EU Regional Policy and Tax Competition

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by

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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 of whether 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 analyse these questions using a model where 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

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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 factors of production. 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 of how EU infrastructure policies affect tax competition may be of crucial importance.[1] 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

[1] For instance, on a visit in Poland after its accession to the EU, on May 26th 2004, the German chancellor Gerhard Schröder 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 investment in infrastructure which reduces the transport costs to non-union countries. In this case, uncoordinated expenditures are too high from the perspective of the union, and the effect of infrastructure spending on tax competition within the union is ambiguous.

In the empirical literature on international taxation, the idea that decreasing mobility costs intensifies tax competition is taken for granted.[2] Tax competition is predicted to be strongest between neighboring countries. Indeed, proximity is a strong determinant for the location of investment by multinational investors, see e.g. Markusen (2002) or Buch (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 et al. (2008) do not account for the impact of distance and find significant evidence for tax competition, Overesch & Rincke (2008) show that the evidence becomes weak when distance is omitted from the regression equation.[3]

Apart from this, our paper is related to several distinct strands of literature. Firstly, there is a theoretical literature dealing with the regional policies of central governments in federal systems. Fuest & 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)

[2] See the surveys by Devereux (2007) and Hines (1999).

[3] Further evidence for tax competition is provided in Winner (2005) and Lahrèche-Révil (2006).

explores whether redistributive goals can be achieved by more efficient instruments than those used by the EU. Behrens et al. (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 & 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 & Gahvari (2000). Fourthly, there is a literature which analyzes interjurisdictional competition for profitable firms.[4] These contributions 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 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.[5] A final related strand of literature analyzes the effects of policy coordination in a subset of competing countries.[6] 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 concludes.

[4] See e.g. Black & Hoyt (1989), Haaparanta (1996), Haufler & Wooton (1999, 2006) and Fuest (2005).

[5] In so far, this literature builds on the New Trade Theory or New Economic Geography, see Baldwin & Krugman (2004).

[6] 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 & Schjelderup (1999) and Sørensen (2004).

2 Infrastructure expenditure and tax competition within the European Union

According to the EU, transport infrastructure investments contribute to achieving sustainable growth, which is one of the core objectives of EU policies. The Fourth Report on Economic and Social Cohesion by the European Commission (2007a) 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.

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 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. This corresponds 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.[7] Figure 1 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[8], 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*

[7] All data are taken from European Commission (2007b).

[8] http://ec.europa.eu/ten/transport/legislation/doc/2004_0884_en.pdf

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).

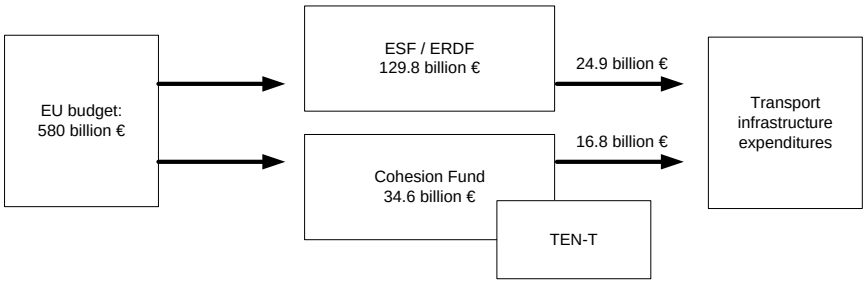

Figure 1: Financing transport infrastructures (2000-2006).

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.

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)[9] 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)

[9]This would explain why the evidence reported in some studies discussed in Boldrin & Canova (2001) is rather pessimistic about the effects of regional policy on convergence.

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 & 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 with links to Brussels and Cologne. For the whole list, see European Commission (2005). Thus, the EU seems to believe in the beneficial effect of infrastructure not 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 which allows to study these issues.

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. 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. Country C only plays the role of a market for goods produced by firms locating in the union. In section 5, we modify this setting and consider competition for firms between C and a union country (A).

