A Theory of Economic Disintegration*

Eckhard Janeba[†], Karl Schulz[‡]

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Abstract

We develop a theory of economic disintegration with both endogenously formed tax and trade policies. We show very generally that the economic disintegration of a country from an economic union leads to a deeper integration of international trade institutions. Moreover, we set up a multi-country, multi-sector general equilibrium trade model with internationally mobile firms. We address the key dimensions of economic disintegration, such as tariffs, non-tariff barriers, the harmonization of production standards and regulations, as well as household migration and analyze their effects on the domestic tax policies of asymmetric countries.

Keywords: Trade Policy, Tax/Subsidy Competition, Oligopolistic Markets, Economic Integration
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[†]University of Mannheim, Department of Economics, L7 3-5, 68131 Mannheim, Germany, janeba@uni-mannheim.de.

[‡]University of Mannheim, Center for Doctoral Studies in Economics, L7 3-5, 68131 Mannheim, Germany, karl.schulz@gess.uni-mannheim.de.

1 Introduction

> "We're going to stop the ridiculous trade deals that have taken everybody out of our country and taken companies out of our country, and it's going to be reversed." – Donald Trump, President of the United States.

After decades of international integration, recent movements towards economic disintegration have emerged. The United Kingdom's referendum to leave the European Union, as well as US President Trump's threat to depart from the WTO, are prominent examples of such protective policy measures that have gained significant influence lately. Similarly, this is the case for the renegotiation of NAFTA and the failure to finalize trade agreements like TPP and TTIP.

The emergence of this protectionism raises several economic policy issues: First of all, is unilateral (or partial) economic disintegration the same as reverse integration? How are international trade agreements affected by such movements?

Contributors to the literature on trade policy, as founded by Bagwell and Staiger (1999), highlight the advantages of forming international trade agreements to overcome the Prisoner's Dilemma of mutual terms-of-trade manipulation. Ceteris paribus, in a state of economic disintegration, countries are, therefore, worse off compared to free trade.

However, the disintegration of one country from an economic union or a regional trade agreement has global repercussions for existing international agreements. In other words, international agreements react worldwide to economic disintegration. For example, it may well be the case that the UK and the remaining European Union are adversely affected as the conditions under which these countries trade with each other worsen due to Brexit. At the same time, both the UK and the EU are now free to (re)negotiate trade agreements with other countries without the need to consider each other. To put it differently, their objective function and the set of available trade policy instruments change. In turn, cooperative and non-cooperative trade policies towards third countries are affected. As a consequence, the implications of unilateral economic disintegration become less straightforward compared to those of a reverse multilateral integration.

Another critical question is how domestic policies, such as business taxation, react to the degree of economic integration. A significant 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, Nigai, and Strecker (2019)) and lower tax rates on corporations (Dyreng, Hanlon, Maydew, and Thornock (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.

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 for tax policies from the US exiting 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 higher capital inflows to the US (through FDI). These could make higher taxes in the US possible and put downward pressure on tax rates elsewhere to prevent capital outflows.

To the best of our knowledge, this is the first paper that builds a comprehensive theory of partial economic disintegration. We develop a novel first-order approach to study very generally the impact of unilateral disintegration on trade policies worldwide. That is, we not only speak to the effects on trade policies in countries that are directly affected by the disintegration of one country from an economic union or a regional trade agreement, but also to the effects on trade policies in third countries. We address both tariff and non-tariff trade policies.

Moreover, we build a highly tractable multi-country, multi-sector general equilibrium trade model with international firm mobility and non-cooperative business tax policy. 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 Ricardian idea of international specialization inspires the latter. Industries differ in 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 has a direct bearing on the elasticity of firm relocation, as it determines the firms' degree of attachment to a particular country. Economically, we interpret the relative fixed costs 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 each country's Nash equilibrium business tax policy in closed form as a function of country-pair specific trade costs, firm-location fixed cost distributions, country sizes, and preferences.

We characterize partial economic disintegration by several comparative statics. 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 relocation costs of mobile firms in a given country and address household migration.

We derive two sets of results. Firstly, when the disintegration of a country from an economic union (or a trade agreement) 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. That is the case when there is a large single market with few competing markets. The contrary is true when the economic union is small relative to the world market. That is, under a significant size of competing markets, which is the case at an advanced stage of globalization, the remaining member countries need to compete harsher for mobile firms after a member country leaves. Under considerable asymmetries in the size of member countries, tax policy reactions within the union point in opposite directions. Since third countries outside the economic union become more attractive as a business location relative to the other countries, their ability to tax improves. These observations hold for both tariffs and non-tariff barriers to trade.

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 firms do not anticipate this cost change, they may become less mobile across countries which tends to raise tax rates in our model. In the long run, economic disintegration discourages investment in the leaving country because it reduces the sum of future profits, firms can realize in that country. We model this by a shift in the relocation cost distributions to the detriment of the leaving country. We highlight substantial differences in the reaction of tax rates depending on whether or not firms anticipate the economic disintegration.

Secondly, as pointed out, we go beyond the initial model setup, in which trade policies are exogenously given and change mechanically with disintegration, and consider the situation in which tariffs and non-tariff barriers are endogenously bargained over by countries initially, without relying on a specific model. We distinguish between two cases of economic disintegration: the exit from an economic union and the exit from regional trade agreements. Our only assumption is that the welfare of one country is increasing in trade costs between two other countries, which is standard in existing models of trade policy and also fulfilled in our above-described economy.

On the one hand, when one country leaves the union unexpectedly (case 1), we predict that the countries inside the union integrate more with each other and with countries with which they form regional trade agreements. The leaving country also intensifies trade agreements with third countries. Similarly, non-cooperative trade policies by the economic union, as well as by the leaving country, become less protective. On the other hand, as one country departs from regional trade agreements (case 2), not surprisingly, the leaving country implements more protective trade policies. These trade policy responses have repercussions on the setting of optimal business tax rates.

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 trade policies the leaving country and the remaining member countries undertake subsequently. We predict that both deepen their trade relations with other countries.

At the same time, our model applies more broadly beyond the case of Brexit. A similar argument applies to countries which consider leaving the 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 fixed firm-relocation costs. 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 link to each other through the mobility of capital (Zodrow and Mieszkowski (1986) and Wilson (1986)), labor (Lehmann, Simula, and Trannoy (2014)), or foreign direct investment (Haufler and Wooton (1999) and Haufler and Wooton (2006)). The presence of location rents incentivizes governments to modify their domestic policy instruments, such as tax rates, to attract these factors. Just as our model, some of the papers, for instance, Bucovetsky (1991) and Haufler and Wooton (1999), can speak to cross-country asymmetries. We show that not only the relative size of a given market but also the institutional structure of the world economy profoundly 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 in which contributors 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 carefully.

Secondly, 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 critical for a firm to set up an FDI platform in the larger market, as export costs to this market are then low, and the firm can easily access both markets irrespective of its location. Vice versa, if trade costs were high, firms would like to locate in the sized market irrespective of the business tax differential until the increased degree of regional competition consumes the location rents in the large market. 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), the government of one country is presumed to be completely inactive. Darby, Ferrett, and Wooton (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.

Two key challenges have, so far, prevented the literature from progressing to more realistic multi-country models. The first one is that, in a multi-country setting, firm relocation is a multinomial choice problem. The equilibrium distribution of firms across regions is a function of relative location rents, which are, in turn, endogenous to the distribution of firms. As a result, it is hard to derive the objective function of the government in each country. Secondly, each country's tax rate is the best response to all the other countries' tax rates. Therefore, the optimal tax rate in a country is a general equilibrium object. Restricting attention to partial equilibrium responses lacks critical insights from the empirical literature on tax competition. We overcome both of these issues by reducing the dimensionality of the firm-level relocation problem. At the same time, on an aggregate level, the distribution of firms is a high-dimensional object that is still tractable enough to solve for general equilibrium tax policies.

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. Furthermore, we extend the classical debate on optimal tariffs, started by Bagwell and Staiger (1999), by two dimensions. We study the impact of economic disintegration on trade policies worldwide, taking existing imperfections of trade agreements as given. Moreover, we endogenize various other components of trade policy, including non-tariff trade barriers and the harmonization in production standards and business regulations. Contrary to tariffs, the non-tariff dimensions embrace no revenue collection motive of the government while still affecting the terms of trade and firm relocation.

This paper is structured as follows. In Section 2, we develop a multi-country, multi-sector general equilibrium trade model with firm mobility and non-cooperative business taxation. As we show, tax policies substantially interact with the degree of economic integration along several trade policy dimensions. In particular, we deal with the effects of non-tariff barriers, tariffs, the number of member countries in an economic union, the degree of harmonization in production standards and business regulations, and the migration of households. In Section 3, we present our first-order approach for studying the readjustment of tariff and non-tariff trade policies worldwide in reaction to economic disintegration. Section 4 concludes. We relegate all relevant proofs to Appendix A.

2 A Model of Tax Policy, Trade, and Economic Disintegration

In this section, we analyze a three-stage game of fiscal competition with initially three countries, which we will 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 countries, in which firms produce, 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 they trade across all jurisdictions.

We analyze partial economic (dis)integration by carrying out comparative statics 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. An increase in the trade costs of respective country-pairs captures partial (dis)integration. Moreover, we consider country-pair specific distributions of fixed cost for setting up a firm, whichis an additional way of modeling partial (dis)integration. Finally, we deal with migration between countries as a simultaneous offsetting change in the population between country-pairs.

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 $K > 3$. Figure 1 illustrates the three-country economy.

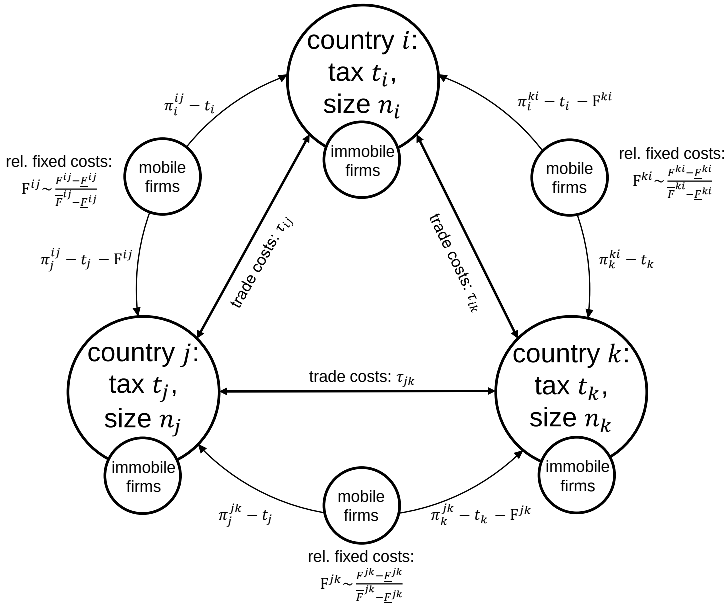

Figure 1: The three-country model

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 firms produce under perfect competition. Varieties, $x_i(\mu)$, are indexed by $\mu \in \Omega$. Labor is the only production input. Under the assumption that the production of the numéraire good takes place 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] 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 particular case of those in Melitz and Ottaviano (2008).[2]

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

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

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 read as $w + \tau_{ij}$. We interpret trade costs in a broader sense as the degree of economic integration. These refer to all non-tariff barriers to trade of goods and services such as consumer protection, quality requirements, health standards, and environmental protection. 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 deal with tariffs and show that our results carry over. Moreover, we endogenize tariff and non-tariff trade policies.

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 $\mathscr{K}$. As we will show later on, our results are robust to the accrual of domestic profits.

Inspired by Melitz (2003), we introduce firm heterogeneity as follows: In each industry, there are three firms. Two immobile firms produce in two countries (one in each country). Another mobile firm can decide in which of the two countries it locates. In the third country, the production of that specific good is not possible, perhaps due to technological, regulatory, or geographical frictions. This location structure 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 particular 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. One can, therefore, interpret this fixed cost as the cost of relocating from country i to j. We assume that F^{ij} has policy and non-policy components. The policy components are given by the country-specific level of frictions when setting up a business, ν^i, which are determined by factors such as bureaucracy, regulatory complexity, access to infrastructure, and the availability of land. Another policy component is the degree of harmonization in production standards and business regulations between two countries, ϵ^{ij}. Observe that the former affects the level of relative relocation costs, whereas the latter alters their variance. An idiosyncratic location preference shock, ϵ, pins down the non-policy component.

