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# CORPORATE TAXES AND MULTI-PRODUCT EXPORTERS: THEORY AND EVIDENCE FROM TRADE DYNAMICS

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# Corporate taxes and multi-product exporters: theory and evidence from trade dynamics*

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**Abstract**

This paper analyzes how exporters are affected by corporate tax reforms in destination markets. We introduce tax policy in a trade model of multi-product firms and show that producers face tougher competition in export markets with lower corporate tax rates. This competitive effect induces firms to reduce the number of exported products and to skew their export sales towards the better performing varieties. We estimate the effects of corporate taxes on trade dynamics by exploiting policy reforms in 45 destination countries of exports during the period 2005-2012. Our results provide strong support for competitive effects of corporate taxation.

**JEL codes:** H25, F12, L11

**Keywords:** Multi-product firms; corporate taxation; exporter dynamics, international trade

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# 1 Introduction

Over the last decades many countries have conducted substantial reforms of corporate taxation. For a large sample of 178 countries, the average statutory tax rate on corporate income has fallen from 31% in 1996 to 22% in 2016 (Steinmüller et al., 2019).[1] The question how changes in corporate tax policy affect the competitiveness of firms is a central issue in recent policy debates. A large literature has shown that corporate taxation influences foreign direct investment (FDI) flows across countries and the location choices of multinational corporations.[2] However, little is known about the effects of corporate taxation on the export behavior of firms.

This paper asks how multi-product exporters are affected by differences in corporate taxation across countries. Exporters differ substantially from non-exporters and sales by multi-product firms (MPFs) dominate international trade flows.[3] Bernard et al. (2007) find that 92.2% of total U.S. export value is accounted for by 11.9% of U.S. exporters that sell more than five products to more than five destinations. Given the numerous tax reforms in the last decades, it is important to understand how these changes in tax policy influence competition and how large firms adjust to it. These adjustments include adding and dropping products as well as reallocating resources across varieties of different productivity. Reallocation effects within firms have been shown to be important drivers of firm-level productivity and welfare gains from trade (Bernard et al., 2011; Mayer et al., 2014).

We present theory and evidence on MPFs adjustments following policy reforms that decrease corporate tax rates in the destination country of their exports. We first document two empirical facts regarding the relationship between corporate taxes and the exported product range at the firm level. We show that a decrease in the corporate tax rate in the export market is associated with a reduction in the number of exported products to this destination. Interestingly, the opposite relation holds for a change in the origin country: a lower domestic corporate tax rate is positively correlated with the exported product range.

[1] Devereux et al. (2002) also show a strong decrease of corporate taxes during earlier periods. At the same time, broadening of tax bases has led to an increase of tax revenues despite of lower tax rates (Haufler and Langenmayr, 2015).

[2] See Devereux (2007) as well as Feld and Heckemeyer (2011) for reviews of the literature on corporate taxation and FDI.

[3] Exporters have been shown to be more productive, larger in terms of sales, and they pay higher wages compared to non-exporters (Bernard and Jensen, 1999).

We use these facts as motivation for introducing tax policy in a trade model with heterogeneous multi-product exporters based on Mayer et al. (2014). Producers differ in their productivity (Melitz, 2003), which determines the production efficiency for their core product. Additionally, firms face a flexible manufacturing technology as in Eckel and Neary (2010), such that adding products to the portfolio is possible at rising marginal production costs for these varieties. In this framework, we introduce two policy instruments that have played a central role in recent reforms of corporate taxation: a tax rate on firm profits and a share of production costs that can be deducted from the tax base. One important implication of this setup with imperfect deductibility is that corporate tax rates distort prices and production decisions of firms.[4]

The model predicts that a lower tax rate in the destination market increases the price elasticity of export demand, as effective production costs of local firms are reduced. Faced with stronger competition, firms that sell to this destination drop high cost varieties and hence reduce the exported product range. We additionally show that stronger competition caused by tax rate reforms induces exporters to skew their sales towards their better performing varieties. A key feature of our model is the combination of linear demand with cost heterogeneity, which generates endogenous markups across products. A large literature on firm heterogeneity and trade builds on CES demand, which implies complete pass-through of tax rates into prices. In this case, there would be no effect of corporate tax policy on the within-firm skewness of sales. Instead, our model with linear demand features incomplete tax pass-through into prices and hence competition increases the relative sales of the best performing varieties compared to high cost products (Mayer et al., 2014).

We test the predictions of the model using data from the World Bank Exporter Dynamics Database combined with information on corporate tax rates over the period 2005-2012. The combined data have several advantages for our empirical analysis. First, the Exporter Dynamics Database provides information on firm dynamics in 70 origin countries and all their destination countries of exports, which allows us to exploit bilateral variation between many origin and destination pairs instead of a one-country experience.[5] Second, during the period under analysis, many countries have conducted corporate tax reforms. We identify policy reforms in 45 destination countries of exports

[4]Consistent with this, Djankov et al. (2010) show that corporate tax rates distort investment and entrepreneurial activity.

[5]Taking a within-country perspective, Fajgelbaum et al. (2018) quantify spatial misallocation of U.S. tax policy, and Fuest et al. (2018) analyze the effects of German corporate taxation on wages at the municipality level.

that have led to discontinuous decreases in the corporate tax rate over the period 2005-2012. Tax reforms in the destination market have the advantage that, from the perspective of home exporters, they are less subject to endogeneity concerns compared to tax reforms in the home country. Finally, for 11 out of 70 countries from the Exporter Dynamics Database, we use detailed information on the products exported at the firm level, which allows us to calculate the skewness of within-firm sales across products. Moreover, the focus on within-firm adjustments makes it possible to control for other factors that affect reallocations across firms, which implies a cleaner identification of tax effects.

Consistent with the model's predictions, we find that a reduction in the foreign tax rate reduces the number of exported varieties per firm. Moreover, using detailed information on firm export sales by product and destination, we find that a lower corporate tax rate in the destination country increases the within-firm skewness of export sales to this market. Our results are robust when using measures for the effective tax rate that also capture other characteristics of the tax system. We further provide several robustness checks, discuss alternative mechanisms such as profit shifting and show that the results remain robust.

Our analysis contributes to the literature on competitive effects of trade by showing that differences in tax policy are an important determinant of export margins. Closely related to this result, Mayer et al. (2014) show in a cross-section that French firms sell relatively more of their best performing products in larger and more centrally-located destinations, where competition is stronger. Mayer et al. (2016) additionally find that demand shocks in export markets lead to substantial increases of firm-level productivity driven by reallocations of resources towards better performing varieties within MPFs. In our analysis, we show that tax reforms have an equally important effect in comparison to changes in destination GDP. In terms of identification, one advantage of exploiting tax reforms in the destination country is that they are less subject to endogeneity issues in comparison to changes in market size.

We also contribute to the literature that analyzes the effects of differences in corporate taxation across countries. The question how and to which extent firms exploit cross-country differences in corporate taxation has received a lot of attention in the literature. Empirical studies provide evidence for profit shifting to tax havens and the use of transfer pricing (Desai et al., 2006; Egger and Seidel, 2013; Gumpert et al., 2016; Davies et al., 2018; Laffitte and Toubal, 2018). We have excluded

tax havens from our sample and we show that our results are not driven by country pairs with large tax differentials or large firms, which are more likely to use tax havens (Davies et al., 2018). This is consistent with additional fixed costs of profit shifting FDI, such that only the largest firms find it profitable to exploit tax rate differentials across countries (Krautheim and Schmidt-Eisenlohr, 2011). Most importantly, note that profit shifting cannot explain the observed effect of corporate taxation on within-firm skewness. If profit shifting involves additional fixed costs, we should expect that firms respond to lower foreign tax rates by shifting profits of the best performing products. This would decrease the within-firm skewness of sales, whereas we find the opposite result.

Finally, our paper is also related to theoretical work that analyzes the effects of tax competition in the presence of heterogeneous single-product firms (Davies and Eckel, 2010; Krautheim and Schmidt-Eisenlohr, 2011; Haufler and Stähler, 2013; Bauer and Langenmayr, 2013; Bauer et al., 2014).

The paper proceeds as follows. Section 2 shows empirical facts that motivate the theoretical model, which is outlined in Section 3. We test the model's predictions in Section 4. Finally, Section 5 concludes.

## 2 Empirical facts

As a motivation for building the model, we report a simple but striking empirical correlation between corporate tax rates and firm scope, calculated as the number of products exported by the firm. As we will show, the correlations suggest that corporate taxation influences the degree of competition between domestic and foreign firms. In the empirical part of the paper in section 4, we discuss identification and provide the details of the data.

