Online Appendix for "A Theory of Economic Disintegration"

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Abstract

This is the Online Appendix for "A Theory of Economic Disintegration." In Section 1, we analyze other dimensions of economic disintegration, characterizing a union-size, a de-harmonization, and a business-friction effect. Section 2 deals with a modified set of policy instruments. Section 3 formalizes a labor market with endogenous, country-specific wage levels. Finally, Section 4 extends the baseline setup on the consumer and firm side.

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1 Other Dimensions of Disintegration

1.1 Union-Size Effect

Let $n := n_i$ for all $i \in \mathscr{K}$. Moreover, let internal and external trade costs be symmetric, $\tau^* := \tau_{ij}$ for all $i, j \in \mathscr{K}_U$ with $i \neq j$ and $\tau := \tau_{kn} > \tau^*$ for all $k \in \mathscr{K}$ and $n \in \mathscr{K} \backslash \mathscr{K}_U$ with $k \neq n$. Let $K_U > 1$. Under these assumption, the business tax of a member country $m \in \mathscr{K}_U$ simplifies to

$$t_m = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{[(K-1)(2K-2K_U+1)+K_U](K_U-1)}{(K-1)(2K-1)}\frac{3n(\tau-\tau^*)[2(\alpha-w)-(\tau+\tau^*)]}{32\beta}, \tag{1.1}$$

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

$$t_n = 3\overline{F} + 3n\frac{\tau^2 - 2\tau(\alpha - w)}{32\beta} + \frac{K_U(K_U - 1)(2K - 3)}{(K-1)(2K-1)}\frac{3n(\tau^* - \tau)[2(\alpha - w) - (\tau + \tau^*)]}{32\beta}. \tag{1.2}$$

First of all, note that

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

Hence, $t_n < t_m$ whenever $\tau > \tau^*$ and $K_U > 1$. If $K_U = 1$ or $\tau^* = \tau$ (which we rule out by assumption), then $t_n = t_m$.

As a next step, differentiate t_m with respect to the number of member countries, as if it were defined on a continuous domain

$$\frac{dt_m}{dK_U} = \frac{(K-1)[(2K-1) - 4(K_U - 1)] + 2K_U - 1}{(K-1)(2K-1)}\frac{3n(\tau - \tau^*)[2(\alpha - w) - (\tau + \tau^*)]}{32\beta}. \tag{1.3}$$

This expression is positive by the following argument. Firstly, note that the sign of $\frac{dt_m}{dK_U}$ is the same as the sign of $\phi(K)$, where $\phi(K) := (K-1)[(2K-1) - 4(K_U - 1)] + 2K_U - 1$. Then, observe that $\phi(K)$ is positive, since $\phi(1) = 2K_U - 1 > 0$ and $\phi'(K) = (4K-3) - 4(K_U - 1) > 4(K-1) - 4(K_U - 1) \geq 0$, $\forall K \geq K_U \geq 1$.

The other derivatives are also intuitive

$$\frac{dt_m}{d\tau^*} = -\frac{[(K-1)(2K - 2K_U + 1) + K_U](K_U - 1)}{(K-1)(2K-1)}\frac{6n(\alpha - w - \tau^*)}{32\beta} < 0 \tag{1.4}$$

and

$$\begin{aligned}
\frac{dt_m}{d\tau} &= -\frac{6n(\alpha - w - \tau)}{32\beta} + \frac{[(K-1)(2K - 2K_U + 1) + K_U](K_U - 1)}{(K-1)(2K-1)}\frac{6n(\alpha - w - \tau)}{32\beta} \\
&= \frac{(K-1)[2K(K_U - 2) - 2K_U(K_U - 1) + 3K_U] + K_U(K_U - 1)}{(K-1)(2K-1)}\frac{6n(\alpha - w - \tau)}{32\beta} \\
&> \frac{(K-1)K_U[2(K_U - 2) - 2(K_U - 1) + 3] + K_U(K_U - 1)}{(K-1)(2K-1)}\frac{6n(\alpha - w - \tau)}{32\beta} \\
&= \frac{(K-1)K_U[-4 + 2 + 3] + K_U(K_U - 1)}{(K-1)(2K-1)}\frac{6n(\alpha - w - \tau)}{32\beta} > 0.
\end{aligned} \tag{1.5}$$

The comparative statics of t_n are given by

$$\frac{dt_n}{dK_U} = \frac{(2K_U - 1)(2K - 3)}{(K-1)(2K-1)}\frac{3n(\tau^* - \tau)[2(\alpha - w) - (\tau + \tau^*)]}{32\beta} < 0,$$

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

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

The average worldwide business tax $\bar{t} = \frac{K_U}{K}t_m + \frac{K-K_U}{K}t_n$ can be written as

$$\bar{t} = 3\overline{F} - \frac{3n\left[2\tau(\alpha - w) - \tau^2\right]}{32\beta} + \frac{K_U(K_U - 1)}{K(K-1)}\frac{3n(\tau - \tau^*)\left[2(\alpha - w) - (\tau + \tau^*)\right]}{32\beta},$$

which is decreasing in the number of competing markets K. Moreover, the size of the business-tax differential between member and non-member countries depends on the degree of economic integration in the world economy. Note that as the number of countries grows large, business taxes do not diverge

$$\lim_{K\to\infty} t_m = \lim_{K\to\infty} t_n + 3n(K_U - 1)(\tau - \tau^*)\frac{2(\alpha - w) - (\tau + \tau^*)}{32\beta}, \tag{1.6}$$

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

1.2 De-Harmonization Effect

We start with deriving the government objective function. Setting the non-policy component to zero ($\epsilon = \underline{\epsilon} = \overline{\epsilon} = 0$),[1] a firm's location cost draw is $F^{ij} = \nu^j - \nu^i + \epsilon^{ij}$, where $\epsilon^{ij} \in \left[\underline{\epsilon}^{ij}, \overline{\epsilon}^{ij}\right]$ is uniformly distributed around zero ($\overline{\epsilon}^{ij} \equiv -\underline{\epsilon}^{ij}$). Also, note that by definition $\overline{\epsilon}^{ij} = \overline{\epsilon}^{ji}$,$\underline{\epsilon}^{ij} = \underline{\epsilon}^{ji}$, $\overline{F}^{ij} - \underline{F}^{ij} = \overline{F}^{ji} - \underline{F}^{ji}$, $\epsilon^{ij} = -\epsilon^{ji}$, and $F^{ij} = -F^{ji}$. Accordingly, Lemma (1) from the main text still holds. That is, $G^{ij}\left(F^{ij}\right) = \frac{F^{ij}-\underline{F}^{ij}}{\overline{F}^{ij}-\underline{F}^{ij}} = \frac{\overline{F}^{ji}-F^{ji}}{\overline{F}^{ji}-\underline{F}^{ji}} = 1 - G^{ij}\left(F^{ij}\right)$ and $k_i := (K-1) + \sum_{j\in\mathcal{K}\backslash i}\frac{\overline{F}^{ij}-\gamma^{ij}}{\overline{F}^{ij}-\underline{F}^{ij}}$. Consumer surplus in country i then reads as

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

[1] This is without loss of generality because $\overline{\epsilon}^{ij}$ and $\underline{\epsilon}^{ij}$ can always be redefined such that $\overline{\overline{\epsilon}}^{ij} \equiv \overline{\epsilon}^{ij} + \overline{\epsilon}$ and $\underline{\underline{\epsilon}}^{ij} \equiv \underline{\epsilon}^{ij} + \underline{\epsilon}$.

where $\gamma^{ij} := \tilde{\gamma}^{ij} + t_i - t_j$ still denotes the threshold firm in ij-industries, and δ_i^{jl} and Δ_i^{jl} denote the consumer-surplus levels and differentials. The first-order condition

$$\frac{d\left(S_i+T_i+n_i w\right)}{dt_i} = \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{1}{\overline{F}^{ij}-\underline{F}^{ij}} \frac{d\gamma^{ij}}{dt_i}\Delta_i^{ij} + (K-1) + \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{\overline{F}^{ij}-\gamma^{ij}}{\overline{F}^{ij}-\underline{F}^{ij}} + t_i \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{1}{\overline{F}^{ij}-\underline{F}^{ij}}\left(-\frac{d\gamma^{ij}}{dt_i}\right) = 0 \tag{1.7}$$

is sufficient by the second order condition $\frac{d^2(S_i+T_i+n_i w)}{dt_i^2} = \sum_{j\in\mathscr{K}\setminus\{i\}} \frac{-2}{\overline{F}^{ij}-\underline{F}^{ij}} < 0$ and pins down each country's reaction function. Their intersection delivers the Nash equilibrium business taxes.