Formally, let $F^{ij} = \nu^j - \nu^i + \epsilon^{ij} + \epsilon$ where $\epsilon^{ij} + \epsilon \in \left[\underline{\epsilon}_{ij} + \underline{\epsilon}, \overline{\epsilon}^{ij} + \overline{\epsilon}\right]$ is drawn from a uniform cumulative distribution function with zero mean. Therefore, F^{ij} is also uniformly distributed with a CDF $G^{ij}\left(F^{ij}\right) = \frac{F^{ij} - \underline{F}^{ij}}{\overline{F}^{ij} - \underline{F}^{ij}}$, where $\underline{F}^{ij} = \nu^j - \nu^i + \underline{\epsilon}_{ij} + \underline{\epsilon}$ and $\overline{F}^{ij} = \nu^j - \nu^i + \overline{\epsilon}^{ij} + \overline{\epsilon}$. In this section, we impose, for simplicity, symmetry in relocation cost distributions across country pairs. That is, assume $G^{ij}\left(F^{ij}\right) = G\left(F^{ij}\right) = \frac{F^{ij} - \underline{F}}{\overline{F} - \underline{F}}$. In Section 2.2.2, we deal with the effects of the country-specific policy components that alter the mean and the variance of relocation costs (ν^i and $\overline{\epsilon}^{ij} - \underline{\epsilon}_{ij}$). Altogether, each mobile firm pays different fixed costs of production, giving rise to an extensive margin of firm relocation, 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

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

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

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

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 home market, whereas in country k there is no domestic 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[3] are larger in i than in j:

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

In other words, a firm prefers country i if the advantage in gross profits exceeds the tax differential corrected by the relative fixed cost. Since we have a continuum of industries that 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 in which the mobile firm is 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

[3]While pre-tax variable profits (4) are non-negative, we cannot rule out directly that net profits (after tax and fixed cost) are as well. In simulations, we showed for various parameter value combinations that there exist subgame-perfect equilibria in which the profits of all firms were non-negative. The requirement seems to hold more easily when the range of fixed costs is not too broad. In the following, we assume throughout that net profits are non-negative.

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 households in country i consume goods produced by jk-industries, but there is no production in or relocation towards i, which significantly simplifies the analysis. 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 a function of the model parameters

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

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

$$\begin{aligned} \frac{\partial \gamma^{ij}}{\partial t_i} &= 1 \\ \frac{\partial \gamma^{ij}}{\partial t_j} &= -1 \\ \frac{\partial \gamma^{ij}}{\partial t_k} &= 0 \end{aligned} \tag{10}$$

and trade costs

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

for $i \neq j \neq k$. Observing that the sign of $\frac{\partial \gamma^{ij}}{\partial \tau_{ij}}$ depends on the relative size of countries, already hints towards the critical 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 a given level of 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 that 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 $3 - G(\gamma^{ij}) + G\left(\gamma^{ki}\right)$, and hence tax revenues $T_i := t_i\left(3 - G(\gamma^{ij}) + G\left(\gamma^{ki}\right)\right)$. Moreover, Appendix A.1 shows that consumer surplus is given by

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

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

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

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

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

taking t_j and t_k as given. Similarly, 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 location 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, respectively, and

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

The first-order condition of the social planner problem yields a reaction function $t_i\left(t_j, t_k, \Theta\right)$ for each country i with $i \neq j, k$. As Appendix A.1 further shows, the reaction functions are linear in tax rates and that there is a unique intersection of the reaction functions, $t_i\left(\Theta\right)$ 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

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

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

and

(b) *with respect to trade costs*

$$\frac{dt_i}{d\tau_{ij}} = (3n_i - 27n_j)\,\frac{\alpha - w - \tau_{ij}}{160\beta} \begin{cases} > 0 & for\ n_i > 9n_j \\ < 0 & for\ n_i < 9n_j \end{cases}$$

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

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 low-cost access to the huge 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 that 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.

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

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

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

$$\frac{d\frac{1}{2}\left(t_i + t_k\right)}{d\tau_{ij}} = \left(6n_i - 9n_j\right)\frac{\alpha - w - \tau_{ij}}{160\beta}\begin{cases} > 0 & for\ n_i > 1.5n_j \\ < 0 & for\ n_i < 1.5n_j \end{cases},$$

and

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

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. A 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.

2.2 The Impact of Economic 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 less) costly? As Proposition 1 shows, the answer depends on the relative sizes of the three markets. The proposition 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)

$$\frac{dt_i}{d\tau_{ik}} + \frac{dt_i}{d\tau_{jk}} = (3n_i + 9n_j - 18n_k)\,\frac{\alpha - w - \tau}{160\beta} \begin{cases} > 0 & for\ n_i + 3n_j > 6n_k \\ < 0 & for\ n_i + 3n_j < 6n_k \end{cases}$$

and

(b)

$$\frac{dt_k}{d\tau_{ik}} + \frac{dt_k}{d\tau_{jk}} = (6n_k - 27n_i - 27n_j)\,\frac{\alpha - w - \tau}{160\beta} \begin{cases} > 0 & for\ 2n_k > 9n_i + 9n_j \\ < 0 & for\ 2n_k < 9n_i + 9n_j \end{cases}.$$

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, as shown in (b). The market access effect described above drives this result.

Under symmetric market sizes, tax rates in the remaining economic union decrease (see (a)). In case that the leaving country is huge (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 largest of the three markets. 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 tax. 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 policies 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 (whereas still lowering taxes in the other two countries).

2.2.2 Harmonization in Production Standards and Business Regulations

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 drawn from a cost distribution. This cost distribution may differ between country-pairs. Note that these cost distributions influence relocation elasticities, which vary origin-destination-wise. Relocation within the union is cheaper than from inside to the outside of the union. Thus, the relocation-cost differential is another dimension of economic integration. Namely, it describes the degree of harmonization or mutual acceptance of production standards and other business regulations a country-pair has 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. Contributors to the tax competition literature have extensively studied this mechanism. 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. Recall that $F^{ij} \in \left[\underline{F}_{ij}, \overline{F}^{ij}\right]$ is drawn from a uniform distribution $G^{ij}(F^{ij}) = \frac{F^{ij} - \underline{F}^{ij}}{\overline{F}^{ij} - \underline{F}^{ij}}$. Suppose for now that both countries have the same level of business frictions ($\nu^i = \nu^j$) such that $-\underline{F}_{ij} = \overline{F}^{ij}$. Now we can directly interpret $\overline{\epsilon}^{ij}$ and, hence, $\overline{F}^{ij} = \overline{\epsilon}^{ij} + \overline{\epsilon}$ as the degree of harmonization of i and j. Therefore, economic disintegration induces a mean-preserving spread in the distribution of relative fixed costs. The higher $\overline{\epsilon}^{ij}$ (and, accordingly, $\overline{F}^{ij}$), 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, $\overline{\epsilon}^{ij}$ and $\overline{\epsilon}^{ki}$ 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 rate as a function of $(\bar{\epsilon}^{ij})_{i,j\in\mathscr{K}}$. 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 $i \neq j, k$ $\frac{dt_i}{d\bar{\epsilon}^{jk}} > 0$. Moreover, $\frac{dt_i}{d\bar{\epsilon}^{ij}} > 0$ 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 $\overline{F}^{ki} \approx 0$, $\frac{dt_i}{d\bar{\epsilon}^{ij}} < 0$.

(b) Suppose that i and j form an economic union, i.e. $\overline{F}^{jk} = \overline{F}^{ki} \geq \overline{F}^{ij}$. Then, $\frac{dt_i}{\bar{\epsilon}^{jk}} + \frac{dt_i}{\bar{\epsilon}^{ki}} > 0$, $\frac{dt_j}{\bar{\epsilon}^{jk}} + \frac{dt_j}{\bar{\epsilon}^{ki}} > 0$, and $\frac{dt_k}{\bar{\epsilon}^{jk}} + \frac{dt_k}{\bar{\epsilon}^{ki}} > 0$. 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 $\bar{\epsilon}^{jk}$ makes tax bases in the directly affected countries j and k less elastic, which tends (although it does not guarantee) to increase tax rates in these countries. In the Nash equilibrium, this spills over to the tax rate 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 $\bar{\epsilon}^{ij}$. Interestingly, there may be cases in which the tax rate falls, $\frac{dt_i}{d\bar{\epsilon}^{ij}} < 0$. 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 $\bar{\epsilon}^{jk}$ and $\bar{\epsilon}^{ki}$ 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* $i \neq j, k$

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

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

and

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

So far, we have described origin-destination-specific asymmetries in the firm- location costs 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 $\bar{\epsilon}^{jk}$ and $\bar{\epsilon}^{ki}$ 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. Put differently, the disintegration of a country may discourage prospective entrepreneurs from investing 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. Therefore, one of our extensions regards the effects of changing the ex-ante distribution of firms.

Second, we have assumed that economic disintegration triggers a mean-preserving spread in the relocation cost distribution. Therefore, a rise in $\bar{\epsilon}^{jk}$ 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. As before, $F^{ij} \in \left[\underline{F}_{ij}, \overline{F}^{ij}\right]$ 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 $\overline{F}^{ij}-\underline{F}^{ij}=\overline{F}^{jk}-\underline{F}^{jk}=\overline{F}^{ki}-\underline{F}^{ki}$. However, now the relocation cost distributions are allowed to have a different mean:

$$\nu^{ij}:=\nu^{j}-\nu^{i}\gtreqless\nu^{jk}:=\nu^{k}-\nu^{j}\gtreqless\nu^{ki}:=\nu^{i}-\nu^{k}.$$

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 average cost of setting up a business in a country induces lower taxes in that country, whereas taxes in the other countries go up, that is, $\frac{dt_i}{d\nu^{ij}}>0$, $\frac{dt_i}{d\nu^{ki}}<0$, and $\frac{dt_i}{d\nu^{jk}}=0$.*

When ν^{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 ν^{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 ν^{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, ν^{ki} decreases, and ν^{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 exceeds 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 $i, j, k \in \mathcal{K}$ and $i \neq j, k$ 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 into 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 $\sum_{l \in \mathcal{K}} n_l$ 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 irrespective of whereto migrants precisely move.

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

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

(*a*)

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

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 (part (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.

Altogether, migration from outside to inside the union increases taxes inside the union and reduces the tax in the leaving country. This migration effect is the third central 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 analyze the 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, we can readily relax this assumption. 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: countries that were already outside the union before 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}. These assumptions allow us to model economic disintegration purely as a change in K_{EU}. For a detailed derivation of the K-country model, we refer to Appendix A.4.

2.3.1 Trade Costs

We now state Proposition 5, which is the K-country counterpart to Proposition 1.[5] See Appendix A.5 for the proof. 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 $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$*

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

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

[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.

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

$$\frac{dt_m}{d\tau_{ml}} + \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_m}{d\tau_{jl}} = \frac{(K-1)\left[6K_{EU}\bar{n}_{EU} - 6n_l\left(K-K_{EU}\right) - 3n_m\right] + 3K_{EU}\left(n_l - \bar{n}_{EU}\right)}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}$$

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

and

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

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

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 case-specific. 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 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. Furthermore, one can observe the effects of globalization. The more competing countries the economic union faces, the more sensitive react members' tax bases and, hence, tax rates to the disintegration of a member country. Put differently, in a globalized world, the union is vulnerable to the fiscal consequences of economic disintegration.

In Corollary 4, we consider 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 disintegration triggers the following change in the average tax of*

(a) the remaining member countries

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

(b) third countries

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

and

(c) the world

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

The disintegration of country l increases on average 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, the average tax rate inside the union rises when country l leaves, and the size of the remaining economic union is considerable. Vice versa, at a late stage of globalization, the number of rival markets (i.e., K) is significant, and member countries need to lower their taxes to stay competitive on the world market after the exit of a union member.