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:

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

where α and β 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

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

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 transfer from the government (or a 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

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

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

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

and aggregate demand in country i is given by

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

3.2 Firms

The numeraire good z is produced by perfectly competitive firms using a linear production technology where labour is the only input. z is freely traded with negligible trade costs, so that wage costs are equalised across countries.[10]

The goods $x(s)$ are produced under imperfect competition and increasing returns to scale. Each variety s is produced by a monopolist firm. There is no entry or exit of firms, so that the number of firms is fixed. The production technology in the $x(s)$-sector is characterized by fixed costs F and constant marginal costs denoted by c. Due to the existence of prohibitive fixed costs for a second plant, each firm considers investment in just one of the three countries. The fixed costs F differ across firms and locations.[11] The fixed cost for all firms locating 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 $\Delta(s)$) of country B, which differs across varieties (and, hence, firms) s. We assume that s can be continuously mapped to $\Delta(s)$ with

[10] Thus, firm location has no impact on wages.

[11] For an analysis of tax competition in a similar setting with heterogeneity in fixed costs and free entry see Davies & Eckel (2007).

$\Delta(0) = \Delta^-$, $\Delta(1) = \Delta^+$ and $\partial\Delta/\partial s = \gamma$, where γ is a positive parameter.[12] The goods $x(s)$ can be shipped across borders, but there is a transport cost k between each pair of countries. The transport cost between countries i and j is denoted by k_{ij}. Transport costs within countries are assumed to be zero ($k_{ii} = 0$). Thus, each firm in the $x(s)$-sector consists of a production plant in one country and two export platforms (like in Ekholm et al., 2007) in the two other countries.

3.3 National governments and the union

In each union country, a benevolent government maximizes the utility of the representative household. There are two policy instruments. Firstly, there is a tax (or subsidy) per firm denoted by t_i. Considering a tax per firm, rather than a proportional profit tax is common in the literature, see e.g. Haufler & Wooton (1999, 2006), and makes the analysis more tractable but implies that our model abstracts from several aspects of real world tax systems.[13] The results of the following analysis have to be interpreted in the light of these limitations.

The second policy instrument is infrastructure investment θ_i^{ij}. Investment in infrastructure reduces trade costs k_{ij}. We assume $k_{ij} = k_{ij}\left(\theta_i^{ij}, \theta_j^{ij}\right)$ with $k_{\theta_i} < 0$, $k_{\theta_i\theta_i} > 0$. For simplicity, we assume that $k_{\theta_i\theta_j} = 0$. This implies that infrastructure expenditure can be targeted towards trade with particular countries. The underlying idea is that a country may, for instance, improve roads and railway links to one country and neglect the links to another country.

The public sector budget constraint is given by

$$T_i = t_i m_i - \sum_j \theta_i^{ij} \tag{6}$$

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

[12] In order to make sure that an interior equilibrium exists, we assume $\Delta^- < 0$.

[13] Firstly, governments may want to use tax policy to change the quantities of firms operating in imperfectly competitive markets. Accordingly, it may be optimal to subsidize inputs and tax the resulting monopolistic profits via a proportional profit tax. A tax per firm does not allow them to do so. Secondly, a tax per firm assumes away some complexities of the interaction between location decisions of firms, tax changes and public infrastructure investment, as we will explain further below.

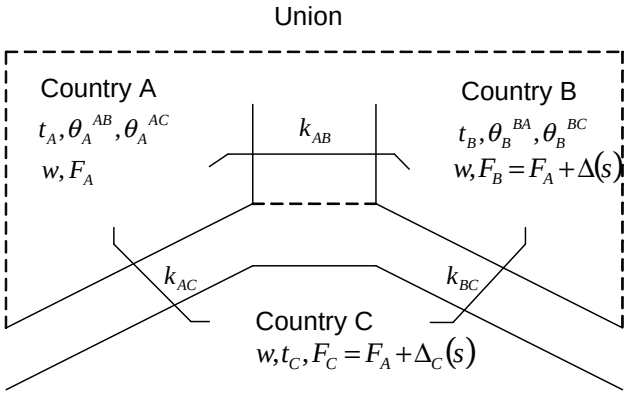

Figure 2: Illustration of the model.

