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A Theory of Economic Disintegration

Abstract

We develop a theory of economic disintegration with both endogenously formed tax and trade policies. We show very generally that, contrary to conventional wisdom, a country's disintegration from an integrated area leads to a deeper integration inside the area. Similarly, the departure of a country from a customs union lowers tariffs world-wide. Moreover, we introduce international firm mobility and non-cooperative business tax policies into the multi-country, multi-sector general equilibrium trade model of Melitz and Ottaviano (2008). We address the model-inherent dimensions of economic disintegration, such as tariffs, non-tariff barriers, the harmonization of production standards and regulations, business frictions, as well as household migration and analyze their effects on the domestic tax policies of asymmetric countries.

JEL-Codes: F130, F150, F220, F530, H250, H730.

Keywords: trade policy, tax/subsidy competition, oligopolistic markets, economic integration.

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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, 45. 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 is a prominent example of such protective policy measures that have lately gained significant influence. Similarly, this is the case for the renegotiation of NAFTA and the failure to finalize trade agreements like TPP and TTIP.

The emergence of protectionism and deglobalization raises several economic policy issues: Is economic disintegration that takes place unilaterally the same as reverse integration that is usually a multilateral process? How do such movements affect the formation and depth of international trade agreements around the world?

Contributors to the modern trade policy literature, 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, depending on the legal implementation of Brexit, both the UK and the EU may now be free to (re)negotiate trade agreements with other countries (e.g., the US and China) without the need to consider each other. When reevaluating their trade policies towards these countries, the EU's objective function changes as the UK does not sit at the negotiating table anymore. Similarly, the UK now sets its policies towards China and the US solely in its own interest. In turn, cooperative and non-cooperative trade policies towards these countries are affected. As a consequence, the welfare 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 in general and unilateral disintegration steps in particular. A significant body of theoretical and empirical research suggests that countries use their taxes 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 taxes on corporations (Dyreng, Hanlon, Maydew, and Thornock (2017)), which fuels fears of a "race to the bottom" of taxes.

If disintegration were the opposite of integration, Brexit should lead to higher taxes according to conventional wisdom. However, many believe that the UK would have to lower taxes after Brexit to stay competitive, and this would also push down taxes in the remaining EU countries. The effects of a trade war between the US and China on tax policies 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 taxes elsewhere to prevent capital outflows.

To the best of our knowledge, this is the first paper that builds a comprehensive theory of economic disintegration. We develop a novel 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, but also to the effects on trade policies in third countries. In the particular context of a country's exit from a customs union, we address the readjustment of cooperative and non-cooperative *trade policies* toward third countries. Moreover, in response to a country's departure from an integrated area (e.g., an economic union), the endogenously formed degree of integration inside the area may change.

To understand the impact of disintegration on global *tax policies*, we build a highly tractable multi-country, multi-sector general equilibrium trade model with non-cooperative setting of business tax rates by introducing international firm relocation into the model of Melitz and Ottaviano (2008). We shut down heterogeneity in firms' marginal production costs and, instead, bring in heterogeneous country-specific setup costs. Thereby, we obtain endogenous firm selection into countries. To keep the model analytically solvable, we adopt the idea of Fuest and Sultan (2019) that, in a given industry, firms can invest in only two out of several countries. The Ricardian idea of international specialization inspires the latter. Industries differ in the country pairs in which firms produce and, as mentioned, in the country-specific setup costs. Competition in taxes 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 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. Our workhorse example for economic disintegration is a country's departure from an economic union. Many of the effects we derive apply more broadly to any economic disintegration, such as the exit from a customs union, a free-trade area, or a trade agreement.

We derive two sets of results relating to tax and trade policies, respectively. The first set of results regards the impact of economic disintegration on *tax policies*. Firstly, when the disintegration of a country (e.g., from an economic union or a trade agreement) raises tariff and non-tariff trade costs (*trade-cost effect*), the tax in the leaving country decreases. The trade-cost effect on business taxes set by the remaining member countries depends on the size of the economic union. 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 countries. 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 insights hold for both tariffs and non-tariff barriers to trade. Observe that this trade-cost effect is not confined to a specific type of economic disintegration, such as the exit from an economic union. It describes the impact of any rise in trade cost on tax policies (e.g., due to a trade war).

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 (*de-harmonization effect*). Thus, in the short run, when firms do not anticipate this cost change, they may become less mobile across countries which tends to raise taxes 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 (*business-friction effect*). We model the latter idea by a shift in the relocation cost distributions to the detriment of the leaving country. We highlight substantial differences in the reaction of taxes depending on whether or not firms anticipate the economic disintegration. Although the de-harmonization and the business-friction effect are at first glance tailor-made to the case of a country's exit from an integrated area (e.g., Brexit), they may also occur in other situations of economic disintegration (e.g., the departure of the US from a multilateral institution).

Altogether, tax policies across the world interact with the economic disintegration along several dimensions. Besides the trade-cost effect, the de-harmonization effect, and the business-friction effect of economic disintegration, we document a *migration effect* that, in its consequences, resembles the business-friction effect and a *union-size effect* that is similar to the trade-cost effect. Again, the former can apply to any economic disintegration. The latter corresponds to a country's departure from an economic union or a customs union.

The second set of results concerns the consequences of economic disintegration on *trade policies*. We go beyond the initial model setup where trade policies are exogenous and change mechanically with disintegration. Instead, we consider a situation in which tariffs and non-tariff barriers are endogenously bargained over by countries initially, without relying on a specific model. We focus on two important cases: the disintegration from an integrated area or union (case 1) and a customs union (case 2). In the first case, we predict that the countries inside the union integrate more with each other along different policy dimensions. They do not only lower their non-tariff barriers to trade but also harmonize more in production standards and business regulations (that is, a reverse of the de-harmonization channel, but now limited to the countries in the union). In the second case, the remaining customs union member countries negotiate lower tariffs with third countries in regional trade agreements. The leaving country also intensifies trade agreements with third countries. Similarly, non-cooperative trade policies by the union members, as well as by the leaving country, become less protective.

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 UK and the remaining EU member countries undertake subsequently. We predict from our model that both deepen their trade relations with other countries.

At the same time, our model applies beyond the case of Brexit. A similar argument applies to countries which engage in a trade war or consider leaving the WTO. When the US exits the WTO or pursues a trade war with China, 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 unilateral 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 policies, 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 (migration effect).

Related literature. Our paper relates to three strands of the literature. First, we add to the debate on inter-jurisdictional tax competition. Usually, in this literature, there are locally separated regions whose economic outcomes are linked 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)). Location rents incentivize governments to modify their domestic policy instruments, such as taxes, to attract these factors. Just as in our model, some of the authors, for instance, Bucovetsky (1991) and Haufler and Wooton (1999), address 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. Complementary to this, there are a more recent papers 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 taxes 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 large market irrespective of the business tax differential until the location rents in the large market are absorbed by an increased degree of regional competition. Although some of the 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. Whereas the two-country and the partial three-country settings may address the impact of integration that countries accomplish multilaterally, these models cannot examine a country's unilateral decision to disintegrate from a set of other countries. As we show in our model, it is misleading to reverse the sign of existing conclusions about (multilateral) economic integration to speak to the effects of (unilateral) disintegration.

Two key challenges have, so far, prevented the authors 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 is a best response to all the other countries' taxes. Therefore, the optimal tax 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 including firm-relocation effects. However, these authors 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.

Outline of the paper. This paper is structured as follows. In Section 2, we first develop a multi-country, multi-sector general equilibrium trade model with firm mobility and non-cooperative business taxation. Then, we derive the effects of economic disintegration along several dimensions. Moreover, we consider various model extensions. In Section 3, we endogenize trade policies to study the readjustment of tariff and non-tariff trade policies worldwide in reaction to economic disintegration. Section 4 concludes. We relegate all relevant proofs to the Online Appendix.

2 The Impact of Economic Disintegration on Tax Policies

In this section, we analyze the impact of economic disintegration on tax policies. We refer to economic disintegration as the departure of one country from a trade agreement formed by a set of countries (in the following called an "economic union"). In Section 2.1, we introduce firm mobility and tax policy into a three-country version of the Melitz and Ottaviano (2008) multi-sector general equilibrium trade model. Our approach allows us to derive each country's optimal Nash equilibrium tax policies. We then identify several model-inherent dimensions of economic disintegration and analyze their effects on optimal tax policies (Section 2.2). In Section 2.3, we demonstrate that our three-country model and the derived economic insights readily extend to an arbitrary number of countries. Then, we consider various extensions to our model (Section 2.4).

2.1 The Three-Country Model

Timing. We build a four-stage economy, $\mathscr{E}$, of fiscal competition with initially three countries, which we will later extend to an arbitrary set of countries, $\mathscr{K}$. In the first stage, taking trade policies as given, each government non-cooperatively chooses a business tax, t_i, to maximize national welfare consisting of consumer surplus and tax revenues.[1] Given tax and trade policies, a continuum of mobile firms selects into countries in the second stage. In the third stage, each mobile firm competes in an oligopolistic industry with two other immobile firms in general equilibrium. All firms are single-product businesses and trade their products worldwide. To achieve tractability, we assume that, in each industry, firms can produce in only two out of multiple countries. Industries differ in the pair of countries in which firms produce and the country-specific fixed costs of setting up a firm. In the fourth stage, households optimally choose their demand. To fix ideas, we define the subgame-perfect Nash equilibrium of this game.

Definition 1. Consider economy $\mathscr{E}$. 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,

[1] In Section 3, we capture the endogenous formation of cooperative and non-cooperative trade policies, which can be interpreted as a Stage 0 of our economy.

(2) oligopolistic firms maximize their profits over quantities, taking location decisions of all firms and taxes of all countries as given,

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

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

Economic Disintegration. We analyze economic disintegration by carrying out comparative statics of this subgame-perfect Nash equilibrium. Specifically, the trade costs between any pair of countries depend on the level of economic integration between these two countries and may differ across country pairs. An increase in the trade costs of respective country pairs captures economic disintegration. Accordingly, we label the impact on tax policies as a trade-cost effect. Moreover, we consider country-pair specific distributions of fixed cost to set up a firm and derive a de-harmonization effect and a business-friction effect. Finally, we deal with migration between countries as a simultaneous offsetting change in the population between country pairs, which triggers a migration effect. There are two main advantages of our approach. Firstly, we impose no a priori assumption on the specific type of economic disintegration. Secondly, except for the de-harmonization, all the effects are equally applicable to small and large policy changes.

We now describe the model more formally. As mentioned, the economy denoted as $\mathscr{E}$ includes four 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.

2.1.1 Households

Preferences. In each country $i \in \mathscr{K}$, a number n_i of identical households consumes a continuum of differentiated varieties, which oligopolistic firms produce, and a numéraire commodity, z_i, which firms produce under perfect competition. Varieties, $x_i(\mu)$, are indexed by $\mu \in \Omega := [0, 1]$. 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

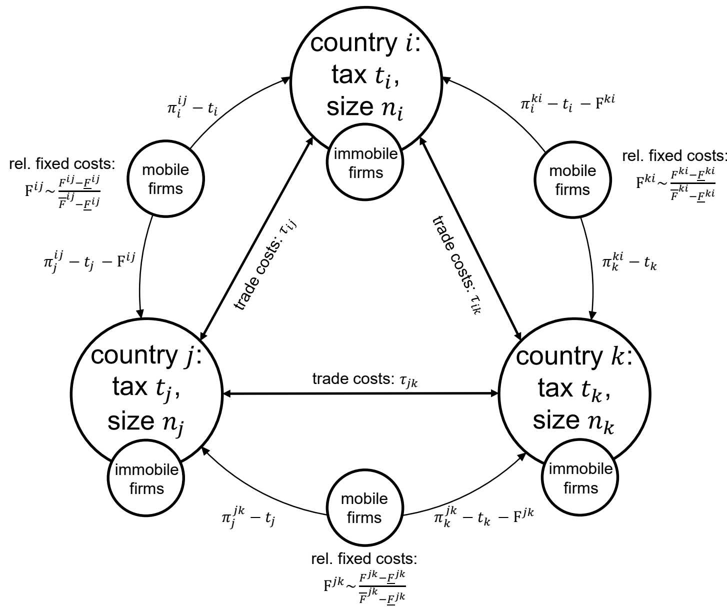

Figure 1: The three-country model

countries. Each variety is produced in an oligopolistic industry, which consists of three firms.[2] Households derive the following utility

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

from the consumption of products manufactured by the numéraire and the oligopolistic industries with $\alpha, \beta > 0$ and in the base version of our model $\eta = 0$. These preferences are a particular case of those in Melitz and Ottaviano (2008). In Section 2.4, we deal with cross-price effects ($\eta > 0$). Household income comes from supplying labor inelastically and from the business taxes the government rebates in lump-sum fashion.

Utility Maximization (Stage 4). The quadratic utility function generates a system of linear aggregate demand functions

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

[2] All the results carry over when one leaves out the immobile firms and considers only a single mobile firm that produces a given variety, which mimics the firm structure in Melitz and Ottaviano (2008) (but now with endogenous location choice). To endogenize the degree of local competition to firm relocation, we decide to conduct our baseline analysis under an oligopolistic market structure. The immobility of two-out-of-three firms is assumed to maintain the tractability of the model.

for each country and industry, where $p_i(\mu)$ denotes the local consumer price. Below, we state conditions under which solutions are interior.

2.1.2 Firms

Production and Trade. Each firm in the oligopolistic 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 $w + \tau_{ij}$.[3] 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. Moreover, our definition of trade costs includes transport cost differentials arising from geographical characteristics and tariffs. Altogether, trade costs raise the unit costs of producing for a foreign market. When introducing firm heterogeneity, we also address non-tariff barriers that affect firms' setup costs. For the time being, we assume trade costs to be exogenous, although subject to change with disintegration, and we abstract from revenue effects of trade taxes/subsidies. In Section 2.4, we deal with revenue effects and show that our results carry over. Moreover, we endogenize tariff and non-tariff trade policies (Section 3).

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 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 in residents' incomes.

Firm Heterogeneity. Inspired by Melitz (2003), we introduce firm heterogeneity as follows: In each industry, there are three firms.[4] One immobile firm produces in each of two countries, say countries i and j. A third, mobile firm can decide in which of these two countries it locates. In the third country, say country k, the production of that specific good is not possible, perhaps due to technological, regulatory, or geographical frictions (and consumption takes place through imports).

[3] In Section (4.7) of the Online Appendix, we relax the assumption that trade costs are symmetric across firms and industries.

[4] In Section 2.4, we relax this assumption.

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. To rule out asymmetries in initial conditions, let the mass of potential firms be ex ante equal across countries. That is, we partition the set of industries Ω into K equally sized intervals.

Our use of the term "industry" should be explained. An industry is a collection of firms producing a specific variety. For $\eta = 0$, there are two interpretations of this firm structure. On the one hand, there may be a set of industries with three firms in each industry (e.g., the clothing sector and the car sector). Each industry differs in the countries that serve as a (potential) production location. On the other hand, the setting could refer to a continuum of varieties (e.g., in the food sector). Three firms produce a specific variety (e.g., apples and bananas). Varieties differ in the countries where firms can produce them.

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.[5] 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 and ν^j, 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,

[5]This is the main difference to Melitz and Ottaviano (2008). In their setting, firms vary by their marginal cost draw, giving rise to endogenous firm exit and entry. Here, firm heterogeneity comes from relocation cost draws, which leads to endogenous firm emigration and immigration.

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- and country-pair-specific policy components that alter the mean and the variance of relocation costs. Altogether, each mobile firm pays different fixed costs of production, giving rise to an extensive margin of firm relocation, which affects local prices and production quantities.

Profit Maximization (Stage 3). A firm producing in country i and and belonging to 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 four-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

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

As we see, prices and mark-ups are endogenous to the location decision of firms. The asymmetry in profits from markets j and k is 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 assumption.[6] In country each i, firms are taxed lump-sum with t_i.

Firm Relocation (Stage 2). 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[7] are larger in i than in j:

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

In other words, a firm prefers country i if the advantage in gross profits exceeds the tax differential

[6]One may easily relax this assumption, as long as this additional firm in country k is immobile.

[7]While pre-tax variable profits (4) are non-negative, we cannot guarantee 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.

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 set-up cost in country i relative to k. The mass of industries with two regional firms (i.e., one mobile and one immobile firm) in i reads as

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

Notice that 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 modeling's advantage is that, although the firm-level location decision is binary, the equilibrium firm distribution is a high-dimensional object that is tractable enough to derive clear-cut policy predictions. Our concept of mobility allows us to write the threshold industry level in closed form as a function of the model parameters. In particular, it is linear in the tax differential

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

Comparative Statics. The partial equilibrium comparative statics are intuitive. The higher the tax in country i relative to j and k, the more firms move out of that country (γ^{ij} increases and γ^{ki} decreases, respectively). Observing that the sign of $\frac{\partial \gamma^{ij}}{\partial \tau_{ij}}$ depends on the country's relative size, already hints towards a critical effect 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. If trade becomes more costly for firms located abroad, firms move to country i ($\frac{\partial \gamma^{ij}}{\partial \tau_{ik}} > 0$ and $\frac{\partial \gamma^{ij}}{\partial \tau_{jk}} < 0$).

2.1.3 Governments

Non-Cooperative Tax Policies (Stage 1). In this section, we consider the first stage of our economy. That is, for a given level of trade costs, we derive Nash equilibrium taxes set by benevolent social planners in each country, who take the effect of taxes on households' consumption choices and 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 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, the Online Appendix shows that consumer surplus is given by

$$S_i := G\left(\gamma^{ij}\right)\Delta_i^{ij} + G\left(\gamma^{jk}\right)\Delta_i^{jk} + G\left(\gamma^{ki}\right)\Delta_i^{ki} + \delta_i^{ij} + \delta_i^{jk} + \delta_i^{ki}, \tag{10}$$

where 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

$$W_i := \max_{t_i} \; S_i + T_i + n_i w \tag{11}$$

taking t_j and t_k as given. Similarly, welfare is maximized in countries j and k over t_j and t_k, respectively.

The first-order condition of the social planner problem yields a reaction function $t_i(t_j, t_k, \Theta)$ for each country i. As we show in the Online Appendix, the reaction functions are linear in taxes and there is a unique intersection of the reaction functions, $t_i(\Theta)$ for $i \in \mathscr{K}$, forming the solution to the tax competition game. In the following, we consider the equilibrium of this game with three countries.

Nash Equilibrium Comparative Statics. Lemma 1 verbally summarizes comparative statics of Nash equilibrium taxes with respect to trade costs and country population sizes (without offsetting population changes elsewhere). For a more technical statement, we refer to the Online Appendix.

Lemma 1 (trade cost change)**.** *In the subgame-perfect equilibrium of economy $\mathscr{E}$,*

(a) a rise in country i's population size, n_i, increases that country's business tax, whereas an increase in another country's population, n_j, reduces country i's tax, as long as trade between these countries is not too cheap relative to the one between other countries ($\tau_{ij} \not\ll \tau_{jk}$), and

(b) a rise in country i's trade costs vis-à-vis another country j, τ_{ij}, decreases country i's business tax, as long as it is not too large relative to the other country ($n_i \not\gg n_j$). An increase in the trade costs of other countries, τ_{jk}, raises country i's business tax.

Lemma 1 (a) shows that an increase in absolute market size, for instance, induced by population growth in a country, improves that country's ability to tax. Therefore, larger countries tend to tax more. The effect of a growing population in another country is less clear. 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 apply to 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.

Moreover, higher trade costs between countries j and k unambiguously lead to an increase in the tax in country i. Intuitively, countries j and k lose attractiveness when their trade costs rise, which puts country i in the position to tax more. Moreover, provided that country i is not too large higher trade costs for firms in i put 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.

Having dealt with these comparative statics, in Corollary 1 in the Online Appendix we consider comparative statics of the (unweighted) average taxes with respect to trade costs. When bilateral trade costs between i and j increase, the average tax in these countries falls. The same holds for the average tax 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 in country i and a third country k is ambiguous.