2.3.2 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 $m, n \in \mathscr{K} \backslash \mathscr{K}_{EU}$ with $m, n \neq l$. Let $K_{EU} > 1$.*

In Appendix A.6, we show that under Assumption 1 the tax rate of member countries, t_m, and the one of non-member countries, t_n, are functions of a reduced set of model primitives $\widetilde{\Theta} := \left(\alpha, \beta, w, n, \tau^*, \tau, \overline{F}, K, K_{EU}\right)$. In Proposition 6, we summarize 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 $\forall n \in \mathscr{K} \backslash \mathscr{K}_{EU}$*

(*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 higher than outside. Being part of the economic union makes countries more attractive to firms, which moderates tax competition for these countries. Once

[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, Konrad, and Kotsogiannis (2006)).

asymmetries in trade costs are removed, all the advantages of the economic union have vanished such that $t_m = t_n$. To sum up, ceteris paribus the tax rate of the country that leaves the economic union will decline.

Secondly, comparative statics of tax rates with respect to trade costs are intuitive. On the one hand, 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. Then, tax rates to drift even further apart.

Third and 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.

Regarding the effects of globalization on taxes inside the economic union, one needs to differentiate t_m with respect to K. As shown in the appendix, the sign of this derivative is ambiguous and, by the same intuition as before, increasing (decreasing) in the number of member (non-member) countries. Non-member countries gain relative attractiveness, as globalization proceeds, and the relative size of the economic union accordingly shrinks ($\frac{dt_n}{dK} > 0$).

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.

2.4 Extensions

In this section, we describe three extensions to our baseline economy. Firstly, we incorporate tariffs into our model (see Appendix A.7). That is, aside from non-tariff trade barriers, we allow for the presence of import and export tariffs. Just as non-tariff trade barriers, trade taxes affect consumer surplus and revenues from taxing corporations. Besides, tariffs generate additional fiscal revenues. For non-negative import tariffs and export subsidies, the optimal business tax rate of a country is revised upwards. As business taxes in a country rise, firms move away from that country. As a result, the government generates extra tariff revenues and saves expenditures on export subsidies. Accordingly, the reaction of business taxes to a rise in non-tariff trade costs is downwards adjusted. The reason is that higher trade costs reduce trade volumes such that the extra gains in tariffs (expenditure savings) decline. Nonetheless, the key trade-offs, in particular concerning the effects of economic disintegration, described in this section, carry over. Another remarkable feature is that the business tax of country i is U-shaped in foreign trade taxes. This pattern is similar to Proposition 1 in Haufler and Wooton (2010) but in our setting for trade policy instruments that have revenue effects.

Secondly, recall that, in our baseline economy, firm profits accrue to citizens in third countries or, at least, do not enter social welfare. This assumption is only reasonable for very wealthy investors and a government with a pronounced redistributive goal but not for smaller entrepreneurs or investors. Therefore, we now deal with the domestic accrual of profits (Appendix A.8). We distinguish two polar cases of firm ownership. The first one considers internationally mobile entrepreneurs who only enter the social welfare of a country when they decide to locate their business there. Usually, this is the case for smaller businesses. In the second case, citizens directly hold a diversified portfolio of enterprises worldwide. This assumption is realistic for mid- and big-cap companies with shares traded on international financial markets. In both cases, the social marginal welfare weight of firm ownership slightly modifies the optimal business tax rate. Moreover, in the former case, tax rates are revised downwards by the accrual of domestic profits and, in general equilibrium, of foreign profits, whereas, in the latter scenario, taxes account for the accrual of international profit differentials. This distinction is intuitive, as, in the first case, social welfare is a function of national income. However, when citizens are shareholders of firms worldwide, they only care about the size but not about the location of accrued profits.

Finally, we generalize our economy to an arbitrary number of immobile firms in each industry (see Appendix A.9). Our results hold as long as the distribution of immobile firms is similar across countries. A rise in the number of immobile firms in one country has opposing effects on the optimal business tax rate there. On the one hand, more firms in the country mechanically raise the government's ability to tax. On the other hand, more firms increase the degree of local competition such that the country becomes less attractive as a business location to mobile firms. In general equilibrium, these two effects point in the same direction for the tax rates of the other countries. Using this model specification, we can shed light on the anticipatory effects of economic disintegration. Suppose that some previously immobile firms learn a country's disintegration and move away from that country (and towards the economic union). This firm relocation lowers (improves) the disintegrating country's (member countries') ability to tax. At the same time, firms face more competition inside the economic union, which lowers mark-ups there. Vice versa, in the leaving country, firms generate higher profits.

3 The Impact of Economic Disintegration on Trade Policy

In this section, we consider another dimension of economic disintegration: Trade policies around the world endogenously react to economic disintegration. Two cases are of interest. First and foremost, one needs to consider the departure by a country from an economic union, which is the Brexit case. Secondly, there is the case where one country reneges on a regional trade agreement (or a set of TAs), for instance, the departure by the US from the WTO or the failure to finalize TTIP. In both cases, there are global effects on trade policies.

How do (non-tariff) trade policies inside the economic union change? How are regional trade agreements between the economic union and third countries affected? What are the effects on regional TAs between third countries? What is the effect on the non-cooperative trade policies of countries, which are not part of the WTO?

To answer these questions, we develop in the following a novel first-order approach of trade policies. In principle, this approach is free of specific assumptions on the structure of the underlying economic model and only relies on a small set of assumptions on the welfare function. It allows us to remain agnostic about whether or not economic disintegration is desirable. Moreover, we draw on the idea that cooperative trade policies result from efficient bargaining (see Grossman and Helpman (1995) and subsequent literature). Then, under the transferability of utilities, efficient cooperative trade policies maximize the respective sum of welfare, as described below.[7] Our approach considers trade policies before (labeled as "old" optimum) and after the disintegration ("new" optimum).

Definition 2. Assume that each optimization problem is concave and solutions are interior. Moreover, suppose that trade policy changes are small. Then, we can describe our first-order approach as a four-step procedure:

(1) Approximate the respective welfare in the new optimum around the old optimum.

(2) Use the optimality of the old and new trade policy choices.

[7] At first glance, this 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 member countries have jointly introduced projects like the Common Market to facilitate trade and commerce in the union, whereas the setting of business tax policies has so far been independent. The Common Market project and the free flow of goods, factors, and services in the EU have taken precedence over tax policies and therefore justify our timing assumptions: Countries choose trade policies simultaneously before tax policies.

(3) Impose the first-order conditions of the old optimum.

(4) Relate the sign of the gradient of welfare to the change in trade policies.

3.1 Departure from an Economic Union

Suppose that one country l (e.g., the UK) leaves an economic union formed by a set of countries $\mathscr{K}_{EU}$ (e.g., Germany, France,...). Our main observation is that the objective function of the economic union changes when one member country leaves. As a consequence, internal non-tariff, as well as external trade policies, are affected. External trade policies include, in particular, tariffs. These form within the framework of regional trade agreements with other markets as customary in the WTO or countries set them non-cooperatively. Moreover, one should note that this form of economic disintegration means effectively, although not legally, the creation of a new trading partner for all countries worldwide, with whom they can form new TAs.

Define $\mathscr{K}_{TA}$ as the set and K_{TA} as the number of countries which participate in regional trade agreements (e.g., the WTO). Let $\mathscr{T}^{old}$ denote the vector of tariff policies before the disintegration of country l. That is,

$$\mathscr{T}^{old} = \left(\mathscr{T}^{old}_{EU,EU}, \mathscr{T}^{old}_{EU,l}, \mathscr{T}^{old}_{EU,TA}, \mathscr{T}^{old}_{l,TA}, \mathscr{T}^{old}_{TA,TA}, \mathscr{T}^{old}_{Rest}\right)$$

is a vector of trade taxes consisting of the null vector $\left(\mathscr{T}^{old}_{EU,EU}, \mathscr{T}^{old}_{EU,l}\right)$, which summarizes bilateral tariffs in the economic union, another vector $\left(\mathscr{T}^{old}_{EU,TA}, \mathscr{T}^{old}_{l,TA}, \mathscr{T}^{old}_{TA,TA}\right)$ which summarizes cooperatively chosen tariffs within the set of countries $\mathscr{K}_{TA}$, the leaving country, and the economic union, and another vector of tariffs which are set non-cooperatively

$$\mathscr{T}^{old}_{Rest} = \left(\mathscr{T}^{old}_{EU,Rest}, \mathscr{T}^{old}_{l,Rest}, \mathscr{T}^{old}_{TA,Rest}, \mathscr{T}^{old}_{Rest,Rest}\right)$$

vis-à-vis countries from the rest of the world (e.g., Iran). Moreover, let

$$\mathcal{T}^{old} = \left(\mathcal{T}^{old}_{EU,EU}, \mathcal{T}^{old}_{EU,l}, \mathcal{T}^{old}_{EU,TA}, \mathcal{T}^{old}_{l,TA}, \mathcal{T}^{old}_{TA,TA}, \mathcal{T}^{old}_{Rest}\right)$$

denote the vector of bilateral non-tariff trade costs. A feature of an economic union is that member countries can cooperatively set these non-tariff trade costs. To begin with, let us assume the following.

Assumption 2. *Let for any* $j, k \neq i$ *where* $i, j, k \in \mathscr{K}$

$$\nabla_{\mathscr{T}_{j,k}} W_i (\mathcal{T}, \mathscr{T}) > 0$$

and

$$\nabla_{\mathcal{T}_{j,k}} W_i (\mathcal{T}, \mathscr{T}) > 0.$$

In Appendix A.10 we show that in our model, as described in Section 2, Assumption 2 is fulfilled given positive business taxes, small trade taxes, and sufficiently similar trade costs ($\tilde{\tau}_{ml} \approx \tilde{\tau}_{np}$). This result has an intuitive appeal. It means that any protective measure (i.e., tariffs as well as non-tariff barriers) between two countries proves beneficial to third countries (positive gradient of the welfare function). The reason is that the third country becomes more attractive to businesses as trade costs between the two other countries rise. Not even a reduction in the business tax rates of the two countries can compensate for this. Firms move to the third country, and prices decline there.

The assertion that third countries benefit from a rise in trade costs between two other countries is more general and well-known in the literature on trade policy. Usually, contributors to this literature refer to it as the terms-of-trade effect of bilateral trade costs (in particular tariffs) on the world price and, in turn, on a third country's welfare. It may result in bilateral opportunism (as in Bagwell and Staiger (2004)).

As mentioned above, countries inside the economic union choose non-tariff trade costs cooperatively. That is, $(\mathcal{T}_{EU,EU}, \mathcal{T}_{EU,l})$ is the outcome of efficient Nash bargaining. Before the disintegration of country l

$$\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{old}\right) := \underset{\left(\mathcal{T}_{EU,EU}, \mathcal{T}_{EU,l}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m (\cdot) .$$

After the disintegration, the remaining members negotiate their internal trade costs without consideration of country l's welfare

$$\left(\mathcal{T}_{EU,EU}^{new}\right) := \underset{\left(\mathcal{T}_{EU,EU}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU}} W_m\left(\cdot\right).$$

Do the remaining member countries integrate more with each other after the disintegration of l? In other words, how do the vectors $\mathcal{T}_{EU,EU}^{old}$ and $\mathcal{T}_{EU,EU}^{new}$ compare with each other? Consider the first-order Taylor approximation of members' welfare in the new optimum

$$\begin{aligned}\sum_{m \in \mathscr{K}_{EU}} W_m\left(\mathcal{T}_{EU,EU}^{new}, \mathcal{T}_{EU,l}^{new}, \cdot\right) = & \sum_{m \in \mathscr{K}_{EU}} W_m\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{new}, \cdot\right) \\ & + \sum_{m \in \mathscr{K}_{EU}} \nabla_{\mathcal{T}_{EU,EU}} W_m\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{new}, \cdot\right)\left(\mathcal{T}_{EU,EU}^{new} - \mathcal{T}_{EU,EU}^{old}\right)' + h.o.t. \\ & > \sum_{m \in \mathscr{K}_{EU}} W_m\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{new}, \cdot\right)\end{aligned}$$

which implies

$$\sum_{m \in \mathscr{K}_{EU}} \nabla_{\mathcal{T}_{EU,EU}} W_m\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{new}, \cdot\right)\left(\mathcal{T}_{EU,EU}^{new} - \mathcal{T}_{EU,EU}^{old}\right)' > 0.$$

By optimality of the old solution

$$\sum_{m \in \mathscr{K}_{EU} \cup \{l\}} \nabla_{\mathcal{T}_{EU,EU}} W_m\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) = 0$$

and, accordingly,

$$\begin{aligned}& \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} \nabla_{\mathcal{T}_{EU,EU}} W_m\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right)\left(\mathcal{T}_{EU,EU}^{new} - \mathcal{T}_{EU,EU}^{old}\right)' \\ & = \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} \nabla_{\mathcal{T}_{EU,EU}} W_m\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{new}, \cdot\right)\left(\mathcal{T}_{EU,EU}^{new} - \mathcal{T}_{EU,EU}^{old}\right)' + h.o.t. = 0.\end{aligned}$$

Therefore,

$$-\nabla_{\mathcal{T}_{EU,EU}} W_l\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right)\left(\mathcal{T}_{EU,EU}^{new} - \mathcal{T}_{EU,EU}^{old}\right)' > 0$$

and one can conclude that, whenever $\nabla_{\mathcal{T}_{EU,EU}} W_l\left(\mathcal{T}_{EU,EU}^{old}, \mathcal{T}_{EU,l}^{old}, \cdot\right) > 0$ (i.e., the welfare of the leaving country is increasing in two member countries' trade costs as in Assumption 2)

$$\mathcal{T}_{EU,EU}^{old} > \mathcal{T}_{EU,EU}^{new}.$$

Intuitively, changes in non-tariff trade barriers do not induce a first-order gain or loss on total welfare inside the economic union. However, for the old bargaining solution to be optimal, in the new optimum, the leaving country 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 trade costs. Hence, member countries integrate more with each other by reducing their internal non-tariff trade costs.