Figure 2 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 union country and country C.

3.4 Equilibrium

The timing of decisions is as follows: At the first stage, countries simultaneously set θ_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 firms set their quantities to maximize profits. Let π_{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

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

Using (4), the profit-maximizing quantities imply

$$n_i x_{ij} = n_i \frac{\alpha - c_{ij}}{2\beta} \tag{8}$$

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.[14] 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 equilbrium where each of the two countries hosts some firms.[15] 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 difference. Firms with a fixed cost difference above Δ^* will prefer country A over country B, and vice versa, where Δ^* is given by

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

Note that if both countries are of equal size, $n_B = 1$, and if 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 taxes: $\Delta^* = t_A - t_B$.[16]

Figure 3 illustrates the firm allocation across countries. Firm varieties are indexed by $s \in [0, 1]$ where firms with a low index have low fixed costs of locating in B 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

[14] Since we do not allow firms to enter and exit the market, we have to assume that the non-negativity condition for profits $\Pi_A \geq 0$ always holds, which is satisfied if F_A is sufficiently low.

[15] The existence of such an interior solution requires Δ^- to be sufficiently small and Δ^+ to be sufficiently large.

[16] Note that this relationship, as well as the impact of taxes and infrastructure changes on location decisions, would be more complex and depend on the level of infrastructure expenditure if a proportional profit tax was considered, rather than a unit tax per firm.

all firms beneath s^* in country B. Policy measures which increase Δ^* decrease the number of firms in country A. The size of this effect depends crucially on the parameter γ which can be interpreted as a determinant of firm mobility. An increase of Δ^* by one unit translates into firm relocation ds of $1/\gamma$. The lower γ, the larger the elasticity of firm relocation with respect to policy changes.

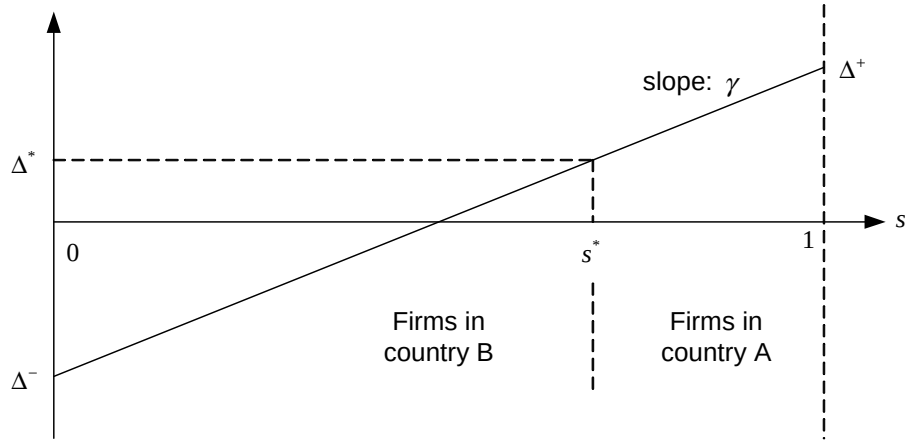

Figure 3: Allocation of firms across countries.

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):

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

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. $\Delta^* < 0$.[17] 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

[17] The role of country size asymmetries for intergovernmental competition is also explored in Kanbur & Keen (1993), who consider a model where consumers engage in cross border shopping. In their model, the small country levies lower taxes because, due to the smaller tax base, the cost of undercutting the other country is lower than for the large country.

