The Impact of Economic (Dis)integration on Tax and Trade Policies*

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Abstract

In contrast to the multilateral process of economic integration, the disintegration of a country involves a unilateral exit from a multilaterally formed economic union. To dissect the effects of this partial disintegration on tax and trade policies, we set up a multi-country, multi-sector general equilibrium trade model with governments competing for a continuum of internationally mobile firms. We address the key dimensions of economic disintegration, such as trade costs, the harmonization of production standards and regulations, as well as household migration. Their effects on tax policies vary not only by countries but also by these dimensions. The model predicts that the leaving country's business tax rate declines. We document asymmetric effects on tax rates inside the remaining union. Third countries' ability to tax improves. When trade policy is endogenous, we predict that the countries inside the union integrate more with each other. That triggers additional downward pressure on the leaving country's tax rate.

Keywords: Tax/Subsidy Competition, Oligopolistic Markets, Economic Integration, Brexit
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1 Introduction

A great body of theoretical and empirical research suggests that countries lower their tax rates to attract internationally mobile capital, labor, and foreign direct investment. The ongoing globalization of the world economy is known to make production factors and firms more mobile across space and, as a result, has led to less progressive income tax schedules (Egger et al. (2019)) and lower tax rates on corporations (Dyreng et al. (2017)), which fuels fears of a "race to the bottom" of tax rates. Thus, a closely related strand of the literature, reviewed in more detail below, investigates the relation between regional tax rates and the dismantling of barriers to factor mobility and international trade.

However, recent movements towards disintegration, such as the UK's referendum decision to leave the European Union and US President Trump's threat in 2019 to leave the WTO, make it important to shed light on the effects of economic disintegration on taxes and trade policies: Will the United Kingdom become a tax haven after leaving the European Union? How will the remaining members of the EU react to compensate for the higher barriers to trade in goods and services? More generally, in how far is unilateral disintegration different from reverse integration? If disintegration were the opposite of integration, Brexit should lead to higher tax rates according to conventional wisdom. However, many believe that the UK would have to lower tax rates after Brexit to stay competitive, and this would also push down tax rates in the remaining EU countries. The possible consequences on tax policies from a possible exit of the US from the WTO are also not clear a priori. Because the US is a large market which foreign firms want to serve, higher barriers to trade between the US and the rest of the world could induce more inward FDI in the US, which could make higher taxes in the US possible, and lower tax rates elsewhere to prevent capital outflows.

To answer these types of questions, we need a model that has at least three countries, which may differ in size and have country-pair specific trade costs: One country which leaves an economic union of at least two other countries, perhaps engaging in regional integration with yet another country which was already outside the economic union (e.g., the UK forms a free trade area with the US after Brexit). In general, trade costs comprise tariffs, transportation costs, and other per-unit costs of shipping goods. We focus on the non-tariff part, which rises in case of economic disintegration.

In this paper, we develop a highly tractable general equilibrium trade model with a continuum of oligopolistic industries and competition over business tax rates between a set of at least three asymmetric countries. To keep the model analytically solvable, we adopt the idea of Fuest and Sultan (2019) that, in a given industry, firms can invest in only two out of several countries. The latter is inspired by the Ricardian idea of international specialization. Industries differ in terms of the country-pairs in which firms produce, as well as in the country-specific location fixed costs. Competition in tax rates arises from the fact that in each industry there is an internationally mobile firm in addition to immobile firms in both countries. Thereby, the country-specific fixed cost distribution over industries measures the elasticity of firm location, as it determines the firms' degree of attachment to a certain country. Economically, the relative fixed costs can be interpreted as the degree of similarity in regulations across countries that apply when setting up a firm. The parsimony in the modeling of firm mobility allows us to characterize in closed form each country's Nash equilibrium business tax policy as a function of country-pair specific trade costs, firm location fixed cost distributions, country sizes, and preferences. Moreover, using a first-order approach, we endogenize trade policy as an efficient bargaining outcome.

Partial economic disintegration is characterized by several counterfactual experiments. Most prominently, we deal with a rise in bilateral trade costs between a leaving country and the remaining member countries of an economic union. Secondly, we directly refer to economic disintegration as a change in the number of member countries. Moreover, we link the degree of economic integration to the elasticity of firm location in a given country and address household migration. Finally, we argue that the trade policy undertaken by the members of the economic union endogenously reacts to the exit of a member country.

We derive two sets of results. First, when the disintegration of a country from an economic union raises trade costs, the tax rate in the leaving country decreases. The effect on business tax rates set by the remaining member countries is ambiguous. When the union is relatively large compared to the rest of the world, the disintegration of one country softens tax competition inside the union. This will be the case when there is a strong single market with few competing markets. The contrary may be true when the economic union is small. Under considerable asymmetries in size, tax policy reactions within the union point in opposite directions. Since third countries outside the economic union become more attractive as a business location, their ability to tax improves. Furthermore, when the economic disintegration of a country reduces the degree of international harmonization in regulations, firms, which seek to relocate, face higher costs of mobility. Thus, in the short run, when this cost change is not anticipated, firms may become less mobile across countries which tends to raise tax rates in our model. Moreover, economic disintegration discourages investment in the leaving country because it would reduce the sum of future profits which can be realized in that country. We model this by a shift in the relocation cost distributions to the detriment of the leaving country.

Second, we go beyond the initial model setup in which trade costs are exogenously given and change mechanically with disintegration, and consider the situation in which trade costs are endogenously bargained over by countries initially. When one country leaves the union unexpectedly we predict that the countries inside the union integrate more with each other as a reaction to the disintegration of one country. This response triggers additional downward pressure on the business tax rate of the leaving country, whereas tax competition in the remaining member countries is reduced.

To anticipate some of the main intuition, let us consider a government in an arbitrary country

i which chooses a lump-sum business tax rate, t_i, to maximize revenues. The government faces a measure, k_i, of internationally mobile firms. Then, the optimal tax rate follows a simple inverse elasticity rule:

$$t_i = \frac{1}{\eta_i(\cdot)}$$

where $\eta_i(\cdot) := -\frac{1}{k_i}\frac{\partial k_i}{\partial t_i}$ denotes the semi-elasticity of firm relocation. Hence, to obtain, for example, the reaction of taxes to trade costs we only need to know how this sufficient statistic is affected. As we will see, the reaction of this elasticity to a change in a country's trade costs heavily depends on the underlying economic structure. As described below, large countries might enjoy a decrease in the relocation elasticity since firms become more attached to the large markets, whereas smaller countries suffer. A rise in the trade costs of third countries, however, lowers the semi-elasticity of firm relocation in country i allowing the government to tax more. When considering the effects of partial disintegration, several, potentially opposing, effects add up. Our model speaks to all of these channels and addresses how the resulting direction of tax policy depends on the underlying institutional structure of the economy.

Our results suggest that the UK might indeed become a tax haven after Brexit and that the effects on business taxes in the remainder of the EU crucially depend on the subsequent trade policy the remaining member countries undertake.

At the same time, our model is not limited to the case of Brexit. A similar argument applies to countries which consider leaving the World Trade Organization (WTO) as threatened by the Trump administration. When the US exits the WTO, our model predicts that the US would need to lower business taxes to compensate for the loss in attractiveness as a business location. A reverse argument holds for partial economic integration. Prominent examples were the 2004 and 2007 enlargement of the European Union with countries mostly from the former Eastern Bloc joining the EU. The dismantling of barriers to trade with the preexisting member countries improved market access for firms located in the joining countries such that the latter countries experienced a rise in their ability to tax corporations. Of course, as our model shows, this observation only holds for fixed trade policy, a given distribution of households across countries, and firm relocation elasticity. To give an example, if the free movement of workers in the EU causes citizens to emigrate from these Eastern European countries, their ability to tax may suffer as a consequence of the lost market size.

Our paper contributes to three strands of the literature. First of all, we add to the debate on inter-jurisdictional tax competition. Usually, in this literature, there are locally separated regions whose economic outcomes are linked through the mobility of capital (Zodrow and Mieszkowski (1986) and Wilson (1986)), labor (Lehmann et al. (2014)), or foreign direct investment (Haufler and Wooton (1999) and Haufler and Wooton (2006)). The presence of location rents incentivizes governments to modify their policy instruments, such as tax rates, to attract these factors. Just as our model, some of the papers, such as Bucovetsky (1991) and Haufler and Wooton (1999), can speak to the effects of cross-country asymmetries. We show that not only the relative size of a given market but also the institutional structure of the world economy heavily affects tax differentials. We follow the standard approach in this literature by assuming a stylized model that can be explicitly solved. Complementary, there is a more recent literature which tries to estimate the effects of tax or subsidy competition in quantitative economic geography models, such as Ossa (2015). So far, this quantitative literature has not addressed the link to economic integration very closely.

A related strand of the literature investigates the relation between regional tax rates and trade costs, e.g. Ottaviano and Van Ypersele (2005) and Haufler and Wooton (2010). In these two-country settings, a reduction in trade barriers makes it less important for a firm to set up an FDI platform in the larger market, as export costs to this market are lower and the firm can easily access both markets irrespective of its location. Domestic prices in the large market exhibit the Metzler paradox and tax competition diminishes for this country. Although some of the existing literature has addressed this link, no work endogenizes tax and trade policy in a model with more than two geographically linked regions. For example, in the three-country models of Raff (2004) and Cook and Wilson (2013), one country is presumed to be completely inactive. Darby et al. (2014) consider a three-country model of tax policy and trade but two of the three markets are connected only through a hub region. Most recently, Fuest and Sultan (2019) assume partial mobility of capital and examine tax policies in a three-country model but ignore trade costs.

Finally, our paper relates to the literature on trade policy. As in Ossa (2011) and Bagwell and Staiger (2012), we deal with the effects of trade policy under firm relocation effects. However, these papers ignore the presence of non-cooperative tax policy which is the focus of our paper. For simplicity, we leave aside some of the important but for our purposes negligible trade-offs in the debate on optimal tariffs as in the classical Bagwell and Staiger (1999) approach. That is, we suppose that tariffs are abolished or by international agreements already regulated such that the revenue collection motive of tariffs is not of first order. Notice, however, that in the following analysis firm relocation and the degree of economic integration will affect the terms of trade.

This paper is structured as follows. In Section 2 we develop a multi-country trade model with tax competition. As we will see, tax policy heavily interacts with the degree of economic integration. In particular, we deal with the effects of trade costs, the number of member countries in an economic union, the elasticity of firm relocation, and the migration of households. In Section 3 we endogenize the trade policy inside the economic union which in turn affects tax policy. Section 4 concludes. All relevant proofs can be found in Appendix A.

2 A Model of Tax Competition and Partial Economic Disintegration

We analyze a three-stage game of fiscal competition with initially three countries, which we later extend to an arbitrary number of countries. First, taking trade policy as given each government sets a non-cooperative business tax rate, which maximizes national welfare consisting of consumer surplus and tax revenues. Fiscal competition arises from the assumption that in each industry, out of a continuum of oligopolistic industries, there is one internationally mobile firm (besides two immobile firms), which decides where to locate in the second stage. To simplify the exposition, we assume that, in a given industry, firms can invest in only two out of $K \geq 3$ countries. Industries differ in the pair of two countries, in which firms are active, as well as in the country-specific fixed costs of setting up a firm. In the last stage, in each industry firms produce in general equilibrium a good which can be traded across all jurisdictions.

We analyze partial economic (dis-)integration by carrying out comparative static analyses of the subgame-perfect equilibrium of this game. Specifically, the trade costs between any pair of countries depend on the level of economic integration between these two countries and thus may differ across country-pairs. Partial disintegration is captured by an increase in the trade cost of one country-pair. Moreover, we consider country-pair specific distributions of fixed cost for setting up a firm, which can be used to model partial (dis-)integration in an additional way. Finally, we deal with migration between countries as a simultaneous offsetting change in the population between a country-pair.

2.1 The Three-Country Model

We now describe the model more formally. The economy denoted as $\mathscr{E}$ comprises three stages. Let $\mathscr{K}$ denote the non-empty set of countries and $K := |\mathscr{K}| \in \mathbb{Z}^+$ its cardinality. In this section we consider $K = 3$, but in Section 2.3 we extend the model to K larger than 3. Figure 1 illustrates the three-country economy.

2.1.1 Households

In each country $i \in \mathscr{K}$ a number n_i of identical households consumes a continuum of differentiated varieties and a numéraire commodity, z_i, which is produced under perfect competition. Varieties, $x_i(\mu)$, are indexed by $\mu \in \Omega$. Labor is the only production input. Assuming that the numéraire good is produced in every country, the numéraire industry pins down a wage rate w which equalizes across countries. Each variety is produced in an oligopolistic industry which comprises three firms.[1]

[1] All the results carry over when one considers monopolists, which are mobile between two countries. To endogenize the degree of local competition with respect to firm relocation, we decide to conduct our main analysis under an oligopolistic market structure. Partial immobility of firms is assumed to maintain the tractability of the model.

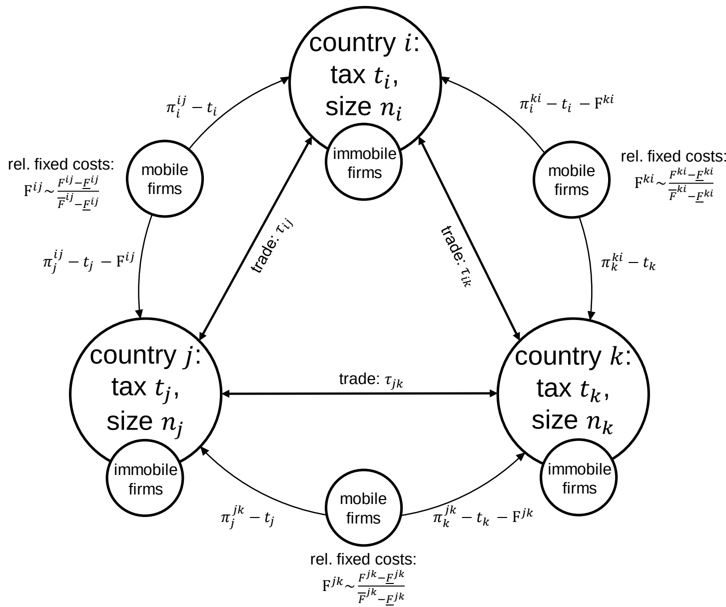

Figure 1: The three-country model

Households derive the following utility

$$u_i := z_i + \int_{\mu \in \Omega} (\alpha x_i(\mu) - \frac{\beta}{2} x_i(\mu)^2) d\mu \tag{1}$$

from the consumption of products manufactured by the numéraire and the oligopolistic industries. Observe that these preferences are a special case of those in Melitz and Ottaviano (2008).[2] Household income comes from supplying labor inelastically and from the return of business taxes collected by the government in lump sum fashion. The quadratic utility function generates a system of linear aggregate demand functions

$$X_i(\mu) = \frac{n_i(\alpha - p_i(\mu))}{\beta} \tag{2}$$

for each country and industry where $p_i(\mu)$ denotes the local consumer price.

2.1.2 Firms

Each firm in the x-industries faces a linear production function with labor as the only input. Exporting one unit of the consumption good from country j to i costs τ_{ij}, where $\tau_{ij} = \tau_{ji} \in \mathbb{R}^+$ and $\tau_{ii} = 0$, such that the marginal costs of production are given by $w + \tau_{ij}$. We interpret

[2] For simplicity, we shut down cross-price effects. As we will see, prices and mark-ups will be endogenous in the location decision of firms.

trade costs in a broader sense as the degree of economic integration. In particular, this refers to product and production standards such as consumer protection, labor rights, quality requirements, and environmental standards. Therefore, our definition of trade costs goes beyond the classical notion of tariffs, quotas, and transport cost differentials arising from geographical characteristics. For the time being, we assume trade costs to be exogenous, although subject to change with (dis)integration. Later we endogenize trade costs.