In the following, we derive comparative statics of the Nash equilibrium with respect to a mean-preserving spread in relocation costs: $\frac{dt_i}{d\overline{\epsilon}^{ij}}$ and $\frac{dt_k}{d\overline{\epsilon}^{ij}}$ for $k \neq i, j$. Observe that (1.7) defines a system of algebraic equations where each equation is given by a (Fredholm-type) summation equation. To simplify the exposition, we now impose several parameter restriction. Firstly, by setting $\nu^j = \nu^i$, we abstract from asymmetries in business frictions (see later for more details on these). Secondly, we evaluate the comparative statics around a special case: initially, countries i and j are fully symmetric (leading to $t_i = t_j$) and all countries are symmetric in their relocation-cost distributions ($\overline{F}^{ij} - \underline{F}^{ij} = \overline{F}^{jk} - \underline{F}^{jk} = 2\overline{F}$, $\forall i \neq j \neq k$). Then, using the implicit function theorem, we make the following observations about each country's reaction function:

$$\frac{\partial t_i\left(\left\{t_j\right\}_{j\neq i}, \left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{\partial t_j} = \frac{\frac{1}{\overline{F}^{ij}-\underline{F}^{ij}}}{2\sum_{j\in\mathscr{K}\setminus\{i\}} \frac{1}{\overline{F}^{ij}-\underline{F}^{ij}}} = \frac{1}{2(K-1)} \in (0,1),$$

$$\frac{\partial t_i\left(\left\{t_j\right\}_{j\neq i}, \left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{\partial \overline{\epsilon}^{ij}} = \frac{\partial t_j\left(\left\{t_j\right\}_{j\neq i}, \left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{\partial \overline{\epsilon}^{ij}} \propto -\frac{\Delta_i^{ij} - \tilde{\gamma}^{ij} - 2t_i + t_j}{2\overline{F}^2} > 0,$$

and

$$\frac{\partial t_i\left(\left\{t_j\right\}_{j\neq i}, \left\{\overline{\epsilon}^{ij}\right\}_{j\neq i}\right)}{\partial \overline{\epsilon}^{jk}} = 0.$$

The first derivative establishes the existence of a unique Nash equilibrium. The derivative with respect to $\overline{\epsilon}^{ij}$ shows that a mean-preserving spread in firms' relocation costs shifts up the reaction functions of countries i and j ($\overline{\epsilon}^{jk}$ has no direct effect). Recall that the firm-relocation semi-elasticity (= inverse number of firms) serves as a sufficient statistic for business taxation and that, under revenue maximization, the reaction function is given by the firm number $t_i = -1/\frac{\partial \ln(k_i)}{\partial t_i}$. Accordingly, a mean-preserving spread in relocation costs moves the reaction function upwards because it reduces the relocation semi-elasticity of firms in the respective countries.

In the Nash equilibrium, there are not only these direct shifts of reaction functions but also equilibrium responses

$$\frac{dt_i\left(\left\{t_j\right\}_{j\neq i},\left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{d\overline{\epsilon}^{ij}}=\frac{\partial t_i\left(\left\{t_j\right\}_{j\neq i},\left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{\partial\overline{\epsilon}^{ij}}+\sum_{j\in\mathcal{K}\setminus\{i\}}\underbrace{\frac{\partial t_i\left(\left\{t_j\right\}_{j\neq i},\left\{\overline{F}^{ij}\right\}_{j\neq i}\right)}{\partial t_j}}_{=\frac{1}{2(K-1)}}\frac{dt_j\left(\left\{t_k\right\}_{k\neq j},\left\{\overline{F}^{jk}\right\}_{k\neq j}\right)}{d\overline{\epsilon}^{ij}}$$

or, in matrix form,

$$\begin{pmatrix}\frac{dt_1}{d\overline{\epsilon}^{ij}}\\ \frac{dt_2}{d\overline{\epsilon}^{ij}}\\ \vdots\\ \frac{dt_K}{d\overline{\epsilon}^{ij}}\end{pmatrix}=\begin{pmatrix}1 & -\frac{1}{2(K-1)} & \cdots & -\frac{1}{2(K-1)}\\ -\frac{1}{2(K-1)} & 1 & & \vdots\\ \vdots & & \ddots & -\frac{1}{2(K-1)}\\ -\frac{1}{2(K-1)} & \cdots & -\frac{1}{2(K-1)} & 1\end{pmatrix}^{-1}\begin{pmatrix}\frac{\partial t_1(\cdot)}{\partial\overline{\epsilon}^{ij}}\\ \frac{\partial t_2(\cdot)}{\partial\overline{\epsilon}^{ij}}\\ \vdots\\ \frac{\partial t_K(\cdot)}{\partial\overline{\epsilon}^{ij}}\end{pmatrix}=\frac{2(K-1)}{(2K-1)(K-1)}\begin{pmatrix}K & 1 & \cdots & 1\\ 1 & K & & \vdots\\ \vdots & & \ddots & 1\\ 1 & \cdots & 1 & K\end{pmatrix}\begin{pmatrix}\frac{\partial t_1(\cdot)}{\partial\overline{\epsilon}^{ij}}\\ \frac{\partial t_2(\cdot)}{\partial\overline{\epsilon}^{ij}}\\ \vdots\\ \frac{\partial t_K(\cdot)}{\partial\overline{\epsilon}^{ij}}\end{pmatrix}.$$

To conclude the proof, let, without loss of generality, $i=1$ and $j=2$ such that

$$\begin{pmatrix}\frac{dt_1}{d\overline{F}^{ij}}\\ \frac{dt_2}{d\overline{F}^{ij}}\\ \frac{dt_3}{d\overline{F}^{ij}}\\ \vdots\\ \frac{dt_K}{d\overline{F}^{ij}}\end{pmatrix}=\frac{2(K-1)}{(2K-1)(K-1)}\begin{pmatrix}(K+1)\\ (K+1)\\ 2\\ \vdots\\ 2\end{pmatrix}\frac{\partial t_1(\cdot)}{\partial\overline{\epsilon}^{12}}>0.$$

1.3 Business-Friction Effect

To derive the business-friction effect, observe that, for $\overline{F}^{ij}=-\underline{F}^{ij}=\overline{F}$, $\forall i\neq j$, the reaction function (1.7), simplifies to a version of the one in the main text

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

Applying the same steps, we derive the Nash equilibrium business taxation

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

Accordingly, a country's business tax declines in the level of local business frictions, and increases with frictions abroad:

$$\frac{dt_i}{d\nu^i}=-\frac{K-1}{2K-1}<0\quad\text{and}\quad\frac{dt_i}{d\nu^j}=\frac{1}{2K-1}>0.$$

2 Policy Instruments

2.1 Tariff Revenues

We extend the notion of trade costs to both non-tariff barriers and tariffs. That is, trade costs from country j to country i, $\tau_{ij} = \tau_{ij}^t + \tau_{ij}^p + \tau_{ij}^n$, are the sum of import taxes by the domestic government in country i, $\tau_{ij}^t \in \mathbb{R}$, and non-tariff barriers, $\tau_{ij}^p + \tau_{ij}^n \in \mathbb{R}_+$. We abstract from export subsidies (see our working-paper version Janeba and Schulz [2021] for more details). 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.[2] We 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 imports from country l to country i is given by

$$M_{il}^{ij} = G\left(\gamma^{ij}\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_l^{ij} x_{il}^{ij}|_{k_i^{ij}=2}. \tag{2.1}$$

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 in industry ij are given by $R_i^{ij} = \sum_{l \in \mathscr{K} \setminus \{i\}} \tau_{ij}^t M_{il}^{ij}$.[3] Therefore, we can write the overall tariff revenues in country i as $R_i = \sum_{j \in \mathscr{K} \setminus \{i\}} R_i^{ij} + \frac{1}{2} \sum_{k \in \mathscr{K} \setminus \{i\}} \sum_{l \in \mathscr{K} \setminus \{i,k\}} R_i^{kl}$. This yields the following objective function of the government in country i:

$$W_i := \max_{t_i} S_i + T_i + n_i w + R_i.$$

As before, the first-order condition is sufficient and there exists a unique equilibrium of the

[2] 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 would lead to the entry of firms such that domestic consumer prices decrease. However, it may be the case for the average price. To be precise, this occurs when a very sizable 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.