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:

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

For the same reason, an improved infrastructure between B and C will attract more firms to country B:

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

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

4 Tax and infrastructure competition

Governments of both union countries set their tax policy to maximize the utility of the representative citizen while taking the tax policy of the other country as given. The objective function of the government of country A can be written as:

$$u_A = \int_{s^*}^{1} \frac{(\alpha - w)^2}{8\beta} \zeta(s)\, ds + \int_{0}^{s^*} \frac{(\alpha - w - k_{AB})^2}{8\beta} \zeta(s)\, ds + w_A + \int_{s^*}^{1} t_A \zeta(s)\, ds - \sum_k \theta_A^k \tag{15}$$

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

$$u_B = \int_{s^*}^{1} \frac{(\alpha - w - k_{AB})^2}{8\beta} \zeta(s)\, ds + \int_0^{s^*} \frac{(\alpha - w)^2}{8\beta} \zeta(s)\, ds + w_B + \int_0^{s^*} \frac{t_B}{n_B} \zeta(s)\, ds - \sum_k \frac{\theta_B^k}{n_B} \tag{16}$$

Note that a variation of s^* affects both countries differently:

$$\frac{\partial u_A}{\partial s^*} = -\left(\frac{\alpha - w - \frac{k_{AB}}{2}}{4\beta} k_{AB} + t_A \right) \zeta(s^*) < 0 \tag{17}$$

$$\frac{\partial u_B}{\partial s^*} = \left(\frac{\alpha - w - \frac{k_{AB}}{2}}{4\beta} k_{AB} + \frac{t_B}{n_B} \right) \zeta(s^*) > 0 \tag{18}$$

A marginal increase in s^* (which corresponds to the relocation of the marginal firm from A to B) affects consumer surplus negatively in A and positively in B, and it reduces tax revenue in A and increases it in B.

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

$$\frac{\partial u_A}{\partial t_A} = \int_{s^*}^{1} \zeta(s)\, ds + \frac{\partial u_A}{\partial s^*} \frac{1}{\gamma} = 0 \tag{19}$$

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 firm relocation to country B. Accordingly, the first order condition for the optimal tax rate of country B is given by

$$\frac{\partial u_B}{\partial t_B} = \frac{1}{n_B} \int_0^{s^*} \zeta(s)\, ds - \frac{\partial u_B}{\partial s^*} \frac{1}{\gamma} = 0 \tag{20}$$

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

The first order condition for the optimal infrastructure expenditure of country

A, θ_A^{AB}, is given by

$$\frac{\partial u_A}{\partial \theta_A^{AB}} = -1 - \int_0^{s^*} \frac{(\alpha - w - k_{AB})}{4\beta} \frac{\partial k_{AB}}{\partial \theta_A^{AB}} \zeta(s)\, ds + \frac{\partial u_A}{\partial s^*} \frac{\partial s^*}{\partial \theta_A^{AB}} = 0 \qquad (21)$$

The first term on the r.h.s. is the pecuniary cost of infrastructure expenditure. The second term is the gain due to lower transport costs which translates into lower consumer prices of products imported from B. The third term 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, see equation (12). The first order condition for the optimal investment of country B is

$$\frac{\partial u_B}{\partial \theta_B^{AB}} = -\frac{1}{n_B} - \int_{s^*}^1 \frac{(\alpha - w - k_{AB})}{4\beta} \frac{\partial k_{AB}}{\partial \theta_B^{AB}} \zeta(s)\, ds + \frac{\partial u_B}{\partial s^*} \frac{\partial s^*}{\partial \theta_B^{AB}} = 0 \qquad (22)$$

which can be interpreted similarly.[18]

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

$$du_A = \frac{\partial u_A}{\partial t_A} dt_A + \frac{\partial u_A}{\partial t_B} dt_B \qquad (23)$$

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

$$\frac{du_A}{dt} = \frac{\partial u_A}{\partial t_B} = -\frac{\partial u_A}{\partial s^*} \frac{1}{\gamma} > 0 \qquad (24)$$

[18] For the second order conditions to hold, the transport cost functions must be sufficiently convex in θ_A^{AB} and θ_B^{AB}. A derivation of the second order conditions is available from the authors on request.