By the construction of the economic union as a customs union trade taxes inside the union remain prohibited $\mathscr{T}^{old}_{EU,EU} = \mathscr{T}^{new}_{EU,EU} = 0$, whereas trade taxes between the leaving country and the economic union can be any number after the disintegration. That is, $\mathscr{T}^{old}_{EU,l} = 0$ and $\mathscr{T}^{new}_{EU,l} \gtreqless 0$. Observe that this includes the case where country l remains in the customs union.

Common external tariffs are an essential feature of the customs union. Therefore, when country l decides to remain a member of the customs union, there will be no first-order change in trade policies vis-à-vis third countries. To put it differently, the countries $\mathscr{K}_{EU}$ and l jointly decide on external trade taxes before and after the disintegration of l. Objective functions and instruments of tariff policies remain the same. Only non-tariff trade barriers inside the customs union change. This change, however, has no first-order effect on the other trade policies. To determine the exact sign of second-order effects, one needs to know about cross derivatives of welfare functions with respect to the respective trade policy instruments.

Now, suppose that country l departs from the customs union but stays within the set of countries that participate in regional trade agreements. Recall that before the disintegration member countries solve

$$\left(\mathcal{T}^{old}_{EU,EU}, \mathcal{T}^{old}_{EU,l}\right) := \underset{\left(\mathcal{T}_{EU,EU}, \mathcal{T}_{EU,l}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m\left(\cdot\right)$$
$$subject\ to\ \left(\mathscr{T}^{old}_{EU,EU}, \mathscr{T}^{old}_{EU,l}\right) = 0,$$

but afterward

$$\left(\mathcal{T}_{EU,l}^{new},\mathscr{T}_{EU,l}^{new}\right) \coloneqq \underset{\left(\mathcal{T}_{EU,l},\mathscr{T}_{EU,l}\right)}{arg\ max} \sum_{m\in\mathscr{K}_{EU}\cup\{l\}} W_m\left(\cdot\right)$$

$$subject\ to\ \left(\mathscr{T}_{EU,EU}^{new}\right)=0$$

$$and\ \left(\mathcal{T}_{EU,EU}^{new}\right) \coloneqq \underset{\left(\mathcal{T}_{EU,EU}\right)}{arg\ max} \sum_{m\in\mathscr{K}_{EU}} W_m\left(\cdot\right).$$

Then, our first-order approach delivers

$$\sum_{m\in\mathscr{K}_{EU}\cup\{l\}} \nabla_{\mathscr{T}_{EU,l}} W_m\left(\mathcal{T}^{old},\mathscr{T}^{old}\right)\left(\mathscr{T}_{EU,l}^{new}\right)' > 0.$$

In principle, the sign of the relevant gradient and, therefore, the sign of post-disintegration trade taxes $\mathscr{T}_{EU,l}^{new}$ are ambiguous. In our model, for example, a domestic import tariff in country l would mean higher prices and a lower consumer surplus there. At the same time, ceteris paribus some marginal firms move to country l to gain low-cost market access, which means a rise in business tax revenues in l. Moreover, country l generates tariff revenues.

Given that we have dealt with the effects of economic disintegration on the trade policies between countries l and $\mathscr{K}_{EU}$, we can now speak to the impact on regional trade agreements of the economic union and the leaving country with third countries. Fix a country $TA \in \mathscr{K}_{TA}$. Once again, observe that the objective function and the trade policy instruments of the Nash bargaining change as follows:

$$\left(\mathscr{T}_{EU,TA}^{old},\mathscr{T}_{l,TA}^{old}\right) \coloneqq \underset{\left(\mathscr{T}_{EU,TA},\mathscr{T}_{l,TA}\right)}{arg\ max} \sum_{m\in\mathscr{K}_{EU}\cup\{l,TA\}} W_m\left(\cdot\right)$$

and

$$\left(\mathscr{T}_{EU,TA}^{new}\right) \coloneqq \underset{\left(\mathscr{T}_{EU,TA}\right)}{arg\ max} \sum_{m\in\mathscr{K}_{EU}\cup\{TA\}} W_m\left(\cdot\right)$$

$$\left(\mathscr{T}_{l,TA}^{new}\right) \coloneqq \underset{\left(\mathscr{T}_{l,TA}\right)}{arg\ max}\ W_l\left(\cdot\right)+W_{TA}\left(\cdot\right).$$

Again, consider a first-order approximation of welfare in $\mathscr{K}_{EU}$ and TA in the new optimum and use the first-order conditions of the respective optimization to show that

$$-\nabla_{\mathscr{T}_{EU,TA}} W_l \left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) \left(\mathscr{T}^{new}_{EU,TA} - \mathscr{T}^{old}_{EU,TA}\right)' > 0$$

which implies together with Assumption 2

$$\mathscr{T}^{old}_{EU,TA} > \mathscr{T}^{new}_{EU,TA}.$$

By similar arguments,

$$-\sum_{m \in \mathscr{K}_{EU}} \nabla_{\mathscr{T}_{l,TA}} W_m \left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) \left(\mathscr{T}^{new}_{l,TA} - \mathscr{T}^{old}_{l,TA}\right)' > 0.$$

Therefore, for $\sum_{m \in \mathscr{K}_{EU}} \nabla_{\mathscr{T}_{l,TA}} W_m \left(\mathcal{T}^{old}_{EU,EU}, \mathscr{T}^{old}_{EU,l}, \cdot\right) > 0$ (i.e., members of the economic union benefit from a trade war between l and TA)

$$\mathscr{T}^{old}_{l,TA} > \mathscr{T}^{new}_{l,TA}.$$

Hence, both country l and member countries of the economic union deepen their regional trade agreement with country TA by lowering trade taxes.

Consider, now, non-cooperative trade policies by the economic union vis-à-vis a country $Rest \in \mathscr{K} \setminus (\mathscr{K}_{TA} \cup \mathscr{K}_{EU} \cup \{l\})$. Use bold letters for trade policy instruments which are under the control of the respective government. Non-cooperative trade policies before and after the disintegration of l are given by

$$\left(\mathscr{T}^{old}_{\boldsymbol{EU},Rest}, \mathscr{T}^{old}_{\boldsymbol{l},Rest}\right) := \underset{\left(\mathscr{T}_{\boldsymbol{EU},Rest}, \mathscr{T}_{\boldsymbol{l},Rest}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m(\cdot)$$

and

$$\left(\mathscr{T}^{new}_{\boldsymbol{EU},Rest}\right) := \underset{\left(\mathscr{T}_{\boldsymbol{EU},Rest}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU}} W_m(\cdot)$$

$$\left(\mathscr{T}^{new}_{\boldsymbol{l},Rest}\right) := \underset{\left(\mathscr{T}_{\boldsymbol{l},Rest}\right)}{arg\ max}\ W_l(\cdot).$$

Again, linearize welfare in the new optimum and use the optimality conditions to demonstrate that

$$-\nabla_{\mathscr{T}_{\boldsymbol{EU},Rest}} W_l \left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) \left(\mathscr{T}^{new}_{\boldsymbol{EU},Rest} - \mathscr{T}^{old}_{\boldsymbol{EU},Rest}\right)' > 0$$

and

$$-\sum_{m \in \mathscr{K}_{EU}} \nabla_{\mathscr{T}_{\boldsymbol{l},Rest}} W_m \left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) \left(\mathscr{T}^{new}_{\boldsymbol{l},Rest} - \mathscr{T}^{old}_{\boldsymbol{l},Rest}\right)' > 0.$$

One can conclude that

$$\mathscr{T}^{old}_{\boldsymbol{EU},Rest} > \mathscr{T}^{new}_{\boldsymbol{EU},Rest}$$

and

$$\mathscr{T}^{old}_{\boldsymbol{l},Rest} > \mathscr{T}^{new}_{\boldsymbol{l},Rest}.$$

Therefore, the disintegration of l reduces not only cooperatively chosen tariffs but also non-cooperative tariffs.

The effects of the economic disintegration on regional TAs between countries, which are not part of the economic union, as well as non-cooperative trade policies by any third country, are of second order. The reason is that the objective functions and instruments of tariff policies remain the same. Therefore, policies are only indirectly altered. Cross derivatives of welfare functions measure the changes in these policies with respect to the respective trade policy instruments.

We summarize the insights formed in this section in Proposition 7.

Proposition 7 (endogenous trade policy responses to disintegration from an economic union)**.** *Suppose that, initially, countries l and $\mathscr{K}_{EU}$ form an economic union (old optimum). In the new optimum, country l leaves the economic union. Let Assumption 2 hold. Then,*

$$\mathcal{T}^{old}_{EU,EU} > \mathcal{T}^{new}_{EU,EU}.$$

If country l also leaves the customs union,

$$\mathscr{T}^{old}_{EU,TA} > \mathscr{T}^{new}_{EU,TA},$$

$$\mathscr{T}^{old}_{l,TA} > \mathscr{T}^{new}_{l,TA},$$

$$\mathscr{T}^{old}_{\boldsymbol{EU},Rest} > \mathscr{T}^{new}_{\boldsymbol{EU},Rest},$$

and

$$\mathscr{T}^{old}_{l,Rest} > \mathscr{T}^{new}_{l,Rest}.$$

In summary, non-tariff barriers inside the economic union and cooperative (non-cooperative) trade taxes of $\mathscr{K}_{EU}$ and country l vis-à-vis $\mathscr{K}_{TA}$ ($\mathscr{K} \setminus (\mathscr{K}_{TA} \cup \mathscr{K}_{EU} \cup \{l\})$, respectively) decline. Therefore, the departure of a country from an economic union leads ceteris paribus to a deeper integration of multilaterally formed institutions around the world and less protectionism.

Above, we have dealt with endogenously determined trade costs, which affect unit costs of international trade. As noted in the model developed in Section 2, another dimension of trade policy in an economic union is the harmonization of production standards and business regulations. For instance, discrepancies in company law, competition law, labor rights, and administrative practice make the relocation of firms from one country to another more difficult. As described, this dimension of economic integration directly affects the extensive margin of firm relocation. The degree of harmonization is, therefore, measured by a mean-preserving spread in the distribution of firm mobility costs.

Similar in spirit to above, one may endogenize the degree of harmonization inside the economic union, measured by $\overline{\mathscr{F}}_{EU,EU}$. That is, member countries efficiently bargain over the harmonization of production standards and business regulations and, therefore, indirectly over firm mobility inside the union. Using our first-order approach one can observe that

$$-\nabla_{\overline{\mathscr{F}}_{EU,EU}} W_l \left(\mathcal{T}^{old}, \mathscr{T}^{old}, \overline{\mathscr{F}}^{old}\right) \left(\overline{\mathscr{F}}^{new}_{EU,EU} - \overline{\mathscr{F}}^{old}_{EU,EU}\right)' > 0$$

such that for $\nabla_{\overline{\mathscr{F}}_{EU,EU}} W_l \left(\mathcal{T}^{old}, \mathscr{T}^{old}, \overline{\mathscr{F}}^{old}\right) > 0$ the remaining member countries harmonize more with each other and firms become more mobile inside the economic union compared to the pre-disintegration policy ($\overline{\mathscr{F}}^{old}_{EU,EU} > \overline{\mathscr{F}}^{new}_{EU,EU}$).