In order to avoid corner solutions, assume that $\tau_{ij} \leq \frac{\alpha - w}{3}$ for all i, j, so that trade flows are weakly positive in equilibrium. As Haufler and Wooton (2010), we assume, moreover, that firm profits do not accrue to residents in $\mathscr{K}$. Inspired by Melitz (2003), we introduce firm heterogeneity as follows: In each industry there are three firms. Two immobile firms are allocated to two countries (one in each country). Another, mobile firm can decide in which of the two countries to be located. In the third country, the production of that specific homogeneous good is not possible, perhaps due to technological, regulatory, or geographical frictions. This is in line with the Ricardian idea of international specialization. However, industries differ in which two of the three countries they can produce. Specifically, there are three types of industries. In an ij-industry, firms are active either in country i or j. jk- and ki-industries are defined accordingly. Throughout the analysis, superscripts will indicate the respective industry type. Moreover, industries differ in a relative fixed cost F^{ij} that the mobile firm pays when comparing the two possible locations, i.e. a firm pays F^{ij} more in country j than in i. This fixed cost can also be interpreted as the cost of relocating from country i to j. $F^{ij} \in \left[\underline{F}, \overline{F}\right]$ is drawn from a uniform cumulative distribution function $G\left(F^{ij}\right) = \frac{F^{ij} - \underline{F}}{\overline{F} - \underline{F}}$.[3] Altogether, each mobile firm pays different fixed costs of production giving rise to an extensive margin of business locations, which affects prices and production quantities.

A firm producing in country i and industry ij maximizes profits by choosing the sales in the home market, x_{ii}, and exports to j and k, x_{ji} and x_{ki}. The maximization problem in the third stage of our three-stage game is, therefore, defined as

$$\pi_i^{ij}(\mu) := \max_{x_{ii}, x_{ji}, x_{ki}} \left(p_i(\mu) - w\right) x_{ii}(\mu) + \left(p_j(\mu) - w - \tau_{ij}\right) x_{ji}(\mu) + \left(p_k(\mu) - w - \tau_{ik}\right) x_{ki}(\mu) \tag{3}$$

subject to the oligopolistic market structure. Then, pre-tax variable profits of a firm located in country i read as

$$\pi_i^{ij}(\mu) = \begin{cases} \frac{n_i(\alpha - w + \tau_{ij})^2}{16\beta} + \frac{n_j(\alpha - w - 2\tau_{ij})^2}{16\beta} + \frac{n_k\left(\alpha - w - 2\tau_{ik} + \tau_{jk}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, i \\ \frac{n_i(\alpha - w + 2\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha - w - 3\tau_{ij})^2}{16\beta} + \frac{n_k\left(\alpha - w - 3\tau_{ik} + 2\tau_{jk}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, j \end{cases} \tag{4}$$

given that the firm is in an ij- industry. The asymmetry in profits from markets j and k are the consequence of our assumption that in an ij industry there is an immobile firm present in country j that faces no trade cost in serving its own market, whereas in country k there is no domestic

[3] Here we impose symmetry in relocation cost distributions across countries. In Section 2.2.2, we relax this assumption.

firm active by construction. In country i firms are taxed lump-sum with rate t_i.

We now turn to the second stage, the location decision of mobile firms. The mobile firm in industry ij produces in country i as long as after-tax profits are larger in i than in j, i.e.

$$\pi_i^{ij}(\mu) - t_i \geq \pi_j^{ij}(\mu) - t_j - F^{ij}. \tag{5}$$

Put differently, a firm prefers country i if the advantage in gross profits is larger than the tax differential corrected by the relative fixed cost. Since we have a continuum of industries which differ in fixed costs, we can now characterize the mass of industries and firms in a country. For this, we define the following threshold industries which are indifferent between the two countries

$$\gamma^{ij} := \pi_j^{ij}(\mu) - t_j - \left(\pi_i^{ij}(\mu) - t_i\right), \quad \gamma^{ki} := \pi_i^{ki}(\mu) - t_i - \left(\pi_k^{ki}(\mu) - t_k\right) \tag{6}$$

In country i the mass of industries with one regional firm (i.e., one immobile firm) is given by

$$G\left(\gamma^{ij}\right) + \left[1 - G\left(\gamma^{ki}\right)\right], \tag{7}$$

where the first term refers to the industries where fixed costs in country j are relatively low compared to i, and similar for the second term, where fixed costs measure the cost in country i relative to k. The mass of industries with two regional firms (i.e., one mobile and one immobile firm) in i reads as

$$\left[1 - G\left(\gamma^{ij}\right)\right] + G\left(\gamma^{ki}\right), \tag{8}$$

Notice that goods produced by jk-industries are consumed in country i but there is no production in or relocation towards i, which greatly simplifies the analysis. In fact, mobility between more than two countries would make necessary extensive numerical simulations, as in Ossa (2015). Our concept of mobility allows us to write the threshold industry level in closed form as function of model parameters

$$\gamma^{ij} = (n_j - n_i)\frac{6\tau_{ij}(\alpha - w) - 3\tau_{ij}^2}{16\beta} + n_k(\tau_{ik} - \tau_{jk})\frac{6(\alpha - w) - 3(\tau_{ik} + \tau_{jk})}{16\beta} + t_i - t_j. \tag{9}$$

This yields intuitive partial equilibrium comparative statics with respect to tax rates

$$\begin{aligned} \frac{d\gamma^{ij}}{dt_i} &= 1 \\ \frac{d\gamma^{ij}}{dt_j} &= -1 \\ \frac{d\gamma^{ij}}{dt_k} &= 0 \end{aligned} \tag{10}$$

and trade costs

$$\begin{aligned}
\frac{d\gamma^{ij}}{d\tau_{ij}} &= 6\left(n_j - n_i\right)\frac{\alpha - w - \tau_{ij}}{16\beta} \begin{cases} > 0 & for\ n_j > n_i \\ < 0 & for\ n_j < n_i \end{cases} \\
\frac{d\gamma^{ij}}{d\tau_{ik}} &= 6n_k\frac{\alpha - w - \tau_{ik}}{16\beta} > 0 \\
\frac{d\gamma^{ij}}{d\tau_{jk}} &= -6n_k\frac{\alpha - w - \tau_{jk}}{16\beta} < 0
\end{aligned} \tag{11}$$

for $j \neq k$. Observing that the sign of $\frac{d\gamma^{ij}}{d\tau_{ij}}$ depends on the relative size of countries, already hints towards the key effects of economic disintegration: As described earlier, a rise in trade costs pushes firms to move to larger countries. For mobile firms, market access considerations become more important compared to business tax differentials.

2.1.3 Governments

In this subsection, we consider the first stage of our economy. That is, for given trade costs we derive Nash equilibrium tax rates set by benevolent social planners in each country, who take the effect of tax rates on location and output decisions of all firms and industries into account. Then, we consider several potential sources of asymmetries which emerge in our model, including trade costs and country sizes, and discuss how these affect tax policy.

Consider country i. We can compute the total number of firms (as opposed to the mass of industries) by adding equation 7 and two times equation 8 to get $3 - G\left(\gamma^{ij}\right) + G\left(\gamma^{ki}\right)$, and hence tax revenues $T_i := t_i\left(3 - G\left(\gamma^{ij}\right) + G\left(\gamma^{ki}\right)\right)$. Moreover, Appendix A.1 shows that consumer surplus is given by

$$\begin{aligned}
S_i :=& \underbrace{n_i\left(\frac{\left(3\alpha - 3w - \tau_{ij}\right)^2}{32\beta}\right)}_{:=\delta_i^{ij}} + G\left(\gamma^{ij}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha - 3w - 2\tau_{ij}\right)^2}{32\beta}\right) - \left(\frac{\left(3\alpha - 3w - \tau_{ij}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{ij}} \\
&+ \underbrace{n_i\left(\frac{\left(3\alpha - 3w - 2\tau_{ij} - \tau_{ik}\right)^2}{32\beta}\right)}_{:=\delta_i^{jk}} + G\left(\gamma^{jk}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha - 3w - \tau_{ij} - 2\tau_{ik}\right)^2}{32\beta}\right) - \left(\frac{\left(3\alpha - 3w - 2\tau_{ij} - \tau_{ik}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{jk}} \\
&+ \underbrace{n_i\left(\frac{\left(3\alpha - 3w - 2\tau_{ik}\right)^2}{32\beta}\right)}_{:=\delta_i^{ki}} + G\left(\gamma^{ki}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha - 3w - \tau_{ik}\right)^2}{32\beta}\right) - \left(\frac{\left(3\alpha - 3w - 2\tau_{ik}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{ki}} \\
=& G\left(\gamma^{ij}\right)\Delta_i^{ij} + G\left(\gamma^{jk}\right)\Delta_i^{jk} + G\left(\gamma^{ki}\right)\Delta_i^{ki} + \delta_i^{ij} + \delta_i^{jk} + \delta_i^{ki} + n_i w,
\end{aligned} \tag{12}$$

i.e. Δ_i^{ij}, Δ_i^{jk},Δ_i^{ki}, δ_i^{ij}, δ_i^{jk}, and δ_i^{ki} are defined as functions of the model's primitives

$$\Theta := \left(\alpha, \beta, w, \left(n_i\right)_{i\in\mathscr{K}}, \left(\tau_{ij}\right)_{i,j\in\mathscr{K}}, \underline{F}, \overline{F}\right).$$

The benevolent social planner in country i maximizes the sum of consumer surplus and tax revenues (recall that profits go to absentee owners), and therefore solves the following optimization problem

$$W_i := \max_{t_i} \; S_i + T_i \tag{13}$$

taking t_j and t_k as given. By the same token, welfare is maximized in countries j and k over t_j and t_k, respectively. Accordingly, we define the Nash equilibrium of the tax policy game as follows.

Definition 1. Consider economy $\mathscr{E}$ with $|\mathscr{K}| = 3$. The set of tax policies, $(t_i)_{i\in\mathscr{K}}$, location and output choices form a subgame-perfect Nash equilibrium, if

(1) consumers choose their demand to maximize utility, taking prices as given,

(2) oligopolistic firms maximize their profits over quantities, taking locations decisions of all firms and tax rates of all countries as given,

(3) mobile firms choose their location optimally, taking tax rates as given and anticipating how firms and consumers react optimally in their output and consumption decisions, and

(4) governments maximize welfare over taxes taking the other countries' tax rates as given, anticipating the behavior of firms and consumers as described in (1) – (3).

The first-order condition of the social planner problem yields reaction functions $t_i(t_j, t_k, \Theta)$ for each country i with $i \neq j, k$. As Appendix A.1 further shows, the reaction functions are linear in tax rates such that there is a unique intersection of the reaction functions, $t_i(\Theta)$ for $i \in \mathscr{K}$, forming the solution to the tax competition game. In the following, we consider the equilibrium of this game with three countries.

Lemma 1 summarizes comparative statics of taxes of this equilibrium with respect to trade costs and country sizes.

Lemma 1. *For any $i, j, k \in \mathscr{K}$ and $j, k \neq i$ the following general equilibrium comparative statics hold for t_i*

(a) with respect to country sizes

$$\frac{dt_i}{dn_i} = 3\tau_{ij}\frac{2(\alpha - w) - \tau_{ij}}{320\beta} + 3\tau_{ik}\frac{2(\alpha - w) - \tau_{ik}}{320\beta} > 0$$

$$\frac{dt_i}{dn_j} = 9\tau_{jk}\frac{2(\alpha - w) - \tau_{jk}}{320\beta} - 27\tau_{ij}\frac{2(\alpha - w) - \tau_{ij}}{320\beta} \begin{cases} > 0 & for\ \tau_{jk} \gg \tau_{ij} \\ < 0 & else \end{cases}$$

and

(b) with respect to trade costs

$$\frac{dt_i}{d\tau_{ij}} = 3\frac{\alpha - w - \tau_{ij}}{160\beta}(n_i - 9n_j) \begin{cases} > 0 & for\ n_i > 9n_j \\ < 0 & for\ n_i < 9n_j \end{cases}$$

$$\frac{dt_i}{d\tau_{jk}} = 9\frac{\alpha - w - \tau_{jk}}{160\beta}(n_j + n_k) > 0.$$

First of all, an increase in absolute market size, for instance induced by population growth in a country, raises that country's tax rate. The effect of a growing population in another country is less clear. Third country effects play a role, i.e. $\frac{d^2 t_i}{dn_j d\tau_{jk}} > 0$. The relationship between t_i and n_j is positive if the trade of country j with k is very costly compared to the one with country i. On the other hand, $\frac{dt_i}{dn_j} < 0$ if τ_{ij} and τ_{jk} are sufficiently similar. The same arguments hold for the effects of n_k on t_i. When i and j form an economic union, i.e. $\tau_{ik} = \tau_{jk} > \tau_{ij}$, an enlargement of market k reduces taxes inside the union.[4]

Moreover, higher trade costs between countries j and k unambiguously increase the tax rate in country i. Intuitively, the other countries lose attractiveness when their trade costs rise, which puts country i in the position to tax more. Vice versa, provided that country i is not too large higher trade costs for firms in i put additional pressure on i's government to lower the tax to attract firms. If country i is very large relative to j, $\frac{dt_i}{d\tau_{ij}}$ can be positive. An increase in τ_{ij} makes tax savings motives less relevant for the location choice of firms because these just want to have cheap access to the very large market. In other words, the tax base of country i becomes less elastic in response to a rise in τ_{ij}. However, one should note that the taxes in i and j cannot increase simultaneously, that is, there will always be a country which has to lower its tax rate.

Having dealt with these comparative statics, Corollary 1 immediately follows. It considers comparative statics of the (unweighted) average tax rates with respect to trade costs.

Corollary 1. *For any $i, j, k \in \mathscr{K}$ with $i \neq j \neq k$*

$$\frac{d\frac{1}{2}(t_i + t_j)}{d\tau_{ij}} = -12(n_i + n_j)\frac{\alpha - w - \tau_{ij}}{160\beta} < 0,$$

$$\frac{d\frac{1}{2}(t_i + t_k)}{d\tau_{ij}} = 3(2n_i - 3n_j)\frac{\alpha - w - \tau_{ij}}{160\beta}\begin{cases} > 0 & for\ n_i > 1.5n_j \\ < 0 & for\ n_i < 1.5n_j \end{cases},$$

and

$$\frac{d\frac{1}{3}\sum_{k\in\mathscr{K}} t_k}{d\tau_{ij}} = -5(n_i + n_j)\frac{\alpha - w - \tau_{ij}}{160\beta} < 0.$$

When bilateral trade costs between i and j increase, the average tax rate in these countries falls. The same holds for the average tax rate worldwide. The rise in τ_{ij} reduces economic activity worldwide and attracting firms to improve domestic prices becomes more important. The effect on the average tax rate in country i and a third country k is ambiguous. For instance, if $n_j > \frac{2}{3}n_i$, the positive reaction of t_k cannot compensate for the negative one of t_i.

[4] To see this, exchange indices j and k in the second line of Lemma 1 (a), and note that $\tau_{kj} = \tau_{jk}$.

2.2 The Impact of Partial Disintegration on Tax Policy

In the following, we will consider several channels through which economic disintegration affects tax policy. First and foremost, the costs of bilateral trade between countries change. Moreover, economic disintegration alters the international mobility of firms via location fixed cost. Finally, we deal with the possible migration of households.

2.2.1 Trade Costs

Suppose now that countries i and j are in an economic union. What happens to taxes when trade between country k and the economic union becomes more (or alternatively less) costly? As Proposition 1 shows, the answer depends on the relative sizes of the three markets. It trivially follows from Lemma 1.