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

$$\frac{du_B}{dt} = \frac{\partial u_B}{\partial t_A} = \frac{\partial u_B}{\partial s^*}\frac{1}{\gamma} > 0 \tag{25}$$

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 some firms to locate 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

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} = -\int_0^{s^*} \frac{(\alpha - w - k_{AB})}{4\beta}\frac{\partial k_{AB}}{\partial \theta_B^{AB}}\zeta(s)\, ds + \frac{\partial u_A}{\partial s^*}\frac{\partial s^*}{\partial \theta_B^{AB}} \tag{26}$$

Using equation (21) 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 infrastructure 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

$$du_A = \frac{\partial u_A}{\partial \theta_A^{AB}} d\theta_A^{AB} + \frac{\partial u_A}{\partial \theta_B^{AB}} d\theta_B^{AB} + \frac{\partial u_A}{\partial t_A} dt_A + \frac{\partial u_A}{\partial t_B} dt_B \tag{27}$$

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:

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} + \frac{\partial u_A}{\partial t_B} \frac{dt_B}{d\theta^{AB}} \tag{28}$$

Total differentiation of (19) and (20) yields

$$\frac{dt_A}{d\theta^{AB}} = -n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{29}$$

$$\frac{dt_B}{d\theta^{AB}} = -\frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{30}$$

The coordinated increase in θ^{AB} raises equilibrium tax rates. Thus, we can rewrite equation (28) as

$$\frac{du_A}{d\theta^{AB}} = -\left(\int_0^{s^*} \zeta(s)\, ds - 2\frac{n_B}{\gamma} \frac{\partial u_A}{\partial s^*} \right) \frac{\alpha - w - k_{AB}}{4\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{31}$$

The equivalent expression for country B is given by

$$\frac{du_B}{d\theta^{AB}} = -\left[\int_{s^*}^1 \zeta(s)\, ds + 2\frac{1}{\gamma} \frac{\partial u_B}{\partial s^*} \right] \frac{\alpha - w - k_{AB}}{4\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{32}$$

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.*

The result in proposition 2 is surprising because the increase in infrastructure spending increases the mobility of goods between countries A and B, and higher mobility is usually thought to intensify tax competition. But here it turns out that taxes increase. This can be explained 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 transport infrastructure is improved.

The model which leads to proposition 2 assumes that, in the absence of policy coordination, taxes and infrastructure expenditures are set simultaneously. An alternative setup would be a sequential approach as in King et al. (1993), where countries commit to infrastructure expenditure first and then set taxes at stage 2. It is straighforward to show that the key results of our analysis would also hold in this case. At stage 1, governments would take into account that an increase in their infrastructure expenditure would lead to higher taxes in the tax competition subgame at stage 2. But, acting individually, they would neglect i) the direct benefit of their infrastructure investment on the foriegn country and ii) the positive impact of their own higher domestic tax on the foreign country. Therefore, departing from an equilibrium without coordination, a coordinated increase in infrastructure expenditures at stage 1 would again increase taxes and union welfare.[19]

4.3 Optimal union-periphery infrastructure policies

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

$$\frac{\partial u_A}{\partial \theta_A^{AC}} = -1 + \frac{\partial u_A}{\partial s^*}\frac{n_C}{\gamma}\frac{\alpha - w - k_{AC}}{2\beta}\frac{\partial k_{AC}}{\partial \theta_A^{AC}} = 0 \tag{33}$$

Equivalently, optimal infrastructure expenditures θ_B^{BC} are given by

$$\frac{\partial u_B}{\partial \theta_B^{BC}} = -\frac{1}{n_B} - \frac{\partial u_B}{\partial s^*}\frac{n_C}{\gamma}\frac{\alpha - w - k_{BC}}{2\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}} = 0 \tag{34}$$

[19] A derivation of these effects is available from the authors on request.

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

$$\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial \theta_B^{BC}} = -\frac{\partial u_A}{\partial s^*}\frac{n_C}{\gamma}\frac{\alpha - w - k_{BC}}{2\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}} < 0. \tag{35}$$

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.

