, consider the optimal levels of infrastructure expenditures  $\theta_A^{AC}$  and  $\theta_B^{BC}$ :

$$\begin{aligned} \frac{\partial u_A}{\partial \theta_A^{AC}} &= -1 - \int_0^{s^*} \frac{1}{8\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} \zeta(s) ds - \left( \frac{k_{AC}}{8\beta} + t_A \right) \frac{\zeta(s^*)}{\gamma} (n_C - 1) \frac{\alpha - w - k_{AC}}{2\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} = 0 \\ \frac{\partial u_B}{\partial \theta_B^{BC}} &= -\frac{1}{n_B} - \int_0^{s^*} \frac{1}{8\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \zeta(s) ds - \frac{k_{AB} - k_{BC}}{8\beta} \frac{\zeta(s^*)}{\gamma} n_B \frac{\alpha - w - k_{BC}}{2\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} = 0 \end{aligned}$$

The above equations are used to derive the equations presented in section 5.

---

<sup>14</sup>Note that the tax policy of country  $B$  can now be neglected because no firms in the  $x(s)$  sector locate in  $B$ .