2.2 The Impact of Economic Disintegration on Tax Policies

In the following, we consider several channels through which economic disintegration affects tax policy. First, the costs of bilateral trade between countries change (trade-cost effect). Moreover, economic disintegration alters the international mobility of firms via location fixed costs (de-harmonization effect and business-friction effect). Finally, we deal with the possible migration of households (migration effect). As already mentioned, we do not impose any assumption on the underlying institutional structure. Our leading example is the exit from an economic union, such as in the Brexit scenario. The main insights carry over to other forms of disintegration.

2.2.1 Trade-Cost Effect

Suppose, for instance, that countries i and j are in an economic union (e.g., the EU) and share similar trade costs between them. What happens to taxes when trade between country k (e.g., the UK) 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 follows from Lemma 1. Again, we relegate a more technical formulation of Proposition 1 to the Online Appendix.

Proposition 1 (trade-cost effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$. Let trade costs between the leaving and the remaining countries be sufficiently similar initially. Then, the disintegration of country k via a rise in bilateral trade costs with countries i and j*

(*a*) *reduces the leaving country's business tax, as long as it is not too large relative to the other countries, and*

(*b*) *reduces taxes in the other countries, as long as these are not too large in terms of population* *relative to the leaving country. Under considerable asymmetries in population sizes, business taxes in countries i and j converge.*

(c) *Under symmetric population sizes of all three countries, the disintegration reduces taxes in all countries.*

When countries have the same population size ($n_i = n_j = n_k$), the tax in the leaving country declines. The same holds if it is not too large relative to the other countries (the economic union). The market access argument described above drives this result.

If market sizes are equal, taxes in the remaining economic union decrease. In case that the leaving country is huge (small) relative to the economic union, taxes in the union decline (rise). Notice that 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 taxes converge as a reaction to the disintegration of k. Although a country's departure from an economic union is our leading example, observe that the statement applies more broadly to any type of economic disintegration that raises trade costs between a leaving country and other countries.

By comparing Proposition 1 to Lemma 1, one can easily see how a two-country setting, as studied in the previous literature, fails to capture the effects of a country's economic disintegration. In Lemma 1, we show that firms move to the larger market in response to a rise in trade costs (e.g., the economic union). This reaction would lower business taxes in the smaller leaving country but increases taxes in the larger market. According to Proposition 1, however, business taxes may decline everywhere. Moreover, a two-country setting cannot address the potentially asymmetric reactions among the other countries.

As we show in the Online Appendix, the assumption that trade costs are initially similar can easily be relaxed. We demonstrate how to adjust the proposition when trade costs differ. The size of the additional term is relatively small and does not alter the main insights concerning relative market sizes. Moreover, it is decreasing in the number of countries.

Proposition 1 is our first main result. It speaks to the hypothesis that, after Brexit, the UK lowers its tax, 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 in France (whereas still lowering taxes in the other two countries).

2.2.2 De-Harmonization Effect and Business-Friction Effect

De-Harmonization Effect. 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 determine the relative number of firms. By contrast, we now consider the direct effects of economic disintegration on firm relocation. Recall from Equation (5) 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 the inside of the union to the outside. Thus, the relocation-cost differential is another dimension of economic integration. 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 disintegrates from a set of other countries by de-harmonizing and, as a result, faces a less elastic tax base. This de-harmonization effect is intuitive in the case of an exit from an economic union. However, it applies more broadly to disintegration whenever governments reduce their efforts to reach similar standards and regulations by multilateral agreements, such as in health and environmental protection.

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 $G^{ij}\left(F^{ij}\right) = \frac{F^{ij} - \underline{F}^{ij}}{\overline{F}^{ij} - \underline{F}^{ij}}$. 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, $\overline{F}^{ij} = -\underline{F}_{ij}$), 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 k disintegrates from i and j, $\overline{\epsilon}^{jk}$ 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 as a function of $(\overline{\epsilon}^{ij})_{i,j \in \mathscr{K}}$. For a detailed exposition, we refer to the Online Appendix . We can now state Proposition 2.

Proposition 2 (de-harmonization effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$ and suppose that trade costs and country sizes are identical. Let the degree of harmonization in business regulations across countries be sufficiently similar initially. Then, a rise in the degree of harmonization between two countries reduces all country's business taxes. Hence, the disintegration of country k via a de-harmonization between countries raises taxes everywhere.*

This result is not surprising in light of the literature. By construction of our model, a rise in $\overline{\epsilon}^{jk}$ makes tax bases in the countries j and k less elastic, which tends to increase taxes in these countries. In the Nash equilibrium, this spills over to the tax of the not directly affected country i. Due to the strategic complementarity of tax policies, t_i increases.

In most cases and in particular for similar initial conditions, the tax of a country goes up when the fixed cost distribution widens between that country and another one, that is, t_i increases in $\overline{\epsilon}^{ij}$. As we show in the Online Appendix, however, there may be cases in which the tax falls ($\frac{dt_i}{d\overline{\epsilon}^{ij}} < 0$). 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.

With regard to economic disintegration, the proposition describes another potential effect of the disintegration of country k from i and j, which we label as a de-harmonization effect. When $\overline{\epsilon}^{jk}$ and $\overline{\epsilon}^{ki}$ increase simultaneously, tax bases become less elastic between, for instance, the economic union and the exiting country k. The lower mobility of firms causes taxes to rise everywhere. Note that the response in tax rates from the de-harmonization effect is the opposite of the one from the trade-cost effect (in the case of symmetric countries).

Business-Friction Effect. So far, we have described origin-destination-specific asymmetries in the firm relocation costs and analyzed the impact of a drop in the mobility of firms between countries. Our second main result suggests that business taxes tend to increase everywhere when economic disintegration occurs in the form of more firm attachment to their countries. When interpreting the reduction in firm mobility as a feature of economic disintegration, two notes of caution are indicated, however.

First, the rise in $\overline{\epsilon}^{jk}$ and $\overline{\epsilon}^{ki}$ 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. For example, when firms anticipate the exit of country k from the economic union, the country's disintegration may discourage prospective entrepreneurs from investing in a firm located in k. To summarize, in the long run, the mass of potential 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 $\overline{\epsilon}^{jk}$ 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.

Therefore, we now consider the case where the disintegration 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 taxes 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 other countries (e.g, the economic union). In Proposition 3, we show that the effects point in intuitive directions. We prove the statement in the Online Appendix.

Proposition 3 (business-friction effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$. An increase in the average cost of setting up a business in a country relative to another country induces lower taxes in the former country and increases taxes in the latter one. Hence, the disintegration of country k via a rise in business frictions lowers business taxes in the leaving country and increases taxes elsewhere.*

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 Effect

So far, we have dealt with changes in parameters that directly affect the production side. Now, we deal with economic disintegration as a trigger of household migration. Migration flows are particularly relevant if a country leaves an economic union that guarantees the free movement of labor. To provide an example, when the UK splits off, some EU citizens in the UK may return to their home countries or other countries in the union. However, also other forms of economic disintegration induce household migration. The reason is that economic disintegration affects local prices and, therefore, utility levels of households in a given country. When households are internationally mobile just like firms, they will migrate from one jurisdiction to another as long as the difference in utilities exceeds the migration cost.

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. For a more detailed statement, we refer to the Online Appendix.

Proposition 4 (migration effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$ and suppose that trade costs are sufficiently similar initially. Then, household migration from country i to j decreases country i's tax and increases the tax in j. The reaction in country k's tax is positive if and only if trade with country j is cheaper than with i ($\tau_{jk} < \tau_{ik}$). Hence, the migration into an integrated area triggered by the disintegration of country k lowers the leaving country's business tax and increases taxes inside the integrated area.*

The effects of migration (i.e., a change in the size of countries while holding $\sum_{l \in \mathscr{K}} n_l$ fixed) on taxes depend on the origin and the destination of migration flows. Migration from the leaving country into another country reduces the leaving country's tax and allows the destination country to tax more. The tax in the third country, which is not directly affected by migration, rises as well if trade with the destination country is cheap. Hence, migration into an integrated area, such as an economic or customs union or a free-trade area, in which trade is cheaper than outside, increases taxes in the integrated area. The intuition is that the integrated area grows as a whole such that member countries become more attractive to mobile firms irrespective of whereto migrants precisely move.

What is the average effect of a population shift from the leaving country towards a member country? One can see from Corollary (3) in the Online Appendix that the average tax of these two countries declines. In other words, the leaving country reduces its tax by more than the member country can raise its tax. The average tax of the world will increase. As described above, the population shift improves the other member country's ability to tax. In sum, taxes in the integrated area increase. This rise outweighs the reduction in the tax of the leaving country, such that the effect on the average tax of the world is positive.

Altogether, referring to our leading example, migration from outside to inside the union increases taxes inside the union and reduces the leaving country's tax. 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 disintegration on third countries that are not directly affected. Let $\mathscr{K}_{EU} \subseteq \mathscr{K}$ denote the non-empty set of countries from which the leaving country disintegrates and $K_{EU} := |\mathscr{K}_{EU}| \in \mathbb{Z}^+$ its cardinality. For example, this can be a customs union, a free-trade area or a set of countries in a trade agreement. Therefore, in the following, we refer to a country $m \in \mathscr{K}_{EU}$ to as a "member country." 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 third countries' tax policy. In the Brexit case, these are countries that were already outside the union before the exit (like the US or China), 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 the Online Appendix.

2.3.1 Trade-Cost Effect

We now state Proposition 5, which is the K-country counterpart to Proposition 1.[8] It is useful to define the average population of the member countries as $\bar{n}_{EU} = \frac{1}{K_{EU}} \sum_{m \in \mathscr{K}_{EU}} n_m$. We relegate the proof and a a more technical statement of the Proposition to the Online Appendix.

Proposition 5 (trade-cost effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$. Let trade costs between the leaving and the remaining countries be sufficiently similar initially. Suppose that country $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$ disintegrates from the member countries $m \in \mathscr{K}_{EU}$. Then, the disintegration of country l via a rise in trade costs*

(*a*) *decreases the leaving country's business tax unless its population is very large relative to $\overline{n}_{EU}$,*

(*b*) *decreases taxes in the remaining member countries under symmetric population sizes of countries l and $m \in \mathscr{K}_{EU}$, and can have asymmetric effects under considerable asymmetries in market sizes, and*

(*c*) *raises taxes in third countries ($\mathscr{K} \setminus (\mathscr{K}_{EU} \cup l)$).*

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

The reaction of taxes in member countries 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 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 ($n \coloneqq n_m = n_l$), the derivative in (*b*)

[8] Observe that we only consider direct effects of economic disintegration, i.e. changes in the trade relations of the leaving country with $\mathscr{K}_{EU}$. 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.

reduces to

$$\frac{dt_m}{d\tau_{ml}} + \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_m}{d\tau_{jl}} = 3n\frac{4K_{EU}-2K-1}{2K-1}\frac{\alpha-w-\tau}{16\beta}\begin{cases} >0 & for\ 4K_{EU}>2K+1 \\ <0 & for\ 4K_{EU}<2K+1 \end{cases}. \tag{12}$$

Referring to the departure from an economic union, taxes inside the 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 (K), the more sensitive react members' tax bases and, hence, taxes 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 the context of Brexit, the condition for members' taxes to rise, according to 12, is clearly not given. The number of countries in the world is larger than twice the EU's 27 member states.

Similar to Proposition 1, there is no need to consider symmetric trade costs between the leaving and the member countries, as we show in the Online Appendix. Moreover, the statement regards any type of economic disintegration that leads to a rise in trade costs between the leaving country and the remaining members.

In Corollary (5) of the Online Appendix, we consider the impact on world, EU, and non-EU average taxes. The disintegration of country l increases on average taxes of third countries, but reduces the average tax 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 inside the union rises in reaction to the disintegration when the remaining economic union size 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 Union-Size Effect

Another way to examine the consequences of economic disintegration for tax policy is to impose some symmetry assumptions across countries and to directly differentiate taxes with respect to K_{EU} as if the number of member countries was defined on a continuous domain.[9] In particular, assume symmetry in country size as well as in internal and external trade costs as in a customs or an economic union.

Assumption 1. *Let* $n := n_i = n_j$ *for all* $i, j \in \mathscr{K}$*. Moreover, let internal and external trade costs be symmetric,* $\tau^* := \tau_{ij} = \tau_{ik}$ *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* $K_{EU} > 1$*, respectively.*

In the Online Appendix, we show that under Assumption 1 the tax 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 (union-size effect)**.** *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,*

(a) *business taxes inside the union are larger than outside,*

(b) *a rise in the number of member countries increases business taxes in member countries, and*

(c) *a rise in the number of member countries decreases business taxes in non-member countries.*

Several aspects are worth mentioning. As shown in (a), under these assumptions, taxes in member countries (e.g., inside the economic union) are higher than in non-member countries (outside the union). Being part of the economic or a customs union makes countries more attractive to firms, which lowers tax competition for these countries. Once asymmetries in trade costs are removed, all the advantages of the union have vanished such that $t_m = t_n$. To sum up, ceteris paribus the tax of the country that leaves the economic or the customs union will decline.

Most importantly, when the 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,

[9] 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)).

will only be in line with Proposition 5 (b) if the union is small compared to the rest of the world. This conflicting finding is not surprising since the analysis conducted in this section is much more gritty compared to the one in Section 2.3.1.

Regarding the effects of globalization on taxes inside the union, one needs to differentiate t_m with respect to K. As shown in the Online Appendix, the sign of this derivative is ambiguous. Non-member countries gain relative attractiveness as globalization proceeds ($\frac{dt_n}{dK} > 0$). The reason is that the relative size of the union shrinks with K.

In this section, 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

Tariff Revenues and Subsidy Expenditures. In this section, we describe several extensions to our baseline economy. Firstly, we incorporate tariffs into our model (see Section (4.1) in the Online Appendix). 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 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 Nash equilibrium 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 above-described effects of economic disintegration 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.

Accrual of Profits. 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 (see Section (4.2) in the Online Appendix).

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. Moreover, in the former case, taxes are revised downwards by the accrual of domestic profits and, in the Nash equilibrium, of foreign profits. In the latter case, 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.

Industry Size. Moreover, we generalize our economy to an arbitrary number of immobile firms in each industry (see Section (4.3) in the Online Appendix). 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 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 the Nash equilibrium, these two effects point in the same direction for the taxes 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 anticipate a country's disintegration and move away from that country (e.g., 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 the member countries, which lowers mark-ups there. Vice versa, in the leaving country, firms generate higher profits.

Cross-Price Effects. In Section (4.4) of the Online Appendix, we generalize the model by allowing for cross-price effects in the demand for differentiated goods ($\eta > 0$). The Nash equilibrium business taxes are revised upwards. The substitutability between the differentiated varieties and the numéraire rises with η. Put differently, the presence of cross-price effects shifts down the demand for differentiated varieties, thereby reducing the welfare loss from firm emigration in the differentiated industries (welfare gain).

Relative to Lemma 1, there are two adjustments. The first one regards the marginal effect on the aforementioned welfare gain. The second adjustment captures that the consumer surplus loss from taxing businesses is endogenous to the average price level. For similar trade costs and market sizes which rules out the Metzler paradox, the effects point in opposite directions. However, the central intuitions regarding the impact of disintegration (e.g., via a rise in trade costs) carry over.

Competition in Regulations. We introduce competition in regulations into the first stage of our economy (Section (4.5) in the Online Appendix), in addition to the business tax as a policy instrument. That is, we endogenize each country's level of business frictions/regulations, ν^i, similar to the non-cooperative setting of business tax policies. Then, each government chooses the set of domestic policies (t_i, ν^i), taking all the other countries' business taxes and regulations as given. A rise in the level of regulations is welfare-detrimental as it triggers firm emigration, which reduces consumer surplus and tax revenues. Therefore, to obtain interior solutions, we introduce a country-specific reduced form regulation surplus $V_i\left(\nu^i\right)$ that is assumed to be increasing, concave, and, for simplicity, independent from taxes. In the context of environmental protection, this surplus could measure the value of clean air. Even without cross-country complementarities in this surplus function ($\frac{dV_i}{d\nu^j} = 0$), the optimal level of regulations is inefficiently low since a country's government does not consider the positive externality of business regulations on other countries' welfare. Thus, just as in the tax competition game, countries would gain from the international coordination of business regulations.

We demonstrate that the domestic policies interact: the optimal business tax is not only affected by the level of regulations, as in Proposition 3, but also vice versa. Interestingly, their (partial equilibrium) comparative statics may point in opposite directions. For example, whereas a rise in τ_{jk} improves country i's ability to tax, it amplifies the size of lost tax revenues and, hence, the welfare costs of ν^i. Accordingly, country i's optimal level of business regulations declines. Altogether, the impact of economic disintegration on the other domestic policies may significantly differ from those on business taxes, even if the domestic policy closely resembles a business tax from mobile firms' perspective as it is, in this setting, the case for business regulations.

Harmonization of Business Taxes. In Section (4.6) of the Online Appendix, we consider the scenario of partial harmonization (e.g., Conconi, Perroni, and Riezman (2008)), where a subset of countries in a harmonized area, $\mathscr{K}_H \subset \mathscr{K}$, coordinates their level of business taxes to maximize their joint welfare. Again, there exists a unique Nash equilibrium in taxes set by the subset of countries and all other countries, which can be derived from the government's (modified) reaction functions. The formulas for the non-cooperative tax policies of countries outside the harmonized area are unaltered relative to the case without tax harmonization. The reaction function in the harmonized area, t_H, accounts for average effects on consumer surplus and tax revenues.

The coordination of business taxes among some countries reduces ceteris paribus the degree of tax competition relative to the setting without harmonization. Conceptually, the harmonized area behaves in its setting of business taxes similar to a large country. Therefore, the impact of economic disintegration on the coordinated business tax resembles the one on a large country's tax policy.

To further shed light on the economic disintegration, we impose cross-country symmetry in market sizes and trade costs. This assumption yields a symmetric tax outside of $\mathscr{K}_H$ in addition to the one inside. In line with the intuition that the harmonized area acts as a large market and is more attractive as a business location than the other isolated markets, the business tax inside the area is higher than outside. Similar to Proposition 6, we differentiate business taxes with respect to the number of members in the harmonized area, K_H, as if it was defined on a continuous domain. Both inside and outside the area, business taxes are positively associated with K_H. Hence, a country's departure from the set of countries that coordinates their business tax policy decreases taxes worldwide. The reason is that the according reduction in K_H is equivalent to creating a new player in the tax competition game and, as a result, amplifies the degree of competition.

Richer Labor Market. In the following, we shortly describe how the presence of a richer labor market affects our insights. In our economy, free trade in numéraire commodities equalizes the wage rate across countries and labor supply is inelastic. Suppose that trade in the numéraire commodity is not possible, and elastic labor supply (via an additively separable disutility from labor) and demand determine a country's wage rate on a labor market. As households' utility is linear in the consumption of the numéraire, a change in tax revenues that the government rebates to households in lump-sum fashion has no income effects on labor supply. However, due to endogenous firm migration, a change in business taxes affects labor demand. The lower a country's business tax, the more mobile firms move into that country, increasing labor demand. The equilibrium wage rate and, thus, welfare in the country rises. If there were income effects on labor supply, a rise in business tax revenues would lower labor supply and, as a result, also increase a country's equilibrium wage. Therefore, a richer labor market gives a country's government an additional incentive (aside from lower consumer prices and higher tax revenues) to reduce business taxes to attract mobile firms (more tax competition). Altogether, this extra wage channel strengthens our main results.

Proportional Tax on Profits. Furthermore, one may replace the lump-sum tax with a proportional tax on profits, $\tilde{t}_i(\mu)$. Observe that the latter tax is equivalent to the former one for $\tilde{t}_i(\mu) = t_i/\pi_i^{ij}(\mu)$ in a given industry $\mu \in [0,1]$. A rise in the lump-sum tax is associated with a higher proportional tax. Accordingly, our analysis above addresses the level of proportional taxes. The proportional tax affects firm relocation (threshold industries γ^{ij}) in the same way as the lump-sum tax. Country i's tax rate $\tilde{t}_i(\mu)$ is the same for all industries with the same firm mobility outcomes and, thus, with the same profit level $\pi_i^{ij}(\mu)$ (e.g., for all $F^{ij} < \gamma^{ij}$). However, it declines in the industry's profit level $\pi_i^{ij}(\mu)$. Domestic firms in sectors with less competing firms in their home market (e.g., $F^{ij} < \gamma^{ij}$ in country i) realize higher profits, whereas firms with more local competition (e.g., $F^{ij} \geq \gamma^{ij}$ in country i) have lower profits. Thus, a country i's government gives a tax discount on high-profit industries. These are sectors in which the government would like to attract firms that opt for the other country. The government levies a higher tax on more competitive/low-profit industries where the government can attract firms in any case.