Proposition 3 *Departing from the uncoordinated equilibrium and holding constant all other policy instruments, a coordinated reduction of expenditures in infrastructure which links the union with the periphery increases union welfare (fortress building).*

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

$$\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial \theta_B^{BC}} + \frac{\partial u_A}{\partial t_B}\frac{dt_B}{d\theta^C} \tag{36}$$

Following the same procedure as before, we can derive

$$\frac{dt_A}{d\theta^C} = -n_C\frac{(\alpha - w - k_{AC})}{6\beta}\frac{\partial k_{AC}}{\partial \theta_A^{AC}} + n_C\frac{(\alpha - w - k_{BC})}{6\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}} \tag{37}$$

$$\frac{dt_B}{d\theta^C} = n_C\frac{(\alpha - w - k_{AC})}{6\beta}\frac{\partial k_{AC}}{\partial \theta_A^{AC}} - n_C\frac{(\alpha - w - k_{BC})}{6\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}} \tag{38}$$

These results imply that, departing from an asymmetric equilibrium, a coordinated increase on union-periphery infrastructure spending has an ambiguous effect on tax levels. This can be explained as follows. Assume, for instance, that the coordinated higher infrastructure spending strongly reduces the transport costs between A and C whereas the impact on the transport cost between B and C is negligible (i.e. $\frac{\partial k_{BC}}{\partial \theta_B^{BC}}$ is close to zero). In this case, country A would attract

more firms because the access to country C it offers improves relative to the access offered by country B. As a result, it would increase its tax whereas B would reduce it. In contrast, if A and B are symmetric, a simultaneous variation in θ_A^{AC} and θ_B^{BC} has no impact on the equilibrium tax levels.

How does the increase in infrastructure expenditure affect welfare? Equation (36) can be rewritten as

$$\frac{du_A}{d\theta^C} = -\frac{\partial u_A}{\partial s^*}\frac{n_C}{\gamma}\left[\frac{\alpha - w - k_{AC}}{6\beta}\frac{\partial k_{AC}}{\partial \theta_A^{AC}} + \frac{\alpha - w - k_{BC}}{3\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}}\right] < 0 \qquad (39)$$

Note that, if A and B are symmetric, this equation boils down to the expression in (35). Equivalently, we can derive the welfare effect for country B:

$$\frac{du_B}{d\theta^C} = \frac{\partial u_B}{\partial s^*}\frac{n_C}{\gamma}\left[\frac{\alpha - w - k_{AC}}{3\beta}\frac{\partial k_{AC}}{\partial \theta_A^{AC}} + \frac{(\alpha - w - k_{BC})}{6\beta}\frac{\partial k_{BC}}{\partial \theta_B^{BC}}\right] < 0 \qquad (40)$$

We summarize this in

Proposition 4 *Departing from the uncoordinated equilibrium and taking into account decentralized tax policy adjustments, a coordinated increase of expenditures in infrastructure which links the union with the periphery unambiguously decreases welfare. Its effect on equilibrium tax rates is ambiguous.*

The result that, from the perspective of the union, there is too much spending on infrastructure which links the union countries to the periphery can be explained as follows. Acting individually, union countries neglect that more infrastructure spending will attract firms from the other union country. This reduces tax revenue and consumer surplus in that country. If countries are asymmetric, the coordinated change in infrastructure will lead to tax changes, but as equations (39) and (40) show, these adjustment will not change the sign of the welfare effect.

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 Δ. The results apply, however, equally for competition between B and C.