Intuitively, a positive gradient means that a reduction in firm mobility inside the economic union is beneficial to the leaving country. In our model, a rise in $\overline{\mathscr{F}}_{EU,EU}$ makes tax bases inside the economic union less elastic. The resulting rise in tax rates pushes firms to move to country l, which gains industry shares and experiences a rise in consumer surplus due to lower domestic prices. As a result, welfare in the leaving country increases. We verify this assertion in our three-country economy with non-negative taxes and sufficiently similar relocation cost distributions (Appendix A.10).

As a byproduct of our above analysis, one can note that the normative effects of economic disintegration are generally equivocal. The main reason for this insight is the fact that trade policies around the world change with the degree of economic integration between a subset of countries.

To give an example, consider the welfare in the leaving country. Several effects of trade policy changes add up. There are adverse effects since the remaining member countries in the economic union do not regard the leaving country's welfare when adjusting their cooperative and non-cooperative trade policies towards third countries as well as their internal degree of economic integration. Vice versa, after the disintegration, the leaving country is free to set its non-cooperative external tariffs solely to its advantage. The renegotiation of existing trade agreements may be beneficial or detrimental to the leaving country. One can show that the leaving country and the respective contractual partner improve their joint surplus after the disintegration. However, this does not mean that the leaving country is better off. It may well be the case that the presence of other countries in the trade agreement, here the member countries of the economic union, proves beneficial to the leaving country. As a consequence, the economic disintegration and the resulting absence of the member countries in the trade agreement are welfare-detrimental to the leaving country. By similar arguments, the normative effects on countries in the economic union and third countries are ambiguous.

In this section, we have endogenized different dimensions of trade policy, namely tariffs, non-tariff trade costs, and the degree of harmonization in production standards and business regulations. Altogether, along these different dimensions of trade policy, the remaining countries in the union take further steps towards the economic integration of their internal market when being confronted with the disintegration of a former member. The leaving country, as well as the remaining economic union, intensify their trade relations with other countries. These further steps of economic integration do, of course, not necessarily mean that economic disintegration stabilizes multilateral institutions. It is possible that leaving an economic union is beneficial from a unilateral perspective, although it is multilaterally detrimental. Moreover, each loss of a member country jeopardizes the credibility of these institutions and increases the uncertainty of economic policy (e.g., Davis (2016)).

Also, note that these considerations assume a fixed set of trade agreements. It could be that, after disintegrating, country l negotiates TAs with countries that do not form TAs with member countries. Vice versa, the leaving country may fail to agree on TAs with third countries that form TAs with the economic union. Without imposing more structure on the underlying economy, it is a priori unclear whether countries breach (form) existing (new) TAs.

To see this, compare, for example, country l's gain from forming a trade agreement with a country $n \in \mathscr{K} \setminus (\mathscr{K}_{EU} \cup \{l\} \cup \mathscr{K}_{TA})$ before and after the disintegration from the economic union. Country l's welfare differential between the cooperative outcome, in which there is a TA with country n, and the non-cooperative trade policies defines the gain. Before the disintegration, the cooperative and the non-cooperative trade policies by country l take into account the welfare of the union's member countries, $\mathscr{K}_{EU}$. As shown above, after the disintegration, the leaving country is free to adjust its cooperative and non-cooperative trade policies (vis-à-vis country n) to its interest. In other words, country l's welfare improves in both the cooperative and the non-cooperative scenario. As a result, it is not clear how the welfare gain from the formation of a trade agreement with country n before and after the disintegration compare with each other. Therefore, we restrict attention to the endogeneity of existing trade agreements (intensive margin of TAs) and refrain from endogenizing the formation of trade agreements (extensive margin of TAs).

3.2 Departure from TAs

In this section, let country l leave the set of countries that participate in regional trade agreements, $\mathscr{K}_{TA}$. Before the disintegration,

$$\left(\mathscr{T}_{l,TA}^{old}\right) \coloneqq \underset{\left(\mathscr{T}_{l,TA}\right)}{arg\ max}\ W_l\left(\cdot\right) + W_{TA}\left(\cdot\right)$$

for each $TA \in \mathscr{K}_{TA}$. Afterwards,

$$\left(\mathscr{T}_{\boldsymbol{l},TA}^{new}\right) := \underset{\left(\mathscr{T}_{\boldsymbol{l},TA}\right)}{arg\ max}\ W_l\left(\cdot\right)$$

$$\left(\mathscr{T}_{l,\boldsymbol{TA}}^{new}\right) := \underset{\left(\mathscr{T}_{l,\boldsymbol{TA}}\right)}{arg\ max}\ W_{TA}\left(\cdot\right).$$

Using our first-order approach one can note that

$$-\nabla_{\mathscr{T}_{l,TA}} W_{TA}\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right)\left(\mathscr{T}_{\boldsymbol{l},TA}^{new} - \mathscr{T}_{\boldsymbol{l},TA}^{old}\right) > 0$$

and

$$-\nabla_{\mathscr{T}_{l,\boldsymbol{TA}}} W_{l}\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right)\left(\mathscr{T}_{l,\boldsymbol{TA}}^{new} - \mathscr{T}_{l,\boldsymbol{TA}}^{old}\right) > 0.$$

Proposition 8 directly follows.

Proposition 8. *Let* $\nabla_{\mathscr{T}_{l,TA}} W_l\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) > 0$ *and* $\nabla_{\mathscr{T}_{l,\boldsymbol{TA}}} W_{TA}\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) > 0$. *Then,*

$$\mathscr{T}_{l,TA}^{new} > \mathscr{T}_{l,TA}^{old}.$$

Intuitively, when $\nabla_{\mathscr{T}_{l,TA}} W_l\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) = -\nabla_{\mathscr{T}_{l,TA}} W_{TA}\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) > 0$ the introduction of a small import tariff is beneficial to a country. Accordingly, the leaving country raises import tariffs, which is retaliated by the other government in country TA. This spiral of retaliation is a classical result in the trade policy literature. Moreover, notice that the effects on trade policies between the other countries are of second order.

As a result, the countries l and $\mathscr{K}_{TA}$ bear a first-order welfare loss when free trade is efficient. Third countries $k \in \mathscr{K} \setminus (\mathscr{K}_{TA} \cup \{l\})$, which are only indirectly affected by the departure of l from $\mathscr{K}_{TA}$, benefit when $\nabla_{\mathscr{T}_{l,TA}} W_k\left(\mathcal{T}^{old}, \mathscr{T}^{old}\right) > 0$. The weakening of regional TAs improves their situation.

In this section, we have built a very general approach for studying the endogeneity of trade policies to economic disintegration. Altogether, the two cases of economic disintegration considered in this section have a different impact on trade policies. This contrast is not surprising given the different implications at an institutional level. In the latter case, economic disintegration triggers beggar-thy-neighbor policies, whereas it alters the very structure of an economic union in the former one. The normative evaluation of economic disintegration is not only country- but also case-specific. It holds under the economic conditions described in Bagwell and Staiger (1999) and the subsequent literature. In particular, the efficiency of global free trade remains valid in our approach. Our central insight is to take existing inefficiencies in trade policies as given. Based on this, trade policies react worldwide to economic disintegration and, therefore, its normative implications may be far from obvious, even if one considers only first-order effects.

4 Conclusion

In this paper, we develop a novel first-order approach for studying the effects of economic disintegration on trade policies. We have considered the departure of a country from an economic union as well as one country which dissolves regional trade agreements. The effects differ not only by countries but also by the type of economic disintegration. Our main contribution has been to show the effects of disintegration by one country on trade policies worldwide. Whereas the disintegration from an economic union raises trade costs for directly affected countries, countries deepen existing trade relations. The same holds for non-tariff trade policies inside the economic union. As a consequence, the welfare implications of economic disintegration are non-trivial. A limitation of our approach is the absence of second-order effects. To consider these, one needs to know the sign and the size of the cross derivatives of welfare functions with respect to trade costs. This requirement would make it necessary to impose more structure on the underlying economy.

Moreover, we have built 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 elasticity of firm relocation is a sufficient statistic for the optimal tax rate in a given country. As we have seen, this elasticity crucially depends not only on the economic conditions in that country but also on those worldwide. This observation 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 influences domestic 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. Consequently, third countries 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 raises bilateral trade costs.

When one country leaves an economic union, we predict tax rates to decline in that country. The effects on tax rates in the remaining members of the union are case-specific. 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.

We have also dealt with the consequences of a lower degree of harmonization in product and production standards, which reduces the mobility of firms between the leaving country and the economic union. In line with the literature on tax competition, tax rates increase as the costs of firm relocation becomes rise. 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 that country's disintegration. In particular, our analysis omits the anticipatory and dynamic effects of economic disintegration. Although we are able to shed light on these, a rigorous analysis is left for future research.

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, we predict the UK 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.

We note several limitations to our analysis. The simplicity of the supply side in our model, such as the two-country industry structure, which allowed us to obtain clear-cut policy predictions, 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, Dvorkin, and Parro (2019). This feature 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 policies 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, 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. Use firms' optimal production quantities to show that 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 $x_i^{ij}(\mu) = \frac{\alpha - p_i^{ij}(\mu)}{\beta}$, $x_i^{jk} = \frac{\alpha - p_i^{jk}(\mu)}{\beta}$, and $x_i^{ki}(\mu) = \frac{\alpha - p_i^{ki}(\mu)}{\beta}$ to obtain household consumer surplus. Multiply with the size of the market to obtain 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 simplifies 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. Hence, the system of equations exhibits a unique solution. 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

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

and

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

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, $\frac{dt_i}{d\overline{\epsilon}^{jk}}$ is always positive. The sign of $\frac{dt_i}{d\overline{\epsilon}^{ij}}$ (by a resembling argument, the sign of $\frac{dt_i}{d\overline{\epsilon}^{ki}}$)

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 $\overline{F}^{jk} \approx 0$, $\frac{dt_i}{d\epsilon^{ij}} > 0$. Indeed, 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 $\frac{dt_i}{d\epsilon^{ij}} < 0$.

Observe that $\frac{dt_i}{d\epsilon^{ij}} + \frac{dt_i}{d\epsilon^{ki}}$ 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 $\frac{dt_j}{d\epsilon^{jk}} + \frac{dt_j}{d\epsilon^{ij}} > 0$. It is easy to see that the tax rate in any member country i increases as well. I.e., $\frac{dt_i}{d\epsilon^{jk}} + \frac{dt_i}{d\epsilon^{ij}} > 0$ 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

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

Then, the reaction function in country i reads as

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

This set of reactions functions implies the equilibrium tax rate in country i

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

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

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

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

The mobile firm locates in country i if and only if

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

Again, simplify the industry threshold

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

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 2 directly follows. It will prove convenient when deriving the objective function of the government.

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

Since there are K countries, one has to consider $\begin{pmatrix} K \\ 2 \end{pmatrix} = \frac{K(K-1)}{2}$ continuums of industries yielding $K(K-1)$ 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 $x_i^{ij}(\mu) = \frac{\alpha - p_i^{ij}(\mu)}{\beta}$ and $x_i^{jl}(\mu) = \frac{\alpha - p_i^{jl}(\mu)}{\beta}$ and sum over all households in a country. The aggregate surplus in country i derived from consumption of goods 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

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

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

$$\max_{t_i} S_i + T_i + n_i w$$

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

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

The reaction function of country i can be simplified to

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

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

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

into

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

Then, notice that

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

to conclude that

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

This condition proves the following Proposition 9.

Proposition 9. *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*

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

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

One can immediately see that $\frac{dt_i}{d\overline{F}} > 0$. This statement 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

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

differentiation with respect to trade costs yields

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

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

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

and

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

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

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

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

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

and

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

Furthermore, since

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

comparative statics with respect to market size are

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

and

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

Simplify these expressions to obtain Lemma 3.