Proposition 1 (trade cost changes). *Suppose that $\tau := \tau_{ik} = \tau_{jk}$ for $i, j, k \in \mathscr{K}$ and $i \neq j, k$. Then, partial disintegration of country k via a rise in bilateral trade costs with countries i and j has the following tax effects*

(a)

$$\frac{dt_i}{d\tau_{ik}} + \frac{dt_i}{d\tau_{jk}} = 3\frac{\alpha - w - \tau}{160\beta}(n_i + 3n_j - 6n_k) \begin{cases} > 0 & for\ n_i + 3n_j > 6n_k \\ < 0 & for\ n_i + 3n_j < 6n_k \end{cases}$$

and

(b)

$$\frac{dt_k}{d\tau_{ik}} + \frac{dt_k}{d\tau_{jk}} = 3\frac{\alpha - w - \tau}{160\beta}(2n_k - 9n_i - 9n_j) \begin{cases} > 0 & for\ 2n_k > 9n_i + 9n_j \\ < 0 & for\ 2n_k < 9n_i + 9n_j \end{cases}.$$

Under symmetric population sizes of all three countries, partial disintegration reduces tax rates in all countries.

When countries have the same size ($n_i = n_j = n_k$), the tax rate in the leaving country declines. The same holds if it is not too large relative to the economic union, asshown in (b). This result is driven by the market access effect described above.

Under symmetric market sizes, tax rates in the remaining economic union decrease (see (a)). In case that the leaving country is large (small) relative to the economic union, tax rates decline (rise). Notice that by (a) the reaction of taxes inside the economic union can be asymmetric depending on the relative size of the two markets. Let j be the larger market. Observe that the increase in trade costs with country k may help the smaller country i to tax more, whereas the larger country j needs to lower its taxes. Country j still taxes more than i but tax rates converge as a reaction to the disintegration of k.

Proposition 1 is our first main result. It speaks to the hypothesis that after Brexit the UK lowers its tax rate and this, in turn, puts pressure on the tax policy of countries inside the union.

Taking the populations of the UK and France (which is very similar at 66 and 67 million) and Germany at 83 million, a UK departure from a union among these three countries would lead to lower taxes in all countries according to our admittedly simple model. The hypothetical exit of a somewhat smaller country like Spain (47 million) from a joint union with France and Germany, however, would lead to an increase in tax rates in France (while still lowering taxes in the other two countries).

2.2.2 Firm Mobility Cost Distributions

So far, we have considered asymmetries which directly affected production choices by firms, that is, the intensive margin of firm decisions. Through pre-tax profit differentials, these asymmetries indirectly also change cutoff industries, which is the extensive margin of firms. By contrast, we now consider the direct effects of economic disintegration on firm location. Recall that a firm in industry ij locates in country i only if $\pi_i^{ij}(\mu) - t_i \geq \pi_j^{ij}(\mu) - t_j - F_{ij}$. That is, the firm has to cover a location cost which is drawn from a cost distribution. This cost distribution may differ between country-pairs. Note that these cost distributions are nothing else than a measure for relocation elasticities, which vary origin-destination-wise. Relocation within the union is easier than from inside to the outside of the union. This is another dimension of economic integration. Namely, it describes the degree of harmonization or mutual acceptance of production standards and other business regulations two countries have reached. One should note that through this channel economic integration tends to intensify tax competition, as it simplifies firm relocation and, hence, makes tax bases more elastic. This mechanism has been extensively studied in the tax competition literature. However, the existing literature is silent about what happens to taxes when one country leaves an economic union and, as a result, faces a less elastic tax base.

We operationalize this channel as follows. Suppose that $F^{ij} \in \left[\underline{F}_{ij}, \overline{F}^{ij}\right]$ is drawn from a uniform distribution $G^{ij}(F^{ij}) = \frac{F^{ij} - \underline{F}^{ij}}{\overline{F}^{ij} - \underline{F}^{ij}}$ where $-\underline{F}_{ij} := \overline{F}^{ij}$. Now we can directly interpret $\overline{F}^{ij}$ as the degree of economic integration of i and j. Therefore, economic disintegration induces a mean-preserving spread in the distribution of relative fixed costs. The higher $\overline{F}^{ij}$, the more firms, and in this setting also industries, are attached to a particular country and the less should business tax differentials matter for location decisions. When country i disintegrates from j and k, $\overline{F}^{ij}$ and $\overline{F}^{ki}$ rise in our model.

To dissect this effect, let us for now assume full country symmetry in all primitives of the model other than the distribution of fixed costs between any two countries. Then, we can derive each country's equilibrium tax rates as a function of $\left(\overline{F}^{ij}\right)_{i,j \in \mathscr{K}}$. For a detailed exposition, we refer to Appendix A.2. We can now state Proposition 2.

Proposition 2 (mean preserving spread of location fixed cost)**.** *Suppose that trade costs and country sizes are identical:* $\tau := \tau_{ij} = \tau_{ik} = \tau_{jk}$ *and* $n := n_i = n_j = n_k$ *for* $i, j, k \in \mathscr{K}$ *and* $i \neq j, k$.

(*a*) *Then, for any* $i, j, k \in \mathscr{K}$ *and* $i \neq j, k$ $\frac{dt_i}{d\overline{F}^{jk}} > 0$. *Moreover,* $\frac{dt_i}{d\overline{F}^{ij}} > 0$ *for either* $\overline{F}^{ij} \approx \overline{F}^{jk} \approx \overline{F}^{ki}$, *or* $\overline{F}^{ij} \approx 0$, *or* $\overline{F}^{jk} \approx 0$. *However, if* $\overline{F}^{ki} \approx 0$, $\frac{dt_i}{d\overline{F}^{ij}} < 0$.

(*b*) *Suppose that i and j form an economic union, i.e.* $\overline{F}^{jk} = \overline{F}^{ki} \geq \overline{F}^{ij}$. *Then,* $\frac{dt_i}{\overline{F}^{jk}} + \frac{dt_i}{\overline{F}^{ki}} > 0$, $\frac{dt_j}{\overline{F}^{jk}} + \frac{dt_j}{\overline{F}^{ki}} > 0$, *and* $\frac{dt_k}{\overline{F}^{jk}} + \frac{dt_k}{\overline{F}^{ki}} > 0$. *Hence, the disintegration of country k raises tax rates everywhere.*

The first result in (a) is not surprising in light of the existing literature. By construction of our model, a rise in $\overline{F}^{jk}$ makes tax bases in the directly affected countries j and k less elastic, which tends (although does not guarantee) to increase tax rates in these countries. In the Nash equilibrium, this spills over to the tax setting of the not directly affected country i. Due to the strategic complementarity of tax policies t_i increases.

In most cases, the tax rate of a country goes up when the fixed cost distribution widens between that country and another one, that is, t_i increases in $\overline{F}^{ij}$. Interestingly, there may be cases in which the tax rate falls, $\frac{dt_i}{d\overline{F}^{ij}} < 0$. Most prominently, a negative sign may occur when $\overline{F}^{ki}$ is very small, i.e. tax bases are very elastic between countries i and k. Then, an increase in the elasticity of firm mobility between i and j makes country i tax more. Our intuition is that also the difference in tax base elasticities of a country plays a role. The more firm relocation to j differs from the one to k, the more elastic is country i's tax base on average leading to the described decrease in t_i.

Result (b) of the Proposition describes another potential effect of the disintegration of country k from i and j. When $\overline{F}^{jk}$ and $\overline{F}^{ki}$ increase simultaneously, tax bases become less elastic between the economic union and country k. The lower mobility of firms causes tax rates to rise everywhere.

Corollary 2 directly follows from the expressions derived for Proposition 2. As we can see, average taxes in any two or more countries are negatively associated with firm mobility.

Corollary 2. *Under the symmetry assumptions of Proposition 2, average tax rates between any two and among all three countries increase with partial economic disintegration, that is, for any* $i, j, k \in \mathscr{K}$ *and* $i \neq j, k$

$$\frac{d\frac{1}{2}\left(t_i + t_j\right)}{d\overline{F}^{ij}} > 0,$$

$$\frac{d\frac{1}{2}\left(t_i + t_k\right)}{d\overline{F}^{ij}} > 0,$$

and

$$\frac{d\frac{1}{3}\sum_{k \in \mathscr{K}} t_k}{d\overline{F}^{ij}} > 0.$$

In this subsection, we have described origin-destination-specific asymmetries in the costs of firm (re)location and analyzed the impact of a drop in the mobility of firms from a country. Our second main result suggests that business taxes tend to increase everywhere when partial economic disintegration occurs in the form of more firm attachment to their countries. When interpreting the reduction in firm mobility as a feature of economic disintegration, two notes of caution are indicated, however.

First, the rise in $\overline{F}^{jk}$ and $\overline{F}^{ki}$ characterizes the economic disintegration of country k only in the short run as it regards those firms which already exist and decide to relocate after the disintegration of k. When firms anticipate the exit of country k from the economic union, the mass of potential firms in country k will decline before the first stage of our economy even starts. Furthermore, the disintegration of a country may discourage prospective entrepreneurs to invest in a firm located in that country. To summarize, in the long run, the mass of firms is endogenous to the degree of economic integration.

Second, we have assumed that economic disintegration triggers a mean-preserving spread in the relocation cost distribution. Therefore, a rise in $\overline{F}^{jk}$ affects countries j and k in the same way, which seems reasonable in the context of production standards and harmonization of regulations. However, regarding the effects of the disintegration of country k from j, it might be that production frictions in country k increase such that firm relocation from j to k becomes more costly than vice versa.

In the following, we, therefore, consider the case where the disintegration of a country from an economic union causes firm relocation cost distributions to shift. Suppose, again, that $F^{ij} \in \left[\underline{F}_{ij}, \overline{F}^{ij}\right]$ is drawn from a uniform distribution $G^{ij}\left(F^{ij}\right) = \frac{F^{ij} - \underline{F}^{ij}}{\overline{F}^{ij} - \underline{F}^{ij}}$ where $\overline{F}^{ij} - \underline{F}^{ij} = \overline{F}^{jk} - \underline{F}^{jk} = \overline{F}^{ki} - \underline{F}^{ki}$. But now the relocation cost distributions are allowed to have a different mean, i.e. $\mathbb{E}\left(F^{ij}\right) = \mu^{ij} \gtreqless \mathbb{E}\left(F^{jk}\right) = \mu^{jk} \gtreqless \mathbb{E}\left(F^{ki}\right) = \mu^{ki}$. By considering comparative statics of tax rates with respect to these means, we can study the effects of a shift in the relocation cost distributions. In particular, we are interested in the case where locating in the leaving country becomes more costly relative to setting up a business in the economic union. In Proposition 3, we show that the effects point in intuitive directions. We prove the statement in Appendix A.3.

Proposition 3 (asymmetric increase in average fixed cost)**.** *For any $i, j, k \in \mathscr{K}$ and $i \neq j, k$ an increase in the cost of setting up a business in a country induces lower taxes in that country, while taxes in the other countries go up, that is, $\frac{dt_i}{d\mu^{ij}} > 0$, $\frac{dt_i}{d\mu^{ki}} < 0$, and $\frac{dt_i}{d\mu^{jk}} = 0$.*

When μ^{ij} increases, the cost of locating in country j relative to country i goes up on average. As a consequence, country i gains market shares. Vice versa, country i loses industries after a rise in μ^{ki}. In the former case, country i's ability to tax improves. In the latter case, country i has to lower its business tax. A change in μ^{jk} does not affect t_i because the reduction in t_k just offsets the rise in t_j.

Consider again the situation in which country k disintegrates from an economic union formed by i and j. When this disintegration makes it relatively more costly to set up a business in country k than inside the economic union, μ^{ki} decreases and μ^{jk} rises. By Proposition 3, country k has to lower its business tax. Members of the economic union tax more.

2.2.3 Migration

So far, we have dealt with changes in parameters that directly affect the production side. However, economic disintegration affects prices and, therefore, utility levels of households in a given country. When households are just like firms internationally mobile, they will migrate from one jurisdiction to another as long as the difference in utilities is larger than the migration cost. In the context of the Brexit debate, some EU citizens in the UK may return to their home countries or other countries in the union if the UK splits off. In the following, we deal with the effects of exogenously driven migration on taxes. Unlike Lemma 1, we now assume that the world population stays constant and consider only population shifts between countries. Moreover, we return to the case where fixed cost distributions are the same $\overline{F}^{ij} = \overline{F}\ \forall i, j$. Proposition 4 follows from the comparative statics of Lemma 1.

Proposition 4 (population shifts). *For any $i, j, k \in \mathscr{K}$ and $j, k \neq i$ one can derive the following general equilibrium comparative statics for t_i from disintegration induced population shifts*

(a)

$$\frac{dt_i}{dn_i} - \frac{dt_i}{dn_j} = 30\tau_{ij}\frac{2(\alpha - w) - \tau_{ij}}{320\beta} + 3\tau_{ik}\frac{2(\alpha - w) - \tau_{ik}}{320\beta} - 9\tau_{jk}\frac{2(\alpha - w) - \tau_{jk}}{320\beta} \lesseqgtr 0$$

and

(b)

$$\frac{dt_i}{dn_j} - \frac{dt_i}{dn_k} = 27(\tau_{ik} - \tau_{ij})\frac{2(\alpha - w) - (\tau_{ik} + \tau_{ij})}{320\beta} \begin{cases} > 0 & for\ \tau_{ik} > \tau_{ij} \\ < 0 & for\ \tau_{ik} < \tau_{ij} \end{cases}.$$

Migration from outside the union to inside the union raises taxes inside the union and lowers the tax rate outside.

The effects of migration, i.e. a change in the size of countries while holding $\sum_{l \in \mathscr{K}} n_l$ fixed, on taxes depend on the origin and the destination of migration flows. By part (a) of the Proposition, migration from the leaving country into a member country reduces the leaving country's tax rate and allows the destination country to tax more. The tax rate in the other member country rises as well (see (b)). The intuition is that the economic union grows as a whole such that member countries become more attractive to mobile firms.

Corollary 3 regards the effect of migration from country j to i on average tax rates, holding $\sum_{l \in \mathscr{K}} n_l$ and n_k fixed.

Corollary 3. *For any $i, j, k \in \mathscr{K}$ and $i \neq j, k$, the effect of population shifts on average tax rates are*

(a)

$$\frac{d\frac{1}{2}(t_i + t_j)}{dn_i} - \frac{d\frac{1}{2}(t_i + t_j)}{dn_j} = 3(\tau_{ik} - \tau_{jk})\frac{2(\alpha - w) - (\tau_{ik} + \tau_{jk})}{160\beta} \begin{cases} > 0 & for\ \tau_{ik} > \tau_{jk} \\ < 0 & for\ \tau_{ik} < \tau_{jk} \end{cases},$$

and

(*b*)

$$\frac{d\frac{1}{3}\sum_{k\in\mathscr{K}} t_k}{dn_i} - \frac{d\frac{1}{3}\sum_{k\in\mathscr{K}} t_k}{dn_j} = 5\left(\tau_{jk} - \tau_{ik}\right)\frac{2\left(\alpha - w\right) - \left(\tau_{jk} + \tau_{ik}\right)}{320\beta} \begin{cases} > 0 & for\ \tau_{jk} > \tau_{ik} \\ < 0 & for\ \tau_{jk} < \tau_{ik} \end{cases}.$$

What is the average effect of a population shift from the leaving country towards a member country? One can see from (a) that the average tax rate of these two countries declines. In other words, the leaving country reduces its tax rate by more than the member country can raise its tax. The average tax rate of the world will increase ((b)). As described above, the population shift improves the other member country's ability to tax. In sum, tax rates in the economic union increase. This rise outweighs the reduction in the tax rate of the leaving country such that the effect on the average tax rate of the world is positive.

Taken together, the results in this section suggest that migration from outside the union to inside tends to increase taxes inside the union and certainly for countries that experience a population increase. This is the third main insight from our model.