Therefore, replace (10) by

$$\Pi_C(s) = \frac{1}{4\beta}(\alpha - w - k_{AC})^2 + \frac{n_B}{4\beta}(\alpha - w - k_{BC})^2 + \frac{n_C}{4\beta}(\alpha - w)^2 - F_A - \Delta_C(s) - t_A \tag{41}$$

where Δ_C is the additional fixed cost in country C, and (11) by

$$\Delta_C^* = \frac{n_C - 1}{4\beta}\left[2k_{AC}(\alpha - w) - k_{AC}^2\right] + (k_{AB} - k_{BC})\frac{n_B}{4\beta}\left[2(\alpha - w) - (k_{AB} + k_{BC})\right] + t_A - t_C \tag{42}$$

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

$$u_A = \int_{s^*}^{1} \frac{(\alpha - w)^2}{8\beta}\zeta(s)\,ds + \int_0^{s^*} \frac{(\alpha - w - k_{AC})^2}{8\beta}\zeta(s)\,ds + w_A + \int_{s^*}^{1} t_A\zeta(s)\,ds - \sum_k \theta_A^k \tag{43}$$

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

$$u_B = \int_{s^*}^{1} \frac{(\alpha - w - k_{AB})^2}{8\beta} \zeta(s)\, ds + \int_{0}^{s^*} \frac{(\alpha - w - k_{BC})^2}{8\beta} \zeta(s)\, ds + w_B - \sum_k \frac{\theta_B^k}{n_B} \tag{44}$$

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. This can be illustrated by considering a marginal increase in s^*:

$$\frac{\partial u_B}{\partial s^*} = \frac{\alpha - w - \frac{k_{AB}+k_{BC}}{2}}{4\beta} (k_{AB} - k_{BC})\, \zeta(s^*) \tag{45}$$

Country A profits from a relocation of the marginal firm from A to C (increasing s^*) if the transport cost from C is lower than from country A.

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

$$u_C = \int_{s^*}^{1} \frac{(\alpha - w - k_{AC})^2}{8\beta} \zeta(s)\, ds + \int_{0}^{s^*} \frac{(\alpha - w)^2}{8\beta} \zeta(s)\, ds + w_C + \int_{0}^{s^*} \frac{t_C}{n_C} \zeta(s)\, ds \tag{46}$$

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 $\frac{\partial u_A}{\partial \theta_A^{AB}} = 0$ and $\frac{\partial u_B}{\partial \theta_B^{AB}} = 0$. It is straightforward to show that $\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta_B^{AB}} = 1$ and $\frac{du_B}{d\theta^{AB}} = \frac{\partial u_B}{\partial \theta_A^{AB}} = \frac{1}{n_B}$, 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 θ_A^{AB} and θ_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 θ_A^{AB} and θ_B^{AB} on its welfare is given by

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial \theta^{AB}} + \frac{\partial u_A}{\partial t_C} \frac{dt_C}{d\theta^{AB}} \tag{47}$$

The appendix shows that coordination in θ^{AB} affects tax rates asymmetrically:

$$\frac{dt_A}{d\theta^{AB}} = -\frac{2}{3}\frac{\partial \Delta^*}{\partial \theta^{AB}} = -\frac{2}{3} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{48}$$

$$\frac{dt_C}{d\theta^{AB}} = \frac{2}{3}\frac{\partial \Delta^*}{\partial \theta^{AB}} = \frac{2}{3} n_B \frac{\alpha - w - k_{AB}}{2\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} < 0 \tag{49}$$

Whereas country A increases its tax rate in response to the coordinated increase in θ^{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 $\frac{\partial u_A}{\partial t_C} = -\frac{\partial u_A}{\partial s^*}\frac{1}{\gamma}$, it follows:

$$\frac{du_A}{d\theta^{AB}} = \frac{\partial u_A}{\partial s^*} \frac{n_B}{\gamma} \frac{\alpha - w - k_{AB}}{6\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} > 0 \tag{50}$$

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 $\frac{\partial u_B}{\partial t_A} = \frac{\partial u_B}{\partial s^*}\frac{1}{\gamma} = -\frac{\partial u_B}{\partial t_C}$:

$$\frac{du_B}{d\theta^{AB}} = -\left[\int_{s^*}^{1} \zeta(s)\, ds + \frac{2}{3}\frac{n_B}{\gamma}\frac{\partial u_B}{\partial s^*}\right] \frac{(\alpha - w - k_{AB})}{4\beta} \frac{\partial k_{AB}}{\partial \theta^{AB}} \tag{51}$$

which is positive as long as k_{BC} is not too large in comparison to k_{AB}, see equation (45). We may summarize this in