First, we investigate how firms react to changes in the home country tax rate. Using panel data on firm dynamics in 70 origin countries for the period 2005-2012, we show that a reduction in the corporate tax rate of the home country is associated with higher export scope. This suggests that a lower home tax rate increases the international competitiveness of home firms leading to an expansion of the exported product range. The negative correlation shown in the first column of Table 1 is based on a linear regression and includes home country ($h$) and year ($t$) fixed effects. The estimation strategy and regression results are summarized in Table B1.

Second, we investigate how firms react to changes in foreign tax rates. For that, we exploit the fact that, in the data, we know the destination country of exports for firms in the home country $h$ exporting to a foreign country $f$. We create a corporate tax ratio between the home and foreign country ($\frac{CorpTax_{ft}}{CorpTax_{ht}}$) and investigate how the exported product range reacts following a change in the corporate tax rate in the destination country of exports, given a home tax. Strikingly, we find the opposite coefficient in comparison to changes in the home tax rates: a decrease in the corporate tax rate in the destination is associated with a decrease in the export scope of firms from $h$ selling to $f$. These correlations suggest important pro-competitive effects from tax policy, as a decrease in the tax rate of the destination country makes local firms more competitive and exporters relatively less competitive. The positive correlation shown in Table 1, column 2, is based on a linear regression and includes exporter-importer country fixed effects, year and exporter-year fixed effects. The estimation strategy and regression results are shown in Table B1.

Table 1: Correlation between corporate tax rates and exported product scope

| | Home $h$ firm scope $\log Scope_{ht}$ | Firm scope in destination $f$ $\log Scope_{hft}$ |
|---|---|---|
| Home corporate tax rate $\log CorpTax_{ht}$ | -0.0722** | |
| Corporate tax rate ratio $\log CorpTax_{ft}/CorpTax_{ht}$ | | 0.0386** |

Notes: Result in column 1 includes country and year fixed effects and controls for GDP. Result in column 2 includes importer-exporter fixed effects, exporter-year and year fixed effects and controls for GDP. The estimation strategy and regression results are reported in Table B1.
*** indicates 1% significance, ** 5% significance, and * 10% significance.

# 3 The model

This section introduces tax policy in a model of heterogeneous MPFs along the lines of Mayer et al. (2014). We consider two countries with $l \in h, f$, and analyze how differences in corporate taxes affect the export behavior of firms.[6] We start by analyzing consumer behavior and the underlying preference structure. In a next step, we introduce tax policy and model firms which

[6]Since our empirical exercise focuses on predictions of the open economy scenario, we start our analysis with the two country case and leave out the autarky scenario in the main text. See the Theoretical Appendix for an analysis of the closed economy.

endogenously determine the set of products that they offer in the two destinations. Our model features both firm heterogeneity (Melitz, 2003) and product heterogeneity within firms based on flexible manufacturing (Eckel and Neary, 2010). Finally, we characterize a free entry equilibrium and derive the main testable predictions which we take to the data in the empirical part of the paper.

### 3.1 Consumers

In each country, there are $L_l$ consumers, each supplying one unit of labor which is the single factor of production. Consumers maximize utility over the consumption of a homogeneous good $q_0^c$, and a potential set of differentiated goods, indexed by $i \in \Lambda$. The direct utility function for both countries is quasi-linear and given by:

$$U = q_0^c + \alpha \int_{i\in\Lambda} q_i^c di - \frac{1}{2}\gamma \int_{i\in\Lambda} (q_i^c)^2 di - \frac{1}{2}\eta \left( \int_{i\in\Lambda} q_i^c di \right)^2. \tag{1}$$

The demand parameters $\alpha$, $\eta$, and $\gamma$ are all positive. Substitutability between the outside good and the differentiated varieties is captured by the parameters $\alpha$ and $\eta$. The degree of product differentiation among varieties $i$ is characterized by $\gamma$. In the extreme case of $\gamma = 0$, varieties are perfect substitutes and hence, consumers only care of their level of total consumption $Q^c = \int_{i\in\Omega} q_i^c di$. This implies that the degree of product differentiation and hence the consumers' need to smooth consumption over varieties increases in $\gamma$.[7]

Throughout our analysis, we assume that consumers have positive demand for the numeraire good $q_0^c$. The inverse demand for each differentiated variety with positive demand levels (i.e. $q_i^c > 0$) is given by:

$$p_i = \alpha - \gamma q_i^c - \eta Q^c. \tag{2}$$

Direct market demand of $L$ consumers in one country can be written as:

$$q_i = \frac{\alpha L}{(\gamma + \eta M)} - \frac{L}{\gamma} p_i + \frac{\eta M}{\gamma + \eta M} \frac{L}{\gamma} \overline{p}, \tag{3}$$

[7] Our specification follows Mayer et al. (2014) and does not distinguish between varieties produced by the same firm and varieties produced by different firms. For an alternative specification which allows for within and between brand differentiation of products see Dhingra (2013).

where $M$ is the number of varieties that are actually consumed in the subset $\Lambda^* \subset \Lambda$. The average price is given by $\overline{p} = (1/M) \int_{i \in \Lambda^*} p_i di$. Given the linear demand, there is a choke price in each of the two destinations:

$$p_l^{\max} = \frac{1}{(\gamma + \eta M_l)} \left( \alpha\gamma + \eta M_l \overline{p}_l \right), \tag{4}$$

at which demand for a variety falls to zero. Inspecting Equation (4) yields that the choke price decreases with a lower average price or a larger number of available varieties. As was shown by Melitz and Ottaviano (2008), variations in $\overline{p}_l$ and $M_l$ affect the degree of competition in market $l$ by changing the price elasticity of demand.[8]

### 3.2 Firm behavior

The numeraire good is produced in a perfectly competitive environment with constant returns to scale. It is sold at $p_0 = 1$, which fixes the returns to labor to unity implying a unit wage. Since there are no profits in the production of the numeraire good, there is no corporate tax revenue in this sector. The differentiated sector is characterized by monopolistic competition and firms supply an endogenous number of products.[9] Firms enter the differentiated goods sector by paying sunk costs $f_E$. After this investment, firms draw a core marginal cost $c$ from a common distribution $G(c)$ with support on $[0, c_M]$. This draw determines the marginal costs for the core product of the firm, which we denote by $m = 0$. We follow Eckel and Neary (2010) and assume that firms face a flexible manufacturing technology, such that introducing additional varieties $m$ is associated with increasing marginal costs. Marginal costs for variety $m$ are given by $v(m, c) = \omega^{-m} c$ with $\omega \in (0, 1)$. A lower $\omega$ implies that expanding the product portfolio incurs a stronger increase in marginal production costs for additional varieties compared to the core product. This assumption introduces cost heterogeneity among varieties within firms.

We introduce two policy instruments that have been central in recent tax reforms. The government in country $l$ imposes a corporate tax rate $t_l \in (0, 1)$ on taxable profits. The tax base is

[8] The price elasticity of demand is given by $\epsilon_i = \frac{\partial q_i}{\partial p_i} \frac{p_i}{q_i} = \left( \frac{p^{\max}}{p_i} - 1 \right)^{-1}$. Note that the latter is not only determined by $\gamma$ as it would be the case with CES preferences.

[9] Throughout our analysis, we assume that each firm offers a countable number of products among the continuum of consumed varieties. This assumption maintains the monopolistic competition environment as varieties offered by one firm are of measure zero in the economy. Note that this assumption rules out the cannibalization effect, that was stressed for instance in Eckel and Neary (2010).

determined by the firm's sales less a tax-deductible share $\beta_l$ of production costs.[10] We additionally assume that exporting from country $h$ to $f$ involves iceberg trade costs $\tau_{hf} > 1$ such that the cost for product $m$ exported to country $f$ is: $\tau_{hf}\omega^{-m}c$. For analytical tractability, we abstract from export or product fixed costs. The export profits for a single variety with cost $v$ of a firm located in country $h$ are then given by:

$$\pi_{hf}(v) = \underbrace{(p_{hf}(v) - \tau_{hf}v)\, q_{hf}(v)}_{\text{Pre-tax profits}} - t_h \underbrace{(p_{hf}(v) - \beta_h\tau_{hf}v)\, q_{hf}(v)}_{\text{Tax base}}. \tag{5}$$

The tax factor is defined as $\Psi_l = \frac{1-t_l\beta_l}{1-t_l}$, which allows to rewrite profits as follows:

$$\pi_{hf}(v) = (1 - t_h)\left[p_{hf}(v) - \Psi_h\tau_{hf}v\right] q_{hf}(v). \tag{6}$$

We assume that production costs are only partially tax deductible ($\beta_l < 1$), which implies that the tax factor $\Psi_l > 1$ increases effective marginal production costs. In the special case of fully deductible costs ($\beta_l = 1$), the tax factor is equal to one and the profit tax will not distort production and pricing decisions of firms. We additionally assume that tax revenues are redistributed to consumers. Note that all income effects arising due to tax revenues are absorbed by consumption of the homogeneous outside good.