[3] If export subsidies, τ_{ij}^s, were allowed, revenues/expenditures would read as $R_i^{ij} = \sum_{l \in \mathscr{K} \setminus \{i\}} \tau_{ij}^t M_{il}^{ij} + \sum_{l \in \mathscr{K} \setminus \{i\}} \tau_{li}^s X_{li}^{ij}$, where $X_{li}^{ij} = G\left(\gamma^{ij}\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=1} + \left(1 - G\left(\gamma^{ij}\right)\right) k_i^{ij} x_{li}^{ij}|_{k_i^{ij}=2}$ is the export volume.

tax-competition game. Apply the same steps as in the base model to obtain the equilibrium taxes

$$
\begin{aligned}
t_i = {} & 3\overline{F} + \frac{1}{2K-1}\sum_{j\in\mathcal{K}\backslash\{i\}}\Delta_i^{ij} + \frac{1}{2K-1}\sum_{j\in\mathcal{K}\backslash\{i\}}\left(\pi_i^{ij}-\pi_j^{ij}\right) + \frac{1}{(K-1)(2K-1)}\sum_{j\in\mathcal{K}}\sum_{m\in\mathcal{K}\backslash\{j\}}\Delta_j^{jm} \\
& + \frac{1}{2K-1}\sum_{j\in\mathcal{K}\backslash\{i\}}\sum_{l\in\mathcal{K}\backslash\{i\}}\tau_{il}^t\left(2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2}\right) \\
& + \frac{1}{(K-1)(2K-1)}\sum_{m\in\mathcal{K}}\sum_{j\in\mathcal{K}\backslash\{m\}}\sum_{l\in\mathcal{K}\backslash\{m\}}\tau_{ml}^t\left(2x_{ml}^{mj}|_{k_m^{mj}=1} - x_{ml}^{mj}|_{k_m^{mj}=2}\right).
\end{aligned}
\tag{2.2}
$$

Observe that for $\tau_{ml}^t = 0$, $\forall m, l$, we obtain Proposition 1 of the main text. The optimal business tax is, now, modified by the marginal effects of business taxes on tariff revenues (through firm relocation). Since $2x_{li}^{ij}|_{k_i^{ij}=2} - x_{li}^{ij}|_{k_i^{ij}=1} = n_l\frac{\alpha-w-\tau_{li}}{4\beta} > 0$ and $2x_{il}^{ij}|_{k_i^{ij}=1} - x_{il}^{ij}|_{k_i^{ij}=2} = 1[j=l]\, n_i\frac{\alpha-w-\tau_{il}}{4\beta} \geq 0$, taxes are revised upwards for (positive) import tariffs. To gain some intuition, consider a rise in the business tax in a country. As a result, firms move away from that country, and the import volume increases. As a result, the revenues from taxing these imports rise—an additional incentive to raise business taxes from *extra tariff revenues*.

Not surprisingly, the main forces behind in the comparative statics of business taxes with respect to $\tau_{ij} = \tau_{ji} \in \mathbb{R}_+$ and $\tau_{jk} = \tau_{kj} \in \mathbb{R}_+$ (Lemma 3 of the main text) remain valid. The derivative is, however, augmented by the effect of (non-tariff) trade costs on the extra incentive effect. That is,

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

and

$$
\frac{dt_i}{d\tau_{jk}^p}|_{\tau_{jk}=\tau_{kj}} = \frac{(2K-3)(n_j+n_k)}{(K-1)(2K-1)}\frac{3(\alpha-w-\tau_{jk})}{16\beta} - \frac{1}{(K-1)(2K-1)}\frac{\tau_{jk}^t n_j + \tau_{kj}^t n_k}{4\beta}.
$$

Therefore, for positive import tariffs, 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 extra gains in tariff revenues marginally decline.

Furthermore, one can study the effects of tariffs on business taxes. The comparative statics

		τ_{ij}^t	τ_{ji}^t	τ_{jm}^t
consumer surplus (home)		–	0	0
profit differentials (home vs. abroad)		+	–	+
consumer surpluses (abroad)		0	–	–
extra tariff revenues (home)	direct	+	0	0
	indirect	–	0	0
extra tariff revenues (abroad)	direct	0	+	+
	indirect	0	–	–
overall effect		+	–	+

Table 1: (*tariff effect*) Effects of Trade Taxes on Business Tax in Country i (overall effect calculated for small trade taxes and $K > 3$)

of business taxes with respect to trade taxes read as

$$\frac{dt_i}{d\tau_{ij}^t} = n_i \frac{(7K-6)\left(\alpha - w - \tau_{ij}\right) - 4K\tau_{ij}^t}{(K-1)(2K-1)16\beta},$$

$$\frac{dt_i}{d\tau_{ji}^t} = -n_i \frac{\left[6(K-1)^2 - 1\right]\left(\alpha - w - \tau_{ji}\right) - 4\tau_{ji}^t}{(K-1)(2K-1)16\beta},$$

and

$$\frac{dt_i}{d\tau_{jm}^t} = n_j \frac{(6K-5)\left(\alpha - w - \tau_{jm}\right) - 4\tau_{jm}^t}{(K-1)(2K-1)16\beta},$$

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 increases tariffs on imports from country j ($\tau_{ij}^t \uparrow$). 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 unit trade costs firms in country j face. The impact on the extra tariff revenues from business taxation are ambiguous. On the one hand, a higher import tariff mechanically increases the size of tariff revenues, which the government can influence by the level of business taxation (positive direct effect). On the other hand, the rise in import tariffs lowers import volumes such that the extra gains from tariff revenues become smaller (negative indirect effect). For initially small tariffs (and $K > 3$), the business taxes in country i, t_i, and import tariffs, τ_{ij}^t, positively correlate. However, the sign of $\frac{dt_i}{d\tau_{ij}^t}$ is negative for a large τ_{ij}^t. Therefore, the relationship between domestic taxes and import tariffs is hump-shaped. Similarly, this is the case with τ_{jm}^t. However, business taxes in country i are U-shaped in tariffs on firms in country i (τ_{ji}^t). This result is similar to Proposition 1 in Haufler and Wooton [2010], although here we explicitly deal with tariffs that have revenue effects.