2.3 The K-Country Model

Having seen the three-country model, extending our economy $\mathscr{E}$ to an arbitrary number of K countries is straightforward and at the same time worthwhile because it allows us to analzye effects of partial disintegration on third countries outside the economic union. Let $\mathscr{K}_{EU} \subseteq \mathscr{K}$ denote the set of countries forming an economic union and $K_{EU} := |\mathscr{K}_{EU}| \in \mathbb{Z}^+$ its cardinality. Note that $1 \leq K_{EU} \leq K$. For simplicity, let us consider the case where $\overline{F} = -\underline{F} > 0$. As we have seen, this assumption can easily be relaxed. However, in this section, we want to focus on two additional dimensions of economic disintegration, which the three-country model is unable to address. First, we show the effect of a rise in trade costs between a country leaving the economic union and the remaining member countries on the tax policy of third countries, that is, countries that were already outside the union prior to the exit (like the US or China in the case of Brexit), which occurs when $K_{EU} < K$. Secondly, we impose some symmetry assumptions and derive the tax policy of each country as a function of K_{EU}. This allows us to model economic disintegration purely as a change in K_{EU}. For a detailed derivation of the K-country model, we refer to the Appendix A.4.

2.3.1 Economic Disintegration as a Change in Trade Costs

We now state Proposition 5, which is the K-country counterpart to Proposition 1.[5] The proof can be found in Appendix A.5. It is useful to define the average population of the union countries as $\bar{n}_{EU} = \frac{1}{K_{EU}} \sum_{m \in \mathscr{K}_{EU}} n_m$.

Proposition 5 (trade cost changes). *Suppose that countries $m \in \mathscr{K}_{EU}$ form an economic union with $\tau = \tau_{ml}$, $\forall m \in \mathscr{K}_{EU}$ and suppose that country $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$ disintegrates from the member countries. This triggers the following change in the tax of*

(*a*) *the leaving country l*

$$\sum_{m \in \mathscr{K}_{EU}} \frac{dt_l}{d\tau_{ml}} = 3K_{EU} \frac{(K-2)\, n_l - \left[2\,(K-1)^2 + 1\right] \bar{n}_{EU}}{(K-1)\,(2K-1)} \frac{\alpha - w - \tau}{16\beta}$$

$$\begin{cases} > 0 & for\ n_l > \frac{2(K-1)^2+1}{K-2} \bar{n}_{EU} \\ < 0 & for\ n_l < \frac{2(K-1)^2+1}{K-2} \bar{n}_{EU} \end{cases},$$

(*b*) *the remaining member countries $m \in \mathscr{K}_{EU}$*

$$\frac{dt_m}{d\tau_{ml}} + \sum_{j \in \mathscr{K}_{EU} \backslash \{m\}} \frac{dt_m}{d\tau_{jl}} = 3 \frac{(K-1)\left[2K_{EU}\bar{n}_{EU} - 2n_l\,(K - K_{EU}) - n_m\right] + K_{EU}\left[n_l - \bar{n}_{EU}\right]}{(K-1)\,(2K-1)} \frac{\alpha - w - \tau}{16\beta}$$

$$\begin{cases} > 0 & for\ n_l < \frac{(2K-3)K_{EU}\bar{n}_{EU} - (K-1)n_m}{2(K-1)K - (2K-1)K_{EU}} \\ < 0 & for\ n_l > \frac{(2K-3)K_{EU}\bar{n}_{EU} - (K-1)n_m}{2(K-1)K - (2K-1)K_{EU}} \end{cases},$$

and

(*c*) *third countries outside the union $k \in \mathscr{K} \backslash (\mathscr{K}_{EU} \cup \{l\})$*

$$\sum_{j \in \mathscr{K}_{EU}} \frac{dt_k}{d\tau_{jl}} = 3K_{EU}\,(2K-3) \frac{\bar{n}_{EU} + n_l}{(K-1)\,(2K-1)} \frac{\alpha - w - \tau}{16\beta} > 0.$$

Trade disintegration between l and $\mathscr{K}_{EU}$ makes third countries, which are not part of the economic union, relatively more attractive, which allows them to tax more (part (c)). As for the three-country case already described, the tax rate of country l will decrease in the aftermath of its disintegration from the economic union provided that it is not too large relative to the average member country.

The reaction of taxes inside the union is less clear. It depends on the size of the leaving country, of the respective member country, as well as the size of the average member country. In general, the effect in a member country is positive, provided that the size of the average market in the union is large enough relative to the respective member country's market and the one of the leaving

[5] Observe that we only consider direct effects of economic disintegration, i.e. changes in the trade relations of the leaving country with the remaining economic union. In particular, we hold trade relations with third countries fixed which is plausible in the Brexit case since the UK remains part of the WTO. Moreover, it ignores the possibility that the UK might form new trade agreements, e.g. with the US.

country. After imposing cross-country symmetry in market size ($n := n_m = n_l$), the derivative in (b) reduces to

$$\frac{dt_m}{d\tau_{ml}} + \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_m}{d\tau_{jl}} = 3n\frac{4K_{EU}-2K-1}{2K-1}\frac{\alpha-w-\tau}{16\beta}\begin{cases} >0 & for\ 4K_{EU} > 2K+1 \\ <0 & for\ 4K_{EU} < 2K+1 \end{cases}. \tag{14}$$

As we can see, tax rates inside the economic union rise when it has many member countries. In our setting, this corresponds to a particularly strong internal market, which covers most of the demand for tradeable goods and services.

Corollary 4 considers average effects. For this we define the world, EU, and non-EU average tax rates as follows:

$$\bar{t} := \frac{1}{K}\sum_{k\in\mathscr{K}} t_k, \quad \bar{t}_{EU} := \frac{1}{K_{EU}}\sum_{k\in\mathscr{K}_{EU}} t_k, \quad \bar{t}_{nonEU} := \frac{1}{K-K_{EU}-1}\sum_{k\in\mathscr{K}\setminus(\mathscr{K}_{EU}\cup\{l\})} t_k. \tag{15}$$

Corollary 4. *Suppose that countries $m \in \mathscr{K}_{EU}$ form an economic union with $\tau = \tau_{ml}$, $\forall m \in \mathscr{K}_{EU}$ and suppose that country $l \in \mathscr{K}\setminus\mathscr{K}_{EU}$ disintegrates from the member countries. This triggers the following change in the average tax of*

(a) *the remaining member countries*

$$\frac{d\bar{t}_{EU}}{d\tau} = 3\frac{[(2K-3)K_{EU}-(K-1)]\,\bar{n}_{EU} + [K_{EU}-2(K-1)(K-K_{EU})]\,n_l}{(K-1)(2K-1)}\frac{\alpha-w-\tau}{16\beta}$$
$$\begin{cases} >0 & for\ n_l < \frac{(2K-3)K_{EU}-(K-1)}{2(K-1)K-(2K-1)K_{EU}}\bar{n}_{EU} \\ <0 & for\ n_l > \frac{(2K-3)K_{EU}-(K-1)}{2(K-1)K-(2K-1)K_{EU}}\bar{n}_{EU} \end{cases},$$

(b) *third countries*

$$\frac{d\bar{t}_{nonEU}}{d\tau} = (\bar{n}_{EU}+n_l)\frac{3K_{EU}(2K-3)}{(K-1)(2K-1)}\frac{\alpha-w-\tau}{16\beta} > 0,$$

and

(c) *the world*

$$\frac{d\bar{t}}{d\tau} = -3K_{EU}\left(\frac{\bar{n}_{EU}(2K-1)+[K-K_{EU}-1]\,n_l}{K(K-1)(2K-1)}\right)\frac{\alpha-w-\tau}{16\beta} < 0.$$

The disintegration of country l on average increases taxes of third countries, but reduces the average tax rate worldwide. This result is robust and does not depend on country sizes or the number of countries in the union. The effect on the average tax in the remaining economic union is ambiguous, however. When the leaving country is as large as the average country inside the union, the effect is negative (positive) for $2K_{EU} \leq K$ (for $2K_{EU} > K$). Thus, under symmetric country sizes, when country l leaves and the remaining economic union is large, the average tax rate inside the union rises.

2.3.2 Economic Disintegration as a Change in the Size of the Economic Union

Another way to examine the consequences of economic disintegration for tax policy is to impose some symmetry assumptions across countries and to directly differentiate tax rates with respect to K_{EU} as if the number of countries was defined on a continuous domain.[6] In particular, assume symmetry in country size as well as in internal and external trade costs as follows.

Assumption 1. *Let* $n := n_i = n_j$ *for all* $i, j \in \mathscr{K}$. *Moreover, let* $\tau^* := \tau_{ij} = \tau_{ik}$ *for all* $i, j, k \in \mathscr{K}_{EU}$ *with* $j, k \neq i$ *and* $\tau := \tau_{lm} = \tau_{ln} > \tau^*$ *for all* $l \in \mathscr{K}$ *and* $m, n \in \mathscr{K} \setminus \mathscr{K}_{EU}$ *with* $m, n \neq l$. *Let* $K_{EU} > 1$.

Appendix A.6 shows that under Assumption 1 the tax rate of member countries t_m and the one of non-member countries t_n can be written as functions of a reduced set of model primitives $\widetilde{\Theta} := \left(\alpha, \beta, w, n, \tau^*, \tau, \overline{F}, K, K_{EU}\right)$. Proposition 6 summarizes the main implications.

Proposition 6 (change in number of union countries)**.** *Consider the subgame-perfect Nash equilibrium of economy* $\mathscr{E}$ *with* $K > 2$ *countries. Let Assumption 1 hold and suppose that* $K, K_{EU} \in \mathbb{R}^+$. *Then,* $\forall m \in \mathscr{K}_{EU}$ *and* $\forall n \in \mathscr{K} \setminus \mathscr{K}_{EU}$

(*a*) $t_m > t_n$,

(*b*) $\frac{dt_m}{dK_{EU}} > 0, \frac{dt_m}{d\tau^*} < 0$, $\frac{dt_m}{d\tau} > 0$, *and*

(*c*) $\frac{dt_n}{dK_{EU}} < 0$, $\frac{dt_n}{d\tau^*} > 0$, $\frac{dt_n}{d\tau} < 0$.

Several aspects are worth mentioning. As shown in (a), under these assumptions tax rates inside the economic union are larger than outside. Being part of the economic union makes countries more attractive to firms which moderates tax competition for these countries. Once asymmetries in trade costs are removed, all the advantages of the economic union have vanished. To sum up, ceteris paribus the tax rate of the country leaving the economic union will decline (see (c)).

Secondly, comparative statics of tax rates with respect to trade costs are intuitive. Higher trade costs inside the economic union toughen tax competition inside the union and help non-member countries to tax more. As a result, tax rates converge. On the other hand, a rise in external trade costs makes the economic union relatively more attractive and weakens the position of non-member countries. This causes tax rates to drift even further apart.

But most importantly, when the economic union loses member countries, the taxes inside the union will fall and those outside the union will rise. The latter mirrors Proposition 5 (c). The former, however, will only be in line with Proposition 5 (b) if the economic union is small compared to the rest of the world. This conflicting finding is not surprising since the analysis conducted in this Subsection is much more gritty compared to the one in Subsection 2.3.1.

In this Subsection, we have extended our model to any number of countries with an arbitrary institutional structure (K_{EU}). As we have seen, the results and intuitions formed in the three-country world remain valid.

[6] This procedure is in its flavor similar to the literature on the effects of federalism and government decentralization on private investment (e.g. Kessing et al. (2006)).

3 The Impact of Partial Disintegration on Trade Policy

In this section we consider another dimension of economic disintegration: trade policy endogenously reacts to the disintegration of one country from an economic union, which in turn has repercussions on the tax policy of each country. Specifically, one may hypothesize that after one country left the union the remaining countries pursue further integration steps, which lead to lower trade costs among them, and affect taxes as a consequence. For simplicity we return to the three-country case. Again, let trade costs be a measure for the degree of economic integration.

Inspired by the literature on trade policy, we endogenize $\vec{\tau} = (\tau_{ij}, \tau_{ik}, \tau_{jk})$ as an efficient bargaining solution.[7] At first glance our approach may seem contradictory to the non-cooperative approach we have adopted in the context of tax policies. However, it fits well the situation of the EU, in which projects like the Common Market have been introduced jointly to facilitate trade and commerce in the union, while business tax policies have so far been set independently. The Common Market project and the free flow of goods, factors and services in the EU have taken precedent over tax policies and therefore justify our timing assumptions: Trade policies are simultaneously chosen before tax policies.

Under transferability of utility efficient trade policies maximize the global payoff. Therefore, when in this setting the three countries form an economic union in the "old" optimum denoted as $\vec{\tau}^{old}$, all bilateral trade costs are chosen to maximize the sum of all countries' welfare. Thus, at an interior solution the first-order conditions

$$\left(\frac{dW_i}{d\tau_{ij}} + \frac{dW_j}{d\tau_{ij}} + \frac{dW_k}{d\tau_{ij}}\right)|_{\vec{\tau}=\vec{\tau}^{old}} = 0,$$

$$\left(\frac{dW_i}{d\tau_{ik}} + \frac{dW_j}{d\tau_{ik}} + \frac{dW_k}{d\tau_{ik}}\right)|_{\vec{\tau}=\vec{\tau}^{old}} = 0, \tag{16}$$

and

$$\left(\frac{dW_i}{d\tau_{jk}} + \frac{dW_j}{d\tau_{jk}} + \frac{dW_k}{d\tau_{jk}}\right)|_{\vec{\tau}=\vec{\tau}^{old}} = 0$$

need to hold.

After country k has left the economic union, the bargaining solution is changed, which we label as the "new" optimum, $\vec{\tau}^{new}$. The economic union negotiates external trade costs with country k such that at the "new" optimum total welfare is still maximized:

$$\left(\frac{dW_i}{d\tau_{ik}} + \frac{dW_j}{d\tau_{ik}} + \frac{dW_k}{d\tau_{ik}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} = 0 \tag{17}$$

[7] For a more detailed exposition, see see Grossman and Helpman (1995) and the subsequent literature. Considering the set of trade policy instruments, there is a difference to the standard approach. Since we do not deal with tariffs, but with the harmonization of production standards and regulations, the choice of τ_{ij} is equal to the one of τ_{ji}.

and

$$\left(\frac{dW_i}{d\tau_{jk}} + \frac{dW_j}{d\tau_{jk}} + \frac{dW_k}{d\tau_{jk}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} = 0. \tag{18}$$

Notice, however, that now countries i and j are free to adjust their internal trade costs to their best advantage. At an interior solution

$$\left(\frac{dW_i}{d\tau_{ij}} + \frac{dW_j}{d\tau_{ij}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} = 0. \tag{19}$$

This shows a new dimension of partial disintegration. When optimizing over τ_{ij}, countries i and j do not consider k's welfare. Hence, the objective function of the trade policy within the remaining economic union changes.