Firms maximize their profits given the demand function (3) taking the average price and the total number of varieties as given. The profit maximizing price for a variety with cost $v$ is given by:

$$p_{hf} = \frac{p_f^{max} + \Psi_h\tau_{hf}v}{2}. \tag{7}$$

The marginal variety that will be exported is determined by a zero-profit condition: effective production costs equal the maximum price that can be charged in the foreign market, such that $p_f^{max} = \Psi_h\tau_{hf}v_{hf}$. Hence, firms with a cost draw $c > v_{hf}$ cannot profitably export their core variety.[11] We express all firm performance measures as a function of tax policy and the cost cutoff

[10] Other models that introduce corporate taxation and imperfect deductibility are Haufler and Runkel (2012), Bauer et al. (2014), Koethenbuerger and Stimmelmayr (2014), Langenmayr et al. (2015), Irlacher and Unger (2018), and Bond and Gresik (2018).

[11] Note that marginal costs for the core variety $m = 0$ are given by $v(0, c) = c$, which implies that $c_{hf} = v_{hf}$.

$v_{hf}$:

$$p_{hf}(v) = \Psi_h \tau_{hf} \frac{v_{hf} + v}{2}, \tag{8}$$

$$\lambda_{hf}(v) = p_{hf}(v) - \psi_h \tau_{hf} v = \Psi_h \tau_{hf} \frac{v_{hf} - v}{2} \tag{9}$$

$$q_{hf}(v) = \frac{L_f \Psi_h \tau_{hf}}{2\gamma} (v_{hf} - v), \tag{10}$$

$$r_{hf}(v) = p_{hf}(v) q_{hf}(v) = \frac{L_f}{4\gamma} \Psi_h^2 \tau_{hf}^2 \left(v_{hf}^2 - v^2\right), \tag{11}$$

$$\pi_{hf}(v) = (1 - t_h) \frac{L_f \Psi_h^2 \tau_{hf}^2}{4\gamma} (v_{hf} - v)^2. \tag{12}$$

Firms with costs $c < c_{hf}$ will export additional varieties as long as $v(m, c) < v_{hf}$.[12] Hence, the total number of exported varieties of a firm with costs $c$ is given by:

$$M_{hf}(c) = \begin{cases} 0 \text{ if } c > c_{hf}, \\ \max(m | c \leq \omega^m c_{hf}) + 1 \text{ if } c \leq c_{hf}. \end{cases} \tag{13}$$

Total after-tax profits of a firm with costs $c$ can be written as:

$$\Pi_{hf}(c) = \sum_{m=0}^{M_{hf}(c)-1} \pi_{hf}(v(m, c)). \tag{14}$$

Since our model features linear demand, there is only imperfect pass-through of taxes into prices. As the price elasticity is not constant, high cost varieties face more price sensitive consumers and hence respond stronger to changes in tax policy. This aspect will be crucial for our results and we discuss it in more detail in the following sections. To show that high cost varieties are more affected by an increase in the tax factor, we differentiate Equation (10) with respect to the latter:

$$\frac{dlnq_{hf}(v)}{dln\Psi_h} = 1 + \frac{v_{hf}}{v_{hf} - v} \frac{dlnv_{hf}}{dln\Psi_h}. \tag{15}$$

As will be shown and discussed in detail below, $\frac{dlnv_{hf}}{dln\Psi_h} < 0$ implying that a higher tax factor in the home country reduces competitiveness of domestic firms in the export destination and hence, increases exit rates of exporting firms. Equation (15) shows that the negative impact of a higher

[12] This condition implies that a firm with cost draw $c$ exports a subset of varieties for which $\pi_{hf}(v) \geq 0$.

tax factor will be more pronounced for low productivity varieties as $\frac{v_{hf}}{v_{hf}-v}$ increases in marginal production cost $v$.

### 3.3 Free entry and equilibrium

Free entry ensures that entry costs equal expected after-tax profits before firms know their cost draw $c$. We further assume that also a fraction $\beta_l$ of fixed entry costs is tax deductible, which leads to the following free entry condition:

$$\int_0^{c_{hh}} \Pi_{hh}(c)\, dG(c) + \int_0^{c_{hf}} \Pi_{hf}(c)\, dG(c) = (1 - t_h\beta_h)\, f_E, \tag{16}$$

where $c_{hh}$ is the cost cutoff for which domestic production falls to zero, $q_{hh}(c_{hh}) = 0$.[13]

We assume that marginal costs $c$ follow a Pareto distribution with $G(c) = \left(\frac{c}{c_M}\right)^k$ on $[0, c_M]$, where $k > 1$ is the Pareto shape parameter. We rewrite the free entry conditions in both countries as follows:

$$L_h c_{hh}^{k+2} + L_f \tau_{hf}^{-k} c_{ff}^{k+2} \left(\frac{\Psi_f}{\Psi_h}\right)^{k+2} = \frac{\gamma\phi}{\Omega\Psi_h}, \tag{17}$$

$$L_f c_{ff}^{k+2} + L_h \tau_{fh}^{-k} c_{hh}^{k+2} \left(\frac{\Psi_h}{\Psi_f}\right)^{k+2} = \frac{\gamma\phi}{\Omega\Psi_f}. \tag{18}$$

where $\phi = 2(k+1)(k+2)\, c_M^k f_E$, and $\Omega = \sum_{m=0}^{\infty} \omega^{mk} = \frac{1}{1-\omega^k}$ captures multi-product flexibility, which increases in $\omega$, i.e. when the cost schedule for additional varieties becomes flatter. Combining Equations (17) and (18) yields the export cost cutoff:[14]

$$c_{hf} = \frac{\Psi_f}{\Psi_h \tau_{hf}} c_{ff} = \frac{\Psi_f^{\frac{k+1}{k+2}}}{\Psi_h \tau_{hf}} \left( \frac{\gamma\phi}{\Omega L_f} \frac{1 - \tau_{fh}^{-k} \left(\frac{\Psi_h}{\Psi_f}\right)^{k+1}}{1 - \tau_{hf}^{-k} \tau_{fh}^{-k}} \right)^{1/(k+2)}. \tag{19}$$

**Assumption 1** *To ensure that there is a positive export cutoff, we assume that:* $\tau_{fh}^{-k} \left(\frac{\Psi_h}{\Psi_f}\right)^{k+1} < 1$.

This assumption puts a lower limit on foreign export costs compared to the domestic tax factor

[13] Note that, in the presence of trade costs, the set of varieties which is produced for the domestic market is larger than the set of exported varieties because the cutoff for domestic production $c_{hh}$ is less restrictive. This also implies that there are some firms which are only active in the domestic market but do not export.

[14] The cutoff for domestic production in country $h$ is given by $c_{hh} = \left( \frac{\gamma\phi}{\Omega L_h \Psi_h} \frac{1 - \tau_{hf}^{-k} \left(\frac{\Psi_f}{\Psi_h}\right)^{k+1}}{1 - \tau_{hf}^{-k} \tau_{fh}^{-k}} \right)^{1/(k+2)}$.

relative to the foreign tax factor. If $\tau_{fh}$ is very low, this would increase expected export profits and hence competition in the foreign market. A very high relative domestic tax factor prevents even the most productive domestic firms from exporting. Combining the maximum price as defined in Equation (4) with the definition of the cost cutoff, $p_f^{max} = \Psi_h \tau_{hf} \upsilon_{hf}$, leads to the total number of available varieties in the home country:

$$M_h = \frac{2\,(k+1)\,\gamma\,(\alpha - \Psi_h c_{hh})}{\eta \Psi_h c_{hh}}. \tag{20}$$

Importantly, all firm performance measures are affected by changes of tax policy in two ways. Besides the direct effect through changes of $\Psi_h$ there is an indirect general equilibrium effect which arises through changes in the cost cutoff. The latter effect determines the degree of competition in the economy and will be discussed in more detail in the following section.