Firm Relocation across Multiple Countries. Finally, one may relax the assumption of binary firm relocation choices. To achieve the degree of tractability necessary to solve explicitly for the Nash equilibrium business tax policies, we restricted the analysis to a firm's location choice between two countries in a given industry. This assumption creates a strong lock-in of a mobile firm to a specific country pair. If firm location were a multinomial choice problem, mobile firms would locate across multiple countries. This additional firm mobility would intensify tax competition as it scales up each country's elasticity of relocation. Since each mobile firm can relocate to any other country instead of one specific country that may be relatively unattractive as a business location, a rise in a country's trade costs would induce stronger firm emigration responses. Vice versa, a decline in a country's trade costs increases firm immigration because firms from all industries (also those where the country is not part of the relocation choice set in our model) can move into the country. We, therefore, expect that firm relocation across multiple countries strengthens our findings.

3 The Impact of Economic Disintegration on Trade Policies

In this section, we consider another dimension of economic disintegration: Trade policies around the world endogenously react to economic disintegration. Referring to our model described in Section 2, the setting of cooperative and non-cooperative trade policies can be modelled as the initial stage of our economy (Stage 0). Taking an arbitrary, previously determined set of trade agreements as given, we develop a novel approach for studying the readjustment of trade policies worldwide triggered by economic disintegration. The approach relies on a small set of well-known assumptions on countries' welfare functions that our tax policy model of Section 2 fulfills.

Trade costs between two countries $\tilde{\tau}_{ij} = t_{ij} + \tau_{ij}$ include tariffs t_{ij} (trade taxes) and non-tariff trade costs τ_{ij}.[10] As in the previous section, non-tariff trade costs entail local characteristics (such as geographical frictions) and non-tariff trade policies (such as environmental protection and product standards) that do not have government revenue effects. To a certain extent, governments can, however, negotiate over these in an economic union. We allow tariff and non-tariff policies to differ across countries (or country groups), and use EU, l, and $Rest$ to denote the economic union, the leaving country, and the rest of the world, respectively, and TA as indicator for a set of countries linked through a trade agreement. We define the vector of tariffs as

$$\boldsymbol{t} = \left(\boldsymbol{t_{EU,EU}}, \boldsymbol{t_{EU,l}}, \boldsymbol{t_{EU,TA}}, \boldsymbol{t_{l,TA}}, \boldsymbol{t_{TA,TA}}, \boldsymbol{t_{Rest}}\right),$$

where the vector $\boldsymbol{t_{EU,TA}} = (\boldsymbol{t}_{\boldsymbol{EU},TA}, \boldsymbol{t}_{EU,\boldsymbol{TA}})$, for instance, contains all external tariffs, $\boldsymbol{t}_{\boldsymbol{EU},TA}$, the economic union (e.g., the European Union) sets vis-à-vis TA-countries (e.g., the WTO) and, vice versa, $\boldsymbol{t}_{EU,\boldsymbol{TA}}$ denotes TA's tariffs towards the economic union. Similarly, the vector of non-tariff trade policies can be denoted as

$$\boldsymbol{\tau} = \left(\boldsymbol{\tau_{EU,EU}}, \boldsymbol{\tau_{EU,l}}, \boldsymbol{\tau_{EU,TA}}, \boldsymbol{\tau_{l,TA}}, \boldsymbol{\tau_{TA,TA}}, \boldsymbol{\tau_{Rest}}\right).$$

In this section, we consider economic disintegration as the departure of one country from an

[10]This definition of trade costs also allows us to incorporate tariffs (that affect government revenues) into our model of Section 2 (see Section (4.1) in the Online Appendix).

economic union (e.g., soft Brexit) and a customs union (e.g., hard Brexit). We refer to an economic union as a set of countries that form a customs union and cooperatively set their internal non-tariff policies. These include internal non-tariff barriers to trade and their degree of harmonization in production standards and regulations. A customs union is defined, as usual, by a set of countries that jointly negotiate their common external tariffs.

We analyze the effects on trade policies around the world in response to disintegration: How do (non-tariff) trade policies inside the union change, and how do these affect endogenous tax policies in turn? How are regional trade agreements between the economic union and third countries affected? What are the effects on TAs between the leaving country and third countries?

Readjustment of Tariffs and Non-Tariff Trade Policies. To answer these questions, we develop a novel approach for the study of trade policies. 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 from the leaving country's perspective. 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.[11] Our approach considers trade policies before (labeled as "old" optimum) and after the disintegration ("new" optimum). The strength of our approach is that it only relies on the following assumption.

Assumption 2. *A rise in bilateral trade costs between two countries raises welfare in third countries:* $\frac{dW_k}{d\tau_{ij}} > 0$ *and* $\frac{dW_k}{dt_{ij}} > 0$.

In the Online Appendix we show that in our model, as described in Section 2.3, Assumption 2 is fulfilled given positive business taxes, small trade taxes, and sufficiently similar trade costs. The

[11] 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 Single European Act (SEA) of 1987 to facilitate trade and commerce in the union, whereas the setting of business tax policies has so far been independent (due to unanimity requirements in tax matters at the EU level). The SEA 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.

proof employs the optimality of a country's business taxes and the Nash equilibrium comparative statics to capture the impact of other countries' adjustment in tax policies on a country's welfare.

Lemma 2. *Consider the subgame-perfect equilibrium of economy* $\mathscr{E}$ *with* $\overline{F}^{ij} = -\underline{F}_{ij}$ *for all* i, j. *For positive business taxes, similar trade costs, and small tariffs, Assumption 2 holds.*

This result has an intuitive appeal. It means that any protective measure (i.e., tariffs t_{ij} as well as non-tariff barriers summarized in τ_{ij}) 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 taxes of the two countries can compensate for this. Firms move to the third country, and prices decline there. This price effect raises welfare.

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 countries' welfare. It may result in bilateral opportunism (as in Bagwell and Staiger (2004)). The assumption, therefore, does not rely on a specific model. For instance, it may include dynamic, anticipatory, and general equilibrium effects. We now present our approach.

Definition 2. Assume that each government optimization problem is concave and solutions are interior.[12] Moreover, suppose that trade policy changes are small. Then, we can describe our approach as a four-step procedure:

(1) Approximate the respective objective function (e.g., countries' joint welfare in a trade agreement) in the new optimum around the old optimum.

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

(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.

[12] To gain an intuition for why solutions are interior, consider, for instance, the multilateral negotiation of bilateral non-tariff trade costs, τ_{mn}, inside a union. On the one hand, a rise in τ_{mn} may reduce welfare in countries m and n. On the other hand, other member countries inside the union benefit from a higher τ_{mn} (Assumption 2 and Lemma 2). As a result, there is a trade-off when choosing τ_{mn} to maximize joint welfare.

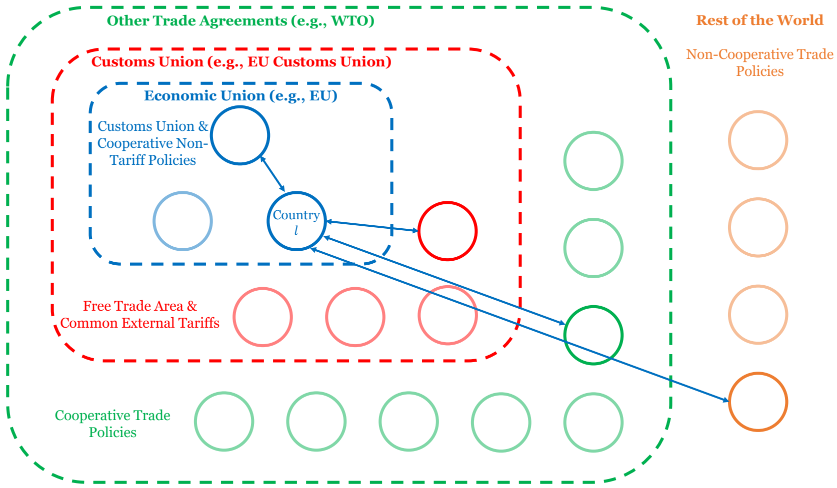

Figure 2: Old Optimum (Country l Member of Economic Union).

What is the effect on trade policies when one country l (e.g., the UK) leaves an economic or a customs 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 (the customs union, respectively) 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 the described 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.

In Figure 2, we visualize an "old" optimum, where country l is part of an economic union. Alternatively, one could draw a similar figure if country l is only part of the customs union (but not the economic union) initially. In Figure 3, we depict the "new" optimum. In the upper panel, country l leaves an economic union but remains in the customs union. The lower panel represents country l's departure from the customs union.

Using the described four-step procedure, we compare cooperative and non-cooperatively chosen trade policies in the old optimum to those in the new optimum, as in Figure 3. We summarize the insights from our approach in Proposition 7. For a more detailed exposition, we refer to the Online Appendix.

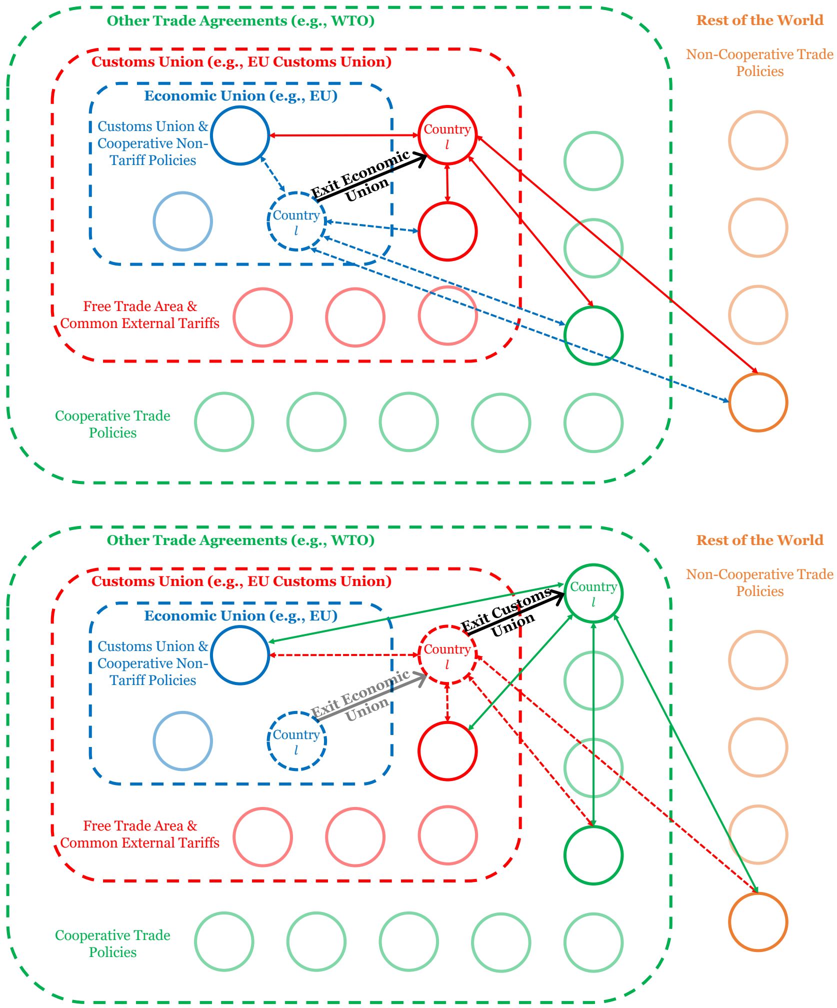

Figure 3: New Optimum; Upper Panel: Exit by Country l from an Economic Union; Lower Panel: Exit by Country l from a Customs Union

Proposition 7 (endogenous trade policy responses to disintegration)**.** *Let Assumption 2 hold.*

(a) Suppose countries l and $\mathscr{K}_{EU}$ initially form an economic union (old optimum), where member countries bargain their internal non-tariff trade policies $(\boldsymbol{\tau}_{\boldsymbol{EU,EU}}, \boldsymbol{\tau}_{\boldsymbol{EU,l}})$. *When country l disintegrates from the economic union (new optimum), the remaining member countries integrate more with each other (lower non-tariff trade costs). That is,* $\boldsymbol{\tau}^{new}_{\boldsymbol{EU,EU}} < \boldsymbol{\tau}^{old}_{\boldsymbol{EU,EU}}$.

(b) Suppose countries l and $\mathscr{K}_{EU}$ initially form a customs union (old optimum). When country l leaves the customs union (new optimum), the leaving country lowers cooperative and non-cooperative tariffs toward third countries. Likewise, cooperative and non-cooperative tariffs by the customs vis-à-vis third countries decline. Hence, $\boldsymbol{t}^{new}_{\boldsymbol{EU,TA}} < \boldsymbol{t}^{old}_{\boldsymbol{EU,TA}}$, $\boldsymbol{t}^{new}_{\boldsymbol{l,TA}} < \boldsymbol{t}^{old}_{\boldsymbol{l,TA}}$, $\boldsymbol{t}^{new}_{\boldsymbol{EU},Rest} < \boldsymbol{t}^{old}_{\boldsymbol{EU},Rest}$, *and* $\boldsymbol{t}^{new}_{\boldsymbol{l},Rest} < \boldsymbol{t}^{old}_{\boldsymbol{l},Rest}$.

In summary, the remaining member countries take efforts to lower their internal non-tariff barriers to trade. When the leaving country also exits the customs union, the union member countries lower cooperatively and non-cooperatively set trade barriers toward third countries. For instance, the EU member countries and the US that are part of the WTO decrease their bilateral tariffs after Brexit. Moreover, the EU members implement lower tariffs toward non-WTO member countries, such as Ethiopia. Similarly, trade barriers between the UK and the US decline after Brexit. The UK also lowers tariffs toward non-WTO members. 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.

Repercussions on Tax Policies. In Section 2, we have only dealt with the effects of exogenously driven economic disintegration on tax policies. As we describe in this section, economic disintegration also affects endogenously formed trade policies worldwide. In other words, disintegration affects the formation of trade policies in the initial stage of our economy $\mathscr{E}$ (Stage 0). For instance, when a country leaves an economic union and stays in the customs union (e.g., soft Brexit), the trade-cost effect in Proposition 5 needs to be augmented by the readjustment of non-tariff trade costs as follows.

Corollary 1 (augmented trade-cost effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$. Let trade costs between the leaving and the remaining countries be sufficiently similar initially. Suppose that country $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$ disintegrates from an economic union formed by countries $m \in \mathscr{K}_{EU}$ with $K_{EU} \geq 2$. Then, the disintegration of country l via a rise in trade costs vis-á-vis member countries and via a reduction in trade costs inside the remaining union (by Proposition 7)*

(*a*) *decreases the leaving country's business tax, as long as its population is not too large relative to $\overline{n}_{EU}$,*

(*b*) *increases taxes in the remaining member countries under symmetric population sizes and can have asymmetric effects under considerable asymmetries in market sizes, and*

(*c*) *lowers taxes in third countries ($\mathscr{K} \setminus (\mathscr{K}_{EU} \cup l)$) if the leaving country's market size is not too large relative to the economic union.*

The statement about the impact on the leaving country's (e.g., UK's) business tax remains qualitatively unchanged (part (*a*)). However, the endogenous reduction in non-tariff trade costs inside the economic union puts additional downward pressure on the leaving country's business tax, making a reduction in its tax more likely. Mathematically, the set of n_l-values, for which the leaving country's tax declines, expands.

As before, the business taxes' reactions inside the remaining economic union (e.g., Germany, France,...) may be asymmetric. Having said this, under symmetric population sizes, the response of taxes inside the union will be positive (part (*b*)). The reason is that the endogenous decline in internal trade costs makes the economic union more attractive as a business location raising member countries' ability to tax.

Third countries (e.g., the US, China,...) may now experience a decline in their business taxes (part (*c*)). On the one hand, trade barriers between the member countries and the leaving countries rise, which increases third countries' taxes (Proposition 5). On the other hand, the adjustment in member countries' trade policies lowers third countries' attractiveness as a business location. If the economic union is large enough relative to the leaving country, the latter effect dominates the former, leading to lower taxes in third countries.

Readjustment of Harmonization. Above, we have dealt with endogenously determined trade costs, which affect unit costs of international trade. As noted in the model developed above, another policy dimension 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. That is, member countries efficiently bargain over the harmonization of production standards and business regulations, denoted as $\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}$ and, therefore, indirectly over firm mobility inside the union. Observe that this setting applies more broadly to a country's exit from a multilateral institution that aims for common production standards and regulations, such as environmental protection. Similar to Assumption 2, we state

Assumption 3 regarding the degree of harmonization.

Assumption 3. *A reduction in the degree of harmonization in production standards and business regulations between two countries raises third countries' welfare:* $\frac{dW_k}{d\overline{F}^{ij}} > 0$.

Intuitively, Assumption 3 means that a reduction in the degree of harmonization inside the economic union is beneficial to the leaving country. In our model, such a reduction occurs as a mean-preserving spread in country-pair specific relocation cost distributions of member countries. This spread makes tax bases inside the economic union less elastic. The resulting rise in taxes 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 Assumption 3 in our three-country economy with non-negative taxes and sufficiently similar relocation cost distributions (see Online Appendix). Similar to above, the proof applies an Envelope condition and the comparative statics of Nash equilibrium taxes in Section 2.

Lemma 3. *Consider the subgame-perfect equilibrium of the three-country economy* $\mathscr{E}$. *For non-negative taxes, similar trade costs, and similar relocation costs, Assumption 3 holds.*

Again, Assumption 3 holds in a more general class of models that may, for instance, feature dynamic and general equilibrium effects. Using our approach, one can observe that the remaining member countries harmonize more with each other in response to the leaving country's disintegration. In our model, firms become more mobile inside the economic union compared to the pre-disintegration policy. We summarize this finding in Proposition 8 and, again, relegate the proof to the Online Appendix.

Proposition 8 (endogenous harmonization responses to disintegration)**.** *Suppose that, initially, countries* l *and* $\mathscr{K}_{EU}$ *form an economic union or a multilateral institution (old optimum). In the new optimum, country* l *disintegrates from the economic union (the multilateral institution). Let Assumption 3 hold. Then, in the new optimum, the member countries harmonize more with each other in terms of production standards and business regulations. That is,* $\overline{\boldsymbol{F}}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}} < \overline{\boldsymbol{F}}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}$.

Altogether, the countries inside an economic union harmonize more with each other in terms of their production standards and business regulations in response to a former member country's exit.

Concerning our tax policy model in Section 2, this readjustment of harmonization puts downward pressure on the leaving country's business tax. The remaining member countries experience a rise in their attractiveness to businesses and, therefore, can tax more.

Normative Implications. As a byproduct of our above analysis, one can note that the normative implications of economic disintegration are generally ambiguous. 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 country leaving an economic union. 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. On the contrary, 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.

These findings hold 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. Therefore, its normative implications may be far from obvious, even if one considers only first-order effects, which we address in our approach.

Endogenous Entry into the Economic Union. Another interesting question is whether a country l's disintegration from an economic union makes third countries less likely to enter the union. A candidate country $n \in \mathscr{K} \setminus \{\mathscr{K}_{EU} \cup l\}$ enters the economic union as long as welfare from entering is higher than from not entering $W_n^{entry} + \kappa_n > W_n^{no\ entry}$, where $\kappa_n \sim P(\kappa_n)$ is a country-specific taste shock from entering the union. When country l disintegrates, trade costs between the leaving and the member countries rise, whereas, by Proposition 7, those between member countries decline. The question is whether these changes in trade costs ultimately lower the probability that the candidate country n wants to join the economic union $1 - P(W_n^{no\ entry} - W_n^{entry})$ (absent of any accession criteria imposed on candidate countries by member countries).