In principle, it is unclear how i and j should react to the unanticipated decision of k to disintegrate. To be precise, we are interested in whether i and j dismantle their bilateral trade barriers (even more) after k has decided to leave the union compared to the situation in which all three countries negotiate τ_{ij}. Suppose that changes in trade costs are small. This allows us to take the following first-order approach. Consider the Taylor approximation of the "old" optimum around the "new" one. "Old" world welfare can be written as

$$\begin{aligned}(W_i + W_j + W_k)|_{\vec{\tau}=\vec{\tau}^{old}} \approx {} & (W_i + W_j + W_k)|_{\vec{\tau}=\vec{\tau}^{new}} \\ & + \left(\frac{dW_i}{d\tau_{ij}} + \frac{dW_j}{d\tau_{ij}} + \frac{dW_k}{d\tau_{ij}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} \left(\tau_{ij}^{old} - \tau_{ij}^{new}\right) \\ & + \left(\frac{dW_i}{d\tau_{ik}} + \frac{dW_j}{d\tau_{ik}} + \frac{dW_k}{d\tau_{ik}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} \left(\tau_{ik}^{old} - \tau_{ik}^{new}\right) \\ & + \left(\frac{dW_i}{d\tau_{jk}} + \frac{dW_j}{d\tau_{jk}} + \frac{dW_k}{d\tau_{jk}}\right)|_{\vec{\tau}=\vec{\tau}^{new}} \left(\tau_{jk}^{old} - \tau_{jk}^{new}\right).\end{aligned}$$

By the above-mentioned reasoning based on equations17, 18, and 19 this simplifies to

$$(W_i + W_j + W_k)|_{\vec{\tau}=\vec{\tau}^{old}} \approx (W_i + W_j + W_k)|_{\vec{\tau}=\vec{\tau}^{new}} + \frac{dW_k}{d\tau_{ij}}|_{\vec{\tau}=\vec{\tau}^{new}} \left(\tau_{ij}^{old} - \tau_{ij}^{new}\right). \tag{20}$$

We are interested in the adjustment of the trade cost. Condition 20 helps us to draw a conclusion. Note first that world welfare in the new equilibrium is lower than in the old equilibrium because in the latter trade costs of all countries were jointly optimized. This is not the case in the former situation. Hence the second term in 20 must be positive, which is itself the product of two terms. We now make the assumption that an increase in the trade cost between two countries raises welfare in the other country.

Assumption 2. *Assume that for $i, j, k \in \mathscr{K}$ with $i, j \neq k$ $\frac{dW_k}{d\tau_{ij}} > 0$.*

Below we show that Assumption 2 is fulfilled in our three country model of Setion 2. Given Assumption 2, optimality of the "old" optimum implies $\tau_{ij}^{new} < \tau_{ij}^{old}$. This observation is summarized in Proposition 7.

Proposition 7 (endogenous response of trade costs to disintegration)**.** *For an economy with three countries, suppose that trade policy is determined by multilateral bargaining and let solutions be interior. Suppose that, initially, all countries form an economic union, indexed by the superscript old. In the new optimum, country k leaves the economic union formed by the countries i and j. Assume that policy changes are sufficiently small. Then, under Assumption 2 it must be the case that in the new regime $\tau_{ij}^{new} < \tau_{ij}^{old}$.*

Intuitively, the change in τ_{ik} and τ_{jk} does not induce a first-order gain or loss in world welfare. The same holds for the effect of τ_{ij} on total welfare inside the economic union. However, for the "old" bargaining solution to be a global optimum, in the "new" optimum country k has to bear a welfare loss induced by the change in trade costs inside the union. Given Assumption 2 this can only be achieved by a reduction in τ_{ij}.

Note that in this first-order approach we can remain agnostic about whether leaving the economic union is overall beneficial to country k. Besides, it can be readily extended to $|\mathscr{K}| > 3$.

As Lemma 2 shows, Assumption 2 is fulfilled in our model. It is proven in Appendix A.7.

Lemma 2. *Consider economy $\mathscr{E}$ with $|\mathscr{K}| = 3$. Assume that $t_k \geq 0$. Let $\tau_{ik} = \tau_{jk}$. Then, for any $i, j, k \in \mathscr{K}$ and $i, j \neq k$*

$$\frac{dW_k}{d\tau_{ij}} > 0.$$

Therefore, in our model $\tau_{ij}^{old} > \tau_{ij}^{new}$. By Lemma 1, this trade policy reaction by countries i and j induces further downward pressure on taxes in k. At the same time, the reduction in τ_{ij} reduces tax competition inside the economic union provided that member countries are of similar size.

4 Conclusion

In this paper, we have analyzed a multi-sector and multi-country general equilibrium trade model in which a continuum of internationally mobile firms generates fiscal competition over business tax rates. Thereby, the optimal tax rate in a given country is determined by the elasticity of firm relocation. As we have seen, this elasticity crucially depends not only on the economic conditions in that country but also on those worldwide. This even holds when a minimum of mobility, here modeled as a bilateral location choice by one firm per industry, is introduced. As a result, the whole economic structure will influence optimal policies in each country.

An important lesson is that the analysis of only two countries is potentially misleading when studying the effects of multilateral trade policy on local tax policy. Consider a change in bilateral trade costs. Firms alter their local prices and production quantities. In response, local governments adjust their taxes which induces firms to move from one jurisdiction to another. This causes third countries to modify their tax rates as well which, in turn, feeds back into local tax policy.

By considering an arbitrary number of countries, our stylized model takes such a broader perspective. We exploit the model to speak to the effects of economic disintegration on business taxation and trade policy. As we have seen, economic disintegration may have different forms of appearance. An important dimension is that economic disintegration rises bilateral trade costs. When one country leaves an economic union, tax rates are predicted to decline in that country. The effects on tax rates in the remaining members of the union are less clear. We show that even under symmetric trade costs, the policies of these countries may react contrary to each other depending on the relative size of the respective local markets. Third countries, however, will enjoy a reduction in the downward pressure on tax rates induced by local business tax differentials. When the remaining member countries reconsider their trade policy, they will integrate more with each other and, thereby, put additional downward pressure on the tax rate of the leaving country.

We have also dealt with the consequences of a lower degree of harmonization in product and production standards, which reduces the international mobility of firms. In line with the literature on tax competition, tax rates increase as firm relocation becomes more difficult. However, this argument only holds in the short run as it regards those firms which are located in a country and decide to relocate after the disintegration of that country. In particular, our analysis omits the anticipatory and dynamic effects of economic disintegration, which is left for future analysis.

From an institutional perspective, economic disintegration manifests as a reduction in the number of member countries in an economic union. The loss of a member country induces a convergence of tax rates worldwide. As above, the tax rate of the leaving country declines.

Applying our model to Brexit, the UK is predicted to become a tax haven after leaving the European Union. Larger countries in the EU might have to lower their taxes as well, whereas members with a small domestic market need not. Third countries gain attractiveness leading to higher tax rates there. If after Brexit the UK forms additional trade agreements with third countries such as the US, it will at least partly regain attractiveness as an investment location and, thereby, mitigate the economic consequences of leaving the EU. However, the long-run effects on general equilibrium tax rates need to be studied in more detail.

We note several limitations of our analysis. The simplicity of the firm side in our model, such as the two-country industry structure can also be considered a weakness. However, putting a more realistic structure into the economy is beyond the scope of this project.

Moreover, labor is an internationally mobile factor as in Caliendo et al. (2019). This holds especially true in the long run. Our comparative statics show that, even in the absence of wage effects, the number of residents strongly affects tax policy and its connection to economic integration merely through the channel of market size. When the disintegration of a country pushes households to migrate from that country to the economic union, the business tax rate of the leaving country declines even further, while it improves the ability of member countries to tax firms. Studying the interplay of tax and trade policy under the full mobility of firms, labor, and capital, we consider a promising area of future research.

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A Appendix

A.1 Proof of Lemma 1

In order to derive consumer surplus, first note that there are three continuums of industries. Depending on whether F^{ij} is less or greater than γ^{ij}, there are two distinct location outcomes per industry type such that we need to consider six different prices. In the following, take country i's perspective. Using firm's optimal production quantities, the prices read as

$$p_i^{ij}(\mu) = \begin{cases} \frac{\alpha+3w+\tau_{ij}}{4} & if\, F^{ij} \geq \gamma^{ij} \\ \frac{\alpha+3w+2\tau_{ij}}{4} & if\, F^{ij} < \gamma^{ij}, \end{cases}$$

$$p_i^{jk}(\mu) = \begin{cases} \frac{\alpha+3w+2\tau_{ij}+\tau_{ik}}{4} & if\, F^{jk} \geq \gamma^{jk} \\ \frac{\alpha+3w+\tau_{ij}+2\tau_{ik}}{4} & if\, F^{jk} < \gamma^{jk}, \end{cases}$$

and

$$p_i^{ki}(\mu) = \begin{cases} \frac{\alpha+3w+2\tau_{ik}}{4} & if\, F^{ki} \geq \gamma^{ki} \\ \frac{\alpha+3w+\tau_{ik}}{4} & if\, F^{ki} < \gamma^{ki}, \end{cases}$$

for any $j, k \in \mathscr{K} \setminus \{i\}$ with $j \neq k$. In general, prices are lower in a country if a mobile firm locates there due to high relative setup cost in the other country. Plug these prices into the demand functions $x_i^{ij}(\mu) = \frac{\alpha - p_i^{ij}}{\beta}$, $x_i^{jk} = \frac{\alpha - p_i^{jk}(\mu)}{\beta}$, and $x_i^{ki}(\mu) = \frac{\alpha - p_i^{ki}(\mu)}{\beta}$, to obtain household consumer surplus. Multiplying with the size of the market, yields aggregate consumer surplus in country i

$$\begin{aligned} S_i = {} & n_i \left(1 - G\left(\gamma^{ij}\right)\right) \left(\alpha x_i^{ij}(\mu) - \frac{\beta}{2}\left(x_i^{ij}(\mu)\right)^2 - p_i^{ij}(\mu)\, x_i^{ij}(\mu)\right)|_{F^{ij} \geq \gamma^{ij}} \\ & + n_i G\left(\gamma^{ij}\right) \left(\alpha x_i^{ij}(\mu) - \frac{\beta}{2}\left(x_i^{ij}(\mu)\right)^2 - p_i^{ij}(\mu)\, x_i^{ij}(\mu)\right)|_{F^{ij} < \gamma^{ij}} \\ & + n_i \left(1 - G\left(\gamma^{jk}\right)\right) \left(\alpha x_i^{jk}(\mu) - \frac{\beta}{2}\left(x_i^{jk}(\mu)\right)^2 - p_i^{jk}(\mu)\, x_i^{jk}(\mu)\right)|_{F^{jk} \geq \gamma^{jk}} \\ & + n_i G\left(\gamma^{jk}\right) \left(\alpha x_i^{jk}(\mu) - \frac{\beta}{2}\left(x_i^{jk}(\mu)\right)^2 - p_i^{jk}(\mu)\, x_i^{jk}(\mu)\right)|_{F^{jk} < \gamma^{jk}} \\ & + n_i \left(1 - G\left(\gamma^{ki}\right)\right) \left(\alpha x_i^{ki}(\mu) - \frac{\beta}{2}\left(x_i^{ki}(\mu)\right)^2 - p_i^{ki}(\mu)\, x_i^{ki}(\mu)\right)|_{F^{ki} \geq \gamma^{ki}} \\ & + n_i G\left(\gamma^{ki}\right) \left(\alpha x_i^{ki}(\mu) - \frac{\beta}{2}\left(x_i^{ki}(\mu)\right)^2 - p_i^{ki}(\mu)\, x_i^{ki}(\mu)\right)|_{F^{ki} < \gamma^{ki}} \end{aligned}$$

which can be simplified to

$$S_i = \underbrace{n_i \left(\frac{(3\alpha - 3w - \tau_{ij})^2}{32\beta} \right)}_{:=\delta_i^{ij}} + G\left(\gamma^{ij}\right) \underbrace{n_i \left[\left(\frac{(3\alpha - 3w - 2\tau_{ij})^2}{32\beta} \right) - \left(\frac{(3\alpha - 3w - \tau_{ij})^2}{32\beta} \right) \right]}_{:=\Delta_i^{ij}}$$

$$+ \underbrace{n_i \left(\frac{(3\alpha - 3w - 2\tau_{ij} - \tau_{ik})^2}{32\beta} \right)}_{:=\delta_i^{jk}} + G\left(\gamma^{jk}\right) \underbrace{n_i \left[\left(\frac{(3\alpha - 3w - \tau_{ij} - 2\tau_{ik})^2}{32\beta} \right) - \left(\frac{(3\alpha - 3w - 2\tau_{ij} - \tau_{ik})^2}{32\beta} \right) \right]}_{:=\Delta_i^{jk}}$$

$$+ \underbrace{n_i \left(\frac{(3\alpha - 3w - 2\tau_{ik})^2}{32\beta} \right)}_{:=\delta_i^{ki}} + G\left(\gamma^{ki}\right) \underbrace{n_i \left[\left(\frac{(3\alpha - 3w - \tau_{ik})^2}{32\beta} \right) - \left(\frac{(3\alpha - 3w - 2\tau_{ik})^2}{32\beta} \right) \right]}_{:=\Delta_i^{ki}}.$$

The first-order condition with respect to the tax rate

$$\frac{d\left(S_i + T_i\right)}{dt_i} = \frac{1}{\overline{F} - \underline{F}} \left(\Delta_i^{ij} \frac{d\gamma^{ij}}{dt_i} + \Delta_i^{ki} \frac{d\gamma^{ki}}{dt_i} \right) + 3 - G\left(\gamma^{ij}\right) + G\left(\gamma^{ki}\right) + t_i \frac{1}{\overline{F} - \underline{F}} \left(-\frac{d\gamma^{ij}}{dt_i} + \frac{d\gamma^{ki}}{dt_i} \right) = 0$$

is a sufficient condition for a maximum by the concavity of welfare

$$\frac{d^2\left(S_i + T_i\right)}{dt_i^2} = \frac{1}{\overline{F} - \underline{F}} \left(-\frac{d\gamma^{ij}}{dt_i} + \frac{d\gamma^{ki}}{dt_i} \right) + \frac{1}{\overline{F} - \underline{F}} \left(-\frac{d\gamma^{ij}}{dt_i} + \frac{d\gamma^{ki}}{dt_i} \right) = -\frac{4}{\overline{F} - \underline{F}} < 0.$$

Country i's reaction function is therefore given by

$$t_i = \frac{1}{4} \left(\Delta_i^{ij} - \Delta_i^{ki} + 3\overline{F} - 3\underline{F} + \pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki} + t_j + t_k \right).$$

Notice that t_i is linear in t_j and t_k. As standard in most of the tax competition literature, tax rates are strategic complements. Moreover, the slope of the reaction functions is less than 1 such that there is a unique solution to the system of equations. Solving for the intersection of the reaction functions gives us the solution

$$t_i = \frac{3}{2}\left(\overline{F} - \underline{F}\right) + \frac{3}{10}\left(\Delta_i^{ij} - \Delta_i^{ki}\right) + \frac{1}{10}\left(\Delta_j^{jk} - \Delta_j^{ij}\right) + \frac{1}{10}\left(\Delta_k^{ki} - \Delta_k^{jk}\right) + \frac{1}{5}\left(\pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki}\right).$$

By differentiating t_i, Lemma 1 follows.