### 3.4 Testable predictions

In the empirical section, we exploit changes in corporate tax rates of destination countries.[15] Hence, we derive testable predictions from our theory, that show how changes in the foreign corporate tax rate affect export behavior of home firms. Note that this shock has no direct effect on production costs (as a change in the home tax rate would have), but affects export performance through changes in the toughness of competition.

In case of imperfect deductibility ($\beta_l < 1$), a change in the tax rate influences the tax factor in the same direction: $\frac{d\Psi_l}{dt_l} > 0$. Hence, for simplicity, we show predictions for changes in the foreign tax factor. The effect of the foreign tax factor on the export cost cutoff follows from the derivative of Equation (19) which shows that a decrease in the foreign tax rate reduces the export cost cutoff:

$$\frac{dlnc_{hf}}{dln\Psi_f} = \frac{k+1}{k+2} \frac{1}{1 - \tau_{fh}^{-k} \left(\frac{\Psi_h}{\Psi_f}\right)^{k+1}} > 0. \tag{21}$$

A decrease in the foreign tax factor leads to lower effective production costs of foreign firms relative to domestic exporters. This aggravates foreign market access and leads to exit of the least productive exporters.

[15] In the robustness checks, presented in section 4.5, we also show results for measures of effective corporate tax rates, that also capture other characteristics of the tax system, such as deductibility of production costs.

Hence, a lower foreign tax rate increases the toughness of competition in this destination. This effect also influences the price elasticity of demand for exported varieties:

$$\epsilon_{hf}(v) = \left| \frac{\partial q_{hf}(v)}{\partial p_{hf}(v)} \frac{p_{hf}(v)}{q_{hf}(v)} \right| = \left( \frac{p_f^{max}}{p_{hf}(v)} - 1 \right)^{-1} = \frac{c_{hf} + v}{c_{hf} - v}. \tag{22}$$

For the last equality, we exploit that $p_f^{max} = \Psi_h \tau_{hf} v_{hf}$ and use the export price in Equation (8). As Equation (21) shows, a decrease in the foreign tax factor reduces the export cutoff $c_{hf}$, and hence increases the price elasticity of demand, whereas this effect is stronger for high cost varieties.

Faced with stronger competition in the foreign market, remaining firms will adjust their exported product scope. We use Equation (13) and define a firm's additional export varieties besides its core product as:

$$m_{hf}(c) = M_{hf}(c) - 1 = \frac{ln\,(c) - ln\,(c_{hf})}{ln\omega}. \tag{23}$$

The effect of tax policy on the exported product scope follows from the derivative of Equation (23).

**Proposition 1** *A decrease in the foreign tax rate reduces a firm's exported product scope to this destination:*

$$\frac{dm_{hf}(c)}{d\Psi_f} = -\underbrace{\frac{1}{ln(\omega)}}_{(-)} \underbrace{\frac{dln\,(c_{hf})}{d\Psi_f}}_{(+)} > 0. \tag{24}$$

Stronger competition induced by a lower foreign tax rate leads to a negative reaction of exported product scope. Note that Proposition 1 would also qualitatively hold in a two-country model with CES preferences. However, we derive a second prediction on the within-firm skewness of export sales that is specific to the underlying linear demand structure. For this purpose, we consider the relative export sales of two varieties $m$ and $m'$ that are produced by the same firm and are both sold in destination $f$. The only difference is that $m < m'$, i.e. the variety $m$ is closer to the core product and hence is more productive. Following Equation (11), we write relative export sales as:

$$\frac{r_{hf}\,(v\,(m,c))}{r_{hf}\,(v\,(m',c))} = \frac{(c_{ff}\Psi_f)^2 - \tau_{hf}^2 \Psi_h^2\,(c\omega^{-m})^2}{(c_{ff}\Psi_f)^2 - \tau_{hf}^2 \Psi_h^2\,(c\omega^{-m'})^2}. \tag{25}$$

Note that a lower foreign tax factor increases the sales ratio in Equation (25), because of $\frac{d\left(c_{ff}\Psi_f\right)}{d\Psi_f} > 0$. As shown by Equation (22), this change in foreign tax policy results in a larger price elasticity

of demand for all exported varieties, which reduces quantities and mark-ups. In our framework with linear demand, this effect is relatively more pronounced for high cost varieties. As a response to tougher competition, firms skew sales towards the better performing products. In our empirical analysis, we use the Theil index as a measure for skewness of within-firm sales, which is given by:

$$T_{hf}(c) = \frac{1}{M_{hf}(c)} \sum_{m=0}^{M_{hf}(c)-1} \frac{r_{hf}\left(v\left(m,c\right)\right)}{\bar{r}_{hf}\left(c\right)} ln\left(\frac{r_{hf}\left(v\left(m,c\right)\right)}{\bar{r}_{hf}\left(c\right)}\right), \tag{26}$$

where average sales of a firm with costs $c$ are defined by $\bar{r}_{hf}\left(c\right) = \frac{\sum_{m=0}^{M_{hf}(c)-1} r_{hf}(v(m,c))}{M_{hf}(c)}$. For a fixed number of exported products $M_{hf}(c)$, a decrease in the foreign tax rate increases the Theil index, where the intuition follows the same reasoning as for the sales ratio in Equation (25). Note that firms also react to a lower foreign tax rate by reducing the exported product scope (see Proposition 1). This adjustment counteracts the first effect, as it tends to decrease the Theil index through an increase in average sales $\bar{r}_{hf}$. We show in Appendix A.3 that this extensive margin effect decreases in $M_{hf}(c)$, and hence the intensive margin effect dominates for a sufficiently large exported product scope.

**Proposition 2** *A lower foreign tax rate increases the Theil index of within-firm sales, i.e. exporters skew their product mix towards the better performing products.*

In case of CES preferences, the ratio of sales in Equation (25) is constant and does not react to tax policy (see Appendix A.2 for a more formal discussion). As firms set a fixed mark-up for all varieties, there is complete pass-through of taxes into prices and no change of the the price elasticity across products. This argument is related to Mayer et al. (2016) who show that changes in foreign demand have no effect on relative performance measures for different products in case of CES preferences.

# 4 Empirical analysis

## 4.1 Data

To test the main predictions of the model, we exploit large corporate tax reforms in the foreign country and investigate their effect on exports from home to foreign. We collect worldwide data

on corporate tax rates and identify 45 tax reforms that have led to discontinuous decreases in the corporate tax rate. We then combine tax data with the Exporter Dynamics Database from the World Bank for the period 2005-2012. The combined data have several advantages for our empirical analysis. First, the Exporter Dynamics Database provides information on firm dynamics in 70 origin countries in all their destination countries of exports, which allows us to exploit variation in many origin and many destination countries instead of a one-country experience. Second, during the period under analysis, many countries have conducted corporate tax reforms. Hence, we can exploit large discontinuous tax changes in several destination countries. Tax reforms in the destination country have the advantage that, from the perspective of home exporters, they are less subject to endogeneity concerns as would be the case for reforms in the home country. Third, for 11 out of 70 countries, we have detailed information on the products exported by the firms, which allows us to analyze the effects of tax policy on the skewness of within-firm sales across products while controlling for factors that influence reallocations across firms. We describe the main data sources below.

**Corporate tax rates** We collect data on countries' corporate tax rates from two main sources: Ernst & Young (EY) Worldwide Corporate Tax Guide and KPMG's Corporate and Indirect Tax Rate Survey. Missing information is complemented with World Bank and OECD data.[16] To minimize concerns with profit shifting, we follow the classification from Hines and Rice (1994) and exclude countries classified as tax havens from the sample.[17] [18] We discuss profit shifting motives in more detail in the robustness checks.

We exploit data on corporate tax reforms in the destination country $f$ to investigate their impact on firms that export from $h$ to $f$. We identify in the data 45 large discontinuous tax changes that

[16]We proceed as follows: in all cases in which EY and KPMG agree on the tax rate, this value is as the tax rate (the majority of common values are the same). If only one source from KPMG and EY is available for a country, this is used as the tax rate. Whenever the two sources disagree, it is left blank. Besides providing a way to double check value entries, OECD and World Bank sources can be used to fill in missing values and provide 8 and 28 additional observations, respectively.