For simplicity, suppose that countries are symmetric in their population sizes and trade costs and that tariffs are negligible. Observe that, by Proposition 5 (a), country n's business tax is ceteris paribus higher when it joins the economic union than when it does not. The changes in trade costs have, now, two opposing effects on the probability of entry. On the one hand, a rise in trade costs between the leaving and the remaining union members makes country n relatively more attractive as a business location. As firms move into that country, the gain that country n can realize from joining the union by being able to tax more increases. On the other hand, the reduction in trade costs that member countries implement inside the union after the leaving country's exit reduces the equilibrium number of firms in country n. As a result, the candidate country's gain from joining the union to raise the business tax declines. If the economic union is not too small ($K_{EU} > 3$), the latter effect dominates the former one. Altogether, the leaving country's disintegration from an economic union does not make third countries' entry into the union less likely per se. It is the endogenous trade policy response of the remaining member countries that does.

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 of an economic union take further steps towards the economic integration of their internal market when being confronted with the disintegration of a former member. After the disintegration from a customs union, 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 a 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 union. Without imposing more structure on the underlying economy, it is a priori unclear whether countries breach (form) existing (new) TAs.

4 Conclusion

In this paper, we develop a novel approach for studying the effects of economic disintegration on trade policies. We have considered the departure of a country from an economic or a customs union. Our first contribution is to show the effects of disintegration by one country on trade policies worldwide. In reaction to the disintegration from a customs union, the leaving and the remaining member countries deepen their trade agreements with other countries. Moreover, the remaining member countries take efforts to integrate further with each other after the exit from an economic union. As a consequence, the welfare implications of economic disintegration are non-trivial. In our approach, we can also address the disintegration from multilateral institutions. A limitation of our approach is that it can only address small policy changes. To consider large changes, 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. Another restriction is that we hold trade agreements fixed and cannot address the formation of new trade agreements after the disintegration.

A second contribution is the development of an analytically tractable, multi-sector, and multi-country general equilibrium trade model in which a continuum of internationally mobile firms generates fiscal competition over business taxes. Thereby, the elasticity of firm relocation is a sufficient statistic for the optimal tax 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 is introduced, here modeled as a bilateral location choice by one firm per industry. As a result, the whole economic structure influences domestic policies in each country.

An important lesson from our approach is that the analysis of only two countries is potentially misleading when studying the effects of 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 taxes 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. Our model's main advantage is that we can address both small and large changes without restricting attention to a specific type of economic disintegration. Our leading example is a country's departure from an economic union. As we have seen, such an economic disintegration may have different forms of appearance. An important dimension is that economic disintegration raises bilateral trade costs, which triggers a trade-cost effect on business taxes. When one country leaves an economic union, we predict taxes to decline in that country. The effects on taxes 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 taxes induced by local business tax differentials.

We have also dealt with the consequences of a lower degree of harmonization in regulations 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, taxes increase as the costs of firm relocation rise (de-harmonization effect). 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.

Besides, we identify a business-friction effect that adversely affects the leaving country's ability to tax and enables the other countries to tax more. 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 taxes worldwide (union-size effect). As above, the tax of the leaving country declines.

Altogether, economic disintegration may affect the underlying economic structure along very distinct dimensions. In particular, it is not only associated with a change of the bilateral costs of trade but also of other parameters of the economy (e.g., the conditions of firm mobility). As we show, these can have different policy implications. Neglecting some of these dimensions in empirical and quantitative work may, therefore, lead to biased conclusions.

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 taxes 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 of the leaving country declines even further, while it improves the ability of member countries to tax firms (migration effect). 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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Online Appendix for "A Theory of Economic Disintegration"*

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Abstract

This is the Online Appendix for "A Theory of Economic Disintegration" by Janeba and Schulz (2020). In Section 1, we formalize the three-country model and derive the trade-cost effect. In Section 2, we characterize the de-harmonization effect, the business-friction, and the migration effect. Section 3 extends our analysis to K countries and proves the trade-cost effect and the union-size effect. In Section 4, we demonstrate various extensions to our model. In Section 5, we endogenize trade policies in the degree of economic integration.

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Contents

1 Proofs for Section 2.1

1.1 Derivation of Optimal Taxes

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

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

$$p_i^{jk}(\mu) = \begin{cases} \frac{\alpha+3w+2\tau_{ij}+\tau_{ik}}{4} & if\, F^{jk} \geq \gamma^{jk} \\ \frac{\alpha+3w+\tau_{ij}+2\tau_{ik}}{4} & if\, F^{jk} < \gamma^{jk}, \end{cases} \quad (1)$$

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 $j,k \in \mathscr{K} \setminus \{i\}$. In general, prices are lower in a country if a mobile firm locates there due to high relative setup costs in the other country because trade costs are saved. 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

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

The first-order condition with respect to the business tax (wage income is constant)

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

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

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

Country i's reaction function is therefore given by

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

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

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

1.2 Proof of Proposition 1

By differentiating Equation 5[1], and using our assumption of non-negative trade flows, $\tau_{ij} \leq \frac{\alpha-w}{3}$ for all i, j, Lemma 1 follows.

Lemma 1. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K = 3$ countries. For any $i, j, k \in \mathscr{K}$ the following Nash equilibrium comparative statics hold for t_i*

(a) with respect to country sizes

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

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

and

(b) with respect to trade costs

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

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

By summing up the expressions in part (b) of Lemma 1, we obtain Corollary 1.

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

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

[1]If not stated otherwise, the equation numbering relates to the equations in this Online Appendix and not to those in the paper.

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

and

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

Proposition 1 also trivially follows from Lemma 1.

Proposition 1 (trade-cost effect)**.** *Consider the subgame-perfect equilibrium of economy $\mathscr{E}$ with $K=3$. Let $\tau_{ik}=\tau_{jk}$. Then, the disintegration of country k via a rise in bilateral trade costs with countries i and j has the following tax effects*

(a)

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

and

(b)

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

Under symmetric population sizes of all three countries, the disintegration reduces taxes in all countries.

Observe that the assumption of identical trade costs, $\tau_{ik}=\tau_{jk}$, is not very restrictive. In particular, the insights about the role of market sizes remain unchanged. For $\tau_{ik}\neq\tau_{jk}$, the signs of the comparative statics are as follows

$$sign\left(\frac{dt_i}{d\tau_{ik}} + \frac{dt_i}{d\tau_{jk}}\right) = sign\left(3n_j + n_i - 6n_k + 3\left(n_j+n_k\right)\frac{\tau_{ik}-\tau_{jk}}{\alpha - w - \tau_{ik}}\right) \tag{6}$$

and

$$sign\left(\frac{dt_k}{d\tau_{ik}} + \frac{dt_k}{d\tau_{jk}}\right) = sign\left(2n_k - 9n_i - 9n_j + \left(n_k - 9n_j\right)\frac{\tau_{ik}-\tau_{jk}}{\alpha - w - \tau_{ik}}\right). \tag{7}$$

The correction term on the right side of the two previous lines adjusts for asymmetries in trade costs. Using the assumption on the primitives that ensure positive consumption choices, $\tau_{ij} \in \left[0, \frac{\alpha-w}{3}\right]$, one may evaluate the adjustment's magnitude: $\left|\frac{\tau_{ik}-\tau_{jk}}{\alpha-w-\tau_{ik}}\right| \in \left[0, \frac{1}{2}\right]$. Therefore, even for large asymmetries in trade costs, the adjustment term is comparably small. The central intuitions carry over.

2 Proofs for Section 2.2

2.1 Proof of Proposition 2

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

$$\frac{d\left(S_i+T_i\right)}{dt_i} = \Delta_i^{ij}\frac{d\gamma^{ij}}{dt_i}g^{ij}\left(\gamma^{ij}\right)+\Delta_i^{ki}\frac{d\gamma^{ki}}{dt_i}g^{ki}\left(\gamma^{ki}\right)+3-G^{ij}\left(\gamma^{ij}\right)+G^{ki}\left(\gamma^{ki}\right)+t_i\left(-g^{ij}\left(\gamma^{ij}\right)\frac{d\gamma^{ij}}{dt_i}+g^{ki}\left(\gamma^{ki}\right)\frac{d\gamma^{ki}}{dt_i}\right)=0 \tag{8}$$

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 (country sizes and trade costs) 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 business tax

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

Now, recalling $\overline{F}^{ij} = \overline{\epsilon}^{ij}+\overline{\epsilon}$, take derivatives

$$\begin{aligned}\frac{dt_i}{d\overline{\epsilon}^{ij}} = \sigma^{-1}3\overline{F}^{ki}\Big(&-3\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^3+13\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^2\overline{F}^{ki}+21\left(\overline{F}^{ij}\right)^2\overline{F}^{jk}\left(\overline{F}^{ki}\right)^2+9\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{ki}\right)^3+42\overline{F}^{ij}\left(\overline{F}^{jk}\right)^3\overline{F}^{ki}\\&+60\overline{F}^{ij}\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^2+18\overline{F}^{ij}\overline{F}^{jk}\left(\overline{F}^{ki}\right)^3+24\left(\overline{F}^{jk}\right)^4\overline{F}^{ki}+45\left(\overline{F}^{jk}\right)^3\left(\overline{F}^{ki}\right)^2+21\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^3\Big)\end{aligned} \tag{10}$$

and

$$\frac{dt_i}{d\epsilon^{jk}} = \sigma^{-1}3\overline{F}^{ij}\overline{F}^{ki}\Big(12\left(\overline{F}^{ij}\right)^3\overline{F}^{ki} + 3\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{jk}\right)^2 + 30\left(\overline{F}^{ij}\right)^2\overline{F}^{jk}\overline{F}^{ki} + 21\left(\overline{F}^{ij}\right)^2\left(\overline{F}^{ki}\right)^2$$
$$+14\overline{F}^{ij}\left(\overline{F}^{jk}\right)^2\overline{F}^{ki} + 30\overline{F}^{ij}\overline{F}^{jk}\left(\overline{F}^{ki}\right)^2 + 12\overline{F}^{ij}\left(\overline{F}^{ki}\right)^3 + 3\left(\overline{F}^{jk}\right)^2\left(\overline{F}^{ki}\right)^2\Big) \tag{11}$$

where

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

Proposition 2 follows.

Proposition 2 (de-harmonization effect)**.** *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K = 3$ countries. 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 $i, j, k \in \mathscr{K}$.*

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

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

Therefore, $\frac{dt_i}{d\epsilon^{jk}}$ is always positive. The sign of $\frac{dt_i}{d\epsilon^{ij}}$ (by a resembling argument, the sign of $\frac{dt_i}{d\epsilon^{ki}}$) 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 $\overline{F}^{ij} \approx 0$, or for $\overline{F}^{jk} \approx 0$, $\frac{dt_i}{d\epsilon^{ij}} > 0$. Indeed, there exists is a set 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 j form an economic union (i.e., $\overline{F}^{jk} = \overline{F}^{ki} \geq \overline{F}^{ij}$) and that k disintegrates. Then, t_k increases because $\frac{dt_j}{d\epsilon^{jk}} + \frac{dt_j}{d\epsilon^{ki}} > 0$. It is easy to see that the business tax in any member country i increases as well. I.e., $\frac{dt_i}{d\epsilon^{jk}} + \frac{dt_i}{d\epsilon^{ki}} > 0$ for $\overline{F}^{jk} = \overline{F}^{ki}$.

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. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K = 3$ countries. Under the symmetry assumptions of Proposition 2, average taxes between any two and among all three countries increase with a reduction in harmonization, that is, for any $i, j, k \in \mathscr{K}$,*

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

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

and

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

2.2 Proof of Proposition 3

Again, the first-order condition of the social planner in country i is described by Equation (8). Then, using $\overline{F}^{ij} - \underline{F}^{ij} = \overline{F}^{jk} - \underline{F}^{jk} = \overline{F}^{ki} - \underline{F}^{ki}$, the reaction function in country i reads as

$$t_i = \frac{1}{4}\left(\Delta_i^{ij} - \Delta_i^{ki} + 3\overline{F} - 3\underline{F} + \pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki} + t_j + t_k + \nu^{ij} - \nu^{ki}\right). \tag{12}$$

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

$$t_i = \frac{3}{2}\left(\overline{F} - \underline{F}\right) + \frac{3}{10}\left(\Delta_i^{ij} - \Delta_i^{ki}\right) + \frac{1}{10}\left(\Delta_j^{jk} - \Delta_j^{ij}\right) + \frac{1}{10}\left(\Delta_k^{ki} - \Delta_k^{jk}\right) + \frac{1}{5}\left(\pi_i^{ij} + \pi_i^{ki} - \pi_j^{ij} - \pi_k^{ki} + \nu^{ij} - \nu^{ki}\right). \tag{13}$$

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 $\frac{dt_i}{d\nu^{jk}} = 0$. Proposition 3 follows.

Proposition 3 (business-friction effect)**.** *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K = 3$ countries. For any $i, j, k \in \mathscr{K}$ $\frac{dt_i}{d\nu^{ij}} > 0$, $\frac{dt_i}{d\nu^{ki}} < 0$, and $\frac{dt_i}{d\nu^{jk}} = 0$.*

2.3 Proof of Proposition 4

Proposition 4 follows from the comparative statics of Lemma 1.

Proposition 4 (migration effect)**.** *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K = 3$ countries. For any $i, j, k \in \mathscr{K}$ one can derive the following Nash 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 an integrated area raises taxes inside the area and lowers the tax outside.

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

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

(*a*)

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

and

(*b*)

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

3 Proofs for Section 2.3

3.1 The K-Country Model in Section 2.3

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

$$\pi_i^{ij}(\mu) = \begin{cases} \frac{n_i(\alpha-w+\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-2\tau_{ij})^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} \frac{n_l\left(\alpha-w-2\tau_{il}+\tau_{jl}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, i \\ \frac{n_i(\alpha-w+2\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-3\tau_{ij})^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} \frac{n_l\left(\alpha-w-3\tau_{il}+2\tau_{jl}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, j. \end{cases} \tag{14}$$

The mobile firm locates in country i if and only if

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

Again, simplifying the industry threshold becomes

$$\gamma^{ij} = (n_j - n_i)\frac{6\tau_{ij}(\alpha-w) - 3\tau_{ij}^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l(\tau_{il} - \tau_{jl})\frac{6(\alpha-w) - 3(\tau_{il}+\tau_{jl})}{16\beta} + t_i - t_j \tag{15}$$

and we derive partial equilibrium comparative statics as

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

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

$$\frac{d\gamma^{ij}}{d\tau_{ij}} = (n_j - n_i)\frac{3(\alpha - w - \tau_{ij})}{8\beta},$$

$$\frac{d\gamma^{ij}}{d\tau_{il}} = n_l\frac{3(\alpha - w - \tau_{il})}{8\beta},$$

and

$$\frac{d\gamma^{ij}}{d\tau_{jl}} = -n_l\frac{3(\alpha - w - \tau_{jl})}{8\beta}$$

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

Since there are K countries, one has to consider $\begin{pmatrix} K \\ 2 \end{pmatrix} = \frac{K(K-1)}{2}$ continuums of industries yielding $K(K-1)$ different prices. These read as

$$p_i^{ij}(\mu) = \frac{\alpha + 3w + k_j^*(\mu)\tau_{ij}}{4} \tag{16}$$

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

$$p_i^{jl}(\mu) = \frac{\alpha + 3w + k_j^*(\mu)\tau_{ij} + k_l^*(\mu)\tau_{il}}{4} \tag{17}$$

for $\left(k_j^*(\mu), k_l^*(\mu)\right) \in \{(1,2), (2,1)\}$ 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

$$\begin{aligned} S_i^{ij}(\mu) &= n_i \left(\alpha x_i^{ij}(\mu) - \frac{\beta}{2}\left(x_i^{ij}(\mu)\right)^2 - p_i^{ij}(\mu)\, x_i^{ij}(\mu)\right) \\ &= \begin{cases} n_i \frac{(3\alpha - 3w - \tau_{ij})^2}{32\beta} & \textit{w/ prob } \left(1 - G\left(\gamma^{ij}\right)\right) \\ n_i \frac{(3\alpha - 3w - 2\tau_{ij})^2}{32\beta} & \textit{w/ prob } G\left(\gamma^{ij}\right), \end{cases} \end{aligned} \tag{18}$$

whereas consumer surplus in the jl-industries reads as

$$\begin{aligned} S_i^{jl}(\mu) &= n_i \left(\alpha x_i^{jl}(\mu) - \frac{\beta}{2}\left(x_i^{jl}(\mu)\right)^2 - p_i^{jl}(\mu)\, x_i^{jl}(\mu)\right) \\ &= \begin{cases} n_i \frac{(3\alpha - 3w - 2\tau_{ij} - \tau_{il})^2}{32\beta} & \textit{w/ prob } \left(1 - G\left(\gamma^{jl}\right)\right) \\ n_i \frac{(3\alpha - 3w - \tau_{ij} - 2\tau_{il})^2}{32\beta} & \textit{w/ prob } G\left(\gamma^{jl}\right). \end{cases} \end{aligned} \tag{19}$$

Summing over industries gives 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 applied to avoid double count. Therefore, consumer surplus in country i can be written as

$$
S_i = \sum_{j \in \mathscr{K} \setminus \{i\}} \left[\delta_i^{ij} + \frac{\gamma^{ij} - \underline{F}}{2\overline{F}} \Delta_i^{ij} \right] + \frac{1}{2} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{l \in \mathscr{K} \setminus \{i,j\}} \left[\delta_i^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_i^{jl} \right] \tag{20}
$$

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

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

where

$$
T_i = t_i \left[(K - 1) + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\overline{F} - \gamma^{ij} \right) \right]. \tag{21}
$$

The first-order condition is given by

$$\frac{d\left(S_i+T_i\right)}{dt_i}=\frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\setminus\{i\}}\frac{d\gamma^{ij}}{dt_i}\Delta_i^{ij}+(K-1)+\frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\setminus\{i\}}\left(\overline{F}-\gamma^{ij}\right)+t_i\frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\setminus\{i\}}\left(-\frac{d\gamma^{ij}}{dt_i}\right)=0 \quad (22)$$

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

$$t_i=\frac{1}{2\left(K-1\right)}\left(\sum_{j\in\mathscr{K}\setminus\{i\}}\Delta_i^{ij}+3\overline{F}\left(K-1\right)+\sum_{j\in\mathscr{K}\setminus\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right)+\sum_{j\in\mathscr{K}\setminus\{i\}}t_j\right). \quad (23)$$

Again, business taxes 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

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

Then, notice that

$$
\sum_{j\in\mathscr{K}}\sum_{m\in\mathscr{K}\backslash\{j\}}\left(\pi_m^{jm}-\pi_j^{jm}\right) = \sum_{j}\sum_{m>j}\left(\pi_m^{jm}-\pi_j^{jm}\right) - \sum_{j}\sum_{m>j}\left(\pi_m^{jm}-\pi_j^{jm}\right) = 0 \tag{24}
$$

to obtain Lemma 3.