Lemma 3. *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* $i \neq j \neq k$

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

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

and

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

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

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

and

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

(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* $i \neq j$

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

and

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

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, taxes inside the economic union fall on average, whereas the average tax rate of non-member countries increases. On the contrary, 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. They depend on relative sizes of the respective 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 3. 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 $\mathscr{K}_{EU}$)

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

For $n := n_m = n_n$, 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

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

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 $m\in\mathscr{K}_{EU}$ simplifies 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 $n\in\mathscr{K}\setminus\mathscr{K}_{EU}$ 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

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

where

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

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

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

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

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

$\phi(K)$ 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

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

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

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

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 Tariffs

We now extend the notion of trade barriers to both non-tariff barriers and tariffs. That is, trade costs from country j to country i, $\tilde{\tau}_{ij}$, are the sum of import taxes by the domestic government in country i, $imt_{ij} \in \mathbb{R}$, export taxes/ subsidies by the foreign government, $ext_{ij} \in \mathbb{R}$, and non-tariff barriers, $\tau_{ij} \in \mathbb{R}_+$ as defined in our baseline economy. Hence, $\tilde{\tau}_{ij} = imt_{ij} + ext_{ij} + \tau_{ij}$. Here, we consider in the language of the trade policy literature a full set of trade policy instruments.

Notice that, from the perspective of the government, tariffs affect three margins: domestic consumer prices, trade volumes, and firm relocation. All three affect consumer surplus, revenues generated from taxing businesses, and revenues from trade taxes. Observe that, unlike in the standard Cournot relocation models, in our economy, industry-specific prices do not exhibit the Metzler paradox, where a rise in import tariffs leads to the entry of firms domestically such that domestic consumer prices decrease. However, it may be the case for the average price. That is, a large country raises import tariffs such that firms in small countries relocate to the former country to have cheap access to the large market. This relocation makes the larger market more competitive and reduces domestic prices there.

Let us now derive the objective function of the government. Consumer surplus and business tax revenues remain unchanged. At the same time, trade taxes generate a new source of revenue. For a given industry ij, the volume of exports from country i to country l is given by

$$X_{li}^{ij} = G\left(\gamma^{ij}\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=2},$$

whereas the import volume reads as

$$M_{il}^{ij} = G\left(\gamma^{ij}\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=2}.$$

Observe that, by our assumption on the industry structure $M_{il}^{ij} = 0$ for all $l \neq j$. To sum up, country i's revenues from taxing imports and exports in industry ij are given by

$$R_i^{ij} = \sum_{l \in \mathscr{K} \setminus \{i\}} imt_{il} M_{il}^{ij} + \sum_{l \in \mathscr{K} \setminus \{i\}} ext_{li} X_{li}^{ij}.$$

Therefore, we can write the overall tariff revenues in country i as

$$R_i = \sum_{j \in \mathscr{K} \setminus \{i\}} R_i^{ij}.$$

This yields the following objective function of the government in country i

$$W_i := S_i + T_i + n_i w + R_i.$$

As before, the first-order condition is sufficient and the equilibrium of the tax competition game exists and is unique. Apply the same steps as in the baseline model to obtain the equilibrium tax rates

$$t_i = 3\overline{F} + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \backslash \{i\}} \Delta_i^{ij} + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \backslash \{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) + \frac{1}{(K-1)(2K-1)} \sum_{j \in \mathscr{K}} \sum_{m \in \mathscr{K} \backslash \{j\}} \Delta_j^{jm}$$
$$+ \frac{1}{2K-1} \sum_{j \in \mathscr{K} \backslash \{i\}} \sum_{l \in \mathscr{K} \backslash \{i\}} \left[imt_{il} \left(2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2}\right) + ext_{li} \left(x_{li}^{ij}|_{k_i^{ij}=1} - 2x_{li}^{ij}|_{k_i^{ij}=2}\right)\right]$$
$$+ \frac{1}{(K-1)(2K-1)} \sum_{m \in \mathscr{K}} \sum_{j \in \mathscr{K} \backslash \{m\}} \sum_{l \in \mathscr{K} \backslash \{m\}} \left[imt_{ml} \left(2x_{ml}^{mj}|_{k_m^{mj}=1} - x_{ml}^{mj}|_{k_m^{mj}=2}\right)\right]$$
$$+ \frac{1}{(K-1)(2K-1)} \sum_{m \in \mathscr{K}} \sum_{j \in \mathscr{K} \backslash \{m\}} \sum_{l \in \mathscr{K} \backslash \{m\}} \left[ext_{lm} \left(x_{lm}^{mj}|_{k_m^{mj}=1} - 2x_{lm}^{mj}|_{k_m^{mj}=2}\right)\right].$$

Observe that for $imt_{ml} = ext_{lm} = 0 \ \forall j, m, l$ we obtain Proposition 9. The optimal tax rate is, now, modified by the marginal effects of business taxation on tariff revenues through firm relocation. Since

$$x_{li}^{ij}|_{k_i^{ij}=1} - 2x_{li}^{ij}|_{k_i^{ij}=2} = -n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} < 0$$

and

$$2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2} = 1\left[j = l\right] n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} \geq 0$$

tax rates are revised upwards for import tariffs and export subsidies. To gain some intuition, consider a rise in the business tax rate in a country. As a result, firms move away from that country. Imports increase, whereas exports decline. The revenues (expenditures) from taxing imports (subsidizing exports) rise (fall).

Not surprisingly, for a given set of trade policies the forces described in the comparative statics of business taxes with respect to $\tau_{ij} = \tau_{ji} \in \mathbb{R}_+$ and $\tau_{jk} = \tau_{kj} \in \mathbb{R}_+$ (Lemma 3) remain valid and are augmented by the effects of (non-tariff) trade costs on the marginal firm relocation effect. That is,

$$\frac{dt_i}{d\tau_{ij}}|_{\tilde{\tau}_{ij}=\tilde{\tau}_{ji}} = \left(n_i (K-2) - 2n_j \left[(K-1)^2 + 0.5\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tilde{\tau}_{ij}}{16\beta} +$$
$$- \frac{1}{(K-1)(2K-1)} \frac{K n_i imt_{ij} + n_j imt_{ji} - K(K-1) n_j ext_{ji} - (K-1) n_i ext_{ij}}{4\beta}$$

and

$$\frac{dt_i}{d\tau_{jk}}|_{\tilde{\tau}_{jk}=\tilde{\tau}_{kj}} = (n_j + n_k)\frac{3(2K-3)}{(K-1)(2K-1)}\frac{\alpha - w - \tilde{\tau}_{jk}}{16\beta}$$
$$- \frac{1}{(K-1)(2K-1)}\frac{imt_{jk}n_j + imt_{kj}n_k - (K-1)\,ext_{jk}n_j - (K-1)\,ext_{kj}n_k}{4\beta}.$$

Therefore, for positive import tariffs and export subsidies, the reaction of the optimal tax rate in country i to a rise in τ_{ij} and τ_{jk}, respectively, is revised downwards. The reason is that the tax rate of country i is upwards adjusted by the marginal effect on tariff revenues due to firm relocation. As non-tariff trade costs rise, the trade volumes decline such that the gains in tariff revenues decline.

Furthermore, one can study the effects of tariffs on business taxes. The comparative statics of business taxes with respect to trade taxes read as

$$\frac{dt_i}{dimt_{ij}} = n_i\frac{(7K-6)(\alpha - w - \tilde{\tau}_{ij}) - 4Kimt_{ij} + 4ext_{ij}}{(K-1)(2K-1)\,16\beta},$$

$$\frac{dt_i}{dext_{ij}} = n_i\frac{(3K-10)(\alpha - w - \tilde{\tau}_{ij}) - 4Kimt_{ij} + 4ext_{ij}}{(K-1)(2K-1)\,16\beta},$$

$$\frac{dt_i}{dimt_{ji}} = n_i\frac{-\left(6(K-1)^2 - 1\right)(\alpha - w - \tilde{\tau}_{ji}) + 4Kext_{ji} - 4imt_{ji}}{(K-1)(2K-1)\,16\beta},$$

$$\frac{dt_i}{dext_{ji}} = n_i\frac{-\left(6(K-1)^2 + 4K + 3\right)(\alpha - w - \tilde{\tau}_{ji}) + 4Kext_{ji} - 4imt_{ji}}{(K-1)(2K-1)\,16\beta},$$

$$\frac{dt_i}{dimt_{jm}} = n_j\frac{(6K-5)(\alpha - w - \tilde{\tau}_{jm}) - 4(imt_{jm} - ext_{jm})}{(K-1)(2K-1)\,16\beta},$$

and

$$\frac{dt_i}{dext_{jm}} = n_j\frac{(6K-13)(\alpha - w - \tilde{\tau}_{jm}) - 4(imt_{jm} - ext_{jm})}{(K-1)(2K-1)\,16\beta}$$

for $j \neq i$ and $m \neq i, j$.

There are, now, several opposing forces on consumer surpluses, profit differentials, and revenues from trade taxes. The rows of Table 1 summarize these forces and their effects on business taxes

		imt_{ij}	ext_{ij}	imt_{ji}	ext_{ji}	imt_{jm}	ext_{jm}
consumer surplus at home		$-$	$-$	0	0	0	0
profit differentials at home relative to abroad		$+$	$+$	$-$	$-$	$+$	$+$
consumer surpluses abroad		0	0	$-$	$-$	$-$	$-$
tariff revenue gains at home	direct	$+$	$-$	0	0	0	0
(import tariffs and export subsidies)	indirect	$-$	$+$	0	0	0	0
tariff revenue gains abroad	direct	0	0	$+$	$-$	$+$	$-$
(import tariffs and export subsidies)	indirect	0	0	$-$	$+$	$-$	$+$
overall effect (for small trade taxes and $K > 3$)		$+$	$+$	$-$	$-$	$+$	$+$

Table 1: Effects of trade taxes on business tax in country i

in country i. To give an example, suppose the domestic government in country i raises tariffs on imports from country j ($imt_{ij} \uparrow$). This policy makes imports from country j more costly and, as a result, lowers consumer surplus in country i. At the same time, country i becomes ceteris paribus more attractive as a business location vis-à-vis country j due to the rise in trade frictions firms in country j face. On the one hand, a higher import tariff mechanically increases the size of tariff revenues, which the government gains due to business taxation (positive direct effect). On the other hand, the rise in import tariffs lowers import volumes such that the gains from tariff revenues become smaller (negative indirect effect).

Let trade taxes be small for simplicity and $K > 3$. Then the relation between business taxes in country i, t_i, and import tariffs, imt_{ij}, is positive. However, the sign of $\frac{dt_i}{dimt_{ij}}$ is negative for large imt_{ij}. Therefore, the relation between domestic taxes and import tariffs is hump-shaped. Similarly, this is the case with imt_{jm}. The relationship between business taxes and trade taxes on firms in country i (imt_{ji} and ext_{ji}) is also U-shaped. This result is similar to Proposition 1 in Haufler and Wooton (2010), although here we deal with tariffs that have revenue effects.

A.8 Domestic Accrual of Firm Profits

So far, we have assumed that the profits of firms do not accrue domestically or, at least, do not enter the objective function of the government. In the following, we relax this assumption. There are two noteworthy variants of firm ownership: one, where firms are owned by entrepreneurs, who enter social welfare in a country only when they locate in that country, and another one, where citizens are shareholders of the firms worldwide. The former one fits well for small corporations, whereas the latter one fits well in the case of larger firms. In the following, we consider both variants.

A.8.1 Entrepreneurs

Let m_i be the (endogenous) number of entrepreneurs in the population of country i and ω be the social marginal welfare weight of entrepreneurs relative to workers.