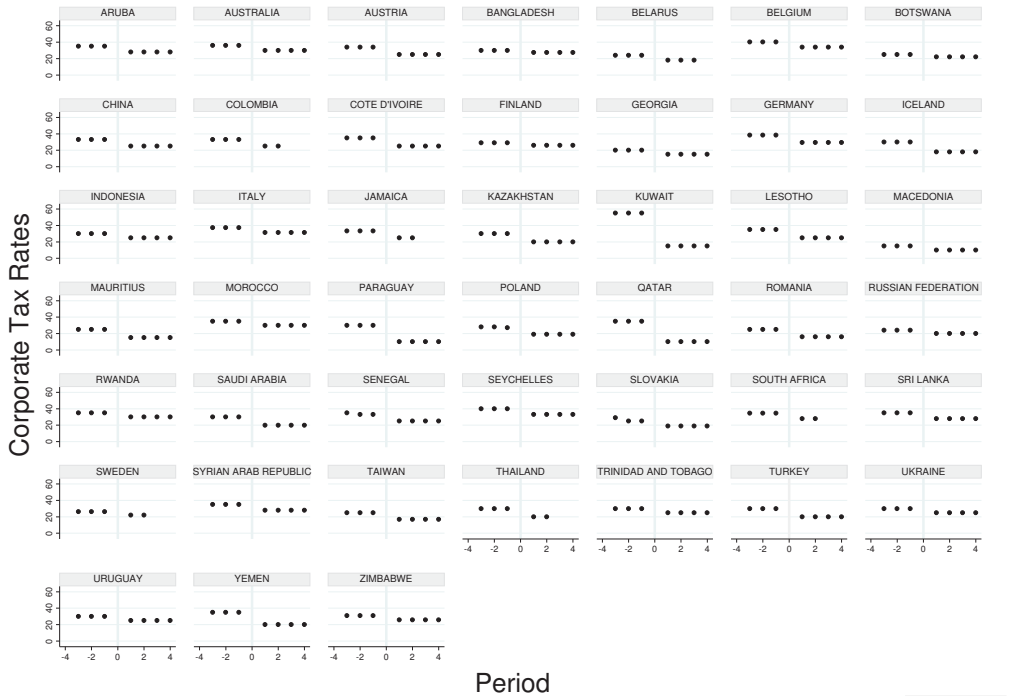
[17]List of countries classified as tax havens in Hines and Rice (1994): Andorra, Anguilla, Antigua and Barbuda, Bahamas, Bahrain, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Channel Islands, Cook Island, Cyprus, Dominica, Gibraltar, Grenada, Hong Kong, Ireland, Isle of Man, Jordan, Lebanon, Liberia, Liechtenstein, Luxembourg, Macao, Maldives, Malta, Marshall Islands, Monaco, Montserrat, Netherlands Antilles, Panama, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint Vincent and the Grenadines, Singapore, Switzerland, Turks and Caicos Islands, Vanuatu.

[18]A further classification of tax havens from Hines (2010) also includes Aruba, Seychelles und Mauritius as tax havens. We conduct robustness checks in which we exclude these countries from the sample and find that the results remain similar.

led to a decrease in the corporate tax rate of at least 2.5 percentage points.[19]

Figure 1 shows the destination countries that were subject to large corporate tax decreases. Figure B1 shows the data including the year of reform. For example, Germany has conducted a corporate tax reform in 2008, which led to a decrease of the statutory corporate tax rate by 10 percentage points. In the online appendix we document the corporate tax data we collected for all countries in the world.

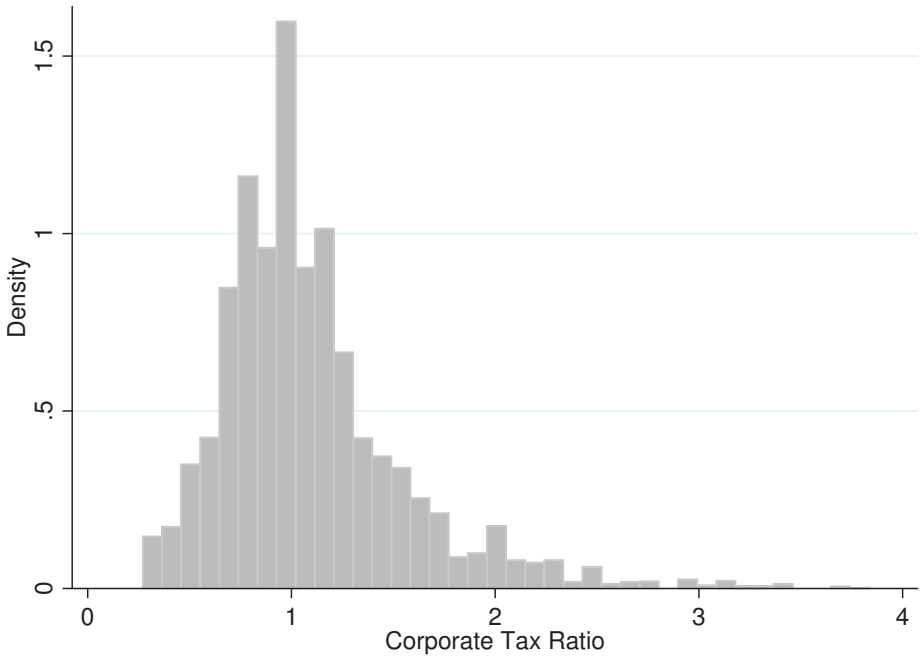
Figure 1: Discontinuous corporate tax rate changes in 45 countries




As we are interested in the reaction from home exporters to changes in the destination country, we define the corporate tax ratio between the corporate tax rate in the foreign country relative to the home country, $\frac{CorpTax_{ft}}{CorpTax_{ht}}$. Figure 2 provides the summary statistics of the corporate tax ratio between foreign $f$ and home $h$. As the figure shows, for few observations the tax ratio is larger than 2. In the empirical analysis, we conduct robustness checks excluding country pairs with large tax differentials, for which profit shifting motives may bias our results.

[19]We also identify tax reforms in four countries in our data that are classified as tax havens in Hines and Rice (1994): Jordan, Liechtenstein, Panama, and Luxembourg. For consistency, we drop these countries from the sample.

Figure 2: Corporate tax ratio ($CorpTax_{ft}/CorpTax_{ht}$)




**Exporter Dynamics Database** Data on firm dynamics come from the World Bank Exporter Dynamics Database documented by Fernandes et al. (2016). To test the predictions from the model, we use both aggregate data as well as raw customs firm-level data from the World Bank. The variables included in the Exporter Dynamics Database are computed using customs data from 70 countries disaggregated by exporter, importer, product and year for the period 1997-2014, though 2005-2012 are the years most commonly covered. We use the sample comprising only manufacturing exporters.[20]

As we are interested in investigating the effect of corporate tax rates on the activity of multi-product exporters, the main variable of interest is firm scope $Scope_{hft}$, which is calculated as the average number of products exported by firms from origin country $h$ to destination country $f$ in year $t$.

[20]List of 70 origin countries in the Exporter Dynamics Database: Albania, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cambodia, Cameroon, Chile, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Denmark, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Gabon, Georgia, Germany, Guatemala, Guinea, Iran, Jordan, Kenya, Kosovo, Kuwait, Kyrgyz Rep, Laos, Lebanon, Macedonia, Madagascar, Malawi, Mali, Mauritius, Mexico, Morocco, Myanmar, Nepal, New Zealand, Nicaragua, Niger, Norway, Pakistan, Paraguay, Peru, Portugal, Romania, Rwanda, Sao Tome, Senegal, Slovenia, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Tanzania, Thailand, Timor-Leste, Turkey, Uganda, Uruguay, Yemen, and Zambia.

Table 2 provides summary statistics of the main variables for the sample of 70 origin countries exporting to 45 destination countries that conducted tax reforms (the destination countries are listed in Figure 1). Because we exploit discontinuous changes in tax rates in the destination country, the within variation in $CorpTax_{ft}$ shown in Table 2 is much larger in comparison to $CorpTax_{ht}$.[21]

Table 2: Summary statistics of the main variables using the sample of 70 origin countries

| Variable | Mean | Std. Dev. | between variation | within variation |
|---|---|---|---|---|
| $Scope_{hft}$ | 2.469 | 1.548 | 1.386 | 0.674 |
| $CorpTax_{ht}$ | 26.888 | 6.620 | 6.590 | 1.931 |
| $CorpTax_{ft}$ | 27.470 | 7.249 | 5.774 | 4.729 |
| $CorpTax_{ft}/CorpTax_{ht}$ | 1.099 | 0.456 | 0.446 | 0.195 |

One advantage of the data is the large coverage, which allows us to capture the relevant mechanism referring to firm adjustments as shown in the first prediction of the model. However, to test Proposition 2, we need more detailed data to compute firm skewness of sales. For 11 countries from the total sample of 70 countries in the World Bank data, it is possible to access raw customs data with information on export values by firm, product, destination country and year.[22] Using this data, we calculate the Theil index, described in Equation (26). As shown in the theoretical model, the Theil index provides information on the skewness of the distribution of firm exports from home country $h$ to destination $f$ in year $t$, using sales of all products exported to destination $f$. Table 3 provides summary statistics of the main variables in the sample using firm-level data from 11 origin countries to 45 destination countries that had large discontinuous corporate tax changes, where $i$ indexes the firm.