2.2 Competition in Regulations

We endogenize the country-specific level of regulations, ν^i. In the first stage of our economy, 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 noncooperatively over the setting of business regulations. By the envelope theorem, country i's welfare declines in ν^i

$$\frac{d\left(S_i + T_i + n_i w\right)}{d\nu^i} = \frac{1}{2\overline{F}}\left[\sum_{j \in \mathcal{K}\setminus\{i\}} \Delta_i^{ij} - (K-1)\, t_i\right] < 0, \tag{2.3}$$

for $t_i > 0$. Two negative effects on welfare add up. Firstly, a rise in ν^i lowers consumer surplus because it triggers firm losses in 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 $V_i\left(\nu^i\right)$ measure in reduced form the regulation surplus function generated from ν^i in country $i \in \mathcal{K}$, where $V_i'\left(\nu^i\right) > 0$ and $V_i''\left(\nu^i\right) < -\frac{K(K-1)}{2\overline{F}(2K-1)}$ for all ν^i. To give an example, 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, $V_i\left(\nu^i, \left\{\nu^j\right\}_{j \neq i}\right)$ could capture 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 taxation of businesses, the government in country i does not take into account the positive externality of firm losses on other countries' welfare $\frac{d(S_j+T_j+n_j w)}{dv^i} > 0$. This leads to an underprovision of regulations (e.g., environmental protection), and countries would gain from coordinating business regulations.

Now, we derive each country's optimal regulation level (reaction function). The first-order condition with respect to v^i

$$\frac{d\left(S_i+T_i+n_i w+V_i\right)}{dv^i}=\frac{1}{2\overline{F}}\left[\sum_{j\in\mathscr{K}\setminus\{i\}}\Delta_i^{ij}-(K-1)\,t_i\right]+V_i'\left(v^i\right)=0 \tag{2.4}$$

determines the optimal level of regulations in country i. Using the expressions from the business-friction effect, business regulations are strategic substitutes:

$$\frac{\partial v^i}{\partial v^j}=-\frac{-\frac{K-1}{2\overline{F}}\frac{dt_i}{dv^j}}{-\frac{K-1}{2\overline{F}}\frac{dt_i}{dv^i}+V_i''\left(v^i\right)}=\frac{1}{K-1+2\overline{F}\frac{2K-1}{K-1}V_i''\left(v^i\right)}<0. \tag{2.5}$$

Since $V_i''\left(v^i\right)<-\frac{K(K-1)}{2\overline{F}(2K-1)}$, the slope of the reaction functions is greater than -1, such that the Nash equilibrium is unique. The first-order condition (2.4) reveals that other domestic policies (here: business regulations) interact with the optimal business-tax policy. Perhaps surprisingly, for positive business taxes, the (partial-equilibrium) comparative statics of regulations and business taxes with respect to trade costs may point in opposite directions. For instance,

$$\frac{\partial v^i}{\partial \tau_{jk}}\propto-\frac{\partial t_i}{\partial \tau_{jk}}. \tag{2.6}$$

The intuition is that a rise in a country's business tax (due to an increase in τ_{jk}) magnifies the size of tax-revenue losses and, thus, the aggregate cost of v^i. In the optimum, this reduces a country's level of business regulations (reaction function).

2.3 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]). That is, a nonempty subset of countries $\mathscr{K}_H$, e.g., the EU, coordinates their level of business taxation to maximize joint welfare $\max_{\{t_m\}_{m\in\mathscr{K}_H}}\sum_{m\in\mathscr{K}_H}\left(S_m+T_m+n_m w\right)$ subject to $t_H := t_m$, $\forall m\in\mathscr{K}_H$. Under this set of constraints, the consumer surplus in the harmonized area reads as

$$\sum_{m\in\mathscr{K}_H} S_m = \sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}_H\setminus\{m\}}\left[\delta_m^{mj} + \frac{\tilde{\gamma}^{mj} - \underline{F}}{2\overline{F}}\Delta_m^{mj}\right] + \sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})}\left[\delta_m^{mj} + \frac{\gamma^{mj} - \underline{F}}{2\overline{F}}\Delta_m^{mj}\right]$$
$$+\frac{1}{2}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})}\sum_{l\in\mathscr{K}_H\setminus\{m,j\}}\left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}}\Delta_m^{jl}\right]$$
$$+\frac{1}{2}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}_H\setminus\{m\}}\sum_{l\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m,j\})}\left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}}\Delta_m^{jl}\right]$$
$$+\frac{1}{2}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}_H\setminus\{m\}}\sum_{l\in\mathscr{K}_H\setminus\{m,j\}}\left[\delta_m^{jl} + \frac{\tilde{\gamma}^{jl} - \underline{F}}{2\overline{F}}\Delta_m^{jl}\right]$$
$$+\frac{1}{2}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})}\sum_{l\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m,j\})}\left[\delta_m^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}}\Delta_m^{jl}\right] \tag{2.7}$$

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

$$\sum_{m\in\mathscr{K}_H} T_m = t_H\sum_{m\in\mathscr{K}_H}\left[(K-1) + \frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}_H\setminus\{m\}}\left(\overline{F} - \tilde{\gamma}^{mj}\right)\right] + t_H\sum_{m\in\mathscr{K}_H}\left[(K-1) + \frac{1}{2\overline{F}}\sum_{j\in\mathscr{K}\setminus(\mathscr{K}_H\cup\{m\})}\left(\overline{F} - \gamma^{mj}\right)\right]. \tag{2.8}$$

The first-order condition of the area is given by

$$\frac{d\sum_{m\in\mathscr{K}_H}(S_m + T_m + n_m w)}{dt_H} = \frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\Delta_m^{mj} + \frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\mathscr{K}_H}\sum_{l\in\mathscr{K}_H\setminus\{m\}}\Delta_m^{lj}$$
$$+\sum_{m\in\mathscr{K}_H}(K-1) + \frac{1}{2\overline{F}}\sum_{m\in\mathscr{K}_H}\sum_{j\in\mathscr{K}\setminus\{m\}}\left(\overline{F} - \gamma^{mj}\right) - t_H\frac{1}{2\overline{F}}K_H(K - K_H) = 0 \tag{2.9}$$

which is sufficient by the second-order condition

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

The reaction function in the harmonized area can be written as

$$t_H = \frac{1}{2\left(K-K_H\right)}\left(\sum_{j\in\mathcal{K}\setminus\mathcal{K}_H}\overline{\Delta}_H^{Hj} + \sum_{j\in\mathcal{K}\setminus\mathcal{K}_H}\overline{\Delta}_H^{H'j} + 3\overline{F}\left(K-1\right) - \sum_{j\in\mathcal{K}\setminus\{m\}}\overline{\tilde{\gamma}}^{Hj} + \sum_{j\in\mathcal{K}\setminus\mathcal{K}_H} t_j\right) \tag{2.10}$$

where we define

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

In the other regions, governments choose their business taxes noncooperatively as before $\max_{t_i} S_i + T_i + n_i w$, yielding the reaction function

$$t_i = \frac{1}{2\left(K-1\right)}\left(\sum_{j\in\mathcal{K}\setminus\{i\}}\Delta_i^{ij} + 3\overline{F}\left(K-1\right) - \sum_{j\in\mathcal{K}\setminus\{i\}}\tilde{\gamma}^{ij} + \sum_{j\in\mathcal{K}\setminus(\mathcal{K}_H\cup\{i\})} t_j + K_H t_H\right) \tag{2.11}$$

for any $i \notin \mathcal{K}_H$. 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 noncooperative tax t_i in country $i \notin \mathcal{K}_H$ is unaltered relative to the case without tax harmonization. The only difference is that $K_H t_H$ replaces $\sum_{j\in\mathcal{K}_H} t_j$. 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 ($\overline{\tilde{\gamma}}^{Hj}$) 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 mechanical 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, $\tilde{\gamma}^{ij} = 0$, $\forall i, j$, $\overline{\tilde{\gamma}}^{Hj} = 0$, $\forall j$, $\overline{\Delta}_H^{H'j} = 0$, $\forall j$, and $\Delta_i^{ij} := \Delta < 0$, $\forall i, j$. The Nash equilibrium business taxes are given by

$$t_H = \frac{3\overline{F}\left(K-1\right)\left(2K-1\right)}{\left(K-K_H\right)\left(2K-2+K_H\right)} + \Delta \text{ and } t_i = t_H - \frac{3\overline{F}\left(K-1\right)\left(K_H-1\right)}{\left(K-K_H\right)\left(2K-2+K_H\right)} \text{ for } i \notin \mathcal{K}_H. \tag{2.12}$$

For $K_H > 1$, taxes inside the harmonized area are higher than outside ($t_H > t_i$). Similar to the union-size effect, 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.