A.2 Proof of Proposition 2

First and similar to before, the first-order condition of the benevolent social planner in country i reads as

$$\frac{d\left(S_i + T_i\right)}{dt_i} = \Delta_i^{ij} \frac{d\gamma^{ij}}{dt_i} g^{ij}\left(\gamma^{ij}\right) + \Delta_i^{ki} \frac{d\gamma^{ki}}{dt_i} g^{ki}\left(\gamma^{ki}\right) + 3 - G^{ij}\left(\gamma^{ij}\right) + G^{ki}\left(\gamma^{ki}\right) + t_i \left(-g^{ij}\left(\gamma^{ij}\right) \frac{d\gamma^{ij}}{dt_i} + g^{ki}\left(\gamma^{ki}\right) \frac{d\gamma^{ki}}{dt_i} \right) = 0$$

which is necessary and sufficient by the second-order condition

$$\frac{d^2\left(S_i+T_i\right)}{dt_i^2}=-2g^{ij}\left(\gamma^{ij}\right)\frac{d\gamma^{ij}}{dt_i}+2g^{ki}\left(\gamma^{ki}\right)\frac{d\gamma^{ki}}{dt_i}=-\frac{1}{\overline{F}^{ij}}-\frac{1}{\overline{F}^{ki}}<0.$$

Under the symmetry assumptions mentioned, we can simplify the first-order condition to

$$\Delta\left(\frac{1}{2\overline{F}^{ij}}-\frac{1}{2\overline{F}^{ki}}\right)+3+t_j\frac{1}{2\overline{F}^{ij}}+t_k\frac{1}{2\overline{F}^{ki}}=t_i\left(\frac{1}{\overline{F}^{ij}}+\frac{1}{\overline{F}^{ki}}\right)$$

for every $i\in\mathscr{K}$ and $i\neq j,k$ where $\Delta:=n\left[\left(\frac{(3\alpha-3w-2\tau)^2}{32\beta}\right)-\left(\frac{(3\alpha-3w-\tau)^2}{32\beta}\right)\right]$. The intersection of the reaction functions delivers the following Nash equilibrium tax rate

$$t_i=\frac{21\left(\overline{F}^{ij}\right)^2\overline{F}^{jk}\overline{F}^{ki}+24\overline{F}^{ij}\left(\overline{F}^{jk}\right)^2\overline{F}^{ki}+21\overline{F}^{ij}\overline{F}^{jk}\left(\overline{F}^{ki}\right)^2+9\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{ki}\right)^2}{3\left(\overline{F}^{ij}\right)^2\left[\overline{F}^{jk}+\overline{F}^{ki}\right]+3\left(\overline{F}^{jk}\right)^2\left[\overline{F}^{ij}+\overline{F}^{ki}\right]+3\left(\overline{F}^{ki}\right)^2\left[\overline{F}^{ij}+\overline{F}^{jk}\right]+7\overline{F}^{ij}\overline{F}^{jk}\overline{F}^{ki}}+\Delta.$$

Now, take derivatives

$$\begin{aligned}\frac{dt_i}{d\overline{F}^{ij}}=\sigma^{-1}3\overline{F}^{ki}\Big(&-3\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^3+13\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^2\overline{F}^{ki}+21\left(\overline{F}^{ij}\right)^2\overline{F}^{jk}\left(\overline{F}^{ki}\right)^2+9\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{ki}\right)^3+42\overline{F}^{ij}\left(\overline{F}^{jk}\right)^3\overline{F}^{ki}\\&+60\overline{F}^{ij}\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^2+18\overline{F}^{ij}\overline{F}^{jk}\left(\overline{F}^{ki}\right)^3+24\left(\overline{F}^{jk}\right)^4\overline{F}^{ki}+45\left(\overline{F}^{jk}\right)^3\left(\overline{F}^{ki}\right)^2+21\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^3\Big)\end{aligned}$$

and

$$\begin{aligned}\frac{dt_i}{d\overline{F}^{jk}}=\sigma^{-1}3\overline{F}^{ij}\overline{F}^{ki}\Big(&12\left(\overline{F}^{ij}\right)^3\overline{F}^{ki}+3\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^2+30\left(\overline{F}^{ij}\right)^2\overline{F}^{jk}\overline{F}^{ki}+21\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{ki}\right)^2\\&+14\overline{F}^{ij}\left(\overline{F}^{jk}\right)^2\overline{F}^{ki}+30\overline{F}^{ij}\overline{F}^{jk}\left(\overline{F}^{ki}\right)^2+12\overline{F}^{ij}\left(\overline{F}^{ki}\right)^3+3\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^2\Big)\end{aligned}$$

where

$$\sigma:=\left(3\left(\overline{F}^{ij}\right)^2\left[\overline{F}^{jk}+\overline{F}^{ki}\right]+3\left(\overline{F}^{jk}\right)^2\left[\overline{F}^{ij}+\overline{F}^{ki}\right]+3\left(\overline{F}^{ki}\right)^2\left[\overline{F}^{ij}+\overline{F}^{jk}\right]+7\overline{F}^{ij}\overline{F}^{jk}\overline{F}^{ki}\right)^2>0.$$

Therefore, $\frac{dt_i}{d\overline{F}^{jk}}$ is always positive. The sign of $\frac{dt_i}{d\overline{F}^{ij}}$ depends on the relation between $\overline{F}^{ij}$, $\overline{F}^{jk}$, and $\overline{F}^{ki}$. Notice that for $\overline{F}^{ij}\approx\overline{F}^{jk}\approx\overline{F}^{ki}$, for $\overline{F}^{ij}\approx 0$, and for $\overline{F}^{jk}\approx 0$, $\frac{dt_i}{d\overline{F}^{ij}}>0$. In fact, there is a bunch of weaker conditions sufficient for a positive sign, e.g. $4\overline{F}^{ki}>\overline{F}^{ji}$, $14\overline{F}^{ki}>\overline{F}^{ij}$, $6\overline{F}^{jk}>\overline{F}^{ij}$, or $\overline{F}^{jk}\approx\overline{F}^{ki}$. The necessary condition is

$$\frac{13}{3}\frac{\overline{F}^{ki}}{\overline{F}^{jk}}+7\left(\frac{\overline{F}^{ki}}{\overline{F}^{jk}}\right)^2+3\left(\frac{\overline{F}^{ki}}{\overline{F}^{jk}}\right)^3+14\frac{\overline{F}^{ki}}{\overline{F}^{ij}}+30\frac{\overline{F}^{ki}}{\overline{F}^{ij}}\frac{\overline{F}^{ki}}{\overline{F}^{jk}}+6\frac{\overline{F}^{ki}}{\overline{F}^{ij}}\left(\frac{\overline{F}^{ki}}{\overline{F}^{jk}}\right)^2+8\frac{\overline{F}^{jk}}{\overline{F}^{ij}}\frac{\overline{F}^{ki}}{\overline{F}^{ij}}+15\left(\frac{\overline{F}^{ki}}{\overline{F}^{ij}}\right)^2+7\frac{\overline{F}^{ki}}{\overline{F}^{jk}}\left(\frac{\overline{F}^{ki}}{\overline{F}^{ij}}\right)^2>1.$$

Notice, however, that for any $\overline{F}^{ki}>0$ with $\overline{F}^{ki}\approx 0$, we can find a $\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^3>0$ such that $\frac{dt_i}{d\overline{F}^{ij}}<0$.

Observe that $\frac{dt_i}{\overline{F}^{ij}}+\frac{dt_i}{\overline{F}^{ki}}$ is always positive. Suppose that i and k form an economic union, i.e. $\overline{F}^{jk}=\overline{F}^{ij}\geq\overline{F}^{ki}$ and that j disintegrates. Then, t_j increases because $\frac{dt_j}{\overline{F}^{jk}}+\frac{dt_j}{\overline{F}^{ij}}>0$. It is easy to see that the tax rate in any member country i increase as well, i.e. $\frac{dt_i}{\overline{F}^{jk}} + \frac{dt_i}{\overline{F}^{ij}} > 0$ for $\overline{F}^{jk} = \overline{F}^{ij}$.

A.3 Proof of Proposition 3

Again, the first-order condition of the social planner in country i is described by

$$\frac{d\left(S_i+T_i\right)}{dt_i} = \Delta_i^{ij}\frac{d\gamma^{ij}}{dt_i}g^{ij}\left(\gamma^{ij}\right)+\Delta_i^{ki}\frac{d\gamma^{ki}}{dt_i}g^{ki}\left(\gamma^{ki}\right)+3-G^{ij}\left(\gamma^{ij}\right)+G^{ki}\left(\gamma^{ki}\right)+t_i\left(-g^{ij}\left(\gamma^{ij}\right)\frac{d\gamma^{ij}}{dt_i}+g^{ki}\left(\gamma^{ki}\right)\frac{d\gamma^{ki}}{dt_i}\right)=0.$$

Define $\overline{F} - \underline{F} := \overline{F}^{ij} - \underline{F}^{ij} = \overline{F}^{jk} - \underline{F}^{jk} = \overline{F}^{ki} - \underline{F}^{ki}$ and notice that we can write $\underline{F}^{ij} = \underline{F} + \mu^{ij}$, $\underline{F}^{jk} = \underline{F} + \mu^{jk}$, and $\underline{F}^{ki} = \underline{F} + \mu^{ki}$. Then, the reaction function in country i reads as

$$t_i = \frac{1}{4}\left(\Delta_i^{ij} - \Delta_i^{ki} + 3\overline{F} - 3\underline{F} + \pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki} + t_j + t_k + \mu^{ij} - \mu^{ki}\right).$$

This implies the equilibrium tax rate in country i

$$t_i = \frac{3}{2}\left(\overline{F} - \underline{F}\right) + \frac{3}{10}\left(\Delta_i^{ij} - \Delta_i^{ki}\right) + \frac{1}{10}\left(\Delta_j^{jk} - \Delta_j^{ij}\right) + \frac{1}{10}\left(\Delta_k^{ki} - \Delta_k^{jk}\right) + \frac{1}{5}\left(\pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki} + \mu^{ij} - \mu^{ki}\right).$$

One can immediately observe that $\frac{dt_i}{d\mu^{ij}} = \frac{1}{5} > 0$, $\frac{dt_i}{d\mu^{ki}} = -\frac{1}{5} < 0$, and $\frac{dt_i}{d\mu^{jk}} = 0$.

A.4 The K-Country Model in Subsection 2.3

Pre-tax profits in an ij-industry look very similar to those in the three-country case. Still, they depend on firm location in the following fashion

$$\pi_i^{ij}\left(\mu\right) = \begin{cases} \frac{n_i\left(\alpha-w+\tau_{ij}\right)^2}{16\beta} + \frac{n_j\left(\alpha-w-2\tau_{ij}\right)^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}}\frac{n_l\left(\alpha-w-2\tau_{il}+\tau_{jl}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, i \\ \frac{n_i\left(\alpha-w+2\tau_{ij}\right)^2}{16\beta} + \frac{n_j\left(\alpha-w-3\tau_{ij}\right)^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}}\frac{n_l\left(\alpha-w-3\tau_{il}+2\tau_{jl}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, j. \end{cases}$$

The mobile firm locates in country i if and only if

$$F^{ij} \geq \pi_j^{ij}\left(\mu\right) - t_j - \left(\pi_i^{ij}\left(\mu\right) - t_i\right) := \gamma^{ij}.$$

Again, simplify the industry threshold

$$\gamma^{ij} = \left(n_j - n_i\right)\frac{6\tau_{ij}\left(\alpha-w\right) - 3\tau_{ij}^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\frac{6\left(\alpha-w\right)\left(\tau_{il}-\tau_{jl}\right) - 3\left(\tau_{il}^2 - \tau_{jl}^2\right)}{16\beta} + t_i - t_j$$

and derive partial equilibrium comparative statics

$$\frac{d\gamma^{ij}}{dt_i} = 1,$$

$$\frac{d\gamma^{ij}}{dt_j} = -1,$$

$$\frac{d\gamma^{ij}}{d\tau_{ij}} = (n_j - n_i)\frac{6(\alpha - w) - 6\tau_{ij}}{16\beta},$$

$$\frac{d\gamma^{ij}}{d\tau_{il}} = n_l \frac{6(\alpha - w) - 6\tau_{il}}{16\beta},$$

and

$$\frac{d\gamma^{ij}}{d\tau_{jl}} = -n_l \frac{6(\alpha - w) - 6\tau_{jl}}{16\beta}$$

for $j \neq l$.

Since $\gamma^{ij} = -\gamma^{ji}$ and $G()$ is symmetric with $\overline{F} = -\underline{F}$, Lemma 3 directly follows. It will prove convenient when deriving the objective function of the government.

Lemma 3. *Consider economy $\mathscr{E}$. Suppose that $\overline{F} = -\underline{F}$. Then, $G(\gamma^{ji}) = 1 - G(\gamma^{ij})$. Moreover, the number of firms in country i is given by $k_i := (K-1) + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus i} \left(\overline{F} - \gamma^{ij}\right)$.*

Since there are K countries, one has to consider $(K-1)!$ continuums of industries yielding $2 \cdot (K-1)!$ different prices. These read as

$$p_i^{ij}(\mu) = \frac{\alpha + 3w + k_j^* \tau_{ij}}{4}$$

for $k_j^* \in \{1, 2\}$ with $j \neq i$ and

$$p_i^{jl}(\mu) = \frac{\alpha + 3w + k_j^* \tau_{ij} + k_l^* \tau_{il}}{4}$$

for $\left(k_j^*, k_l^*\right) \in \{(1,2), (2,1)\}$ with $j, l \neq i$. Plug into the demand functions $x_i^{ij} = \frac{\alpha - p_i^{ij}}{\beta}$ and $x_i^{jl} = \frac{\alpha - p_i^{jl}}{\beta}$ and sum over all households in a country. Aggregate surplus in country i derived from consumption in industry ij simplifies to

$$\begin{aligned} S_i^{ij}(\mu) &= n_i \left(\alpha x_i^{ij}(\mu) - \frac{\beta}{2}\left(x_i^{ij}(\mu)\right)^2 - p_i^{ij}(\mu)\, x_i^{ij}(\mu)\right) \\ &= \begin{cases} n_i \frac{(3\alpha - 3w - \tau_{ij})^2}{32\beta} & w/\ prob\ \left(1 - G\left(\gamma^{ij}\right)\right) \\ n_i \frac{(3\alpha - 3w - 2\tau_{ij})^2}{32\beta} & w/\ prob\ G\left(\gamma^{ij}\right), \end{cases} \end{aligned}$$

whereas consumer surplus in the jl-industries reads as

$$\begin{aligned} S_i^{jl}(\mu) &= n_i \left(\alpha x_i^{jl}(\mu) - \frac{\beta}{2}\left(x_i^{jl}(\mu)\right)^2 - p_i^{jl}(\mu)\, x_i^{jl}(\mu)\right) \\ &= \begin{cases} n_i \frac{(3\alpha - 3w - 2\tau_{ij} - \tau_{il})^2}{32\beta} & w/\ prob\ \left(1 - G\left(\gamma^{jl}\right)\right) \\ n_i \frac{(3\alpha - 3w - \tau_{ij} - 2\tau_{il})^2}{32\beta} & w/\ prob\ G\left(\gamma^{jl}\right). \end{cases} \end{aligned}$$

Summing over industries gives us the total surplus

$$
\begin{aligned}
S_i = & \sum_{j\in\mathscr{K}\setminus\{i\}} \left[\left(1-G\left(\gamma^{ij}\right)\right) n_i \frac{\left(3\alpha-3w-\tau_{ij}\right)^2}{32\beta} + G\left(\gamma^{ij}\right) n_i \frac{\left(3\alpha-3w-2\tau_{ij}\right)^2}{32\beta}\right] \\
& + \frac{1}{2} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{l\,\in\,\mathscr{K}\setminus\{i,j\}} \left[\left(1-G\left(\gamma^{jl}\right)\right) n_i \frac{\left(3\alpha-3w-2\tau_{ij}-\tau_{il}\right)^2}{32\beta} + G\left(\gamma^{jl}\right) n_i \frac{\left(3\alpha-3w-\tau_{ij}-2\tau_{il}\right)^2}{32\beta}\right] \\
= & \sum_{j\in\mathscr{K}\setminus\{i\}} \left[\underbrace{n_i \frac{\left(3\alpha-3w-\tau_{ij}\right)^2}{32\beta}}_{:=\delta_i^{ij}} + \frac{\gamma^{ij}-\underline{F}}{2\overline{F}} \underbrace{n_i \frac{\left(3\alpha-3w-2\tau_{ij}\right)^2-\left(3\alpha-3w-\tau_{ij}\right)^2}{32\beta}}_{:=\Delta_i^{ij}}\right] \\
& + \frac{1}{2} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{l\,\in\,\mathscr{K}\setminus\{i,j\}} \left[\underbrace{n_i \frac{\left(3\alpha-3w-2\tau_{ij}-\tau_{il}\right)^2}{32\beta}}_{:=\delta_i^{jl}}\right] \\
& + \frac{1}{2} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{l\,\in\,\mathscr{K}\setminus\{i,j\}} \left[\frac{\gamma^{jl}-\underline{F}}{2\overline{F}} \underbrace{n_i \frac{\left(3\alpha-3w-\tau_{ij}-2\tau_{il}\right)^2-\left(3\alpha-3w-2\tau_{ij}-\tau_{il}\right)^2}{32\beta}}_{:=\Delta_i^{jl}}\right],
\end{aligned}
$$

where the factor $\frac{1}{2}$ is to avoid double count. Therefore, consumer surplus in country i can be written as

$$
S_i = \sum_{j\in\mathscr{K}\setminus\{i\}} \left[\delta_i^{ij} + \frac{\gamma^{ij}-\underline{F}}{2\overline{F}} \Delta_i^{ij}\right] + \frac{1}{2} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{l\,\in\,\mathscr{K}\setminus\{i,j\}} \left[\delta_i^{jl} + \frac{\gamma^{jl}-\underline{F}}{2\overline{F}} \Delta_i^{jl}\right]
$$

where Δ_i^{ij} , Δ_i^{jl}, δ_i^{ij} and δ_i^{jl} are functions of the model primitives Θ described in Section 2. Accordingly, the social planner in country i faces the following maximization problem

$$
\underset{t_i}{max}\, S_i + T_i + n_i w
$$

where

$$
T_i = t_i \left[(K-1) + \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(\overline{F}-\gamma^{ij}\right)\right].
$$