An increase in the Theil index $Theil_{ihft}$ does not necessarily mean an increase in skewness for existing products as suggested by our theory in Equation (26), since firms could simultaneously add and drop varieties, i.e. adjust the extensive margin of the product. We discuss the extensive margin of the Theil index in Appendix B. In order to get closer to our theoretical mechanism, we compute the Theil index only for the initial exported product scope of the firm to exclude the product extensive margin.

[21] However, also home corporate tax rates vary over time. In the empirical analysis, we also add interacted home country-year $(h-t)$ fixed effects to absorb all time-varying characteristics of the home country, such that we can better evaluate the effect of corporate tax reforms in the destination country on firm dynamics.

[22] The raw customs data is available for Albania, Bulgaria, Burkina Faso, Guatemala, Jordan, Malawi, Mexico,

Table 3: Summary statistics of the main variables using the sample of 11 countries

| Variable | Mean | Std. Dev. | between variation | within variation |
|---|---|---|---|---|
| $Theil_{ihft}$ | 0.465 | 0.534 | 0.449 | 0.272 |
| $CorpTax_{ht}$ | 23.620 | 6.746 | 6.328 | 2.676 |
| $CorpTax_{ft}$ | 30.557 | 8.036 | 7.567 | 3.181 |
| $CorpTax_{ft}/CorpTax_{ht}$ | 1.411 | 0.607 | 0.556 | 0.244 |

**Control variables** In our model, the size of the destination country affects the sales of home exporters. Hence, we control for foreign GDP as a proxy for country size. We also include regional trade agreements as proxies for trade costs as the the literature has shown that trade liberalization leads to within-firm adjustments (Bernard et al., 2011). Data on regional trade agreements come from Egger and Larch (2008) and are publicly available.

### 4.2 Empirical strategy

Our goal in the empirical part of the paper is to test the predictions from the model regarding adjustments of multi-product exporters following discontinuous changes in corporate tax rates in the destination country of exports. For this purpose, we evaluate firm outcomes in each destination country three years before and three years after the reform, as shown in Figure 1.

To test empirically Proposition 1 regarding the exported product scope, we estimate the following equation:

$$\log Scope_{hft} = \beta_1 \log \frac{CorpTax_{ft}}{CorpTax_{ht}} + \mathbf{X}_{hft} + \rho_{hf} + \upsilon_t + \mu_{ht} + \varepsilon_{hft}, \tag{27}$$

where $Scope_{hft}$ is the average exported product range of a firm in home country $h$ exporting to foreign country $f$ in year $t$, $\rho_{hf}$ are interacted exporter-importer country fixed effects and $\upsilon_t$ are year fixed effects. As we are interested in the effect of discontinuous changes in corporate tax rates in the foreign country, we control for exporter-year fixed effects $\mu_{ht}$ to account for time-varying shocks in the home country that may affect the results. $\mathbf{X}_{hft}$ is a vector of time-varying control variables, such as proxies for destination country size and bilateral trade costs.

In the theoretical model, we show that a decrease in the foreign tax rate ($\Psi_f$) reduces firm's exported product scope to this destination. Hence, we expect that $\beta_1 > 0$, as lower foreign tax rates

Peru, Senegal, Uruguay, and Yemen.

lead to stronger competition in the foreign market.

We are also interested in the effect of a decrease in foreign tax rates on the skewness of home exports, as shown by Proposition 2. We conduct the following empirical exercise:

$$Theil_{ihft} = \beta_1 \log \frac{CorpTax_{ft}}{CorpTax_{ht}} + \mathbf{X}_{hft} + \rho_{ihf} + \upsilon_t + \mu_{ht} + \varepsilon_{ihft} \tag{28}$$

where $Theil_{ihft}$ is the skewness of the distribution of firm $i$'s exports from home country $h$ to foreign country $f$ in year $t$ (for three years before and three years after the reform), $\rho_{ihf}$ are interacted firm-exporter-importer fixed effects, $\upsilon_t$ are year fixed effects, and $\mu_{ht}$ are exporter-year fixed effects. $\varepsilon_{hft}$ is an error term. A lower tax rate in the importing country induces exporters to skew their product mix towards the best performing varieties. Following Proposition 2, this increases the Theil index as defined in Equation (26), and hence we expect that $\beta_1 < 0$.

### 4.3 Empirical results

We investigate whether large discontinuous changes in corporate tax rates in the destination country of exports affect within-firm adjustments. Table 4 presents the main empirical results for product scope. We estimate Equation (27) including importer-exporter fixed effects, year and importer-year fixed effects. In the next section, we perform several robustness checks.

As predicted by the theoretical model, a decrease in the foreign tax rate ($\Psi_f$) reduces firm's exported product scope to this destination. Table 4 confirms this prediction, as shown by the positive and significant coefficient for the corporate tax ratio $\log CorpTax_{ft}/CorpTax_{ht}$. Note that in all specifications we control for exporter-year fixed effects, such that all time-varying characteristics of the origin country are absorbed.

Columns 2 to 4 in Table 4 show that an increase in the GDP of the destination country leads to higher firm scope to this destination, which is consistent with the findings of Mayer et al. (2016).[23] A large literature analyzes the product scope responses of MPFs to globalization. To explain positive effects of market size and globalization on product scope, recent papers include fixed costs at the product-level (Qiu and Zhou, 2013; Mayer et al., 2016; Flach and Irlacher, 2018). In our theoretical

[23] Mayer et al. (2016) show that positive demand shocks in export markets induce French multi-product exporters to increase product scope.

model, we abstract from fixed costs for reasons of tractability, as this is not the main focus of our analysis.

In columns 3 and 4, we also control for free trade agreements (FTA) and preferential trade agreements (PTA) to account for the effect of trade liberalization on within-firm adjustments. Baldwin and Gu (2009), Bernard et al. (2011), and Iacovone and Javorcik (2010) evaluate the effect of CUSFTA/NAFTA liberalization on within-firm adjustments. They show that, following trade liberalization, firms reduced the number of products they produce. As in previous studies, we find that FTAs and PTAs have a negative effect on scope, but the effect is very small and not significant.[24]

Table 4: Effects of corporate tax reforms on $\log Scope_{hft}$

| Dependent variable: $\log Scope_{hft}$ | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\log CorpTax_{ft}/CorpTax_{ht}$ | 0.0445* | 0.0499** | 0.0506** | 0.0506** |
| | (0.0242) | (0.0243) | (0.0243) | (0.0243) |
| $\log GDP_{ft}$ | | 0.0987*** | 0.0998*** | 0.0994*** |
| | | (0.0304) | (0.0304) | (0.0304) |
| $RTA_{hft}$ | | | -0.0193 | 0.00112 |
| | | | (0.0170) | (0.0279) |
| $FTA_{hft}$ | | | | -0.0218 |
| | | | | (0.0237) |
| Constant | yes | yes | yes | yes |
| Origin-Destination FE | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | yes |
| Observations | 7,204 | 7,204 | 7,204 | 7,204 |
| R-squared | 0.827 | 0.828 | 0.828 | 0.828 |
| Number of origin-destination pairs | 1,303 | 1,303 | 1,303 | 1,303 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

To test Proposition 2 from the model, we investigate how corporate tax reforms affect firm skewness (see Equation (28)). For this purpose, we exploit firm-level data for 11 origin countries to construct Theil indices. As shown in Table 5, a decrease in the corporate tax rate in the foreign country relative to the origin country leads to an increase in skewness. This effect is consistent with Proposition 2, which shows that lower tax rates in the destination induces firms to skew their

[24]Note that in our empirical analysis we consider a sample of destination countries that conducted corporate tax reforms. For these countries, there is little within-variation over time in trade agreements during the period of analysis, which might explain the very small and not significant results. This is, however, an advantage in our framework, as we want to rule out simultaneous events that affect firm outcomes.

product mix towards their best performing varieties. All results in Table 5 include firm-importer fixed effects as well as year fixed effects. In addition, columns 2 to 4 include exporter-year fixed effects, which account for any time-varying change in the home country.