Lemma 3. *Consider economy $\mathscr{E}$ with K countries. Suppose that $\overline{F} = -\underline{F}$. Then, the subgame-perfect Nash equilibrium of the tax competition game is given by*

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

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

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

$$
\pi_i^{ij} - \pi_j^{ij} = (n_i - n_j)\,\frac{6\tau_{ij}(\alpha-w) - 3\tau_{ij}^2}{16\beta} - \sum_{l\in\mathscr{K}\backslash\{i,j\}} n_l\,\frac{6(\alpha-w)(\tau_{il}-\tau_{jl}) - 3\left(\tau_{il}^2-\tau_{jl}^2\right)}{16\beta}, \tag{25}
$$

differentiation with respect to trade costs yields

$$
\begin{aligned}
\frac{d\left(\pi_i^{ij}-\pi_j^{ij}\right)}{d\tau_{ij}} &= 6\left(n_i-n_j\right)\frac{\alpha-w-\tau_{ij}}{16\beta}\begin{cases}>0 & for\ n_i>n_j\\ <0 & for\ n_i<n_j\end{cases}\\
\frac{d\left(\pi_i^{ij}-\pi_j^{ij}\right)}{d\tau_{il}} &= -6n_l\frac{\alpha-w-\tau_{il}}{16\beta}<0 \\
\frac{d\left(\pi_i^{ij}-\pi_j^{ij}\right)}{d\tau_{jl}} &= 6n_l\frac{\alpha-w-\tau_{jl}}{16\beta}>0
\end{aligned} \tag{26}
$$

and

$$
\begin{aligned}
\frac{d\left(\pi_i^{il}-\pi_l^{il}\right)}{d\tau_{il}} &= 6\left(n_i-n_l\right)\frac{\alpha-w-\tau_{il}}{16\beta}\begin{cases}>0 & for\ n_i>n_l\\ <0 & for\ n_i<n_l\end{cases}\\
\frac{d\left(\pi_i^{il}-\pi_l^{il}\right)}{d\tau_{ij}} &= -6n_j\frac{\alpha-w-\tau_{ij}}{16\beta}<0 \\
\frac{d\left(\pi_i^{il}-\pi_l^{il}\right)}{d\tau_{lj}} &= 6n_j\frac{\alpha-w-\tau_{lj}}{16\beta}>0.
\end{aligned} \tag{27}
$$

It is more convenient to write t_i as

$$
t_i = 3\overline{F}+\frac{K}{(K-1)(2K-1)}\sum_{l\in\mathscr{K}\setminus\{i\}}\Delta_i^{il}+\frac{1}{2K-1}\sum_{l\in\mathscr{K}\setminus\{i\}}\left(\pi_i^{il}-\pi_l^{il}\right)+\frac{1}{(K-1)(2K-1)}\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{l\in\mathscr{K}\setminus\{j\}}\Delta_j^{jl} \tag{28}
$$

such that

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

and

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

Furthermore, since

$$t_i = 3\overline{F} + \frac{K}{(K-1)(2K-1)} 3n_i \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{\tau_{ij}^2 - 2\tau_{ij}(\alpha - w)}{32\beta}$$
$$+ \frac{1}{2K-1} \sum_{j\neq i} \left((n_i - n_j) \frac{6\tau_{ij}(\alpha - w) - 3\tau_{ij}^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l \frac{6(\alpha - w)(\tau_{jl} - \tau_{il}) - 3\left(\tau_{jl}^2 - \tau_{il}^2\right)}{16\beta} \right)$$
$$+ \frac{1}{(K-1)(2K-1)} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{m\in\mathscr{K}\setminus\{j\}} 3n_j \frac{\tau_{jm}^2 - 2\tau_{jm}(\alpha - w)}{32\beta}, \tag{29}$$

comparative statics with respect to market size are

$$\frac{dt_i}{dn_i} = \frac{K}{(K-1)(2K-1)} 3 \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{\tau_{ij}^2 - 2\tau_{ij}(\alpha - w)}{32\beta}$$
$$+ \frac{1}{2K-1} \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{6\tau_{ij}(\alpha - w) - 3\tau_{ij}^2}{16\beta}$$
$$= \frac{K-2}{(K-1)(2K-1)} 3 \sum_{j\in\mathscr{K}\setminus\{i\}} \tau_{ij} \frac{2(\alpha - w) - \tau_{ij}}{32\beta} \tag{30}$$

and

$$\frac{dt_i}{dn_k} = \frac{-1}{2K-1} \frac{6\tau_{ik}(\alpha - w) - 3\tau_{ik}^2}{16\beta}$$
$$+ \frac{1}{2K-1} \sum_{j\in\mathscr{K}\setminus\{i,k\}} \frac{6(\alpha - w)(\tau_{jk} - \tau_{ik}) - 3\left(\tau_{jk}^2 - \tau_{ik}^2\right)}{16\beta}$$
$$+ \frac{1}{(K-1)(2K-1)} \sum_{m\in\mathscr{K}\setminus\{k\}} 3 \frac{\tau_{km}^2 - 2\tau_{km}(\alpha - w)}{32\beta}$$
$$= -\frac{6(K-1)^2 + 3}{(K-1)(2K-1)} \frac{2\tau_{ik}(\alpha - w) - \tau_{ik}^2}{32\beta}$$
$$+ \frac{6(K-1) - 3}{(K-1)(2K-1)} \sum_{j\in\mathscr{K}\setminus\{i,k\}} \frac{2(\alpha - w)\tau_{jk} - \tau_{jk}^2}{32\beta}. \tag{31}$$

Simplify these expressions to obtain Lemma 4.

Lemma 4. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K \geq 2$ countries. Then, for any $i, j, k \in \mathscr{K}$ one can derive the following Nash equilibrium comparative statics for t_i*

(a) *with respect to country sizes*

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

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

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 the three-country setting, 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 4.

Corollary 4. *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* $i, j, k \in \mathscr{K}$

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

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

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* $i,j\in\mathscr{K}_{EU}$

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

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* $i,j\in\mathscr{K}\setminus\mathscr{K}_{EU}$

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

and

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

Part (a) of Corollary 4 is the K-country equivalent of Corollary 1. $(b)-(d)$ describe the effects of a rise in bilateral trade costs on average taxes. When trade between two member countries becomes more costly, members' taxes fall on average, whereas the average tax 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 of non-member (member) countries. 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.

3.2 Proof of Proposition 5

Similar to Proposition 1, we state Proposition 5.

Proposition 5 (trade-cost effect)**.** *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K \geq 2$ countries. Suppose that trade costs between the leaving country $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$ and countries $m \in \mathscr{K}_{EU}$ are the same, $\tau = \tau_{ml}$, $\forall m \in \mathscr{K}_{EU}$, and let country l disintegrate from the member countries. This triggers the following change in the tax of*

(a) the leaving country $l \in \mathscr{K} \backslash \mathscr{K}_{EU}$

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

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

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

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

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

and

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

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

To show Proposition 5, we use Lemma 4. For part (a), take country l which is supposed to leave, in the sense that all bilateral trade costs between 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 $\mathscr{K}_{EU}$)

$$\begin{aligned}\sum_{m \in \mathscr{K}_{EU}} \frac{dt_l}{d\tau_{ml}} &= \sum_{m \in \mathscr{K}_{EU}} \left(n_l(K-2) - 2n_m\left[(K-1)^2 + 0.5\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\ &= \left(n_l K_{EU}(K-2) - \sum_{m \in \mathscr{K}_{EU}} n_m \left[2(K-1)^2 + 1\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}. \qquad (32)\end{aligned}$$

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 business tax in country m reads as

$$\begin{aligned}\frac{dt_m}{d\tau_{ml}} + \sum_{j \in \mathscr{K}_{EU} \setminus \{m\}} \frac{dt_m}{d\tau_{jl}} &= \left(n_m(K-2) - 2n_l\left[(K-1)^2 + 0.5\right]\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\ &+ \sum_{j \in \mathscr{K}_{EU} \setminus \{m\}} (n_j + n_l) \frac{3(2K-3)}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta} \\ &= \Bigg((K-1)\left[2\sum_{j \in \mathscr{K}_{EU}} n_j - 2n_l(K - K_{EU}) - n_m\right] \\ &+ K_{EU}\left[n_l - \frac{1}{K_{EU}} \sum_{j \in \mathscr{K}_{EU}} n_j\right]\Bigg) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}. \qquad (33)\end{aligned}$$

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

$$\begin{aligned}\sum_{j\in\mathscr{K}_{EU}} \frac{dt_k}{d\tau_{jl}} &= \sum_{j\in\mathscr{K}_{EU}} (n_j + n_l)\frac{3(2K-3)}{(K-1)(2K-1)}\frac{\alpha - w - \tau}{16\beta} \\ &= \left(\frac{1}{K_{EU}}\sum_{j\in\mathscr{K}_{EU}} n_j + n_l\right)\frac{3K_{EU}(2K-3)}{(K-1)(2K-1)}\frac{\alpha - w - \tau}{16\beta} > 0. \end{aligned} \tag{34}$$

As in Proposition 1, the main insights regarding market sizes carry over when dealing with asymmetries in trade costs. The positive effect on third countries' taxes (part (c)) is fully robust to the inclusion of differing trade costs. A correction term that accounts for the asymmetries adjusts the sign in part (a) as follows:

$$\begin{aligned} sign\left(\sum_{m\in\mathscr{K}_{EU}} \frac{dt_l}{d\tau_{ml}}\right) = sign\Bigg(& n_l - \frac{2(K-1)^2+1}{K-2}\bar{n}_{EU} \\ &+ \sum_{m\in\mathscr{K}_{EU}}\left(n_l - \frac{2(K-1)^2+1}{K-2}n_m\right)\frac{\tau - \tau_{ml}}{K_{EU}(\alpha - w - \tau)}\Bigg) \end{aligned} \tag{35}$$

Again, the adjustment is comparably small since $\left|\frac{\tau-\tau_{ml}}{K_{EU}(\alpha-w-\tau)}\right| \in \left[0, \frac{1}{2K_{EU}}\right]$. The larger the cardinality of the set of countries left by country l, the more negligible is this adjustment. The correction in part (b) is less straightforward

$$\begin{aligned} sign\left(\frac{dt_m}{d\tau_{ml}} + \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}}\frac{dt_m}{d\tau_{jl}}\right) = sign\Bigg(& \frac{(2K-3)K_{EU}\bar{n}_{EU} - (K-1)n_m}{2(K-1)K - (2K-1)K_{EU}} - n_l \\ &+ \frac{3(K-2)n_m - \left[4(K-1)^2+2\right]n_l}{6(K-1)K-(6K-3)K_{EU}}\frac{\tau-\tau_{ml}}{\alpha-w-\tau} \\ &+ \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}}\frac{(6K-9)(n_j+n_l)}{6(K-1)K-(6K-3)K_{EU}}\frac{\tau-\tau_{jl}}{\alpha-w-\tau}\Bigg). \end{aligned} \tag{36}$$

The adjustment term is bounded $\left|\frac{\tau-\tau_{ml}}{\alpha-w-\tau}\frac{1}{6(K-1)K-(6K-3)K_{EU}}\right| \in \left[0, \frac{1}{6(K-1)}\right]$ and decreases in the number of countries.

In Corollary 5, we consider average effects. For this we define the world, EU, and non-EU average taxes as follows:

$$\bar{t} := \frac{1}{K} \sum_{k \in \mathscr{K}} t_k, \quad \bar{t}_{EU} := \frac{1}{K_{EU}} \sum_{k \in \mathscr{K}_{EU}} t_k, \quad \bar{t}_{nonEU} := \frac{1}{K - K_{EU} - 1} \sum_{k \in \mathscr{K} \setminus (\mathscr{K}_{EU} \cup \{l\})} t_k. \tag{37}$$

Corollary 5. *Consider the subgame-perfect Nash equilibrium of economy $\mathscr{E}$ with $K \geq 2$ countries. Suppose that trade costs between the leaving country $l \in \mathscr{K} \setminus \mathscr{K}_{EU}$ and countries $m \in \mathscr{K}_{EU}$ are the same, $\tau = \tau_{ml}$, $\forall m \in \mathscr{K}_{EU}$, and let country l disintegrate from the member countries. This disintegration triggers the following change in the average tax of*

(a) the remaining member countries

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

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

(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

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

3.3 Proof of Proposition 6

Suppose Assumption 1 holds.

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

Then, the business tax of a member country $m \in \mathscr{K}_{EU}$ simplifies to

$$t_m = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{[(K-1)(2K - 2K_{EU} + 1) + K_{EU}](K_{EU} - 1)}{(K-1)(2K-1)} 3n(\tau - \tau^*) \frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}, \tag{38}$$

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

$$t_n = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{K_{EU}(K_{EU} - 1)(2K - 3)}{(K-1)(2K-1)} 3n(\tau^* - \tau) \frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}. \tag{39}$$

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 $K_{EU} > 1$. If $K_{EU} = 1$ or $\tau^* = \tau$ (which we rule out by assumption), then $t_n = t_m$. 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, business taxes do not diverge

$$\lim_{K \to \infty} t_m = \lim_{K \to \infty} t_n + 3n(K_{EU} - 1)(\tau - \tau^*) \frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta} \tag{40}$$

where

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

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

$$\frac{dt_m}{dK_{EU}} = \frac{(K-1)[(2K-1) - 4(K_{EU} - 1)] + 2K_{EU} - 1}{(K-1)(2K-1)} 3n \left(\frac{2(\alpha - w)(\tau - \tau^*) - (\tau^2 - \tau^{*2})}{32\beta} \right). \tag{41}$$

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

$$\phi(K) \coloneqq (K-1)[(2K-1) - 4(K_{EU} - 1)] + 2K_{EU} - 1. \tag{42}$$

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

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

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

$$\frac{dt_m}{dK} = \frac{4(K-1)^2(K_{EU}-1) - K_{EU}(4K-3)}{(K-1)^2(2K-1)^2}(K_{EU}-1)\,3n_{K_{EU}}\left(\frac{2(\alpha-w)(\tau-\tau^*) - (\tau^2 - \tau^{*2})}{32\beta}\right) \tag{43}$$

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

$$\frac{dt_m}{d\tau^*} = -\frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left[(K-1)(2K-2K_{EU}+1) + K_{EU}\right](K_{EU}-1)\frac{\alpha - w - \tau^*}{32\beta} < 0 \tag{44}$$

and

$$\begin{aligned}
\frac{dt_m}{d\tau} &= 6n_{K_{EU}}\frac{\tau - (\alpha - w)}{32\beta} + \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left[(K-1)(2K-2K_{EU}+1) + K_{EU}\right](K_{EU}-1)\frac{\alpha - w - \tau}{32\beta} \\
&= \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)\left[2K(K_{EU}-2) - 2K_{EU}(K_{EU}-1) + 3K_{EU}\right] + K_{EU}(K_{EU}-1)\right\}\frac{\alpha - w - \tau}{32\beta} \\
&> \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)K_{EU}\left[2(K_{EU}-2) - 2(K_{EU}-1) + 3\right] + K_{EU}(K_{EU}-1)\right\}\frac{\alpha - w - \tau}{32\beta} \\
&= \frac{1}{(K-1)(2K-1)}6n_{K_{EU}}\left\{(K-1)K_{EU}\left[-4+2+3\right] + K_{EU}(K_{EU}-1)\right\}\frac{\alpha - w - \tau}{32\beta} > 0.
\end{aligned} \tag{45}$$

The comparative statics in part (c) of Proposition 6 are given by

$$\begin{aligned}
\frac{dt_n}{dK_{EU}} &= \frac{(2K_{EU}-1)(2K-3)}{(K-1)(2K-1)}3n(\tau^* - \tau)\frac{2(\alpha-w) - (\tau+\tau^*)}{32\beta} < 0, \\
\frac{dt_n}{dK} &= \frac{(2K-3)^2 - 2}{(K-1)^2(2K-1)^2}3nK_{EU}(K_{EU}-1)(\tau - \tau^*)\frac{2(\alpha-w) - (\tau+\tau^*)}{32\beta} > 0, \\
\frac{dt_n}{d\tau} &= 6n\frac{\tau - (\alpha - w)}{32\beta} + \frac{K_{EU}(K_{EU}-1)(2K-3)}{(K-1)(2K-1)}6n\frac{\tau - (\alpha - w)}{32\beta} < 0,
\end{aligned} \tag{46}$$

and

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

To summarize, we formulate Proposition 6.

Proposition 6 (union-size effect)**.** *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) $\frac{dt_n}{dK_{EU}} < 0$, $\frac{dt_n}{d\tau^*} > 0$, $\frac{dt_n}{d\tau} < 0$.

4 Proofs for Section 2.4

4.1 Tariff Revenues and Subsidy Expenditures

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, $\tilde{\tau}_{ij} \equiv t_{ij} + \tau_{ij} \equiv imt_{ij} + ext_{ij} + \tau_{ij}$. 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

$$X_{li}^{ij} = G\left(\gamma^{ij}\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=2}, \tag{47}$$

whereas the import volume reads as

$$M_{il}^{ij} = G\left(\gamma^{ij}\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=2}. \tag{48}$$

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

$$R_i^{ij} = \sum_{l \in \mathscr{K} \setminus \{i\}} imt_{il} M_{il}^{ij} + \sum_{l \in \mathscr{K} \setminus \{i\}} ext_{li} X_{li}^{ij}. \tag{49}$$

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

$$W_i \coloneqq S_i + T_i + n_i w + R_i. \tag{50}$$

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 business taxes

$$\begin{aligned} t_i = 3\overline{F} &+ \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \Delta_i^{ij} + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) + \frac{1}{(K-1)(2K-1)} \sum_{j \in \mathscr{K}} \sum_{m \in \mathscr{K} \setminus \{j\}} \Delta_j^{jm} \\ &+ \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{l \in \mathscr{K} \setminus \{i\}} \left[imt_{il} \left(2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2}\right) + ext_{li} \left(x_{li}^{ij}|_{k_i^{ij}=1} - 2x_{li}^{ij}|_{k_i^{ij}=2}\right)\right] \\ &+ \frac{1}{(K-1)(2K-1)} \sum_{m \in \mathscr{K}} \sum_{j \in \mathscr{K} \setminus \{m\}} \sum_{l \in \mathscr{K} \setminus \{m\}} \left[imt_{ml} \left(2x_{ml}^{mj}|_{k_m^{mj}=1} - x_{ml}^{mj}|_{k_m^{mj}=2}\right)\right] \\ &+ \frac{1}{(K-1)(2K-1)} \sum_{m \in \mathscr{K}} \sum_{j \in \mathscr{K} \setminus \{m\}} \sum_{l \in \mathscr{K} \setminus \{m\}} \left[ext_{lm} \left(x_{lm}^{mj}|_{k_m^{mj}=1} - 2x_{lm}^{mj}|_{k_m^{mj}=2}\right)\right]. \end{aligned} \tag{51}$$

Observe that for $imt_{ml} = ext_{lm} = 0 \ \forall j, m, l$ we obtain Lemma 3. The optimal business tax is, now, modified by the marginal effects of business taxation on tariff revenues through firm relocation.

Since

$$x_{li}^{ij}|_{k_i^{ij}=1} - 2x_{li}^{ij}|_{k_i^{ij}=2} = -n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} < 0 \tag{52}$$

and

$$2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2} = 1\left[j = l\right] n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} \geq 0 \tag{53}$$

taxes are revised upwards for import tariffs and export subsidies. To gain some intuition, consider a rise in the business tax 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 4) remain valid and are augmented by the effects of (non-tariff) trade costs on the marginal firm relocation effect. That is,

$$\begin{aligned} \frac{dt_i}{d\tau_{ij}}|_{\tilde{\tau}_{ij}=\tilde{\tau}_{ji}} = & \left(n_i\left(K-2\right) - 2n_j\left[\left(K-1\right)^2 + 0.5\right]\right) \frac{3}{\left(K-1\right)\left(2K-1\right)} \frac{\alpha - w - \tilde{\tau}_{ij}}{16\beta} + \\ & - \frac{1}{\left(K-1\right)\left(2K-1\right)} \frac{Kn_i imt_{ij} + n_j imt_{ji} - K\left(K-1\right) n_j ext_{ji} - \left(K-1\right) n_i ext_{ij}}{4\beta} \end{aligned} \tag{54}$$

and

$$\begin{aligned} \frac{dt_i}{d\tau_{jk}}|_{\tilde{\tau}_{jk}=\tilde{\tau}_{kj}} = & \left(n_j + n_k\right) \frac{3\left(2K-3\right)}{\left(K-1\right)\left(2K-1\right)} \frac{\alpha - w - \tilde{\tau}_{jk}}{16\beta} \\ & - \frac{1}{\left(K-1\right)\left(2K-1\right)} \frac{imt_{jk} n_j + imt_{kj} n_k - \left(K-1\right) ext_{jk} n_j - \left(K-1\right) ext_{kj} n_k}{4\beta}. \end{aligned} \tag{55}$$

Therefore, for positive import tariffs and export subsidies, the reaction of the optimal tax in country i to a rise in τ_{ij} and τ_{jk}, respectively, is revised downwards. The reason is that the tax 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 decrease 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

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

		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: (tariff effect) Effects of trade taxes on business tax in country i.

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

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

$$\frac{dt_i}{dext_{ji}} = n_i \frac{-\left(6(K-1)^2 + 4K + 3\right)(\alpha - w - \tilde{\tau}_{ji}) + 4Kext_{ji} - 4imt_{ji}}{(K-1)(2K-1)16\beta}, \tag{56}$$

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

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 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 influences by 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 ($imt_{ij} \approx 0$ and $ext_{ij} \approx 0$) 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 U-shaped. This result is similar to Proposition 1 in Haufler and Wooton (2010), although here we deal with tariffs that have revenue effects.