3 Richer Labor Market

Suppose there is no free trade in the numéraire commodity that would equalize the wage rates across countries. Moreover, let each country's wage level w_i form in general equilibrium according to labor supply and demand. Firm profits

$$\pi_i^{ij}(\mu) = \begin{cases} \sum_{k\in\mathcal{K}} \frac{n_k\left(\alpha - w_k - 2\tau_{ik} + \tau_{jk}\right)^2}{16\beta} & \text{if mobile firm locates in i} \\ \sum_{k\in\mathcal{K}} \frac{n_k\left(\alpha - w_k - 3\tau_{ik} + 2\tau_{jk}\right)^2}{16\beta} & \text{if mobile firm locates in j.} \end{cases}$$

lead to new threshold industries

$$\gamma^{ij} = \sum_{k\in\mathcal{K}} n_k\left(\tau_{ik} - \tau_{jk}\right)\frac{6\left(\alpha - w_k\right) - 3\left(\tau_{ik} + \tau_{jk}\right)}{16\beta} + t_i - t_j.$$

Accordingly, tax revenues $T_i := t_i\left[(K-1) + \frac{1}{2\overline{F}}\sum_{j\in\mathcal{K}\setminus\{i\}}\left(\overline{F} - \gamma^{ij}\right)\right]$ and consumer surplus

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

with $\delta_i^{ij} := n_i\frac{\left(3\alpha - 3w_i - \tau_{ij}\right)^2}{32\beta}$, $\delta_i^{jl} := n_i\frac{\left(3\alpha - 3w_i - 2\tau_{ij} - \tau_{il}\right)^2}{32\beta}$, $\Delta_i^{ij} := n_i\frac{\left(3\alpha - 3w_i - 2\tau_{ij}\right)^2 - \left(3\alpha - 3w_i - \tau_{ij}\right)^2}{32\beta}$, and $\Delta_i^{jl} := n_i\frac{\left(3\alpha - 3w_i - \tau_{ij} - 2\tau_{il}\right)^2 - \left(3\alpha - 3w_i - 2\tau_{ij} - \tau_{il}\right)^2}{32\beta}$, depend on equilibrium wage levels $\{w_i\}_{i\in\mathcal{K}}$. In the following, we abstract from labor supply effects, assuming an inelastically supplied labor quantity n_i.[4] Suppose that each production unit requires ζ_i workers. Then, the wage level w_i clears the

[4]Labor supply responses can be easily incorporated by adding an additively separable, increasing, and concave disutility from labor to the the utility function $u_i - v_i(l_i)$. Noting that, by the household budget constraint $z_i + \int_{\mu\in\Omega} p_i(\mu)x_i(\mu)\,d\mu = \frac{T_i}{n_i} + w_i l_i$, labor supply would only depend on the wage level $l_i = (v')^{-1}(w_i)$ and any change in tax revenues that the government rebates to households in lump-sum fashion would have no income effects on labor supply. Any rise in a country's wage level would also increase labor supply, raising national income.

labor market

$$n_i = \zeta_i \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{k\in\mathscr{K}} \underbrace{\left[2\left(1-G\left(\gamma^{ij}\right)\right) x_{ki}^{ij}|_{F^{ij}\geq\gamma^{ij}} + G\left(\gamma^{ij}\right) x_{ki}^{ij}|_{F^{ij}<\gamma^{ij}}\right]}_{:=X_{ki}^{ij}}, \tag{3.1}$$

where $x_{ki}^{ij} = \frac{n_k\left(\alpha - w_i - \left(4-k_i^{ij}\right)\tau_{ik} + k_j^{ij}\tau_{jk}\right)}{4\beta}$ are each firm's production quantities and $k_j^{ij} = k_i^{ij} - 1 = 1$ ($k_j^{ij} = k_i^{ij} + 1 = 2$) if $F^{ij} \geq \gamma^{ij}$ ($F^{ij} < \gamma^{ij}$).

Observe that the right-hand side of (3.1) is the aggregate production quantity, $\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} X_{ki}^{ij}$, scaled by the unit labor requirement, ζ_i. Therefore, without labor supply effects and growth effects that would reduce ζ_i, any change in trade costs leads to a wage-rate adjustment that holds the country's aggregate production quantity (right-hand side) fixed. To make this more formal, differentiate (3.1) with respect to τ_{ik}

$$\begin{aligned}
\frac{\partial w_i}{\partial \tau_{ik}} &= -\frac{\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \tau_{ik}} + \sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \gamma^{ij}}\frac{\partial \gamma^{ij}}{\partial \tau_{ik}}}{\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial w_i} + \sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \gamma^{ij}}\frac{\partial \gamma^{ij}}{\partial w_i}} \\
&= \frac{-\sum_{k\in\mathscr{K}}\frac{n_k}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}}\left[4-G\left(\gamma^{ij}\right)\right] - \frac{1}{2F}\sum_{k\in\mathscr{K}}\frac{n_k(\alpha-w_i-\tau_{ik})}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}} n_k\frac{6(\alpha-w_k-\tau_{ik})}{16\beta}}{\sum_{k\in\mathscr{K}}\frac{n_k}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}}\left[2-G\left(\gamma^{ij}\right)\right] + \frac{1}{2F}\sum_{k\in\mathscr{K}}\frac{n_k(\alpha-w_i-\tau_{ik})}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}}\frac{6n_i\tau_{ij}}{16\beta}} < 0
\end{aligned}$$

and with respect to τ_{jk}

$$\begin{aligned}
\frac{\partial w_i}{\partial \tau_{jk}} &= -\frac{\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \tau_{jk}} + \sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \gamma^{ij}}\frac{\partial \gamma^{ij}}{\partial \tau_{jk}}}{\sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial w_i} + \sum_{j\in\mathscr{K}\setminus\{i\}}\sum_{k\in\mathscr{K}} \frac{\partial X_{ki}^{ij}}{\partial \gamma^{ij}}\frac{\partial \gamma^{ij}}{\partial w_i}} \\
&= \frac{2(K-1)\sum_{k\in\mathscr{K}}\frac{n_k}{4\beta} + \frac{1}{2F}\sum_{k\in\mathscr{K}}\frac{n_k(\alpha-w_i-\tau_{ik})}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}} n_k\frac{6(\alpha-w_k-\tau_{jk})}{16\beta}}{\sum_{k\in\mathscr{K}}\frac{n_k}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}}\left[2-G\left(\gamma^{ij}\right)\right] + \frac{1}{2F}\sum_{k\in\mathscr{K}}\frac{n_k(\alpha-w_i-\tau_{ik})}{4\beta}\sum_{j\in\mathscr{K}\setminus\{i\}}\frac{6n_i\tau_{ij}}{16\beta}} > 0,
\end{aligned}$$

where we hold business taxes fixed (partial-equilibrium comparative statics). Thus, ceteris paribus a country's wage rate declines in own (others') trade costs τ_{ik} (τ_{jk}). The intuition is straightforward. Exports decrease with a country's trade costs, reducing that country's aggregate production level. As a result, domestic firms demand less labor, and the wage level declines. In addition, a rise in trade costs triggers a decline in inward FDI, further lowering the labor-demand curve and the wage level.