The first-order condition is given by

$$
\frac{d\left(S_i+T_i\right)}{dt_i} = \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{d\gamma^{ij}}{dt_i} \Delta_i^{ij} + (K-1) + \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(\overline{F}-\gamma^{ij}\right) + t_i \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(-\frac{d\gamma^{ij}}{dt_i}\right) = 0
$$

which is sufficient by the second-order condition

$$\frac{d^2\left(S_i+T_i\right)}{dt_i^2}=\frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(-\frac{d\gamma^{ij}}{dt_i}\right)+\frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(-\frac{d\gamma^{ij}}{dt_i}\right)=-\frac{(K-1)}{\overline{F}}<0.$$

The reaction function of country i can be simplified to

$$t_i=\frac{1}{2\left(K-1\right)}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+3\overline{F}\left(K-1\right)+\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)+\sum_{j\in\mathscr{K}\backslash\{i\}}t_j\right).$$

Again, tax rates are strategic complements, the relation is linear and the slope is less than 1. Thus, there will be a unique interior intersection of reaction functions in this tax competition game. In the following, we derive this intersection. First of all, plug

$$\begin{aligned}
t_i-t_l=&\frac{1}{K-1}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+3\overline{F}\left(K-1\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{ij}-\pi_i^{ij}+t_i-t_j\right)\right.\\
&\left.-\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_l^{lj}-3\overline{F}\left(K-1\right)+\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{lj}-\pi_l^{lj}+t_l-t_j\right)\right)\\
=&\frac{1}{K-1}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}-\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_l^{lj}+\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{lj}-\pi_l^{lj}\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{ij}-\pi_i^{ij}\right)\right.\\
&\left.+\sum_{j\in\mathscr{K}}\left(t_l-t_j\right)-\left(t_l-t_l\right)+\sum_{j\in\mathscr{K}}\left(t_j-t_i\right)-\left(t_i-t_i\right)\right)\\
=&\frac{1}{K-1}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}-\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_l^{lj}+\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{lj}-\pi_l^{lj}\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{ij}-\pi_i^{ij}\right)+K\left(t_l-t_i\right)\right)\\
=&\frac{1}{2K-1}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}-\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_l^{lj}+\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{lj}-\pi_l^{lj}\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{ij}-\pi_i^{ij}\right)\right)
\end{aligned}$$

into

$$
\begin{aligned}
t_i &= \frac{1}{K-1}\left(\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+3\overline{F}\left(K-1\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_j^{ij}-\pi_i^{ij}\right)-\sum_{j\in\mathscr{K}\backslash\{i\}}\left(t_i-t_j\right)\right)\\
&= 3\overline{F}+\frac{K}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+\frac{K}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)\\
&+\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\Delta_j^{jm}-\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{m\in\mathscr{K}\backslash\{i\}}\Delta_i^{im}\\
&-\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\left(\pi_m^{jm}-\pi_j^{jm}\right)+\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{m\in\mathscr{K}\backslash\{i\}}\left(\pi_m^{im}-\pi_i^{im}\right)\\
&= 3\overline{F}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)\\
&+\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\Delta_j^{jm}-\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\left(\pi_m^{jm}-\pi_j^{jm}\right).
\end{aligned}
$$

Then, notice that

$$
\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\left(\pi_m^{jm}-\pi_j^{jm}\right)=\sum_{j}\sum_{m>j}\left(\pi_m^{jm}-\pi_j^{jm}\right)-\sum_{j}\sum_{m>j}\left(\pi_m^{jm}-\pi_j^{jm}\right)=0
$$

to conclude that

$$
t_i=3\overline{F}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)+\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\Delta_j^{jm}.
$$

This proves the following Proposition 8.

Proposition 8. *Consider economy $\mathscr{E}$ with K countries. Suppose that $\overline{F}=-\underline{F}$. Then, the subgame-perfect Nash equilibrium of the tax competition game is given by*

$$
t_i=3\overline{F}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\Delta_i^{ij}+\frac{1}{2K-1}\sum_{j\in\mathscr{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)+\frac{1}{\left(K-1\right)\left(2K-1\right)}\sum_{j\in\mathscr{K}}\sum_{l\in\mathscr{K}\backslash\{j\}}\Delta_j^{jl}
$$

for any $i\in\mathscr{K}$.

One can immediately see that $\frac{dt_i}{d\overline{F}}>0$. This is a standard result from the literature on tax competition. A rise in $\overline{F}$ widens the range of relative fixed costs. Some industries will choose to stay in country i no matter how large the tax differential is.

We now derive further comparative statics. Since

$$
\pi_i^{ij}\left(\mu\right)-\pi_j^{ij}\left(\mu\right)=\left(n_i-n_j\right)\frac{6\tau_{ij}\left(\alpha-w\right)-3\tau_{ij}^2}{16\beta}-\sum_{l\in\mathscr{K}\backslash\{i,j\}}n_l\frac{6\left(\alpha-w\right)\left(\tau_{il}-\tau_{jl}\right)-3\left(\tau_{il}^2-\tau_{jl}^2\right)}{16\beta},
$$

differentiation with respect to trade costs yields

$$\frac{d\left(\pi_i^{ij}(\mu)-\pi_j^{ij}(\mu)\right)}{d\tau_{ij}} = 6\left(n_i-n_j\right)\frac{\alpha-w-\tau_{ij}}{16\beta}\begin{cases}>0 & for\ n_i>n_j\\ <0 & for\ n_i<n_j\end{cases}$$

$$\frac{d\left(\pi_i^{ij}(\mu)-\pi_j^{ij}(\mu)\right)}{d\tau_{il}} = -6n_l\frac{\alpha-w-\tau_{il}}{16\beta}<0$$

$$\frac{d\left(\pi_i^{ij}(\mu)-\pi_j^{ij}(\mu)\right)}{d\tau_{jl}} = 6n_l\frac{\alpha-w-\tau_{jl}}{16\beta}>0$$

and

$$\frac{d\left(\pi_i^{il}(\mu)-\pi_l^{il}(\mu)\right)}{d\tau_{il}} = 6\left(n_i-n_l\right)\frac{\alpha-w-\tau_{il}}{16\beta}\begin{cases}>0 & for\ n_i>n_l\\ <0 & for\ n_i<n_l\end{cases}$$

$$\frac{d\left(\pi_i^{il}(\mu)-\pi_l^{il}(\mu)\right)}{d\tau_{ij}} = -6n_j\frac{\alpha-w-\tau_{ij}}{16\beta}<0$$

$$\frac{d\left(\pi_i^{il}(\mu)-\pi_l^{il}(\mu)\right)}{d\tau_{lj}} = 6n_j\frac{\alpha-w-\tau_{lj}}{16\beta}>0.$$

It is more convenient to write t_i as

$$t_i = 3\overline{F}+\frac{K}{(K-1)(2K-1)}\sum_{l\in\mathscr{K}\setminus\{i\}}\Delta_i^{il}+\frac{1}{2K-1}\sum_{l\in\mathscr{K}\setminus\{i\}}\left(\pi_i^{il}-\pi_l^{il}\right)+\frac{1}{(K-1)(2K-1)}\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{l\in\mathscr{K}\setminus\{j\}}\Delta_j^{jl}$$

such that

$$\begin{aligned}\frac{dt_i}{d\tau_{ij}} &= \frac{K}{(K-1)(2K-1)}\left(-3n_i\frac{\alpha-w-\tau_{ij}}{16\beta}\right)+\frac{1}{2K-1}6\left(n_i-n_j\right)\frac{\alpha-w-\tau_{ij}}{16\beta}\\ &\quad+\frac{1}{2K-1}\sum_{l\in\mathscr{K}\setminus\{i,j\}}\left(-6n_j\frac{\alpha-w-\tau_{ij}}{16\beta}\right)+\frac{1}{(K-1)(2K-1)}\left(-3n_j\frac{\alpha-w-\tau_{ij}}{16\beta}\right)\end{aligned}$$

and

$$\begin{aligned}\frac{dt_i}{d\tau_{jl}} &= \frac{1}{2K-1}6n_j\frac{\alpha-w-\tau_{jk}}{16\beta}+\frac{1}{2K-1}6n_k\frac{\alpha-w-\tau_{jk}}{16\beta}\\ &\quad+\frac{1}{(K-1)(2K-1)}\left(-3n_j\frac{\alpha-w-\tau_{ij}}{16\beta}\right)+\frac{1}{(K-1)(2K-1)}\left(-3n_k\frac{\alpha-w-\tau_{ij}}{16\beta}\right).\end{aligned}$$

Furthermore, since

$$
\begin{aligned}
t_i = {} & 3\overline{F} + \frac{K}{(K-1)(2K-1)} 3n_i \sum_{j \in \mathscr{K} \setminus \{i\}} \frac{\tau_{ij}^2 - 2\tau_{ij}(\alpha - w)}{32\beta} \\
& + \frac{1}{2K-1} \sum_{j \neq i} \left((n_i - n_j) \frac{6\tau_{ij}(\alpha - w) - 3\tau_{ij}^2}{16\beta} + \sum_{l \in \mathscr{K} \setminus \{i,j\}} n_l \frac{6(\alpha - w)(\tau_{jl} - \tau_{il}) - 3\left(\tau_{jl}^2 - \tau_{il}^2\right)}{16\beta} \right) \\
& + \frac{1}{(K-1)(2K-1)} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{m \in \mathscr{K} \setminus \{j\}} 3n_j \frac{\tau_{jm}^2 - 2\tau_{jm}(\alpha - w)}{32\beta},
\end{aligned}
$$

comparative statics with respect to market size are

$$
\begin{aligned}
\frac{dt_i}{dn_i} = {} & \frac{K}{(K-1)(2K-1)} 3 \sum_{j \in \mathscr{K} \setminus \{i\}} \frac{\tau_{ij}^2 - 2\tau_{ij}(\alpha - w)}{32\beta} \\
& + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \frac{6\tau_{ij}(\alpha - w) - 3\tau_{ij}^2}{16\beta} \\
= {} & \frac{K-2}{(K-1)(2K-1)} 3 \sum_{j \in \mathscr{K} \setminus \{i\}} \tau_{ij} \frac{2(\alpha - w) - \tau_{ij}}{32\beta}
\end{aligned}
$$

and

$$
\begin{aligned}
\frac{dt_i}{dn_k} = {} & \frac{-1}{2K-1} \frac{6\tau_{ik}(\alpha - w) - 3\tau_{ik}^2}{16\beta} \\
& + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i,k\}} \frac{6(\alpha - w)(\tau_{jk} - \tau_{ik}) - 3\left(\tau_{jk}^2 - \tau_{ik}^2\right)}{16\beta} \\
& + \frac{1}{(K-1)(2K-1)} \sum_{m \in \mathscr{K} \setminus \{k\}} 3 \frac{\tau_{km}^2 - 2\tau_{km}(\alpha - w)}{32\beta} \\
= {} & -\frac{6(K-1)^2 + 3}{(K-1)(2K-1)} \frac{2\tau_{ik}(\alpha - w) - \tau_{ik}^2}{32\beta} \\
& + \frac{6(K-1) - 3}{(K-1)(2K-1)} \sum_{j \in \mathscr{K} \setminus \{i,k\}} \frac{2(\alpha - w)\tau_{jk} - \tau_{jk}^2}{32\beta}.
\end{aligned}
$$

Simplify these expressions to obtain Lemma 4.

Lemma 4. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with K countries. Then, for any $i, j, k \in \mathscr{K}$ and $j, k \neq i$ one can derive the following general equilibrium comparative statics for t_i*

(*a*) *with respect to country sizes*

$$
\frac{dt_i}{dn_i} = \frac{K-2}{(K-1)(2K-1)} 3 \sum_{j \in \mathscr{K} \setminus \{i\}} \tau_{ij} \frac{2(\alpha - w) - \tau_{ij}}{32\beta} > 0
$$

$$\frac{dt_i}{dn_k} = \frac{6(K-1)-3}{(K-1)(2K-1)} \sum_{j \in \mathscr{K} \setminus \{i,k\}} \frac{2(\alpha-w)\tau_{jk} - \tau_{jk}^2}{32\beta} - \frac{6(K-1)^2+3}{(K-1)(2K-1)} \frac{2\tau_{ik}(\alpha-w) - \tau_{ik}^2}{32\beta} \lesseqgtr 0$$

and

(*b*) *with respect to trade costs*

$$\frac{dt_i}{d\tau_{ij}} = \left(n_i(K-2) - 2n_j\left[(K-1)^2+0.5\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} \begin{cases} >0 & for\ n_i > \frac{2(K-1)^2+1}{K-2} n_j \\ <0 & for\ n_i < \frac{2(K-1)^2+1}{K-2} n_j \end{cases}$$

$$\frac{dt_i}{d\tau_{jk}} = (n_j+n_k) \frac{3(2K-3)}{(K-1)(2K-1)} \frac{\alpha-w-\tau_{jk}}{16\beta} > 0.$$

To sum up, the intuitions from the three-country model hold. As already mentioned in Section 2, a country's size positively affects its ability to tax, whereas it is not clear how t_i reacts to an expansion of market k.

Furthermore, when trade costs between j and k rise, country i becomes relatively more attractive which gives the latter country the leverage to tax more. Moreover, $\frac{dt_i}{d\tau_{ij}}$ will be negative if market i is not too large. Interestingly, the more countries there are, the larger market i has to be relative to j to have $\frac{dt_i}{d\tau_{ij}} > 0$. Similar to Corollary 1, we formulate Corollary 5.