Proposition 5 *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 θ_A^{AC} in θ_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:

$$\frac{dt_A}{d\theta^C} = -n_C \frac{(\alpha - w - k_{AC})}{4\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} + n_B \frac{\alpha - w - k_{BC}}{6\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \tag{52}$$

and

$$\frac{dt_C}{d\theta^C} = -\frac{(\alpha - w - k_{AC})}{4\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} - n_B \frac{\alpha - w - k_{BC}}{6\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \tag{53}$$

The first terms on the r.h.s. of (52) and (53) 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 (52) and (53).

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

$$\frac{du_A}{d\theta^C} = \frac{\partial u_A}{\partial s^*} \frac{1}{\gamma} \left[\frac{(\alpha - w - k_{AC})}{4\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} - n_B \frac{\alpha - w - k_{BC}}{3\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \right] \tag{54}$$

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. 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, θ_A^{AC} and θ_B^{BC}, are increased. If, however, the union countries agree on increasing θ_A^{AC} and decreasing θ_B^{BC} (or leaving θ_B^{BC} unaffected), the welfare effect on country A is positive.

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: $\frac{du_B}{d\theta^C} = \frac{\partial u_B}{\partial \theta_A^{AC}} + \frac{\partial u_B}{\partial t_A} \frac{\partial t_A}{\partial \theta^C} + \frac{\partial u_B}{\partial t_C} \frac{\partial t_C}{\partial \theta^C}$ or

$$\frac{du_B}{d\theta^C} = \frac{\partial u_B}{\partial s^*} \frac{1}{\gamma} \left[(n_C - 1) \frac{\alpha - w - k_{AC}}{4\beta} \frac{\partial k_{AC}}{\partial \theta_A^{AC}} + n_B \frac{\alpha - w - k_{BC}}{3\beta} \frac{\partial k_{BC}}{\partial \theta_B^{BC}} \right] \tag{55}$$

If transport costs k_{AB} and k_{BC} are equal, then the coordinated increase does not affect the welfare in country B, which follows from (45). If these transport costs differ, the change in welfare of country B is also ambiguous. This may be summarized as

Proposition 6 *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 departs 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 individual 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 & Huber (2006) and Behrens et al. (2007), albeit in the context of different models and for different reasons. In particular, national expenditures on intra-union infrastructure are inefficiently low in our model whereas expenditures on infrastructure linking the union countries with the periphery are too high. By increasing or decreasing the expenditure levels under consideration, the union corrects for intra union spillovers of these policies.[20]

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

[20] Keen & Marchand (1997) argue in a different framework that countries will tend to spend 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.

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 γ. As indicated above, γ determines how elastically firms react to policy changes, e.g. $\partial s^*/\partial t_A = 1/\gamma$. Here, if γ 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 γ has implications for tax competition.[21] However, as this paper's focus is on regional policy directed at reducing trade costs, we do not analyze the effects of variations in γ in greater detail. For a given level of firm mobility, though, a decrease in transport costs mitigates tax competition.[22] 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 for the union. The non-union country would, however, be negatively affected by this type of coordination.

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 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 both countries 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 effects of policy coordination (see above), these benefits may come at the cost of decreasing welfare in non-EU countries, though.

[21] E.g., assuming symmetry, total differentiation of (19) yields $dt_A/d\gamma = \frac{\partial u_A}{\partial s^*}\frac{1}{\gamma^2}/\frac{\partial^2 u_A}{\partial t_A^2} > 0$, which implies that a decline in firm mobility increases equilibrium tax rates, as one would expect.

[22] The idea that increasing mobility reduces tax competition is not completely new in the literature. Kessler et al. (2002) show that, starting from a situation with integrated capital markets, an increasing integration of labor markets across borders may mitigate corporate tax competition.

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