4.2 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 is suited for the case of larger firms. In the following, we consider both variants.

4.2.1 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

$$S_i = \sum_{j \in \mathscr{K} \setminus \{i\}} \left[\delta_i^{ij} + \frac{\gamma^{ij} - \underline{F}}{2\overline{F}} \Delta_i^{ij} \right] + \frac{1}{2} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{l \in \mathscr{K} \setminus \{i,j\}} \left[\delta_i^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_i^{jl} \right] \tag{57}$$

and

$$T_i = t_i \left[(K-1) + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\overline{F} - \gamma^{ij} \right) \right]. \tag{58}$$

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

$$\begin{aligned}
\pi_i^{ij}(\mu) &= \begin{cases} \frac{n_i(\alpha-w+\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-2\tau_{ij})^2}{16\beta} + \sum_{l \in \mathscr{K} \setminus \{i,j\}} \frac{n_l\left(\alpha-w-2\tau_{il}+\tau_{jl}\right)^2}{16\beta} & w/\ prob\ \left(1 - G\left(\gamma^{ij}\right)\right) \\ \frac{n_i(\alpha-w+2\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha-w-3\tau_{ij})^2}{16\beta} + \sum_{l \in \mathscr{K} \setminus \{i,j\}} \frac{n_l\left(\alpha-w-3\tau_{il}+2\tau_{jl}\right)^2}{16\beta} & w/\ prob\ G\left(\gamma^{ij}\right) \end{cases} \\
&:= \begin{cases} \pi_i^{ij}(2) & w/\ prob\ \left(1 - G\left(\gamma^{ij}\right)\right) \\ \pi_i^{ij}(1) & w/\ prob\ G\left(\gamma^{ij}\right) \end{cases}.
\end{aligned} \tag{59}$$

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

$$\begin{aligned}
\tilde{\Pi}_i^{ij} &:= G\left(\gamma^{ij}\right) \cdot 1 \cdot \left(\pi_i^{ij}(1) - t_i\right) + \left(1 - G\left(\gamma^{ij}\right)\right) \cdot 2 \cdot \left(\pi_i^{ij}(2) - t_i\right) - \frac{1}{2} G\left(\gamma^{ji}\right) \cdot 1 \cdot \mathbb{E}\left(F^{ji} | F^{ji} \leq \gamma^{ji}\right) \\
&= G\left(\gamma^{ij}\right)\left(\pi_i^{ij}(1) - t_i\right) + \left(1 - G\left(\gamma^{ij}\right)\right)\left(2\pi_i^{ij}(2) - 2t_i\right) - \frac{1}{8\overline{F}}\left(\left(\gamma^{ji}\right)^2 - \overline{F}^2\right).
\end{aligned} \tag{60}$$

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

$$\max_{t_i} n_i \left(\frac{S_i + T_i}{n_i} + w \right) + \omega m_i \frac{\Pi_i - T_i}{m_i} = \max_{t_i} S_i + (1-\omega) T_i + n_i w + \omega \Pi_i. \tag{61}$$

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

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

$$\begin{aligned} t_i = 3\overline{F} &+ \frac{(1-\omega)(K-1) + \left(1 - \frac{1}{2}\omega\right)}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\Delta_i^{ij} - \omega\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1)\right)\right) \\ &+ \frac{(1-\omega)(K-1)\left(1-\frac{1}{2}\omega\right)}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) \\ &+ \frac{1-\frac{1}{2}\omega}{(1-\omega)(K-1)\left[\left(1-\frac{1}{2}\omega\right)K + (1-\omega)(K-1)\right]} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{m \in \mathscr{K} \setminus \{j\}} \left(\Delta_j^{jm} - \omega\left(2\pi_j^{jm}(2) - \pi_j^{jm}(1)\right)\right) \end{aligned} \tag{62}$$

for every $i \in \mathscr{K}$. Observe that for $\omega = 0$ one obtains Lemma 3. For $\omega > 0$, Equation (62) is just an adjusted version of the solution in Lemma 3. Aside from modified factors, the only difference to before is that the optimal tax also accounts for the accrual of profits at home $(2\pi_i^{ij}(2) - \pi_i^{ij}(1))$ and, in the Nash 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 business taxes. Due to this close similarity of Equation (62) to Lemma 3 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 taxes.

Moreover, one can show that the extra terms in Equation (62) have intuitive comparative statics:

$$\begin{aligned}
\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)\right)}{d\tau_{ij}} &= -n_i\frac{4\tau_{ij}}{16\beta}-n_j\frac{2\tau_{ij}+2(\alpha-w)}{16\beta}<0,\\
\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)\right)}{d\tau_{il}} &= n_l\frac{4\tau_{jl}+2(\alpha-w-\tau_{il})}{16\beta}>0,\\
\frac{d\left(2\pi_i^{ij}(2)-\pi_i^{ij}(1)\right)}{d\tau_{jl}} &= -n_l\frac{4\tau_{jl}+2(\alpha-w-2\tau_{il})}{16\beta}<0,
\end{aligned} \tag{63}$$

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 business tax 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.

4.2.2 Citizens as Shareholders

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

$$\max_{t_i} n_i\left(\frac{S_i+T_i}{n_i}+w\right)+n_i\frac{\omega\sum_{i\in\mathscr{K}}(\Pi_i-T_i)}{n_i}. \tag{64}$$

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

$$
\begin{aligned}
t_i = {} & 3(1-\omega)\overline{F} + \frac{1}{(2-\omega)K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\Delta_i^{ij} - \omega \left[2\pi_i^{ij}(2) - \pi_i^{ij}(1) - \left(2\pi_j^{ij}(2) - \pi_j^{ij}(1) \right) \right] \right) \\
& + \frac{1}{(2-\omega)K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij} \right) \\
& + \frac{1-\omega}{(K-1)((2-\omega)K-1)} \sum_{l \in \mathscr{K}} \sum_{m \in \mathscr{K} \setminus \{l\}} \left(\Delta_l^{lm} - \omega \left[2\pi_l^{lm}(2) - \pi_l^{lm}(1) - \left(2\pi_m^{lm}(2) - \pi_m^{lm}(1) \right) \right] \right). \quad (65)
\end{aligned}
$$

Again, for $\omega = 0$ one gets Lemma 3. 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 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

$$
\begin{aligned}
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1) - \left(2\pi_j^{ij}(2) - \pi_j^{ij}(1)\right)\right)}{d\tau_{ij}} &= (n_i - n_j)\frac{2(\alpha - w - \tau_{ij})}{16\beta}, \\
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1) - \left(2\pi_j^{ij}(2) - \pi_j^{ij}(1)\right)\right)}{d\tau_{il}} &= n_l \frac{2\tau_{il} + 4(\alpha - w)}{16\beta} > 0, \qquad (66) \\
\frac{d\left(2\pi_i^{ij}(2) - \pi_i^{ij}(1) - \left(2\pi_j^{ij}(2) - \pi_j^{ij}(1)\right)\right)}{d\tau_{jl}} &= -n_l \frac{2\tau_{jl} + 4(\alpha - w)}{16\beta} < 0,
\end{aligned}
$$

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.

4.3 Arbitrary Number of Firms

We now relax the assumption that, in each industry, there are only three producing firms of which two are immobile. To be precise, in an ij-industry let $k_i^{ij} \in \mathbb{R}_+$ be the number of firms in country i. Hence, $k_i^{ij} + k_j^{ij} + 1 \coloneqq k^{ij} + 1$ is the total number of firms producing in a given industry, of which only one continues to be mobile. 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

$$k_i = \sum_{j \in \mathscr{K} \setminus \{i\}} k_i^{ij} + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\overline{F} - \gamma^{ij} \right). \tag{67}$$

Then, the reaction function of country i is

$$t_i = \frac{1}{2(K-1)} \left(\sum_{j \in \mathscr{K} \setminus \{i\}} \Delta_i^{ij} + \overline{F}(K-1) + 2\overline{F} \sum_{j \in \mathscr{K} \setminus \{i\}} k_i^{ij} + \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij} \right) + \sum_{j \in \mathscr{K} \setminus \{i\}} t_j \right). \tag{68}$$

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

$$\begin{aligned} t_i = {} & 3\overline{F} + 2\overline{F} \frac{K \sum_{j \in \mathscr{K} \setminus \{i\}} k_i^{ij} + \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{m \in \mathscr{K} \setminus \{j\}} k_j^{jm} - (K-1)(2K-1)}{(K-1)(2K-1)} \\ & + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \Delta_i^{ij} + \frac{1}{2K-1} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\pi_i^{ij} - \pi_j^{ij} \right) + \frac{1}{(K-1)(2K-1)} \sum_{j \in \mathscr{K}} \sum_{m \in \mathscr{K} \setminus \{j\}} \Delta_j^{jm}. \end{aligned} \tag{69}$$

Relative to Lemma 3, the new optimal business tax 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

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

$$\begin{aligned} \pi_i^{ij} - \pi_j^{ij} = {} & (n_i - n_j) \frac{2(\alpha - w) - \tau_{ij}}{\beta \left(k^{ij}+2\right)^2} \left(k^{ij}+1\right)\tau_{ij} + \left(k_j^{ij} - k_i^{ij}\right)(n_i + n_j) \frac{\tau_{ij}^2}{\beta \left(k^{ij}+2\right)^2} \left(k^{ij}+1\right) \\ & + \sum_{l \in \mathscr{K} \setminus \{i,j\}} n_l (\tau_{jl} - \tau_{il}) \frac{2(\alpha - w) - (\tau_{jl} + \tau_{il}) - \left(k_i^{ij} - k_j^{ij}\right)(\tau_{jl} - \tau_{il})}{\beta \left(k^{ij}+2\right)^2} \left(k^{ij}+1\right), \end{aligned} \tag{70}$$

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 4 are slightly modified

$$\begin{aligned} \frac{dt_i}{d\tau_{ij}} &= \frac{n_i\left(K-2\right) - n_j\left[2\left(K-1\right)^2+1\right]}{\left(K-1\right)\left(2K-1\right)} \frac{\left(\alpha - w - \tau_{ij}\right)\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2} \\ &+ \frac{\left[2\left(K-1\right)\left(k^{ij}+1\right)+K\right]n_i + \left[2\left(K-1\right)\left(k^{ij}+1\right)\left(\sum_{m\in\mathscr{K}\setminus\{i,j\}}\frac{\tau_{ij}-\tau_{mj}}{\tau_{ij}}+1\right)-1\right]n_j}{\left(K-1\right)\left(2K-1\right)} \frac{\tau_{ij}\left(k_j^{ij}-k_i^{ij}\right)}{\beta\left(k^{ij}+2\right)^2} \end{aligned} \tag{71}$$

and

$$\begin{aligned} \frac{dt_i}{d\tau_{jk}} &= \frac{\left(2K-3\right)\left(n_j+n_k\right)}{\left(K-1\right)\left(2K-1\right)} \frac{\left(\alpha - w - \tau_{jk}\right)\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2} + \frac{\tau_{jk}\left(k_k^{jk}-k_j^{jk}\right)\left(n_j-n_k\right)}{\left(K-1\right)\left(2K-1\right)\beta\left(k^{ij}+2\right)^2} \\ &+ \frac{\left[2n_k\left(K-1\right)\left(k_j^{ij}-k_i^{ij}\right)\left(\tau_{jk}-\tau_{ik}\right)+2n_j\left(K-1\right)\left(k_k^{ik}-k_i^{ik}\right)\left(\tau_{jk}-\tau_{ij}\right)\right]\left(k^{ij}+1\right)}{\left(K-1\right)\left(2K-1\right)\beta\left(k^{ij}+2\right)^2}. \end{aligned} \tag{72}$$

Observe that for $k_j^{ij} = k_i^{ij} = k_k^{jk}$ and $k^{ij} = 2$ one obtains the expressions in Lemma 4. 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 business tax 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

$$\frac{dt_i}{dk_i^{ij}} = \frac{2\overline{F}K}{(K-1)(2K-1)} - \frac{\left[(K-1)\left(k^{ij}+1\right)n_i + \left((K-1)\left(k^{ij}+1\right)-2\right)n_j\right]\tau_{ij}^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} + \frac{(K-1)\left(k^{ij}+1\right)\sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tau_{jl}-\tau_{il}\right)^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} \lesseqgtr 0, \quad (73)$$

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

and

$$\frac{dt_i}{dk_k^{jk}} = 2\overline{F}\frac{1}{(K-1)(2K-1)} + \frac{n_j\tau_{jk}^2}{(K-1)(2K-1)\beta\left(k^{jk}+2\right)^2} > 0 \quad (74)$$

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). 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 business tax, 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 taxes 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 business tax 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 business taxes 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:

$$\sum_{m \in \mathscr{K}_{EU}} \left(\frac{dt_k}{dk_m^{lm}} - \frac{dt_k}{dk_l^{lm}} \right) = \frac{K_{EU} \left(n_l - \overline{n}_{EU} \right) \tau^2}{\left(K - 1 \right) \left(2K - 1 \right) \beta \left(k^{ij} + 2 \right)^2} \begin{cases} > 0 & for\ \overline{n}_{EU} < n_l \\ < 0 & for\ \overline{n}_{EU} > n_l \end{cases}. \tag{75}$$

The exit of firms in the leaving country and the entry into member countries, respectively, have no direct effect on the business taxes of third countries outside the union. Also, the mechanical effects of the exit and entry of firms cancel out. However, in the Nash equilibrium, the business taxes 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 taxes, 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.

4.4 Cross-Price Effects

In the following, we deal with cross-price effects. That is, we specify preferences of the representative household in country i as in Melitz and Ottaviano (2008)

$$u_i := z_i + \alpha \int_{\mu \in \Omega} x_i \left(\mu \right) d\mu - \frac{\beta}{2} \int_{\mu \in \Omega} x_i \left(\mu \right)^2 d\mu - \frac{\eta}{2} \left(\int_{\mu \in \Omega} x_i \left(\mu \right) d\mu \right)^2 \tag{76}$$

for $\eta > 0$. The parameters α and η measure the substitutability between the numéraire and the differentiated varieties, whereas the parameter β determines the degree of product differentiation of varieties. A rise in η shifts down the demand for the differentiated varieties compared to the numéraire. Since we are interested in the effects of firm selection in the differentiated industries, let $\beta > \eta$ such that consumers are sufficiently interested in consuming sufficiently differentiated varieties.

The aggregate demand functions are still linear in the industry price, but the vertical intercepts are endogenously shifted

$$X_i(\mu) = \frac{n_i(\alpha_i - p_i(\mu))}{\beta} \tag{77}$$

where $\alpha_i := \frac{\alpha\beta + \eta\overline{p}}{\beta+\eta}$ and $\overline{p}_i := \int_{\mu\in\Omega} p_i(\mu)\, d\mu$. As before, optimal production quantities by firms lead to country- and industry-specific prices

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

$$p_i^{jk}(\mu) = \frac{\alpha_i + 3w + k_j^*\tau_{ij} + k_k^*\tau_{ik}}{4} = \begin{cases} \frac{\alpha_i+3w+2\tau_{ij}+\tau_{ik}}{4} & if\, F^{jk} \geq \gamma^{jk} \\ \frac{\alpha_i+3w+\tau_{ij}+2\tau_{ik}}{4} & if\, F^{jk} < \gamma^{jk} \end{cases}, \tag{78}$$

and

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

for any $j, k \in \mathscr{K} \setminus \{i\}$. Again, prices depend on firms' relocation choices. Pre-tax variable profits of a firm in country i are given by

$$\pi_i^{ij}(\mu) = \begin{cases} \frac{n_i(\alpha_i - w + \tau_{ij})^2}{16\beta} + \frac{n_j(\alpha_j - w - 2\tau_{ij})^2}{16\beta} + \frac{n_k\left(\alpha_k - w - 2\tau_{ik} + \tau_{jk}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, i \\ \frac{n_i(\alpha_i - w + 2\tau_{ij})^2}{16\beta} + \frac{n_j(\alpha_j - w - 3\tau_{ij})^2}{16\beta} + \frac{n_k\left(\alpha_k - w - 3\tau_{ik} + 2\tau_{jk}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, j. \end{cases} \tag{79}$$

Interestingly, the cutoff industries γ^{ij}, γ^{jk}, and γ^{ki} remain unchanged. Thus, cross-price effects do not directly affect firm mobility in our model.

Accordingly, tax revenues in country i still read as $T_i := t_i\left(3 - G(\gamma^{ij}) + G\left(\gamma^{ki}\right)\right)$. However, consumer surplus accounts for cross-price effects

$$\begin{aligned} S_i = & \underbrace{n_i\left(\frac{\left(3\alpha_i-3w-\tau_{ij}\right)^2}{32\beta}\right)}_{:=\delta_i^{ij}} + G\left(\gamma^{ij}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha_i-3w-2\tau_{ij}\right)^2}{32\beta}\right)-\left(\frac{\left(3\alpha_i-3w-\tau_{ij}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{ij}} \\ & + \underbrace{n_i\left(\frac{\left(3\alpha_i-3w-2\tau_{ij}-\tau_{ik}\right)^2}{32\beta}\right)}_{:=\delta_i^{jk}} + G\left(\gamma^{jk}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha_i-3w-\tau_{ij}-2\tau_{ik}\right)^2}{32\beta}\right)-\left(\frac{\left(3\alpha_i-3w-2\tau_{ij}-\tau_{ik}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{jk}} \\ & + \underbrace{n_i\left(\frac{\left(3\alpha_i-3w-2\tau_{ik}\right)^2}{32\beta}\right)}_{:=\delta_i^{ki}} + G\left(\gamma^{ki}\right)\underbrace{n_i\left[\left(\frac{\left(3\alpha_i-3w-\tau_{ik}\right)^2}{32\beta}\right)-\left(\frac{\left(3\alpha_i-3w-2\tau_{ik}\right)^2}{32\beta}\right)\right]}_{:=\Delta_i^{ki}} \end{aligned} \tag{80}$$

through the dependence of $\alpha_i := \frac{\alpha\beta+\eta\bar{p}_i}{\beta+\eta}$ on the country's average price level

$$\alpha_i = \frac{4\alpha\beta}{4\beta+\eta} + \frac{\eta}{4\beta+\eta}\left[9w+3\tau_{ij}+3\tau_{ik}+G\left(\gamma^{ij}\right)\tau_{ij}+G\left(\gamma^{jk}\right)\left(\tau_{ik}-\tau_{ij}\right)-G\left(\gamma^{ki}\right)\tau_{ik}\right]. \tag{81}$$

The first-order condition with respect to the business tax

$$\begin{aligned} \frac{d\left(S_i+T_i\right)}{dt_i} = & \frac{1}{\overline{F}-\underline{F}}\left(\Delta_i^{ij}-\Delta_i^{ki}\right)+3-G\left(\gamma^{ij}\right)+G\left(\gamma^{ki}\right)-2t_i\frac{1}{\overline{F}-\underline{F}} \\ & + \frac{3n_i}{16\beta}\frac{\eta}{4\beta+\eta}\frac{1}{\overline{F}-\underline{F}} \\ & \times\left(\tau_{ij}+\tau_{ki}\right)\left(3\left(3\left(\alpha_i-w\right)-\tau_{ij}-\tau_{ik}\right)-G\left(\gamma^{ij}\right)\tau_{ij}+G\left(\gamma^{jk}\right)\left(\tau_{ij}-\tau_{ik}\right)+G\left(\gamma^{ki}\right)\tau_{ik}\right)=0 \end{aligned} \tag{82}$$

is sufficient by the second-order condition

$$\frac{d^2\left(S_i+T_i\right)}{dt_i^2} = -\frac{4}{\overline{F}-\underline{F}} - \frac{3n_i}{16\beta}\left(\frac{\tau_{ij}+\tau_{ki}}{\overline{F}-\underline{F}}\right)^2\frac{\eta\left(8\beta-7\eta\right)}{\left(4\beta+\eta\right)^2} < 0.$$

The reaction function t_i is linear in t_j and t_k. One can easily find conditions under which business taxes are strategic complements, and the slope of the reaction functions is less than 1, such that the Nash equilibrium is unique. With cross-price effects, the optimal taxes are revised upward relative to $\eta = 0$. The higher η, the smaller the demand for differentiated varieties compared to the numéraire, and the smaller the welfare loss from firm emigration: $\frac{dS_i}{d\alpha_i}\frac{d\alpha_i}{dt_i} > 0$. Thus, there is a welfare gain from taxing firms so that optimal taxes increase in η.