As before, consumer surplus and tax revenues, respectively, read as

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

and

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

Moreover, profits of a firm in industry ij and country i are given by

$$\pi_i^{ij}(\mu) = \begin{cases} \frac{n_i(\alpha-w+\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-2\tau_{ij})^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}}\frac{n_l\left(\alpha-w-2\tau_{il}+\tau_{jl}\right)^2}{16\beta} & w/\ prob\ \left(1-G\left(\gamma^{ij}\right)\right) \\ \frac{n_i(\alpha-w+2\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-3\tau_{ij})^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}}\frac{n_l\left(\alpha-w-3\tau_{il}+2\tau_{jl}\right)^2}{16\beta} & w/\ prob\ G\left(\gamma^{ij}\right) \end{cases}$$

$$:= \begin{cases} \pi_i^{ij}(2) & w/\ prob\ \left(1-G\left(\gamma^{ij}\right)\right) \\ \pi_i^{ij}(1) & w/\ prob\ G\left(\gamma^{ij}\right) \end{cases}.$$

To calculate the expected profits, one needs to keep track of the number of firms and how it affects profits. Besides, for every second industry type the mobile firm pays the relative fixed cost, when it decides to locate in country i. To give an example, in the three-country setting, this would happen in ki-industries but not in ij-industries. Therefore, the expected profits of firms in ij-industries and country i can be written as

$$\begin{aligned}\tilde{\Pi}_i^{ij} &:= G\left(\gamma^{ij}\right) \cdot 1 \cdot \left(\pi_i^{ij}(1) - t_i\right) + \left(1 - G\left(\gamma^{ij}\right)\right) \cdot 2 \cdot \left(\pi_i^{ij}(2) - t_i\right) - \frac{1}{2} G\left(\gamma^{ji}\right) \cdot 1 \cdot \mathbb{E}\left(F^{ji} | F^{ji} \leq \gamma^{ji}\right) \\ &= G\left(\gamma^{ij}\right)\left(\pi_i^{ij}(1) - t_i\right) + \left(1 - G\left(\gamma^{ij}\right)\right)\left(2\pi_i^{ij}(2) - 2t_i\right) - \frac{1}{8\overline{F}}\left(\left(\gamma^{ji}\right)^2 - \overline{F}^2\right).\end{aligned}$$

Summing over all industries gives expected total profits in country i

$$\begin{aligned}\tilde{\Pi}_i &:= \sum_{j \in \mathscr{K} \setminus \{i\}} \tilde{\Pi}_i^{ij} \\ &= \sum_{j \in \mathscr{K} \setminus \{i\}} \left[\frac{\gamma^{ij} + \overline{F}}{2\overline{F}} \pi_i^{ij}(1) + \frac{\overline{F} - \gamma^{ij}}{2\overline{F}} 2\pi_i^{ij}(2) - \frac{1}{8\overline{F}}\left(\left(\gamma^{ji}\right)^2 - \overline{F}^2\right)\right] - T_i \\ &:= \Pi_i - T_i.\end{aligned}$$

The benevolent social planner in country i, now, solves

$$\max_{t_i} n_i \left(\frac{S_i + T_i}{n_i} + w\right) + \omega m_i \frac{\Pi_i - T_i}{m_i}$$

if and only if

$$\max_{t_i} S_i + (1 - \omega) T_i + n_i w + \omega \Pi_i.$$

The first-order condition is sufficient for $\omega < \frac{4}{3}$. The reaction function is again linear in the tax rates of the other countries. Tax rates are strategic complements, and the slope is less than 1 for $\omega < \frac{4K-6}{3(K-1)}$ which, for instance, is fulfilled when $\omega = \frac{1}{3}$ and $K \geq 2$.

Notice that for $\omega = 1$ the equilibrium of the tax competition game is indeterminate. The reason is that the reaction functions intercept for each possible combination of solutions $\{t_i\}_{i \in \mathscr{K}}$. Hence, in the following, we consider the cases where $\omega \neq 1$. By the same techniques as above, we solve for $\sum_{j \in \mathscr{K} \setminus \{i\}} (t_j - t_i)$ and plug it into the reaction function of country i. This yields a new equilibrium to the tax competition game

$$
\begin{aligned}
t_i = 3\overline{F} &+ \frac{(1-\omega)(K-1) + \left(1 - \frac{1}{2}\omega\right)}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(\Delta_i^{ij} - \omega\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)\right) \\
&+ \frac{(1-\omega)(K-1)\left(1-\frac{1}{2}\omega\right)}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) \\
&+ \frac{1-\frac{1}{2}\omega}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{m\in\mathscr{K}\setminus\{j\}} \left(\Delta_j^{jm} - \omega\left(2\pi_j^{jm}(2) - \pi_j^{jm}(1)\right)\right)
\end{aligned} \tag{16}
$$

for every $i \in \mathscr{K}$. Observe that for $\omega = 0$ one obtains Proposition 9. For $\omega > 0$, equation (16) is just an adjusted version of the solution in Proposition 9. Aside from modified factors, the only difference to before is that the optimal tax rate also accounts for the accrual of profits at home $(2\pi_i^{ij}(2) - \pi_i^{ij}(1))$ and, in equilibrium, profits accrued abroad $(2\pi_j^{jm}(2) - \pi_j^{jm}(1))$. Now, governments have an additional incentive to attract firms because their presence raises national income. As a result, the accrual of profits tends to reduce tax rates. Due to this close similarity of Equation (16) to Proposition 9 our main results carry over. This finding holds, in particular, for low ω. There may be rare exemptions when the accrual of domestic profits becomes very important. However, from an economic perspective, this case is not particularly relevant as almost all governments in the world pursue a more or less pronounced redistributive goal in their setting of business tax rates.

Moreover, one can show that the extra terms in Equation (16) have intuitive comparative statics:

$$
\begin{aligned}
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)}{d\tau_{ij}} &= -n_i \frac{4\tau_{ij}}{16\beta} - n_j \frac{2\tau_{ij} + 2(\alpha - w)}{16\beta} < 0, \\
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)}{d\tau_{il}} &= n_l \frac{4\tau_{jl} + 2(\alpha - w - \tau_{il})}{16\beta} > 0, \\
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)}{d\tau_{jl}} &= -n_l \frac{4\tau_{jl} + 2(\alpha - w - 2\tau_{il})}{16\beta} < 0,
\end{aligned}
$$

and

$$
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)}{d\tau_{lm}} = 0
$$

for $i \neq j \neq l \neq m$. A worsening of the conditions under which mobile firms in ij-industries can trade in country i with country j ($\tau_{ij} \uparrow$) lowers the gains from the domestic accrual of profits. As a consequence, the social planner in country i lowers the tax rate by less. The same happens when trade with third countries becomes less costly ($\tau_{il} \downarrow$) or when trade costs between country j and third countries rise ($\tau_{jl} \uparrow$). The reason is that domestic competition becomes harsher as country i becomes more attractive vis-à-vis country j. The negative effect of a more competitive pricing and lower profit margins overcompensates the positive direct effect of improved trading conditions. Therefore, the accrual of extra profits from having two firms instead of one in the country in a given industry is less important. Trade costs between third countries (τ_{lm}) do not matter.

A.8.2 Citizens as Shareholders

Now suppose that, in each country, citizens own a share ω of firms worldwide. Then, the social planner solves

$$\max_{t_i} n_i \left(\frac{S_i + T_i}{n_i} + w \right) + n_i \frac{\omega \sum_{i \in \mathscr{K}} (\Pi_i - T_i)}{n_i}.$$

The first-order condition is sufficient for $\omega < 2$. Then, the equilibrium of the tax competition game exists and is unique. Its solution is given by

$$\begin{aligned} t_i = 3(1-\omega)\overline{F} + \frac{1}{(2-\omega)K - 1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\Delta_i^{ij} - \omega \left[2\pi_i^{ij}(2) - \pi_i^{ij}(1) - \left(2\pi_j^{ij}(2) - \pi_j^{ij}(1) \right) \right] \right) \\ + \frac{1}{(2-\omega)K - 1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij} \right) \\ + \frac{1-\omega}{(K-1)((2-\omega)K - 1)} \sum_{l \in \mathscr{K}} \sum_{m \in \mathscr{K} \setminus \{l\}} \left(\Delta_l^{lm} - \omega \left[2\pi_l^{lm}(2) - \pi_l^{lm}(1) - \left(2\pi_m^{lm}(2) - \pi_m^{lm}(1) \right) \right] \right). \end{aligned}$$

Again, for $\omega = 0$ one gets Proposition 9. Aside from modified factors, additional terms enter the optimal tax function for $\omega > 0$. Our main results remain valid. In contrast to above, where the extra terms measure the accrual of profits by domestic and foreign entrepreneurs, now the extra terms downward adjust the optimal tax rate by the accrual of profit differentials at home $(2\pi_i^{ij}(2) - \pi_i^{ij}(1) - (2\pi_j^{ij}(2) - \pi_j^{ij}(1)))$ and abroad $(2\pi_l^{lm}(2) - \pi_l^{lm}(1) - (2\pi_m^{lm}(2) - \pi_m^{lm}(1)))$. The reason is that profits enter social welfare no matter where they realize as profits accrue to the citizens who are the shareholders of the firms worldwide. A shareholder in a given country, therefore, only cares about how much firms earn in one country versus another.

Furthermore, comparative statics of these extra terms are very similar to above

$$\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)-\left(2\pi_j^{ij}(2)-\pi_j^{ij}(1)\right)\right)}{d\tau_{ij}}=(n_i-n_j)\frac{2(\alpha-w-\tau_{ij})}{16\beta},$$
$$\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)-\left(2\pi_j^{ij}(2)-\pi_j^{ij}(1)\right)\right)}{d\tau_{il}}=n_l\frac{2\tau_{il}+4(\alpha-w)}{16\beta}>0,$$
$$\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)-\left(2\pi_j^{ij}(2)-\pi_j^{ij}(1)\right)\right)}{d\tau_{jl}}=-n_l\frac{2\tau_{jl}+4(\alpha-w)}{16\beta}<0,$$

and

$$\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)-\left(2\pi_j^{ij}(2)-\pi_j^{ij}(1)\right)\right)}{d\tau_{lm}}=0$$

with the only exception that the one with respect to τ_{ij} now depends on the relative size of countries. The above-described intuitions carry over.

A.9 Arbitrary Number of Firms

We now relax the assumption that, in each industry, there are only three producing firms. To be precise, in an ij-industry let $k_i^{ij}\in\mathbb{R}_+$ be the number of firms in country i . Hence, $k_i^{ij}+k_j^{ij}+1:=k^{ij}+1$ is the total number of firms producing in a given industry. Assume, for simplicity, that k^{ij} is the same for all industry types. Furthermore, one has to modify the upper bound of trade costs $\tau_{ij}\leq\frac{\alpha-w}{k^{ij}+1}$.

Note that the new number of firms country i is given by

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

Then, the reaction function of country i is

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

By the same techniques as above, one can derive the equilibrium of the tax competition game

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

Relative to Proposition 9, the new optimal tax rate is modified by the second term on the right-hand side. Notice, moreover, that the other terms implicitly depend on k_i^{ij} and k_j^{ij} since

$$\Delta_i^{ij} = n_i\frac{\left(\alpha\left(k^{ij}+1\right) - w\left(k^{ij}+1\right) - \left(k_j^{ij}+1\right)\tau_{ij}\right)^2 - \left(\alpha\left(k^{ij}+1\right) - w\left(k^{ij}+1\right) - k_j^{ij}\tau_{ij}\right)^2}{2\beta\left(k^{ij}+2\right)^2},$$

$$\pi_i^{ij} - \pi_j^{ij} = (n_i - n_j)\frac{2(\alpha - w) - \tau_{ij}}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right)\tau_{ij} + \left(k_j^{ij} - k_i^{ij}\right)(n_i + n_j)\frac{\tau_{ij}^2}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right)$$
$$+ \sum_{l\in\mathscr{K}\backslash\{i,j\}} n_l(\tau_{jl} - \tau_{il})\frac{2(\alpha - w) - (\tau_{jl} + \tau_{il}) - \left(k_i^{ij} - k_j^{ij}\right)(\tau_{jl} - \tau_{il})}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right),$$

and

$$\Delta_j^{jl} = n_j\frac{\left(\alpha\left(k^{jl}+1\right) - w\left(k^{jl}+1\right) - \left(k_l^{jl}+1\right)\tau_{jl}\right)^2 - \left(\alpha\left(k^{jl}+1\right) - w\left(k^{jl}+1\right) - k_l^{jl}\tau_{jl}\right)^2}{2\beta\left(k^{jl}+2\right)^2}.$$

Therefore, the comparative statics of Lemma 1 are slightly modified

$$\frac{dt_i}{d\tau_{ij}} = \frac{n_i(K-2) - n_j\left[2(K-1)^2 + 1\right]}{(K-1)(2K-1)}\frac{(\alpha - w - \tau_{ij})\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2}$$
$$+ \frac{\left[2(K-1)\left(k^{ij}+1\right) + K\right]n_i + \left[2(K-1)\left(k^{ij}+1\right)\left(\sum_{m\in\mathscr{K}\backslash\{i,j\}}\frac{\tau_{ij}-\tau_{mj}}{\tau_{ij}} + 1\right) - 1\right]n_j}{(K-1)(2K-1)}\frac{\tau_{ij}\left(k_j^{ij} - k_i^{ij}\right)}{\beta\left(k^{ij}+2\right)^2}$$

and

$$\frac{dt_i}{d\tau_{jk}} = \frac{(2K-3)(n_j + n_k)}{(K-1)(2K-1)}\frac{(\alpha - w - \tau_{jk})\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2} + \frac{\tau_{jk}\left(k_k^{jk} - k_j^{jk}\right)(n_j - n_k)}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2}$$
$$+ \frac{\left[2n_k(K-1)\left(k_j^{ij} - k_i^{ij}\right)(\tau_{jk} - \tau_{ik}) + 2n_j(K-1)\left(k_k^{ik} - k_i^{ik}\right)(\tau_{jk} - \tau_{ij})\right]\left(k^{ij}+1\right)}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2}.$$

Observe that for $k_j^{ij} = k_i^{ij} = k_k^{jk}$ and $k^{ij} = 2$ one obtains the expressions in Lemma 3. Moreover, for a similar number of immobile firms across countries, the main results hold.