By a similar firm-relocation argument, a rise (reduction) in a (another) country's business tax lowers the wage rate:

$$\frac{\partial w_i}{\partial t_i} = \frac{-\frac{1}{2\overline{F}}\sum_{k\in\mathcal{K}}\frac{n_k(\alpha - w_i - \tau_{ik})}{4\beta}(K-1)}{\sum_{k\in\mathcal{K}}\frac{n_k}{4\beta}\sum_{j\in\mathcal{K}\setminus\{i\}}\left[2-G\left(\gamma^{ij}\right)\right]+\frac{1}{2\overline{F}}\sum_{k\in\mathcal{K}}\frac{n_k(\alpha - w_i - \tau_{ik})}{4\beta}\sum_{j\in\mathcal{K}\setminus\{i\}}\frac{6n_i\tau_{ij}}{16\beta}} < 0$$

and

$$\frac{\partial w_i}{\partial t_j} = \frac{\frac{1}{2\overline{F}}\sum_{k\in\mathcal{K}}\frac{n_k(\alpha - w_i - \tau_{ik})}{4\beta}}{\sum_{k\in\mathcal{K}}\frac{n_k}{4\beta}\sum_{j\in\mathcal{K}\setminus\{i\}}\left[2-G\left(\gamma^{ij}\right)\right]+\frac{1}{2\overline{F}}\sum_{k\in\mathcal{K}}\frac{n_k(\alpha - w_i - \tau_{ik})}{4\beta}\sum_{j\in\mathcal{K}\setminus\{i\}}\frac{6n_i\tau_{ij}}{16\beta}} > 0.$$

Therefore, the endogeneity of wages adds to the trade-off governments face in their business taxation:

$$\frac{d\left(S_i + T_i + n_i w_i\right)}{dt_i} = -\frac{\partial S_i}{\partial w_i} - t_i\frac{\partial k_i}{\partial w_i} - n_i + \frac{1}{2\overline{F}}\sum_{j\in\mathcal{K}\setminus\{i\}}\Delta_i^{ij} + (K-1) + \frac{1}{2\overline{F}}\sum_{j\in\mathcal{K}\setminus\{i\}}\left(\overline{F}-\gamma^{ij}\right) - t_i\frac{1}{2\overline{F}}(K-1) = 0 \tag{3.2}$$

On the one hand, by lowering business taxes, a government attracts firms (higher labor-demand curve), raising wages and national income. On the other hand, this wage rise increases the unit costs of production. As a result, some firms move abroad, shrinking the tax base ($\frac{\partial k_i}{\partial w_i} < 0$). Moreover, higher unit production costs raise the local price level, lowering consumer surplus (to make this formal, note that $\frac{\partial S_i}{\partial w_i} < 0$, for $\tau_{ij} = \tau_{ik} \forall j,k$). Assuming that a country's welfare rises in the wage level (effect on national income dominates cost effect), a richer labor market gives countries an additional incentive to reduce business taxes to attract mobile firms (more tax competition).

4 Consumers and Firms

4.1 Cross-Price Effects

In the following, we study cross-price effects. That is, we specify preferences of the representative household in country i as in Melitz and Ottaviano [2008]

$$u_i := z_i + \alpha\int_{\mu\in\Omega} x_i(\mu)\,d\mu - \frac{\beta}{2}\int_{\mu\in\Omega} x_i(\mu)^2\,d\mu - \frac{\eta}{2}\left(\int_{\mu\in\Omega} x_i(\mu)\,d\mu\right)^2 \tag{4.1}$$

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

$$X_i(\mu) = \frac{n_i(\alpha_i - p_i(\mu))}{\beta} \tag{4.2}$$

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

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

and

$$p_i^{jl}(\mu) = \frac{\alpha_i + 3w + k_j^*\tau_{ij} + k_l^*\tau_{il}}{4} = \begin{cases} \frac{\alpha_i+3w+2\tau_{ij}+\tau_{il}}{4} & \text{if } F^{jl} \geq \gamma^{jl} \\ \frac{\alpha_i+3w+\tau_{ij}+2\tau_{il}}{4} & \text{if } F^{jl} < \gamma^{jl} \end{cases}, \tag{4.3}$$

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

$$\pi_i^{ij}(\mu) = \begin{cases} \sum_{k\in\mathscr{K}} \frac{n_k\left(\alpha_k - w - 2\tau_{ik} + \tau_{jk}\right)^2}{16\beta} & \text{if mobile firm locates in i} \\ \sum_{k\in\mathscr{K}} \frac{n_k\left(\alpha_k - w - 3\tau_{ik} + 2\tau_{jk}\right)^2}{16\beta} & \text{if mobile firm locates in j.} \end{cases} \tag{4.4}$$

The cutoff industries are modified as follows

$$\begin{aligned} \gamma^{jl} &= \sum_{k\in\mathscr{K}} n_k\left(\tau_{jk} - \tau_{lk}\right) \frac{6(\alpha_k - w) - 3\left(\tau_{jk} + \tau_{lk}\right)}{16\beta} + t_j - t_l \\ &:= n_i\left(\tau_{ij} - \tau_{il}\right) \frac{6(\alpha_i - w) - 3\left(\tau_{ij} + \tau_{il}\right)}{16\beta} + \widehat{\gamma}^{jl} + t_j - t_l \end{aligned}$$

Thus, cross-price effects affect firm mobility only through international profit differentials. Accordingly, tax revenues in country i still read as $T_i := t_i\left[(K-1) + \frac{1}{2\overline{F}} \sum_{j\in\mathscr{K}\setminus\{i\}} \left(\overline{F} - \gamma^{ij}\right)\right]$. However, consumer surplus

$$S_i := \sum_{j\in\mathscr{K}\setminus\{i\}} \left[\delta_i^{ij} + \frac{\gamma^{ij} - \underline{F}}{2\overline{F}} \Delta_i^{ij}\right] + \frac{1}{2} \sum_{j\in\mathscr{K}\setminus\{i\}} \sum_{l\in\mathscr{K}\setminus\{i,j\}} \left[\delta_i^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_i^{jl}\right] - \frac{\eta}{2}\left(\frac{\alpha - \overline{p}_i}{\beta+\eta}\right)^2 n_i,$$

with $\delta_i^{ij} := n_i \frac{\left(3\alpha_i - 3w - \tau_{ij}\right)^2}{32\beta}$, $\delta_i^{jl} := n_i \frac{\left(3\alpha_i - 3w - 2\tau_{ij} - \tau_{il}\right)^2}{32\beta}$, $\Delta_i^{ij} := n_i \frac{\left(3\alpha_i - 3w - 2\tau_{ij}\right)^2 - \left(3\alpha_i - 3w - \tau_{ij}\right)^2}{32\beta}$, and $\Delta_i^{jl} := n_i \frac{\left(3\alpha_i - 3w - \tau_{ij} - 2\tau_{il}\right)^2 - \left(3\alpha_i - 3w - 2\tau_{ij} - \tau_{il}\right)^2}{32\beta}$, now accounts for cross-price effects through the dependence of $\alpha_i := \frac{\alpha\beta + \eta\overline{p}_i}{\beta + \eta}$ on the country's average price level

$$\overline{p}_i = \int_{\mu \in \Omega} p_i(\mu)\, d\mu = \frac{1}{2}\frac{2}{K(K-1)} \sum_j \sum_{l \neq j} \left[\left(1 - G\left(\gamma^{jl}\right)\right) p_i^{jl}(\mu)|_{F^{jl} \geq \gamma^{jl}} + G\left(\gamma^{jl}\right) p_i^{jl}(\mu)|_{F^{jl} < \gamma^{jl}} \right].$$

Tedious, but straightforward algebra leads to a closed-form expression for $\overline{p}_i$. The effect of taxes on domestic price levels is more interesting. One can show that

$$\frac{d\overline{p}_i}{dt_i} \propto \sum_{l \neq i} \tau_{il} > 0, \text{ and } \frac{d\overline{p}_i}{dt_j} \propto \sum_{l \neq j} \left(\tau_{il} - \tau_{ij}\right).$$