Corollary 5. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K \geq 2$ countries. Define $\bar{t} := \frac{1}{K}\sum_{k\in\mathscr{K}} t_k$, $\bar{t}_{EU} := \frac{1}{K_{EU}}\sum_{k\in\mathscr{K}_{EU}} t_k$, and $\bar{t}_{nonEU} := \frac{1}{K-K_{EU}}\sum_{k\in\mathscr{K}\setminus\mathscr{K}_{EU}} t_k$. Then,*

(*a*) *for any $i,j,k \in \mathscr{K}$ with $i \neq j \neq k$*

$$\frac{d\frac{1}{2}(t_i+t_j)}{d\tau_{ij}} = -\frac{3\left[(K-1)(2K-3)+2\right](n_i+n_j)}{2(K-1)(2K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} < 0,$$

$$\frac{d\frac{1}{2}(t_i+t_k)}{d\tau_{ij}} = \frac{3\left[n_i(3K-5) - n_j(2(K-1)(K-2)+2)\right]}{2(K-1)(2K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} \begin{cases} >0 & for\ n_i > \frac{2(K-1)(K-2)+2}{3K-5} n_j \\ <0 & for\ n_i < \frac{2(K-1)(K-2)+2}{3K-5} n_j \end{cases},$$

and

$$\frac{d\bar{t}}{d\tau_{ij}} = -\frac{3(n_i+n_j)}{K(K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} < 0.$$

(*b*) *for $i,j \in \mathscr{K}_{EU}$ with $i \neq j$*

$$\frac{d\bar{t}_{EU}}{d\tau_{ij}} = -\frac{3\left[(K-K_{EU}+1)(2K-3)+2\right](n_i+n_j)}{K_{EU}(K-1)(2K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} < 0$$

and

$$\frac{d\bar{t}_{nonEU}}{d\tau_{ij}} = \frac{3(2K-3)(n_i+n_j)}{(K-1)(2K-1)} \frac{\alpha-w-\tau_{ij}}{16\beta} > 0.$$

(c) *for* $i \in \mathscr{K}_{EU}$ *and* $j \in \mathscr{K} \setminus \mathscr{K}_{EU}$

$$\frac{d\bar{t}_{EU}}{d\tau_{ij}} = \frac{3\left(n_i\left[K-2+\left(K_{EU}-1\right)\left(2K-3\right)\right]-n_j\left[2\left(K-1\right)\left(K-K_{EU}\right)+K_{EU}\right]\right)}{K_{EU}\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau_{ij}}{16\beta}$$
$$\begin{cases} >0 & for\ n_i > \frac{2(K-1)(K-K_{EU})+K_{EU}}{K-2+(K_{EU}-1)(2K-3)}n_j \\ <0 & for\ n_i < \frac{2(K-1)(K-K_{EU})+K_{EU}}{K-2+(K_{EU}-1)(2K-3)}n_j \end{cases}$$

and

$$\frac{d\bar{t}_{nonEU}}{d\tau_{ij}} = \frac{3\left(n_j\left[K-2+\left(K-K_{EU}-1\right)\left(2K-3\right)\right]-n_i\left[2\left(K-1\right)K_{EU}+K-K_{EU}\right]\right)}{\left(K-K_{EU}\right)\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau_{ij}}{16\beta}$$
$$\begin{cases} >0 & for\ n_j > \frac{2(K-1)K_{EU}+K-K_{EU}}{K-2+(K-K_{EU}-1)(2K-3)}n_i \\ <0 & for\ n_j < \frac{2(K-1)K_{EU}+K-K_{EU}}{K-2+(K-K_{EU}-1)(2K-3)}n_i \end{cases}.$$

(d) *for* $i, j \in \mathscr{K} \setminus \mathscr{K}_{EU}$ *with* $i \neq j$

$$\frac{d\bar{t}_{EU}}{d\tau_{ij}} = \frac{3\left(2K-3\right)\left(n_i+n_j\right)}{\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau_{ij}}{16\beta} > 0$$

and

$$\frac{d\bar{t}_{nonEU}}{d\tau_{ij}} = -\frac{3\left[\left(K_{EU}+1\right)\left(2K-3\right)+2\right]\left(n_i+n_j\right)}{\left(K-K_{EU}\right)\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau_{ij}}{16\beta} < 0.$$

Part (a) of Corollary 5 is the K-country equivalent of Corollary 1. $(b)-(d)$ describe the effects of a rise in bilateral trade costs on average taxes inside and outside the economic union. When trade between two member countries becomes more costly, on average taxes inside the economic union fall whereas the average tax rate of non-member countries increases. On the other hand, the higher the bilateral trade costs for two non-member countries, the lower (higher) is the average tax outside (inside) the economic union. Part (c) shows that the effects of a rise in trade costs between a member and a non-member country are unclear. These depend on relative sizes of countries as well as the number of member countries in the economic union.

A.5 Proof of Proposition 5

To show Proposition 5 we use Lemma 4. For part (a), take country l which is supposed to leave the economic union, in the sense that all bilateral trade costs between union members and country l are going to increase, and sum $\frac{dt_l}{d\tau_{ml}}$ over all relevant country combinations, i.e. over the set $\mathscr{K}_{EU}$,

$$\begin{aligned} \sum_{m\in\mathscr{K}_{EU}}\frac{dt_l}{d\tau_{ml}} &= \sum_{m\in\mathscr{K}_{EU}}\left(n_l\left(K-2\right)-2n_m\left[\left(K-1\right)^2+0.5\right]\right)\frac{3}{\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau}{16\beta} \\ &= \left(n_lK_{EU}\left(K-2\right)-\sum_{m\in\mathscr{K}_{EU}}n_m\left[2\left(K-1\right)^2+1\right]\right)\frac{3}{\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau}{16\beta}. \end{aligned}$$

For $n \coloneqq n_m = n_n$, we obtain a simpler expression

$$\sum_{m=1}^{K_{EU}} \frac{dt_n}{d\tau_{mn}} = \left(5K - 5 - 2K^2\right) \frac{3K_{EU}n}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} < 0.$$

Proceed similarly to obtain the reaction of a member country $m \in \mathscr{K}_{EU}$ to the disintegration of l. It is important to note that two effects play a role here. First of all, there is a direct effect induced by the increase in bilateral trade costs between the countries m and l. At the same time trade costs between l and the other member countries rise. Therefore, the overall effect on the tax rate in country m reads as

$$\begin{aligned}
\frac{dt_m}{d\tau_{ml}} + \sum_{j \in \mathscr{K}_{EU} \setminus \{m\}} \frac{dt_m}{d\tau_{jl}} &= \left(n_m (K-2) - 2n_l \left[(K-1)^2 + 0.5\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\
&\quad + \sum_{j \in \mathscr{K}_{EU} \setminus \{m\}} (n_j + n_l) \frac{3(2K-3)}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\
&= \Bigg((K-1) \left[2 \sum_{j \in \mathscr{K}_{EU}} n_j - 2n_l (K - K_{EU}) - n_m\right] \\
&\quad + K_{EU} \left[n_l - \frac{1}{K_{EU}} \sum_{j \in \mathscr{K}_{EU}} n_j\right]\Bigg) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}.
\end{aligned}$$

Under symmetric market size

$$\frac{dt_m}{d\tau_{ml}} + \sum_{j \in \mathscr{K}_{EU} \setminus \{m\}} \frac{dt_m}{d\tau_{jl}} = (4K_{EU} - 2K - 1) \frac{3n}{2K-1} \frac{\alpha - w - \tau}{16\beta}.$$

For the proof of part (c) we only need to consider one set of effects, namely that the rise in trade costs considered here is a third country effect for non-member countries. That is, for any $k \in \mathscr{K} \setminus (\mathscr{K}_{EU} \cup \{l\})$ the effect on business taxation is given by

$$\begin{aligned}
\sum_{j \in \mathscr{K}_{EU}} \frac{dt_k}{d\tau_{jl}} &= \sum_{j \in \mathscr{K}_{EU}} (n_j + n_l) \frac{3(2K-3)}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\
&= \left(\frac{1}{K_{EU}} \sum_{j \in \mathscr{K}_{EU}} n_j + n_l\right) \frac{3K_{EU}(2K-3)}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} > 0.
\end{aligned}$$

A.6 Proof of Proposition 6

Suppose Assumption 1 holds. Then, the tax rate of a member country $m \in \mathscr{K}_{EU}$ can be simplified to

$$t_m = 3\overline{F} + 3n \frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{[(K-1)(2K - 2K_{EU} + 1) + K_{EU}](K_{EU} - 1)}{(K-1)(2K-1)} 3n(\tau - \tau^*) \frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta},$$

whereas the tax in a non-member country $n \in \mathscr{K} \backslash \mathscr{K}_{EU}$ reads as

$$t_n = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{K_{EU}(K_{EU}-1)(2K-3)}{(K-1)(2K-1)} 3n(\tau^* - \tau)\frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}.$$

First of all, note that

$$t_n - t_m = \frac{K_{EU}(2K-3) + (K-1)(2K - 2K_{EU} + 1) + K_{EU}}{(K-1)(2K-1)}(K_{EU}-1)3n(\tau^* - \tau)\frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}.$$

Hence, $t_n < t_m$ whenever $\tau^* < \tau$ and $K_{EU} > 1$. Otherwise, $t_n = t_m$. As we can see, the size of the business tax differential between member and non-member countries depends on the institutional structure of the world economy. Moreover, note that as the number of countries grows large, tax rates do not diverge

$$\lim_{K \to \infty} t_m = \lim_{K \to \infty} t_n + 3n(K_{EU}-1)(\tau - \tau^*)\frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}$$

where

$$\lim_{K \to \infty} t_n = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta}.$$

For part (b) of the Proposition, differentiate t_m with respect to the number of member countries

$$\frac{dt_m}{dK_{EU}} = \frac{(K-1)[(2K-1) - 4(K_{EU}-1)] + 2K_{EU} - 1}{(K-1)(2K-1)} 3n\left(\frac{2(\alpha - w)(\tau - \tau^*) - \left(\tau^2 - \tau^{*2}\right)}{32\beta}\right).$$

This expression is positive by the following argument. Firstly, note that the sign of $\frac{dt_m}{dK_{EU}}$ is the same as the sign of $\phi(K)$, where

$$\phi(K) \coloneqq (K-1)[(2K-1) - 4(K_{EU}-1)] + 2K_{EU} - 1.$$

$\phi(K)$ is positive, since $\phi(1) = 2K_{EU} - 1 > 0$ and

$$\begin{aligned}\phi'(K) &= (4K-3) - 4(K_{EU}-1) \\ &> 4(K-1) - 4(K_{EU}-1) \geq 0 \ \forall K \geq K_{EU} \geq 1.\end{aligned}$$

Moreover, take the derivative of t_m with respect to the number of countries worldwide

$$\frac{dt_m}{dK} = \frac{4(K-1)^2(K_{EU}-1) - K_{EU}(4K-3)}{(K-1)^2(2K-1)^2}(K_{EU}-1)3n_{K_{EU}}\left(\frac{2(\alpha - w)(\tau - \tau^*) - \left(\tau^2 - \tau^{*2}\right)}{32\beta}\right)$$

which is negative for $K_{EU} = 2$ and $K = 3$ and positive for $K_{EU} = 2$ and $K = 4$.

The other derivatives are unambiguous as

$$\frac{dt_m}{d\tau^*} = -\frac{1}{(K-1)(2K-1)}6n_{K_{EU}}[(K-1)(2K - 2K_{EU} + 1) + K_{EU}](K_{EU}-1)\frac{\alpha - w - \tau^*}{32\beta} < 0$$

and

$$\begin{aligned}
\frac{dt_m}{d\tau} &= 6n_{K_{EU}}\frac{\tau-(\alpha-w)}{32\beta}+\frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left[(K-1)(2K-2K_{EU}+1)+K_{EU}\right](K_{EU}-1)\frac{\alpha-w-\tau}{32\beta}\\
&= \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)\left[2K(K_{EU}-2)-2K_{EU}(K_{EU}-1)+3K_{EU}\right]+K_{EU}(K_{EU}-1)\right\}\frac{\alpha-w-\tau}{32\beta}\\
&> \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)K_{EU}\left[2(K_{EU}-2)-2(K_{EU}-1)+3\right]+K_{EU}(K_{EU}-1)\right\}\frac{\alpha-w-\tau}{32\beta}\\
&= \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)K_{EU}\left[-4+2+3\right]+K_{EU}(K_{EU}-1)\right\}\frac{\alpha-w-\tau}{32\beta}>0.
\end{aligned}$$

The comparative statics in part (c) are given by

$$\frac{dt_n}{dK_{EU}}=\frac{(2K_{EU}-1)(2K-3)}{(K-1)(2K-1)}3n(\tau^*-\tau)\frac{2(\alpha-w)-(\tau+\tau^*)}{32\beta}<0,$$

$$\frac{dt_n}{dK}=\frac{(2K-3)^2-2}{(K-1)^2(2K-1)^2}3nK_{EU}(K_{EU}-1)(\tau-\tau^*)\frac{2(\alpha-w)-(\tau+\tau^*)}{32\beta}>0,$$

$$\frac{dt_n}{d\tau}=6n\frac{\tau-(\alpha-w)}{32\beta}+\frac{K_{EU}(K_{EU}-1)(2K-3)}{(K-1)(2K-1)}6n\frac{\tau-(\alpha-w)}{32\beta}<0,$$

and

$$\frac{dt_n}{d\tau^*}=\frac{K_{EU}(K_{EU}-1)(2K-3)}{(K-1)(2K-1)}6n\frac{\alpha-w-\tau^*}{32\beta}>0.$$

A.7 Proof of Lemma 2

It is to show that for any combination of trade costs $\frac{dW_k}{d\tau_{ij}}\left(\tau_{ik}^{new},\tau_{ij}^{new},\tau_{jk}^{new}\right)>0$ for $i,j\neq k$ and $\tau_{ik}^{new}=\tau_{jk}^{new}$. Welfare in country k reads as

$$W_k:=\max_{t_k}\ G\left(\gamma^{ki}\right)\Delta_k^{ki}+G\left(\gamma^{ij}\right)\Delta_k^{ij}+G\left(\gamma^{jk}\right)\Delta_k^{jk}+t_k\left(3-G\left(\gamma^{ki}\right)+G\left(\gamma^{jk}\right)\right)+\delta_k^{ki}+\delta_k^{ij}+\delta_k^{jk}+n_kw.$$

Given that $\tau_{ik}^{new}=\tau_{jk}^{new}$, $\Delta_k^{ij}=0$ and $\Delta_k^{ki}=-\Delta_k^{jk}$. Observe that $\frac{d\delta_k^{ki}}{d\tau_{ij}}=\frac{d\delta_k^{ij}}{d\tau_{ij}}=\frac{d\delta_k^{jk}}{d\tau_{ij}}=0$. Then, by the envelope theorem

$$\begin{aligned}
\frac{dW_k}{d\tau_{ij}}\left(\tau_{ki}^{new},\tau_{ij}^{new},\tau_{jk}^{new}\right) &= \left(\frac{\partial\gamma^{ki}}{\partial\tau_{ij}}g\left(\gamma^{ki}\right)+\frac{\partial\gamma^{ki}}{\partial t_i}\frac{\partial t_i}{\partial\tau_{ij}}g\left(\gamma^{ki}\right)\right)\left(\Delta_k^{ki}-t_k\right)\\
&+\left(\frac{\partial\gamma^{jk}}{\partial\tau_{ij}}g\left(\gamma^{jk}\right)+\frac{\partial\gamma^{jk}}{\partial t_j}\frac{\partial t_j}{\partial\tau_{ij}}g\left(\gamma^{jk}\right)\right)\left(-\Delta_k^{ki}+t_k\right)\\
&= \left(\frac{\partial\gamma^{ki}}{\partial\tau_{ij}}-\frac{\partial t_i}{\partial\tau_{ij}}\right)g\left(\gamma^{ki}\right)\left(\Delta_k^{ki}-t_k\right)\\
&+\left(\frac{\partial\gamma^{jk}}{\partial\tau_{ij}}+\frac{\partial t_i}{\partial\tau_{ij}}\right)g\left(\gamma^{jk}\right)\left(-\Delta_k^{ki}+t_k\right)\\
&= \left[(n_i+n_j)\frac{\alpha-w-\tau_{ij}^{new}}{2\overline{F}}\frac{36}{160\beta}\right]\left(t_k-\Delta_k^{ki}\right)
\end{aligned}$$

where the last equality follows by our partial equilibrium comparative statics in Subsubsection 2.1.2 and by the general equilibrium comparative statics shown in Lemma 1 (b). Observing that $\Delta_k^{ki} < 0$ concludes the proof.