Compared to Lemma 1, one needs to add to the comparative statics (e.g., $\frac{\partial t_i}{\partial \tau_{ij}} = -\left(\frac{d^2(S_i+T_i)}{dt_i d\tau_{ij}} / \frac{d^2(S_i+T_i)}{dt_i^2}\right)$) two marginal effects, which account for the endogeneity of α_i in the average price level. Observe that the average price level and, hence, α_i tends to rise in trade costs. Under considerable asymmetries in the market sizes, the Metzler paradox may occur ($\frac{d\overline{p}_i}{d\tau_{ij}} < 0$). However, for sufficiently similar market sizes, this will not be the case. In the following, suppose that market sizes and trade costs are similar. The first adjustment regards the mentioned welfare gain (reduction in the welfare loss from firm emigration). This welfare gain rises in trade costs. The second one accounts for the endogeneity of the consumer surplus loss from taxing businesses $\frac{d\left(\Delta_i^{ij} - \Delta_i^{ki}\right)}{d\alpha_i} \neq 0$. A rise in trade costs increases this welfare loss. Hence, both adjustments work in opposite directions. Nonetheless, the key trade-offs and the insights from the model without cross-price effects remain unchanged.

4.5 Competition on Regulations

In the model of Section 2, we now endogenize the country-specific level of regulations, ν^i. In the first stage of our economy $\mathcal{E}$, a country i chooses not only the optimal business tax policy but also the optimal level of regulations taking all other countries' business taxes and regulations as given. Observe that this features a situation where countries compete non-cooperatively over the setting of business regulations. For positive taxes, country i's welfare declines in ν^i

$$\frac{d\left(S_i + T_i\right)}{d\nu^i} = \frac{1}{\overline{F} - \underline{F}} \left(\Delta_i^{ij} - \Delta_i^{ki} - 2t_i\right) < 0, \tag{83}$$

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

Two negative effects on welfare add up. Firstly, a rise in ν^i lowers consumer surplus because it triggers firm emigration out of country i. This leads to a rise in the country's price level and reduces aggregate welfare. Secondly, as firms move away from country i, tax revenues in that country decline. To obtain interior solutions, let V_i measure the regulation surplus generated from ν^i in country $i \in \mathscr{K}$ in reduced form, where $\frac{dV_i}{d\nu^i} > 0$ and $\frac{d^2 V_i}{(d\nu^i)^2} < -\frac{6}{5\left(\overline{F} - \underline{F}\right)}$ for all ν^i. In the context of environmental protection, a rise in environmental standards may lower air pollution in cities or reduce the risk of natural disasters. V_i captures the resulting aggregate regulation surplus in country i. In principle, this surplus may be a function of the other countries' regulations as well. That is, $V_i\left(\nu^i, \{\nu^j\}_{j\in\mathscr{K}}\right)$ captures cross-country complementarities in regulations. For simplicity, let us abstract from such complementarities. Even in the absence of cross-country complementarities, a country's optimal level of regulations will be inefficiently low. The reason is that, similar to the tax competition game, the government in country i does not take into account the positive externality of firm emigration on other countries' welfare $\frac{d(S_j+T_j)}{d\nu^i} > 0$. This leads to an underprovision of regulations (e.g., environmental protection), and countries would gain from coordinating business regulations.

The first-order condition with respect to ν^i

$$\frac{d\left(S_i+T_i+V_i\right)}{d\nu^i} = \frac{1}{\overline{F}-\underline{F}}\left(\Delta_i^{ij}-\Delta_i^{ki}-2t_i\right)+\frac{dV_i}{d\nu^i}=0 \tag{84}$$

determines the optimal level of regulations in country i. By Proposition 3, $\frac{dt_i}{d\nu^j} = 1$ such that regulations are strategic substitutes:

$$\frac{\partial\nu^i}{\partial\nu^j} = -\frac{-\frac{2}{\overline{F}-\underline{F}}\frac{dt_i}{d\nu^j}}{\frac{4}{5\left(\overline{F}-\underline{F}\right)}+\frac{d^2V_i}{(d\nu^i)^2}} = \frac{2}{4+5\left(\overline{F}-\underline{F}\right)\frac{d^2V_i}{(d\nu^i)^2}} < 0. \tag{85}$$

Since $\frac{d^2V_i}{(d\nu^i)^2} < -\frac{6}{5\left(\overline{F}-\underline{F}\right)}$, the slope of the reaction functions is greater than -1, such that the Nash equilibrium is unique.

The first-order condition reveals that other domestic policies (here: business regulations) interact with the optimal business tax policy. Perhaps surprisingly, for positive business taxes, the comparative statics of regulations and business taxes (Lemma 1) may point in opposite directions. For instance,

$$sign\left(\frac{\partial\nu^i}{\partial\tau_{jk}}\right) = -sign\left(\frac{\partial t_i}{\partial\tau_{jk}}\right). \tag{86}$$

The intuition is that a rise in a country's business tax (e.g., by an increase in τ_{jk}) magnifies the size of lost tax revenues and, thus, the welfare costs of ν^i. In the optimum, this reduces a country's level of business regulations.

4.6 Harmonization of Business Taxes

In this section, we deal with the effects of economic disintegration on harmonized taxes. We look at the scenario of partial harmonization (e.g., Conconi, Perroni, and Riezman (2008)) in the K-country economy described above. That is, a non-empty subset of countries, $\mathscr{K}_H$, (e.g., the EU) coordinates their level of business taxation to maximize joint welfare

$$\max_{\{t_m\}_{i\in\mathscr{K}_H}} \sum_{m\in\mathscr{K}_H} (S_m + T_m + n_m w) \tag{87}$$

subject to $t_H := t_m = t_n \; \forall m, n \in \mathscr{K}_H$. Under this set of constraints, the consumer surplus in the harmonized area reads as

$$\begin{aligned}
\sum_{m\in\mathscr{K}_H} S_m = & \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}_H\setminus\{m\}} \left[\delta_m^{mj} + \frac{\tilde{\gamma}^{mj} - \underline{F}}{2\overline{F}} \Delta_m^{mj}\right] + \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})} \left[\delta_m^{mj} + \frac{\gamma^{mj} - \underline{F}}{2\overline{F}} \Delta_m^{mj}\right] \\
& + \frac{1}{2} \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})} \sum_{l\,\in\,\mathscr{K}_H\setminus\{m,j\}} \left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_m^{jl}\right] \\
& + \frac{1}{2} \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}_H\setminus\{m\}} \sum_{l\,\in\,\mathscr{K}\setminus(\mathscr{K}_H\cup\{m,j\})} \left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_m^{jl}\right] \\
& + \frac{1}{2} \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}_H\setminus\{m\}} \sum_{l\,\in\,\mathscr{K}_H\setminus\{m,j\}} \left[\delta_m^{jl} + \frac{\tilde{\gamma}^{jl} - \underline{F}}{2\overline{F}} \Delta_m^{jl}\right] \\
& + \frac{1}{2} \sum_{m\in\mathscr{K}_H} \sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})} \sum_{l\,\in\,\mathscr{K}\setminus(\mathscr{K}_H\cup\{m,j\})} \left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_m^{jl}\right]
\end{aligned} \tag{88}$$

where $\tilde{\gamma}^{mj} := \gamma^{mj} - t_m + t_j = \pi_j^{mj} - \pi_m^{mj}$ is independent from business taxes. Similarly, one can decompose tax revenues as follows

$$\begin{aligned}
\sum_{m\in\mathscr{K}_H} T_m = & \, t_H \sum_{m\in\mathscr{K}_H} \left[(K-1) + \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}_H\setminus\{m\}} \left(\overline{F} - \tilde{\gamma}^{mj}\right)\right] \\
& + t_H \sum_{m\in\mathscr{K}_H} \left[(K-1) + \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})} \left(\overline{F} - \gamma^{mj}\right)\right].
\end{aligned} \tag{89}$$

The first-order condition is given by

$$\frac{d\sum_{m\in\mathscr{K}_H}\left(S_m+T_m+n_m w\right)}{dt_H}=\frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\Delta_m^{mj}+\frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\sum_{l\in\mathscr{K}_H\setminus\{m\}}\Delta_m^{lj}$$
$$+\sum_{m\in\mathscr{K}_H}(K-1)+\frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\{m\}}\left(\overline{F}-\gamma^{mj}\right)-t_H\frac{1}{2\overline{F}}K_H\left(K-K_H\right)=0 \tag{90}$$

which is sufficient by the second-order condition

$$\frac{d^2\sum_{m\in\mathscr{K}_H}\left(S_m+T_m+n_m w\right)}{dt_H^2}=\frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})}\left(-\frac{d\gamma^{mj}}{dt_m}\right)-\frac{1}{2\overline{F}}K_H\left(K-K_H\right)$$
$$=-\frac{K_H\left(K-K_H\right)}{\overline{F}}<0.$$

The reaction function in the harmonized area can be written as

$$t_H=\frac{1}{2\left(K-K_H\right)}\left(\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\overline{\Delta}_H^{Hj}+\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\overline{\Delta}_H^{H'j}+3\overline{F}\left(K-1\right)-\sum_{j\in\mathscr{K}\setminus\{m\}}\overline{\tilde{\gamma}}^{Hj}+\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}t_j\right) \tag{91}$$

where we define $\overline{\Delta}_H^{Hj}:=\frac{1}{K_H}\sum_{m\in\mathscr{K}_H}\Delta_m^{mj}$, $\overline{\Delta}_H^{H'j}:=\frac{1}{K_H}\sum_{l\in\mathscr{K}_H\setminus\{m\}}\sum_{m\in\mathscr{K}_H}\Delta_m^{lj}$, and $\overline{\tilde{\gamma}}^{Hj}:=\frac{1}{K_H}\sum_{m\in\mathscr{K}_H}\tilde{\gamma}^{mj}$.

In the other regions, governments choose their business taxes non-cooperatively as before

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

yielding the reaction function

$$t_i=\frac{1}{2\left(K-1\right)}\left(\sum_{j\in\mathscr{K}\setminus\{i\}}\Delta_i^{ij}+3\overline{F}\left(K-1\right)-\sum_{j\in\mathscr{K}\setminus\{i\}}\tilde{\gamma}^{ij}+\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{i\})}t_j+K_H t_H\right) \tag{92}$$

for any $i\notin\mathscr{K}_H$.

Business taxes are, as before, strategic complements, the relation is linear, and the slope is less than 1. Thus, there exists a unique interior intersection of reaction functions forming the Nash equilibrium in this tax competition game.

The formula for the non-cooperative tax t_i in country $i \notin \mathscr{K}_H$ is unaltered relative to the case without tax harmonization. The only difference is that $K_H t_H$ replaces $\sum_{j \in \mathscr{K}_H} t_j$. The reaction function in the harmonized area, t_H, accounts for average effects on consumer surplus ($\overline{\Delta}_H^{Hj}$ and $\overline{\Delta}_H^{H'j}$) and tax revenues ($\bar{\tilde{\gamma}}^{Hj}$) vis-à-vis other countries j. Another remarkable feature is the prefactor $\frac{1}{K-K_H}$ that is increasing in the number of countries in the harmonized area, K_H. It accounts for the gain in tax revenues a country realizes from participating in the coordination of business taxes.

In the following, we derive the symmetric Nash equilibrium. Suppose that $\tau_{ij} = \tau_{k,l}$ for all $i \neq j$ and $k \neq l$ and let $n_i = n_j$ for all i, j. Then, $\tilde{\gamma}^{ij} = 0 \; \forall i, j$, $\bar{\tilde{\gamma}}^{Hj} = 0 \; \forall j$, $\overline{\Delta}_H^{H'j} = 0 \; \forall j$, and $\Delta_i^{ij} := \Delta < 0 \; \forall i, j$. The Nash equilibrium business taxes are given by

$$t_H = 3\overline{F}\frac{(K-1)(2K-1)}{(K-K_H)(2K-2+K_H)} + \Delta \tag{93}$$

and

$$t_i = t_H - 3\overline{F}\frac{(K-1)(K_H-1)}{(K-K_H)(2K-2+K_H)} \tag{94}$$

for $i \notin \mathscr{K}_H$. Taxes inside the harmonized area are higher than outside ($t_H > t_i$). Similar to Proposition 6, one can derive the comparative statics of business taxes with respect to K_H. Both t_H and t_i increase in the number of members in the harmonized area ($\frac{dt_H}{dK_{EU}} > 0$ and $\frac{dt_i}{dK_{EU}} > 0$). In other words, when a country disintegrates from the harmonized area, business taxes decline everywhere. The reason is that tax harmonization leads to a reduction in the degree of tax competition worldwide. As a country leaves the harmonized area, there is effectively one more player in the tax competition game leading to harsher competition and lower taxes.

4.7 Industry-Specific Trade Costs

In this section, we allow for heterogeneity in firms' trade costs. To be precise, we let trade costs vary by industry types. Trade between the countries m and n costs a firm in an ij-industry $\tau_{mn}^{ij} = \tau_{mn} + \tilde{\tau}_{mn}^{ij}$, where τ_{mn} measures the country-pair specific level of trade costs, and $\tilde{\tau}_{mn}^{ij}$ is an idiosyncratic component that may vary across industry types. Then, a firm's profits in country i

and industry ij read as

$$\pi_i^{ij}(\mu) = \begin{cases} \frac{n_i\left(\alpha-w+\tilde{\tau}_{ij}^{ij}\right)^2}{16\beta} + \frac{n_j\left(\alpha-w-2\tilde{\tau}_{ij}^{ij}\right)^2}{16\beta} + \frac{n_k\left(\alpha-w-2\tilde{\tau}_{ik}^{ij}+\tilde{\tau}_{jk}^{ij}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, i \\ \frac{n_i\left(\alpha-w+2\tilde{\tau}_{ij}^{ij}\right)^2}{16\beta} + \frac{n_j\left(\alpha-w-3\tilde{\tau}_{ij}^{ij}\right)^2}{16\beta} + \frac{n_k\left(\alpha-w-3\tilde{\tau}_{ik}^{ij}+2\tilde{\tau}_{jk}^{ij}\right)^2}{16\beta} & if\, mobile\, firm\, locates\, in\, j. \end{cases} \tag{95}$$

Accordingly, industry thresholds are adjusted as follows

$$\gamma^{ij} = (n_j - n_i)\frac{6\tilde{\tau}_{ij}^{ij}(\alpha - w) - 3\left(\tilde{\tau}_{ij}^{ij}\right)^2}{16\beta} + \sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tilde{\tau}_{il}^{ij} - \tilde{\tau}_{jl}^{ij}\right)\frac{6(\alpha - w) - 3\left(\tilde{\tau}_{il}^{ij} + \tilde{\tau}_{jl}^{ij}\right)}{16\beta} + t_i - t_j, \tag{96}$$

leading to the same tax revenue function $T_i = t_i\left[(K-1) + \frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\setminus\{i\}}\left(\overline{F} - \gamma^{ij}\right)\right]$. Observe that introducing firm-specific trade costs would make firm heterogeneity in a given industry type two-dimensional. Then, γ^{ij} may not be uniquely defined. Therefore, we focus on the setting described here.

Consumer surplus also remains qualitatively unchanged

$$S_i = \sum_{j\in\mathscr{K}\setminus\{i\}}\left[\delta_i^{ij} + \frac{\gamma^{ij} - \underline{F}}{2\overline{F}}\Delta_i^{ij}\right] + \frac{1}{2}\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{l\,\in\,\mathscr{K}\setminus\{i,j\}}\left[\delta_i^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}}\Delta_i^{jl}\right] \tag{97}$$

with adjusted terms

$$\delta_i^{ij} := n_i\frac{\left(3\alpha - 3w - \tilde{\tau}_{ij}^{ij}\right)^2}{32\beta},$$

$$\delta_i^{jl} := n_i\frac{\left(3\alpha - 3w - 2\tilde{\tau}_{ij}^{jl} - \tilde{\tau}_{il}^{jl}\right)^2}{32\beta},$$

$$\Delta_i^{ij} := n_i\frac{\left(3\alpha - 3w - 2\tilde{\tau}_{ij}^{ij}\right)^2 - \left(3\alpha - 3w - \tilde{\tau}_{ij}^{ij}\right)^2}{32\beta},$$

and

$$\Delta_i^{jl} := n_i\frac{\left(3\alpha - 3w - \tilde{\tau}_{ij}^{jl} - 2\tilde{\tau}_{il}^{jl}\right)^2 - \left(3\alpha - 3w - 2\tilde{\tau}_{ij}^{jl} - \tilde{\tau}_{il}^{jl}\right)^2}{32\beta}.$$

The remainder of the analysis is identical to Section 3.1. Relative to the comparative statics of Nash equilibrium business taxes with respect to country-pair specific trade costs τ_{mn} (Lemma 4 and Proposition 5), one has to keep track of industry-type trade cost differentials. Nonetheless, our main insights remain unchanged. Since we are interested in the effects of economic disintegration that is supposed to affect all firms in a country, we abstain from carrying out comparative statics with respect to industry-type specific trade costs $\tilde{\tau}^{ij}_{mn}$. As we have shown in this section, however, our model may also speak to the effects of trade shocks that hit a country's firms to a varying extent.

5 Proofs for Section 3

5.1 The Impact of Disintegration on Trade Policies

5.1.1 Tariffs and Non-Tariff Trade Policies

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 $\boldsymbol{t^{old}}$ denote the vector of tariff policies before the disintegration of country l from the integrated area/economic union abbreviated EU. That is,

$$\boldsymbol{t^{old}} = \left(\boldsymbol{t^{old}_{EU,EU}}, \boldsymbol{t^{old}_{EU,l}}, \boldsymbol{t^{old}_{EU,TA}}, \boldsymbol{t^{old}_{l,TA}}, \boldsymbol{t^{old}_{TA,TA}}, \boldsymbol{t^{old}_{Rest}}\right) \tag{98}$$

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

$$\boldsymbol{t^{old}_{Rest}} = \left(\boldsymbol{t^{old}_{EU,Rest}}, \boldsymbol{t^{old}_{l,Rest}}, \boldsymbol{t^{old}_{TA,Rest}}, \boldsymbol{t^{old}_{,Rest,Rest}}\right) \tag{99}$$

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

$$\boldsymbol{\tau^{old}} = \left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{old}_{EU,l}}, \boldsymbol{\tau^{old}_{EU,TA}}, \boldsymbol{\tau^{old}_{l,TA}}, \boldsymbol{\tau^{old}_{TA,TA}}, \boldsymbol{\tau^{old}_{Rest}}\right) \tag{100}$$

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 $i, j, k \in \mathscr{K}$, $\nabla_{t_{ij}} W_k(\boldsymbol{\tau}, \boldsymbol{t}) > 0$ and $\nabla_{\tau_{ij}} W_k(\boldsymbol{\tau}, \boldsymbol{t}) > 0$.*

Hence the cross-country welfare effects of higher trade costs are positive. In Section 5.2, we show that in our model with tax competition, as described in the paper, Assumption 2 is fulfilled given positive business taxes, small trade taxes, and sufficiently similar trade costs ($\tilde{\tau}_{ml} = t_{ml} + \tau_{ml} \approx \tilde{\tau}_{np} = t_{np} + \tau_{np}$).