Country i's local price increases linearly with the country's business tax. Moreover, a rise in another country j's tax reduces prices in country i only if trade with other countries $l \neq j$ is, on average, cheaper than with j. Notice that this response of average prices to taxation is also present without cross-price effects ($\eta = 0$). Define $\frac{\partial S_i}{\partial \alpha_i}$ and $\frac{\partial T_i}{\partial \alpha_i}$ as the marginal effect of the average price level ($\overline{p}_i$) on consumer surplus and tax revenues. The first-order condition with respect to the business tax

$$\frac{d\left(S_i + T_i + n_i w\right)}{dt_i} = \left(\frac{\partial S_i}{\partial \alpha_i} + \frac{\partial T_i}{\partial \alpha_i}\right) \frac{\eta}{\beta + \eta} \frac{\partial \overline{p}_i}{\partial t_i} + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i\}} \Delta_i^{ij} + (K-1) + \frac{1}{2\overline{F}} \sum_{j \in \mathscr{K} \setminus \{i\}} \left(\overline{F} - \gamma^{ij}\right) - t_i \frac{1}{2\overline{F}}(K-1) \tag{4.5}$$

is sufficient if the second-order condition holds $\frac{d^2\left(S_i + T_i + n_i w\right)}{dt_i^2} = -\frac{K-1}{\overline{F}} + \left(\frac{\partial^2 S_i}{\partial \alpha_i^2} + \frac{\partial^2 T_i}{\partial \alpha_i^2}\right)\left(\frac{d\overline{p}_i}{dt_i}\right)^2 < 0$. The reaction function t_i is linear in t_j. One can 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 ($\eta > 0$), the optimal taxes are revised upward (relative to $\eta = 0$) if and only if $\frac{\partial S_i}{\partial \alpha_i} + \frac{\partial T_i}{\partial \alpha_i} > 0$.

To understand the driving forces, consider first the role of cross-price effects. The higher η, the smaller the demand for differentiated varieties compared to the numéraire, and the lower the welfare loss from potential loss of firms (producing these differentiated varieties). Now, suppose there is a marginal increase in the business tax, t_i, triggering firm relocation. It is immediate that the resulting rise in the country's average price reduces the surplus from consuming differentiated varieties. However, this loss is smaller than in a situation without cross-price effects ($\eta = 0$), where differentiated varieties add a comparably larger share to consumer surplus ($\frac{\partial S_i}{\partial \alpha_i} > 0$). Moreover, observe that firm relocation is self-limiting because any tax-induced rise in $\overline{p}_i$ increases the level of profits in that country, thereby raising the number of firms and expanding the tax base ($\frac{\partial T_i}{\partial \alpha_i} > 0$).

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. The first adjustment regards the described marginal welfare gain (reduction in the welfare loss from firm relocation). The second one accounts for the endogeneity of the revenue losses from taxing businesses. Without imposing more structure, it is unclear how these two margins add up in the comparative statics. Nonetheless, the key trade-off and insights from the model without cross-price effects remain present.

4.2 Industry Structure

We now relax the assumption that, in each industry, there are only three producing firms of which two are immobile. To be precise, let $k_i^{ij} \in \mathbb{R}_+$ be the number of firms in country i and industry ij. Hence, $k_i^{ij} + k_j^{ij} + 1 := k^{ij} + 1$ 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 in country i is given by $k_i = \sum_{j\in\mathcal{K}\setminus\{i\}} k_i^{ij} + \frac{1}{2\overline{F}} \sum_{j\in\mathcal{K}\setminus\{i\}} \left(\overline{F} - \gamma^{ij}\right)$. Then, the reaction function of country i reads as

$$t_i = \frac{1}{2(K-1)} \left(\sum_{j\in\mathcal{K}\setminus\{i\}} \Delta_i^{ij} + \overline{F}(K-1) + 2\overline{F} \sum_{j\in\mathcal{K}\setminus\{i\}} k_i^{ij} + \sum_{j\in\mathcal{K}\setminus\{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) + \sum_{j\in\mathcal{K}\setminus\{i\}} t_j \right). \tag{4.6}$$

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

$$\begin{aligned} t_i = {} & 3\overline{F} + 2\overline{F} \frac{K \sum_{j\in\mathcal{K}\setminus\{i\}} k_i^{ij} + \sum_{j\in\mathcal{K}\setminus\{i\}} \sum_{m\in\mathcal{K}\setminus\{j\}} k_j^{jm} - (K-1)(2K-1)}{(K-1)(2K-1)} \\ & + \frac{1}{2K-1} \sum_{j\in\mathcal{K}\setminus\{i\}} \Delta_i^{ij} + \frac{1}{2K-1} \sum_{j\in\mathcal{K}\setminus\{i\}} \left(\pi_i^{ij} - \pi_j^{ij}\right) + \frac{1}{(K-1)(2K-1)} \sum_{j\in\mathcal{K}} \sum_{m\in\mathcal{K}\setminus\{j\}} \Delta_j^{jm}. \end{aligned} \tag{4.7}$$

Relative to Proposition 1, the Nash equilibrium business tax is modified by the second term on the right-hand side. Moreover, notice that the other terms implicitly depend on k_i^{ij} and k_j^{ij}, since

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

$$\begin{aligned}\pi_i^{ij} - \pi_j^{ij} = {} & \left(n_i - n_j\right)\frac{2\left(\alpha - w\right) - \tau_{ij}}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right)\tau_{ij} + \left(k_j^{ij} - k_i^{ij}\right)\left(n_i + n_j\right)\frac{\tau_{ij}^2}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right) \\ & + \sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tau_{jl} - \tau_{il}\right)\frac{2\left(\alpha - w\right) - \left(\tau_{jl}+\tau_{il}\right) - \left(k_i^{ij} - k_j^{ij}\right)\left(\tau_{jl} - \tau_{il}\right)}{\beta\left(k^{ij}+2\right)^2}\left(k^{ij}+1\right),\end{aligned} \tag{4.8}$$

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 are slightly modified:

$$\begin{aligned}\frac{dt_i}{d\tau_{ij}} = {} & \frac{n_i\left(K-2\right) - n_j\left[2\left(K-1\right)^2+1\right]}{\left(K-1\right)\left(2K-1\right)}\frac{\left(\alpha - w - \tau_{ij}\right)\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2} \\ & + \frac{\left[2\left(K-1\right)\left(k^{ij}+1\right)+K\right]n_i + \left[2\left(K-1\right)\left(k^{ij}+1\right)\left(\sum_{m\in\mathscr{K}\setminus\{i,j\}}\frac{\tau_{ij}-\tau_{mj}}{\tau_{ij}}+1\right)-1\right]n_j}{\left(K-1\right)\left(2K-1\right)}\frac{\tau_{ij}\left(k_j^{ij} - k_i^{ij}\right)}{\beta\left(k^{ij}+2\right)^2}\end{aligned} \tag{4.9}$$

and

$$\begin{aligned}\frac{dt_i}{d\tau_{jk}} = {} & \frac{\left(2K-3\right)\left(n_j+n_k\right)}{\left(K-1\right)\left(2K-1\right)}\frac{\left(\alpha - w - \tau_{jk}\right)\left(k^{ij}+1\right)}{\beta\left(k^{ij}+2\right)^2} + \frac{\tau_{jk}\left(k_k^{jk} - k_j^{jk}\right)\left(n_j - n_k\right)}{\left(K-1\right)\left(2K-1\right)\beta\left(k^{ij}+2\right)^2} \\ & + \frac{\left[2n_k\left(K-1\right)\left(k_j^{ij} - k_i^{ij}\right)\left(\tau_{jk} - \tau_{ik}\right) + 2n_j\left(K-1\right)\left(k_k^{ik} - k_i^{ik}\right)\left(\tau_{jk} - \tau_{ij}\right)\right]\left(k^{ij}+1\right)}{\left(K-1\right)\left(2K-1\right)\beta\left(k^{ij}+2\right)^2}.\end{aligned} \tag{4.10}$$