As in Table 4, we control for GDP and for trade agreements. Mayer et al. (2016) provide theory and evidence from French export data that demand shocks in destination markets lead to an increase in the skewness of sales of exporters, measured by the Theil index. In our empirical analysis, this effect is captured by the positive coefficient for $\log GDP_{ft}$. Moreover, we control for RTAs and FTAs to account for trade liberalization and changes in trade costs. Baldwin and Gu (2009) and Bernard et al. (2011) show that CUSFTA induced an increase in the skewness of production across products. In our data at the firm level for 11 home countries, there is very little variation in the variables $RTA_{hft}$ and $FTA_{hft}$ during the period of analysis, which might explain the fact that the coefficients are not significant and very small.[25]

Table 5: Effects of corporate tax reforms on $Theil_{ihft}$

| Dependent variable: $Theil_{ihft}$ | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\log CorpTax_{ft}/CorpTax_{ht}$ | -0.0521*** | -0.0483** | -0.0469** | -0.0469** |
| | (0.0179) | (0.0192) | (0.0197) | (0.0197) |
| $\log GDP_{ft}$ | | 0.0594 | 0.0568 | 0.0568 |
| | | (0.0406) | (0.0418) | (0.0418) |
| $RTA_{hft}$ | | | -0.0120 | |
| | | | (0.0138) | |
| $FTA_{hft}$ | | | | -0.0120 |
| | | | | (0.0138) |
| Constant | yes | yes | yes | yes |
| Origin-Destination-Firm FE | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | yes |
| Observations | 50,802 | 50,802 | 50,802 | 50,802 |
| R-squared | 0.744 | 0.744 | 0.744 | 0.744 |
| Number of firm-destination pairs | 16,494 | 16,494 | 16,494 | 16,494 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

[25]For the 11 exporting countries and the 45 importing countries for which we evaluate the effect of tax reforms, there is little variation in the variables $RTA_{hft}$ and $FTA_{hft}$ in the same period. Note that, different from Table 4, we only include $RTA_{hft}$ and $FTA_{hft}$ separately because these variables are multicollinear.

### 4.4 Application to the German tax reform in 2008

In this section, we apply the estimated effects of the previous subsection to the German corporate tax reform in 2008. The main change of this reform was a decrease of the statutory tax rate on corporate income from 25% to 15%. We are interested how this shock affects exports from other countries to Germany. Hence, we take the estimates of Table 4 to calculate the effects of the German tax reform on the number of exported products to Germany. To illustrate the magnitude of this effect, we compare this result to a hypothetical change in German GDP.

We take the estimate $\beta_1 = 0.0506$ from Table 4 and calculate the effect on scope for a decrease in the corporate tax rate of 10pp, which corresponds to a change of -40%. We evaluate this effect at the mean export scope to Germany in 2007 (=2.8), which leads to a decrease by $dScope_{hGER2008} = -0.0567$. We multiply this effect by the total number of exporters to Germany in 2007, which is 51,219 in our sample. Hence, the tax reform reduces the exported scope to Germany by 2,902products, which corresponds to a decrease of 2%. Note that this effect has to be interpreted with caution, as our sample does not include all trading partners of Germany, in particular countries such as the U.S., China and France. Hence, our results can be seen as a lower bound of the total effect.

As Table 4 shows, the destination GDP has a positive impact on export scope to this destination. Hence, we use the coefficient on $logGDP_{ft}$ (=0.0994), to calculate the equivalent change in the German GDP that would have led to the same decrease in the number of exported products to Germany. We find that the German GDP would have to decrease by around 20% to generate the same effect as the 40% cut in the corporate tax rate. Note that this is a ceteris-paribus analysis, which assumes that all other trading partners of Germany do not change their corporate tax rate, but highlights the importance of the reforms in terms of reallocation effects and magnitudes.

### 4.5 Robustness checks

In this section, we show that our results are robust to alternative mechanisms, such as profit shifting and other policy reforms. Moreover, we provide evidence for measures of the effective tax rate, which capture other characteristics of the tax system.

**Profit shifting and large tax differentials** As shown in Figure 2, for few country pairs the corporate tax ratio is larger than two or smaller than 0.5, which could increase incentives for firms to establish an affiliate abroad and export to the affiliate. To minimize concerns with profit shifting as a reason to export, we drop all large tax differentials from the sample.

In our framework, concerns with profit shifting are reduced for two main reasons. First, all our estimations exclude tax havens from the sample. Second, we use the data from the Exporter Dynamics Database that corresponds to manufacturing exporters. Davies et al. (2018) provide empirical evidence of profit shifting and show that it is concentrated in countries in the lowest-tax deciles and most prevalent in tax havens. Moreover, they show that it is even more severe in services than in manufacturing. Hence, by excluding these two groups (tax havens and services), we already reduce concerns with profit shifting. Moreover, Davies et al. (2018) show that, except for the lowest-tax countries, profit shifting is unlikely to change, should a given destination marginally alter its tax rate, implying that the tax reforms we observe are not a key driver of profit shifting.

However, to avoid the fact that large tax differentials might influence our estimates, we drop all country pairs with large tax differentials from the sample and reestimate Equations (27) and (28). The list of country pairs that we drop is documented in the online data appendix.[26] The results shown in Table 6 suggest that, if anything, the effect on within-firm adjustments is underestimated when not accounting for large tax differentials. Columns 1-3 report the effect on scope and columns 4-6 the effect on the Theil index. In both cases, the coefficients remain significant and are larger in magnitudes compared to the baseline results reported in Tables 4 and 5.

**Profit shifting and large exporters** Davies et al. (2018) show that transfer pricing is concentrated in a small number of large multinational firms. They provide evidence for French exporters that 90% of intra-firm exports to tax havens come from a few number of firms, which implies that concerns with profit shifting are reduced for the average firm. In the data we use, there is no information on the multinational activity of firms. However, we may exploit exporter size. As a robustness check, we drop the largest firms in the sample. In the results reported in Table 7 columns 1-3, we drop the firms with the largest number of products. We find that the coefficients are larger in magnitudes when excluding large exporters, which again reduces our concerns with

[26] We exclude all countries with $CorpTax_{ft}/CorpTax_{ht} > 2$ or $CorpTax_{ft}/CorpTax_{ht} < 0.5$.

Table 6: Effect of corporate tax reforms on firm adjustments excluding large tax differentials

| Dependent variable | $\log Scope_{hft}$ | | | $Theil_{ihft}$ | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\log CorpTax_{ft}/CorpTax_{ht}$ | 0.0734** | 0.0712** | 0.0711** | -0.0494** | -0.0470** | -0.0455** |
| | (0.0330) | (0.0329) | (0.0329) | (0.0207) | (0.0223) | (0.0227) |
| $\log GDP_{ft}$ | | 0.0840** | 0.0853** | | 0.0660 | 0.0643 |
| | | (0.0335) | (0.0335) | | (0.0418) | (0.0422) |
| $RTA_{hft}$ | | | -0.0171 | | | -0.0156 |
| | | | (0.0179) | | | (0.0172) |
| Constant | yes | yes | yes | yes | yes | yes |
| Origin-Destination FE | yes | yes | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | no | yes | yes |
| Origin-Destination-Firm FE | no | no | no | yes | yes | yes |
| Observations | 6,629 | 6,629 | 6,629 | 46,950 | 46,950 | 46,950 |
| R-squared | 0.827 | 0.828 | 0.828 | 0.750 | 0.750 | 0.750 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

profit shifting.

In a further robustness analysis, we exclude the smallest firms in the sample. The Theil index $Theil_{ihft}$ could be driven by changes in the concentration of sales for MPFs with very small product scope. However, as shown in Table 7 columns 4-6, the coefficient is even larger when excluding the smallest firms from the sample.