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

$$\left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{old}_{EU,l}}\right) := \underset{(\boldsymbol{\tau_{EU,EU}}, \boldsymbol{\tau_{EU,l}})}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m(\cdot). \tag{101}$$

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

$$\left(\boldsymbol{\tau^{new}_{EU,EU}}\right) := \underset{(\boldsymbol{\tau_{EU,EU}})}{arg\ max} \sum_{m \in \mathscr{K}_{EU}} W_m(\cdot). \tag{102}$$

Do the remaining member countries integrate more with each other after the disintegration of l? In other words, how do the vectors $\boldsymbol{\tau^{old}_{EU,EU}}$ and $\boldsymbol{\tau^{new}_{EU,EU}}$ compare with each other? Consider the first-order Taylor approximation of members' welfare in the new optimum

$$\begin{aligned}
\sum_{m \in \mathscr{K}_{EU}} W_m\left(\boldsymbol{\tau^{new}_{EU,EU}}, \boldsymbol{\tau^{new}_{EU,l}}, \cdot\right) &= \sum_{m \in \mathscr{K}_{EU}} W_m\left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{new}_{EU,l}}, \cdot\right) \\
&+ \sum_{m \in \mathscr{K}_{EU}} \nabla_{\boldsymbol{\tau_{EU,EU}}} W_m\left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{new}_{EU,l}}, \cdot\right)\left(\boldsymbol{\tau^{new}_{EU,EU}} - \boldsymbol{\tau^{old}_{EU,EU}}\right)' + h.o.t. \\
&> \sum_{m \in \mathscr{K}_{EU}} W_m\left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{new}_{EU,l}}, \cdot\right)
\end{aligned} \tag{103}$$

where the inequality holds by Assumption 2, and therefore implies

$$\sum_{m \in \mathscr{K}_{EU}} \nabla_{\boldsymbol{\tau_{EU,EU}}} W_m\left(\boldsymbol{\tau^{old}_{EU,EU}}, \boldsymbol{\tau^{new}_{EU,l}}, \cdot\right)\left(\boldsymbol{\tau^{new}_{EU,EU}} - \boldsymbol{\tau^{old}_{EU,EU}}\right)' > 0. \tag{104}$$

By optimality of the old solution

$$\sum_{m\in\mathscr{K}_{EU}\cup\{l\}} \nabla_{\boldsymbol{\tau_{EU,EU}}} W_m\left(\boldsymbol{\tau^{old}}, \boldsymbol{t^{old}}\right) = 0 \tag{105}$$

and, accordingly,

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

Therefore,

$$-\nabla_{\boldsymbol{\tau_{EU,EU}}} W_l\left(\boldsymbol{\tau^{old}}, \boldsymbol{t^{old}}\right)\left(\boldsymbol{\tau^{new}_{EU,EU}} - \boldsymbol{\tau^{old}_{EU,EU}}\right)^{'} > 0 \tag{106}$$

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

$$\boldsymbol{\tau^{new}_{EU,EU}} < \boldsymbol{\tau^{old}_{EU,EU}}. \tag{107}$$

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 $\boldsymbol{t^{old}_{EU,EU}} = \boldsymbol{t^{new}_{EU,EU}} = 0$, whereas trade taxes between the leaving country and the economic union can be anything after the disintegration. That is, $\boldsymbol{t^{old}_{EU,l}} = 0$ and $\boldsymbol{t^{new}_{EU,l}} \gtreqless 0$. 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

$$\begin{aligned} \left(\boldsymbol{\tau}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}, \boldsymbol{\tau}^{\boldsymbol{old}}_{\boldsymbol{EU,l}}\right) &:= \underset{\left(\boldsymbol{\tau_{EU,EU}}, \boldsymbol{\tau_{EU,l}}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m\left(\cdot\right) \\ subject\ to\ &\left(\boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}, \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU,l}}\right) = 0, \end{aligned} \tag{108}$$

but afterwards

$$\begin{aligned} \left(\boldsymbol{\tau}^{\boldsymbol{new}}_{\boldsymbol{EU,l}}, \boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU,l}}\right) &:= \underset{\left(\boldsymbol{\tau_{EU,l}}, \boldsymbol{t_{EU,l}}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m\left(\cdot\right) \\ subject\ to\ &\left(\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}}\right) = 0 \\ and\ &\left(\boldsymbol{\tau}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}}\right) := \underset{\left(\boldsymbol{\tau_{EU,EU}}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU}} W_m\left(\cdot\right). \end{aligned} \tag{109}$$

Then, our approach delivers

$$\sum_{m \in \mathscr{K}_{EU} \cup \{l\}} \nabla_{\boldsymbol{t_{EU,l}}} W_m\left(\boldsymbol{\tau}^{\boldsymbol{old}}, \boldsymbol{t}^{\boldsymbol{old}}\right)\left(\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU,l}}\right)' > 0. \tag{110}$$

In principle, the sign of the relevant gradient and, therefore, the sign of post-disintegration trade taxes $\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU,l}}$ 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:

$$\left(\boldsymbol{t^{old}_{EU,TA}}, \boldsymbol{t^{old}_{l,TA}}\right) := \underset{\left(\boldsymbol{t_{EU,TA}}, \boldsymbol{t_{l,TA}}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l, TA\}} W_m\left(\cdot\right) \tag{111}$$

and

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

$$\left(\boldsymbol{t^{new}_{l,TA}}\right) := \underset{\left(\boldsymbol{t_{l,TA}}\right)}{arg\ max}\ W_l\left(\cdot\right) + W_{TA}\left(\cdot\right).$$

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

$$-\nabla_{\boldsymbol{t_{EU,TA}}} W_l\left(\boldsymbol{\tau^{old}}, \boldsymbol{t^{old}}\right)\left(\boldsymbol{t^{new}_{EU,TA}} - \boldsymbol{t^{old}_{EU,TA}}\right)' > 0$$

which implies together with Assumption 2

$$\boldsymbol{t^{new}_{EU,TA}} < \boldsymbol{t^{old}_{EU,TA}}. \tag{112}$$

By similar arguments,

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

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

$$\boldsymbol{t^{new}_{l,TA}} < \boldsymbol{t^{old}_{l,TA}}. \tag{113}$$

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

$$\left(\boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU},Rest}, \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{l},Rest}\right) := \underset{\left(\boldsymbol{t}_{\boldsymbol{EU},Rest}, \boldsymbol{t}_{\boldsymbol{l},Rest}\right)}{arg\ max} \sum_{m \in \mathscr{K}_{EU} \cup \{l\}} W_m\left(\cdot\right) \tag{114}$$

and

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

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

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

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

and

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

One can conclude that

$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU},Rest} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU},Rest} \tag{115}$$

and

$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{l},Rest} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{l},Rest}. \tag{116}$$

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)**.** *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,*

$$\boldsymbol{\tau}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}} < \boldsymbol{\tau}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}.$$

If country l also leaves the customs union,

$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU,TA}} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU,TA}},$$
$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{l,TA}} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{l,TA}},$$
$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{EU},Rest} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{EU},Rest},$$

and

$$\boldsymbol{t}^{\boldsymbol{new}}_{\boldsymbol{l},Rest} < \boldsymbol{t}^{\boldsymbol{old}}_{\boldsymbol{l},Rest}.$$

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.

5.1.2 Harmonization of Production Standards and Business Regulations

Similar in spirit to above, one may endogenize the degree of harmonization inside the economic union, measured by $\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}$. That is, member countries efficiently bargain over the harmonization of production standards and business regulations and, therefore, indirectly over firm mobility inside the union. Similar to Assumption 2, let the following assumption hold.

Assumption 3. *Let* $\nabla_{\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}} W_l \left(\boldsymbol{\tau}, \boldsymbol{t}, \overline{\boldsymbol{F}}\right) > 0.$

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 $\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}$ makes tax bases inside the economic union less elastic. The resulting rise in taxes 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 (Section 5.4).

Using our approach one can observe that

$$- \nabla_{\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}} W_l \left(\boldsymbol{\tau}^{\boldsymbol{old}}, \boldsymbol{t}^{\boldsymbol{old}}, \overline{\boldsymbol{F}}^{\boldsymbol{old}}\right) \left(\overline{\boldsymbol{F}}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}} - \overline{\boldsymbol{F}}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}\right)' > 0 \tag{117}$$

such that for $\nabla_{\overline{\boldsymbol{F}}_{\boldsymbol{EU,EU}}} W_l \left(\boldsymbol{\tau}^{\boldsymbol{old}}, \boldsymbol{t}^{\boldsymbol{old}}, \overline{\boldsymbol{F}}^{\boldsymbol{old}}\right) > 0$ the remaining member countries harmonize more with each other and firms become more mobile inside the economic union compared to the pre-disintegration policy, which we summarize in Proposition 8.

Proposition 8 (endogenous harmonization responses to disintegration)**.** *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 3 hold. Then,*

$$\overline{\boldsymbol{F}}^{\boldsymbol{new}}_{\boldsymbol{EU,EU}} < \overline{\boldsymbol{F}}^{\boldsymbol{old}}_{\boldsymbol{EU,EU}}.$$

5.2 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, applying the envelope theorem, welfare in country i positively depends on non-tariff trade costs between two other countries m and k

$$\begin{aligned} \frac{dW_i}{d\tau_{mk}} &= \frac{1}{2\overline{F}} \left(t_i - \sum_{l \in \mathscr{K} \setminus \{i\}} 1\left[l = m\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l \in \mathscr{K} \setminus \{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{im} \right) \left(\frac{dt_m}{d\tau_{mk}} - \frac{\partial \gamma^{im}}{\partial \tau_{mk}} \right) \\ &+ \frac{1}{2\overline{F}} \left(t_i - \sum_{l \in \mathscr{K} \setminus \{i\}} 1\left[l = k\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l \in \mathscr{K} \setminus \{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ik} \right) \left(\frac{dt_k}{d\tau_{mk}} - \frac{\partial \gamma^{ik}}{\partial \tau_{mk}} \right) \\ &+ \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i,m,k\}} \left(\frac{dt_j}{d\tau_{mk}} - \frac{\partial \gamma^{ij}}{\partial \tau_{mk}} \right) \left(t_i - \sum_{l \in \mathscr{K} \setminus \{i\}} 1\left[l = j\right] imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l \in \mathscr{K} \setminus \{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} \right) > 0 \end{aligned} \tag{118}$$

since

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

for small trade taxes and $\frac{dt_j}{d\tau_{mk}} > 0$, $\frac{\partial \gamma^{ij}}{\partial \tau_{mk}} = 0$, $\Delta_i^{im} < 0$, and $\Delta_i^{ik} < 0$.

Similarly, for tariffs $t_{mk} = imt_{mk} + ext_{mk}$ that may include import taxes

$$\begin{aligned}\frac{dW_i}{dimt_{mk}} &= \frac{1}{2\overline{\overline{F}}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1[l=m]\, imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right) \\ &\times \left(\frac{dt_m}{dimt_{mk}} + \frac{dt_k}{dimt_{mk}} - \frac{\partial \gamma^{im}}{\partial imt_{mk}} - \frac{\partial \gamma^{ik}}{\partial imt_{mk}}\right) \\ &+ \frac{1}{2\overline{\overline{F}}} \sum_{j\in\mathscr{K}\setminus\{i,m,k\}} \left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1[l=m]\, iimt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta}\right) \frac{dt_j}{dimt_{mk}} > 0\end{aligned} \tag{119}$$

and export taxes

$$\begin{aligned}\frac{dW_i}{dext_{mk}} &= \frac{1}{2\overline{\overline{F}}}\left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1[l=m]\, imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_i \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta} - \Delta_i^{ij}\right) \\ &\times \left(\frac{dt_m}{dext_{mk}} + \frac{dt_k}{dext_{mk}} - \frac{\partial \gamma^{im}}{\partial ext_{mk}} - \frac{\partial \gamma^{ik}}{\partial ext_{mk}}\right) \\ &+ \frac{1}{2\overline{\overline{F}}} \sum_{j\in\mathscr{K}\setminus\{i,m,k\}} \left(t_i - \sum_{l\in\mathscr{K}\setminus\{i\}} 1[j=l]\, imt_{il} n_i \frac{\alpha - w - \tilde{\tau}_{il}}{4\beta} + \sum_{l\in\mathscr{K}\setminus\{i\}} ext_{li} n_l \frac{\alpha - w - \tilde{\tau}_{li}}{4\beta}\right) \frac{dt_j}{dext_{mk}} > 0\end{aligned} \tag{120}$$

as

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

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

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

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

and

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

for small trade taxes and similar trade costs (see Appendix 4.1).

5.3 Repercussions on Tax Policies

In this section, we derive the augmented trade-cost effect. That is, we do not only consider the exogenously driven rise in trade costs between a leaving country l and the remaining member countries $m \in \mathscr{K}_{EU}$, but also the endogenous downward adjustment in trade costs inside the remaining economic union.

The overall effect on the leaving country's business tax reads as

$$\sum_{m\in\mathscr{K}_{EU}} \frac{dt_l}{d\tau_{ml}} - \frac{1}{2} \sum_{m\in\mathscr{K}_{EU}} \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_l}{d\tau_{jm}} = \left(n_l (K-2) - \overline{n}_{EU} \left[2(K-1)^2 + (2K-3)(K_{EU}-1) + 1\right]\right) \times \frac{3K_{EU}}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}, \tag{121}$$

which is negative for $n_l < \overline{n}_{EU} \frac{2(K-1)^2+1+(2K-3)(K_{EU}-1)}{K-2}$. Without the readjustment of trade policies inside the union, the according condition was $n_l < \overline{n}_{EU} \frac{2(K-1)^2+1}{K-2}$.

The augmented trade-cost effect on the remaining member countries taxes is given by

$$\begin{aligned} &\frac{dt_m}{d\tau_{ml}} + \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_m}{d\tau_{jl}} - \sum_{j\in\mathscr{K}_{EU}\setminus\{m\}} \frac{dt_m}{d\tau_{mj}} - \frac{1}{2} \sum_{l\in\mathscr{K}_{EU}\setminus\{m\}} \sum_{j\in\mathscr{K}_{EU}\setminus\{m,l\}} \frac{dt_m}{d\tau_{jl}} \\ &= \left(\left(2(K-1)^2 + 2(K_{EU}-1)(K-1) + 1\right) K_{EU}\overline{n}_{EU} - 2(K-1)\, n_l (K-K_{EU}) \right. \\ &\left. - \left(2(K-1)^2 + 2K - K_{EU}\right) n_m + K_{EU}(n_l - \overline{n}_{EU})\right) \frac{3}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}. \end{aligned} \tag{122}$$

Under symmetric market sizes the equation simplifies to

$$\begin{aligned} ... = &\left(\left(2(K-1)^2 + 2K_{EU}(K-1) + 4(K-K_{EU})\right)(K_{EU}-1) - 2K(K-K_{EU})\right) \\ &\times \frac{3n}{(K-1)(2K-1)} \frac{\alpha - w - \tau}{16\beta}, \end{aligned}$$

which is increasing in K_{EU} and positive for $K_{EU} = 2$. Therefore, for all $K_{EU} \geq 2$, the equation is positive.

The augmented effect on third countries writes as

$$\sum_{j\in\mathscr{K}_{EU}}\frac{dt_k}{d\tau_{jl}}-\frac{1}{2}\sum_{m\in\mathscr{K}_{EU}}\sum_{j\in\mathscr{K}_{EU}\setminus\{m\}}\frac{dt_k}{d\tau_{jm}}=-\frac{3K_{EU}\left(2K-3\right)}{\left(K-1\right)\left(2K-1\right)}\frac{\alpha-w-\tau}{16\beta}\left(\left(K_{EU}-2\right)\bar{n}_{EU}-n_l\right), \quad (123)$$

which is negative if $n_l<\left(K_{EU}-2\right)\bar{n}_{EU}$.

5.4 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 taxes of country i and j. More formally,

$$\frac{dW_k}{d\overline{F}^{ij}}=\frac{dW_k}{dt_i}\frac{dt_i}{d\overline{F}^{ij}}+\frac{dW_k}{dt_j}\frac{dt_j}{d\overline{F}^{ij}}. \quad (124)$$

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 $\frac{dt_j}{d\overline{F}^{ij}}>0$ for $\overline{F}^{ij^{new}}\approx\overline{F}^{kj^{new}}\approx\overline{F}^{ki^{new}}$.

5.5 Endogenous Entry into the Economic Union

A candidate country $n\in\mathscr{K}\setminus\{\mathscr{K}_{EU}\cup l\}$ enters the union if and only if $W_n^{entry}+\kappa_n>W_n^{no\,entry}$ with a country-specific entry taste shock $\kappa_n\sim P\left(\kappa_n\right)$. Without any further accession criteria, the probability of joining reads as $1-P\left(W_n^{no\,entry}-W_n^{entry}\right)$. Suppose that countries are symmetric in their trade costs and population sizes. Let tariffs be negligible. Under these conditions, the more country n can tax, the more a rise in third countries' trade costs raises country n's welfare: $\frac{dW_n}{d\tau_{mk}}\propto t_n$. Then, a rise in trade costs between two countries m and k affects the probability of entering proportionally to the change in business taxes

$$
\begin{aligned}
\frac{d\left[1-P\left(W_n^{no\,entry}-W_n^{entry}\right)\right]}{d\tau_{mk}} &= -P'\left(W_n^{no\,entry}-W_n^{entry}\right)\left[\frac{dW_n^{no\,entry}}{d\tau_{mk}}-\frac{dW_n^{entry}}{d\tau_{mk}}\right] \\
&\propto \frac{dW_n^{entry}}{d\tau_{mk}}-\frac{dW_n^{no\,entry}}{d\tau_{mk}} \\
&= \frac{3n\left(\alpha-w-\tilde{\tau}_{mk}\right)}{8\beta\overline{F}}\frac{\left(2K-3\right)\left(K-1\right)-2}{\left(K-1\right)\left(2K-1\right)}\left(t_n^{entry}-t_n^{no\,entry}\right) \\
&\propto t_n^{entry}-t_n^{no\,entry} \qquad (125)
\end{aligned}
$$

Inverting Proposition 5 (a), a country n's business tax is higher when it enters the economic union ($t_n^{entry} > t_n^{no\,entry}$). There are two effects on trade costs. Firstly, country l's disintegration raises trade costs between l and member countries m ($\tau_{ml}\uparrow\ \forall m\in\mathscr{K}_{EU}$). The effect on the entry probability is positive

$$
\sum_{m\in\mathscr{K}_{EU}}\frac{d\left[1-P\left(W_n^{no\,entry}-W_n^{entry}\right)\right]}{d\tau_{ml}} = K_{EU}\cdot\frac{3n\left(\alpha-w-\tilde{\tau}\right)}{8\beta\overline{F}}\frac{\left(2K-3\right)\left(K-1\right)-2}{\left(K-1\right)\left(2K-1\right)}\left(t_n^{entry}-t_n^{no\,entry}\right)>0. \qquad (126)
$$

Secondly, by Proposition 7, member countries lower their internal trade costs in response to country l's exit ($\tau_{mj}\downarrow\ \forall m,j\in\mathscr{K}_{EU}$). This trade cost response lowers the entry probability

$$
\begin{aligned}
&\frac{1}{2}\sum_{m\in\mathscr{K}_{EU}}\sum_{j\in\mathscr{K}_{EU}\setminus\{m\}}\frac{d\left[1-P\left(W_n^{no\,entry}-W_n^{entry}\right)\right]}{d\left(-\tau_{mj}\right)} \\
&= -\frac{1}{2}K_{EU}\left(K_{EU}-1\right)\cdot\frac{3n\left(\alpha-w-\tilde{\tau}\right)}{8\beta\overline{F}}\frac{\left(2K-3\right)\left(K-1\right)-2}{\left(K-1\right)\left(2K-1\right)}\left(t_n^{entry}-t_n^{no\,entry}\right)>0. \qquad (127)
\end{aligned}
$$

Taking stock, country n is less likely to enter the union

$$
\begin{aligned}
&\sum_{m\in\mathscr{K}_{EU}}\frac{d\left[1-P\left(W_n^{no\,entry}-W_n^{entry}\right)\right]}{d\tau_{ml}}-\frac{1}{2}\sum_{m\in\mathscr{K}_{EU}}\sum_{j\in\mathscr{K}_{EU}\setminus\{m\}}\frac{d\left[1-P\left(W_n^{no\,entry}-W_n^{entry}\right)\right]}{d\tau_{mj}} \\
&= -K_{EU}\left(\frac{1}{2}\left(K_{EU}-1\right)-1\right)\cdot\frac{3n\left(\alpha-w-\tilde{\tau}\right)}{8\beta\overline{F}}\frac{\left(2K-3\right)\left(K-1\right)-2}{\left(K-1\right)\left(2K-1\right)}\left(t_n^{entry}-t_n^{no\,entry}\right)<0. \qquad (128)
\end{aligned}
$$

for $K_{EU} > 3$.

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