Observe that for $k_j^{ij} = k_i^{ij} = k_k^{jk}$ and $k^{ij} = 2$, one obtains the expressions in the main text. Moreover, for a similar number of immobile firms across countries ($k_j^{ij} \approx k_i^{ij}$), the main results hold. However, one should note that there is an adjustment by the number of immobile firms in the 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 locating there. The firm relocation semi-elasticity rises in the degree of domestic competition. In other words, the mobile firms are increasingly 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

$$\frac{dt_i}{dk_i^{ij}} = \frac{2\overline{F}K}{(K-1)(2K-1)} - \frac{\left[(K-1)\left(k^{ij}+1\right)n_i + \left((K-1)\left(k^{ij}+1\right)-2\right)n_j\right]\tau_{ij}^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} + \frac{(K-1)\left(k^{ij}+1\right)\sum_{l\in\mathscr{K}\setminus\{i,j\}} n_l\left(\tau_{jl}-\tau_{il}\right)^2}{(K-1)(2K-1)\beta\left(k^{ij}+2\right)^2} \lessgtr 0, \tag{4.11}$$

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

and

$$\frac{dt_i}{dk_k^{jk}} = 2\overline{F}\frac{1}{(K-1)(2K-1)} + \frac{n_j\tau_{jk}^2}{(K-1)(2K-1)\beta\left(k^{jk}+2\right)^2} > 0 \tag{4.12}$$

for $i \neq j \neq k$. On the one hand, a rise in k_i^{ij} tends to make the domestic market in country i more competitive (see above). 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, ceteris paribus, 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 union formed by a set of countries $\mathscr{K}_U$. Suppose that, as a reaction to this economic disintegration, firms exit from the leaving market and enter the union via changes in k_i^{ij}, holding the total number of firms per industry fixed. The effect on the business tax of the leaving country, suffering firm exit, 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 broadens (narrows) the government's tax base. Nonetheless, one should bear in mind that this reasoning is in the absence of employment and growth effects triggered by firm entry.

What is the effect on business taxes of third countries outside the union, $k \in \mathscr{K} \setminus (\mathscr{K}_U \cup l)$? The answer depends on the size of the leaving country relative to the average country inside the union:

$$\sum_{m \in \mathscr{K}_U} \left(\frac{dt_k}{dk_m^{lm}} - \frac{dt_k}{dk_l^{lm}} \right) = \frac{K_U \left(n_l - \overline{n}_U\right) \tau^2}{(K-1)\,(2K-1)\,\beta\,(k^{ij}+2)^2} \begin{cases} > 0 & for\ \overline{n}_U < n_l \\ < 0 & for\ \overline{n}_U > n_l \end{cases}. \tag{4.13}$$

The exit of firms in the leaving country and the entry into member countries, 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, third countries' business taxes depend on the consumer surplus in the leaving country and the remaining union members. The exit of firms in the leaving country makes member countries' prices more elastic to firm relocation. In other words, there are larger gains in consumer surplus, which member countries realize from attracting firms by lowering taxes. 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. Altogether, when a relatively large country leaves a union and firms exit (enter) the leaving country (member countries), third countries tax more.

4.3 Firm Location Across Multiple Countries

In each industry ij, the mobile firm can relocate between countries i and j. Recall that the mobile firm produces in country i if and only if

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

The equilibrium number of firms in the industry is given by

$$1 \cdot \left(1 - \mathbb{P}\left(F^{ij} \geq \gamma_{ij}\right)\right) + 2 \cdot \mathbb{P}\left(F^{ij} \geq \gamma_{ij}\right) = 1 + \mathbb{P}\left(F^{ij} \geq \gamma_{ij}\right).$$

If instead the mobile firm could also locate in another country k, it produces in country i only if

$$\pi_i^{ij}(\mu) - t_i \geq \pi_j^{ij}(\mu) - t_j - F^{ij} \text{ and } \pi_i^{ij}(\mu) - t_i \geq \pi_k^{ij}(\mu) - t_k - F^{ik}.$$

Then, the industry's equilibrium firm number is (weakly) lower

$$1 \cdot \left(1 - \mathbb{P}\left(F^{ij} \geq \gamma_{ij}, F^{ik} \geq \gamma_{ik}\right)\right) + 2 \cdot \mathbb{P}\left(F^{ij} \geq \gamma_{ij}, F^{ik} \geq \gamma_{ik}\right) = 1 + \mathbb{P}\left(F^{ij} \geq \gamma_{ij}, F^{ik} \geq \gamma_{ik}\right),$$

resulting in a (weakly) higher firm relocation semi-elasticity.

4.4 Industry-Specific Trade Costs

In this section, we allow for inter-industry heterogeneity in trade costs. To be precise, we let trade costs vary by industry types. Trade between 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

$$\pi_i^{ij}(\mu) = \begin{cases} \sum_{k \in \mathscr{K}} \frac{n_k \left(\alpha - w - 2\tau_{ik}^{ij} + \tau_{jk}^{ij}\right)^2}{16\beta} & \text{if mobile firm locates in } i \\ \sum_{k \in \mathscr{K}} \frac{n_k \left(\alpha - w - 3\tau_{ik}^{ij} + 2\tau_{jk}^{ij}\right)^2}{16\beta} & \text{if mobile firm locates in } j. \end{cases} \tag{4.14}$$

Accordingly, industry thresholds are adjusted as follows

$$\gamma^{ij} = \left(n_j - n_i\right) \frac{6\tau_{ij}^{ij}(\alpha - w) - 3\left(\tau_{ij}^{ij}\right)^2}{16\beta} + \sum_{l \in \mathscr{K} \setminus \{i,j\}} n_l \left(\tau_{il}^{ij} - \tau_{jl}^{ij}\right) \frac{6(\alpha - w) - 3\left(\tau_{il}^{ij} + \tau_{jl}^{ij}\right)}{16\beta} + t_i - t_j, \tag{4.15}$$

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 industry-specific trade costs would make firm heterogeneity in a given industry type two-dimensional. Consumer surplus also remains qualitatively unchanged

$$S_i = \sum_{j \in \mathscr{K} \setminus \{i\}} \left[\delta_i^{ij} + \frac{\gamma^{ij} - \underline{F}}{2\overline{F}} \Delta_i^{ij}\right] + \frac{1}{2} \sum_{j \in \mathscr{K} \setminus \{i\}} \sum_{l \in \mathscr{K} \setminus \{i,j\}} \left[\delta_i^{jl} + \frac{\gamma^{jl} - \underline{F}}{2\overline{F}} \Delta_i^{jl}\right], \tag{4.16}$$

with adjusted terms $\delta_i^{ij} := n_i \frac{\left(3\alpha - 3w - \tau_{ij}^{ij}\right)^2}{32\beta}$, $\delta_i^{jl} := n_i \frac{\left(3\alpha - 3w - 2\tau_{ij}^{jl} - \tau_{il}^{jl}\right)^2}{32\beta}$, $\Delta_i^{ij} := n_i \frac{\left(3\alpha - 3w - 2\tau_{ij}^{ij}\right)^2 - \left(3\alpha - 3w - \tau_{ij}^{ij}\right)^2}{32\beta}$, and $\Delta_i^{jl} := n_i \frac{\left(3\alpha - 3w - \tau_{ij}^{jl} - 2\tau_{il}^{jl}\right)^2 - \left(3\alpha - 3w - 2\tau_{ij}^{jl} - \tau_{il}^{jl}\right)^2}{32\beta}$.

In the comparative statics of Nash equilibrium business taxes with respect to country-pair-specific trade costs τ_{mn}, 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 affects all firms in a country, we abstain from carrying out comparative statics with respect to industry-type-specific trade costs τ_{mn}^{ij}. As we have shown in this section, however, our model may also speak to the effects of trade shocks that hit a country's industries differentially.

References

Paola Conconi, Carlo Perroni, and Raymond Riezman. Is partial tax harmonization desirable? *Journal of Public Economics*, 92(1-2):254–267, 2008.

Andreas Haufler and Ian Wooton. Competition for firms in an oligopolistic industry: The impact of economic integration. *Journal of International Economics*, 80(2):239–248, 2010.

Eckhard Janeba and Karl Schulz. A theory of economic disintegration. 2021.

Marc J Melitz and Gianmarco IP Ottaviano. Market size, trade, and productivity. *The Review of Economic Studies*, 75(1):295–316, 2008.