One should, however, note that there is an interaction between the number of immobile firms and the above mentioned comparative statics. For instance, $\frac{dt_i}{d\tau_{ij}}$ tends to decrease (increase) in k_i^{ij} (k_j^{ij}). The more immobile firms produce in country i and the higher the costs of trade, the less can the mobile firms gain from moving there. In other words, the mobile firms are more and more willing to move somewhere else as both τ_{ij} and k_i^{ij} increase. Therefore, a rise in k_i^{ij} puts additional pressure on the government of country i to lower the tax rate when it loses attractiveness as a business location due to a rise in τ_{ij}. A reverse argument holds for k_j^{ij}.

Furthermore, notice that

$$\frac{dt_i}{dk_i^{ij}} = \frac{2\overline{F}K}{(K-1)(2K-1)} - \frac{\left[(K-1)\left(k^{ij}+1\right)n_i + \left((K-1)\left(k^{ij}+1\right)-2\right)n_j\right]\tau_{ij}^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} + \frac{(K-1)\left(k^{ij}+1\right)\sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tau_{jl}-\tau_{il}\right)^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} \lesseqgtr 0,$$

$$\frac{dt_i}{dk_j^{ij}} = 2\overline{F}\frac{1}{(K-1)(2K-1)} + \frac{\left[\left((K-1)\left(k^{ij}+1\right)+K\right)n_i + (K-1)\left(k^{ij}+1\right)n_j\right]\tau_{ij}^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} + \frac{(K-1)\left(k^{ij}+1\right)\sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tau_{jl}-\tau_{il}\right)^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} > 0,$$

and

$$\frac{dt_i}{dk_k^{jk}} = 2\overline{F}\frac{1}{(K-1)(2K-1)} + \frac{n_j\tau_{jk}^2}{(K-1)(2K-1)\beta\left(k^{jk}+2\right)^2} > 0$$

for $i \neq j \neq k$. On the one hand, similar to above, a rise in k_i^{ij} tends to make the domestic market in country i more competitive. As a consequence, country i's government competes harsher for mobile firms (lower tax rate). On the other hand, more immobile firms in country i mechanically raise the government's ability to tax. Altogether, the effect of k_i^{ij} on the domestic tax rate, t_i, is ambiguous. Vice versa, as the degree of local competition increases abroad ($k_j^{ij} \uparrow$ and $k_k^{jk} \uparrow$), market i becomes relatively more attractive, which improves country i's ability to tax. Also, more immobile firms abroad mechanically raise tax rates there, which positively feeds back into country

i's tax.

Let us now study the effects of firm exit and entry as a reaction to the disintegration of a country from an economic union formed by a set of countries $\mathscr{K}_{EU}$. Suppose that, as a reaction to this economic disintegration, firms exit from the leaving market and enter the economic union holding fixed the number of firms per industry. The effect on the tax rate of the leaving country and on the member countries, which experience firm entry, is ambiguous by the opposing forces described above. That is, the entry (exit) of firms in a country raises (reduces) the degree of local competition and makes that country less (more) attractive for mobile firms, while it mechanically increases (decreases) the government's ability to tax corporations. Nonetheless, one should bear in mind that this reasoning is in the absence of employment and growth effects attached to firm relocation.

What is the effect on tax rates of third countries outside the union, $k \in \mathscr{K} \setminus (\mathscr{K}_{EU} \cup l)$? As we can see, the answer depends on the size of the leaving country relative to the average country inside the union:

$$\sum_{m \in \mathscr{K}_{EU}} \left(\frac{dt_k}{dk_m^{lm}} - \frac{dt_k}{dk_l^{lm}} \right) = \frac{K_{EU}\left(n_l - \overline{n}_{EU}\right)\tau^2}{\left(K-1\right)\left(2K-1\right)\beta\left(k^{ij}+2\right)^2} \begin{cases} > 0 & for\ \overline{n}_{EU} < n_l \\ < 0 & for\ \overline{n}_{EU} > n_l \end{cases}.$$

The exit of firms in the leaving country and the entry into member countries, respectively, have no direct effect on the tax rates of third countries outside the union. Also, the mechanical effects of the exit and entry of firms cancel out. However, in equilibrium, the tax rates of third countries depend on the consumer surplus in the leaving country and the remaining union members. The exit of firms in the leaving country makes domestic prices in the member countries more elastic to firm relocation towards member countries. In other words, the gains in consumer surplus, which member countries realize from attracting firms by lowering tax rates, rise. The size of this effect is proportional to $\overline{n}_{EU}$. Vice versa, more firms inside the union make prices in the leaving country less elastic to firm relocation towards that country. Altogether, when a relatively large country leaves an economic union and firms exit (enter) the leaving country (member countries), third countries tend to tax more.

A.10 Welfare and Trade Costs

Let business taxes be positive, suppose that trade taxes are small and let trade costs be similar $\tilde{\tau}_{lm} \approx \tilde{\tau}_{jk}$. Then, welfare in country i positively depends on non-tariff trade costs between two other countries m and k

$$\begin{aligned}\frac{dW_i}{d\tau_{mk}} &= \frac{1}{2\overline{\overline{F}}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=m\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right)\left(\frac{dt_m}{d\tau_{mk}} - \frac{\partial\gamma^{im}}{\partial\tau_{mk}}\right)\\ &+ \frac{1}{2\overline{\overline{F}}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=k\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right)\left(\frac{dt_k}{d\tau_{mk}} - \frac{\partial\gamma^{ik}}{\partial\tau_{mk}}\right)\\ &+ \frac{1}{2\overline{\overline{F}}}\sum_{j\in\mathscr{K}\setminus\{i,m,k\}}\left(\frac{dt_j}{d\tilde{\tau}_{mk}} - \frac{\partial\gamma^{ij}}{\partial\tilde{\tau}_{mk}}\right)\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=j\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta}\right) > 0\end{aligned}$$

since

$$\begin{aligned}\frac{dt_m}{d\tau_{mk}} - \frac{\partial\gamma^{im}}{\partial\tau_{mk}} &= 3n_m \frac{K-2}{(K-1)(2K-1)}\frac{\alpha - w - \tilde{\tau}_{mk}}{16\beta} + 3n_k \frac{2(K-1)K-1}{(K-1)(2K-1)}\frac{\alpha - w - \tilde{\tau}_{mk}}{16\beta}\\ &- \frac{1}{(K-1)(2K-1)}\frac{Kn_m imt_{mk} + n_k imt_{km} - K(K-1)n_k ext_{km} - (K-1)n_m ext_{mk}}{4\beta} > 0\end{aligned}$$

and

$$\Delta_i^{ij} < 0.$$

Similarly, for import taxes

$$\begin{aligned}\frac{dW_i}{dimt_{mk}} &= \frac{1}{2\overline{\overline{F}}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=m\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right)\\ &\times\left(\frac{dt_m}{dimt_{mk}} + \frac{dt_k}{dimt_{mk}} - \frac{\partial\gamma^{im}}{\partial imt_{mk}} - \frac{\partial\gamma^{ik}}{\partial imt_{mk}}\right)\\ &+ \frac{1}{2\overline{\overline{F}}}\sum_{j\in\mathscr{K}\setminus\{i,m,k\}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=m\right] iimt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta}\right)\frac{dt_j}{dimt_{mk}} > 0\end{aligned}$$

and export taxes

$$\frac{dW_i}{dext_{mk}} = \frac{1}{2\overline{F}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[l=m\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right)$$
$$\times\left(\frac{dt_m}{dext_{mk}} + \frac{dt_k}{dext_{mk}} - \frac{\partial\gamma^{im}}{\partial ext_{mk}} - \frac{\partial\gamma^{ik}}{\partial ext_{mk}}\right)$$
$$+ \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i,m,k\}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1\left[j=l\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta}\right)\frac{dt_j}{dext_{mk}} > 0$$

as

$$\frac{dt_m}{dimt_{mk}} + \frac{dt_k}{dimt_{mk}} - \frac{\partial\gamma^{im}}{\partial imt_{mk}} - \frac{\partial\gamma^{ik}}{\partial imt_{mk}}$$
$$= n_m \frac{(12K-11)\,K\,(\alpha - w - \tilde{\tau}_{mk}) - 4K imt_{mk} + 4ext_{mk}}{(K-1)\,(2K-1)\,16\beta}$$
$$+ n_k \frac{\left[6\,(K-1)\,K+1\right](\alpha - w - \tilde{\tau}_{mk}) - 4imt_{mk} + 4K ext_{mk}}{(K-1)\,(2K-1)\,16\beta} > 0,$$

$$\frac{dt_m}{dext_{mk}} + \frac{dt_k}{dext_{mk}} - \frac{\partial\gamma^{im}}{\partial ext_{mk}} - \frac{\partial\gamma^{ik}}{\partial ext_{mk}}$$
$$= n_m \frac{\left[6\,(K-1)\,(2K-1) + (3K-10)\right](\alpha - w - \tilde{\tau}_{mk}) - 4K imt_{mk} + 4ext_{mk}}{(K-1)\,(2K-1)\,16\beta}$$
$$+ n_k \frac{\left[6\,(K-1)\,K - 4K - 3\right](\alpha - w - \tilde{\tau}_{mk}) - 4imt_{mk} + 4K ext_{mk}}{(K-1)\,(2K-1)\,16\beta} > 0,$$

$$\Delta_i^{ij} < 0,$$

$$\frac{dt_j}{dimt_{mk}} > 0,$$

and

$$\frac{dt_j}{dext_{mk}} > 0$$

for $j \neq m, k$ (see Appendix A.7).

A.11 Welfare and Firm Mobility

First, note that $\Delta_k^{ij} = 0$ for $\tau_{ik} = \tau_{jk},$. Therefore, a change in $\overline{F}^{ij}$ has no direct effect on consumer surplus and welfare in country k. By the envelope theorem, W_k is only affected through a change in the tax rates of country i and j. More formally,

$$\frac{dW_k}{d\overline{F}^{ij}} = \frac{dW_k}{dt_i}\frac{dt_i}{d\overline{F}^{ij}} + \frac{dW_k}{dt_j}\frac{dt_j}{d\overline{F}^{ij}}.$$

Observe that

$$\frac{dW_k}{dt_i} = \frac{\partial \gamma^{ki}}{\partial t_i} g^{ki}\left(\gamma^{ki}\right)\left(\Delta_k^{ki} - t_k\right) > 0$$

and

$$\frac{dW_k}{dt_j} = \frac{\partial \gamma^{jk}}{\partial t_j} g^{jk}\left(\gamma^{jk}\right)\left(\Delta_k^{jk} + t_k\right) > 0$$

since $\frac{\partial \gamma^{ki}}{\partial t_i} = -1$, $\frac{\partial \gamma^{jk}}{\partial t_j} = 1$, $\Delta_k^{ki} < 0$, $\Delta_k^{jk} > 0$ and, by assumption, $t_k \geq 0$. To conclude the proof note that, by Proposition 2, $\frac{dt_i}{d\overline{F}^{ij}} > 0$ and $\frac{dt_j}{d\overline{F}^{ij}}$ for $\overline{F}^{ij^{new}} \approx \overline{F}^{kj^{new}} \approx \overline{F}^{ki^{new}}$.