Table 7: Effect of corporate tax reforms on firm adjustments excluding large or small firms

| Dependent variable | drop firms with scope>100 | | | drop firms with scope<5 | | |
|---|---|---|---|---|---|---|
| $Theil_{ihft}$ | (1) | (2) | (3) | (4) | (5) | (6) |
| $\log CorpTax_{ft}/CorpTax_{ht}$ | -0.0667*** | -0.0630*** | -0.0629*** | -0.0692*** | -0.0643*** | -0.0628*** |
| | (0.0183) | (0.0195) | (0.0198) | (0.0212) | (0.0232) | (0.0233) |
| $\log GDP_{ft}$ | | 0.0566 | 0.0563 | | 0.132*** | 0.130*** |
| | | (0.0441) | (0.0452) | | (0.0480) | (0.0484) |
| $RTA_{hft}$ | | | -0.00122 | | | -0.0253 |
| | | | (0.0115) | | | (0.0285) |
| Constant | yes | yes | yes | yes | yes | yes |
| Origin-Destination-Firm FE | yes | yes | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | yes | yes | yes |
| Observations | 45,511 | 45,511 | 45,511 | 36,269 | 36,269 | 36,269 |
| R-squared | 0.733 | 0.733 | 0.733 | 0.767 | 0.767 | 0.767 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

**Robustness analysis using EATR and EMTR tax rates** As a robustness check, we investigate how firms react to tax reforms that have decreased effective tax rates. In our model, we consider the tax rate on firm profits but also the share of production costs that can be deducted from the tax base. Hence, the use of effective tax rates offers one important validity test for our results.

We take data on effective tax rates calculated by Spengel et al. (2018), which is based on the methodology proposed by Devereux and Griffith (1999) and Devereux and Griffith (2003). We use the company level effective average tax rate (EATR) and effective marginal tax rate (EMTR). Data are available for 28 EU countries as well as Switzerland, Norway, Republic of Macedonia, Turkey, USA, Canada and Japan. This restricts our analysis to 10 destination countries that conducted tax reforms over the period under analysis.[27] The results shown in Table 8 strengthen our hypothesis. We find that a decrease in EATR (results in columns 1 and 2) and EMTR (results in columns 3 and 4) in the foreign country leads to a decrease in the average scope of firms exporting to this destination. As we use a different sample for this robustness check, we validate the results for effective tax rates against a decrease in the foreign corporate tax rate, as shown in columns 5 and 6. In all cases, the results are in accordance with our theoretical predictions.

**Discontinuous tax changes at home** In the empirical analysis, we investigate discontinuous changes in corporate tax rates in the destination country of exports. According to our model, a decrease in the domestic corporate tax rate should lead to opposite effects, as home MPFs increase the exported product scope. Out of the 70 origin countries in the Exporter Dynamics Database, 19 conducted large reforms that appear in Figure 1.[28] Hence, we estimate the effect of discontinuous tax changes in the origin country on the average product scope. We estimate the following equation: $\log Scope_{ht} = \beta_1 \log CorpTax_{ht} + \mathbf{X}_{ht} + \rho_h + \upsilon_t + \varepsilon_{ht}$. As we are interested in the effect of the domestic corporate tax rate on the exported product scope of home firms, the equation varies only by origin and year. Results reported in Table 9 confirm that corporate tax reforms in the home country have the opposite effect on firm scope in the home country in comparison to a corporate tax reform in the foreign country, which confirms the predictions from our theoretical model.

[27] The list of countries is: Austria, Belgium, Finland, Germany, Italy, Poland, Romania, Slovakia, Sweden, and Turkey. Note that the listed countries also appear in Figure 1.

[28] The 19 countries from the Exporter Dynamics Database that conducted corporate tax reforms are Bangladesh, Botswana, Colombia, Cote D'Ivoire, Georgia, Jordan, Kuwait, Macedonia, Mauritius, Morocco, Myanmar, Paraguay,

Table 8: Effect of corporate tax reforms on firm adjustments using EATR and EMTR

| Dependent variable: $\log Scope_{hft}$ | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $\log EATR_{ft}$ | 0.154** | 0.145** | | | | |
| | (0.0687) | (0.0719) | | | | |
| $\log EMTR_{ft}$ | | | 0.0244* | 0.0237* | | |
| | | | (0.0132) | (0.0133) | | |
| $\log CorpTax_{ft}$ | | | | | 0.128* | 0.120* |
| | | | | | (0.0683) | (0.0709) |
| $\log GDP_{ft}$ | 0.658*** | 0.700*** | 0.523*** | 0.582*** | 0.655*** | 0.700*** |
| | (0.203) | (0.209) | (0.202) | (0.212) | (0.207) | (0.211) |
| $RTA_{hft}$ | | -0.0475 | | -0.0568 | | -0.0505 |
| | | (0.0673) | | (0.0664) | | (0.0672) |
| Constant | yes | yes | yes | yes | yes | yes |
| Origin-Destination FE | yes | yes | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | yes | yes | yes |
| Observations | 2,186 | 2,186 | 2,186 | 2,186 | 2,186 | 2,186 |
| R-squared | 0.897 | 0.897 | 0.897 | 0.897 | 0.897 | 0.897 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

Table 9: Effects of corporate tax reforms in the home country on $\log Scope_{ht}$

| Dependent variable: $\log Scope_{ht}$ | (1) | (2) | (3) |
|---|---|---|---|
| $\log CorpTax_{ht}$ | -0.372*** | -0.288** | -0.311** |
| | (0.0765) | (0.123) | (0.135) |
| $\log GDP_{ht}$ | | | 0.161 |
| | | | (0.381) |
| Constant | yes | yes | yes |
| Origin FE | yes | yes | yes |
| Year FE | no | yes | yes |
| Observations | 107 | 107 | 107 |
| R-squared | 0.945 | 0.947 | 0.947 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

**Corporate tax change as a package of reforms** Some tax reforms happen simultaneously with other reforms in the country. We investigate whether the 45 corporate tax reforms reported in Figure 1 have been conducted as part of a package of other policy changes.[29] In particular, simultaneous reforms related to labor market regulations could affect the competitiveness of firms

Romania, Rwanda, Senegal, South Africa, Turkey, Uruguay, and Yemen.

[29]For every country in which there was a tax reform, we look at country reports from the OECD, IMF, and reports from the European Commission to investigate whether further reforms happened during the same period.

and our outcome variables. For many countries, we cannot precisely uncover all reforms conducted by the country. However, as a first robustness check, we exclude from the sample countries that conducted labor market reforms in the same time period. In the results reported in columns 1 and 2 of Table 10, we exclude Belgium, Slovakia, Turkey, Uruguay, and Syria, which we identify as countries that have conducted further reforms at the same time or the year following the tax reform. As reported in Table 10, the results remain significant, which reinforces our mechanism through corporate tax changes. As a further robustness check, in columns 3 and 4 we report results excluding Sweden, which conducted reforms to increase investments in infrastructure as well as research and innovation. Also in this case, the results remain significant.

Table 10: Effects of corporate tax reforms on $\log Scope_{hft}$ excluding countries that conducted simultaneously labor market reforms

| Dependent variable: $\log Scope_{hft}$ | Package of reforms labor markets | | Package of reforms innovation | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\log CorpTax_{ft}/CorpTax_{ht}$ | 0.0423* | 0.0434* | 0.0527** | 0.0533** |
| | (0.0252) | (0.0252) | (0.0242) | (0.0242) |
| $\log GDP_{ft}$ | 0.0994*** | 0.101*** | 0.0964*** | 0.0975*** |
| | (0.0311) | (0.0311) | (0.0302) | (0.0303) |
| $RTA_{hft}$ | | -0.0332* | | -0.0171 |
| | | (0.0185) | | (0.0173) |
| Constant | yes | yes | yes | yes |
| Origin-Destination FE | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes |
| Origin-Year FE | yes | yes | yes | yes |
| Observations | 6,406 | 6,406 | 7,026 | 7,026 |
| R-squared | 0.832 | 0.832 | 0.827 | 0.827 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.

# 5 Conclusion

In this paper, we have analyzed how multi-product exporters react to changes of corporate tax rates in destination markets. We exploit 45 corporate tax reforms in the destination country and combine tax data with detailed information on exporter dynamics for 70 origin countries during the period 2005-2012. We find strong evidence for competitive effects of corporate tax rate reforms on export behavior. A decrease of the corporate tax rate in the foreign destination induces firms

to reduce the exported product range to this market, and to skew their export sales towards their better performing products.

To rationalize these findings, we introduce corporate tax policy in a trade model of MPFs. The model features linear demand and cost heterogeneity across firms and products. We consider a tax rate on corporate profits and a parameter that governs the imperfect deductibility of production costs. These two policy parameters determine the effective corporate tax rate and lead to production and pricing distortions across firms and countries.

Consistent with our empirical findings, our model highlights competitive effects of corporate tax reforms. A decrease in the foreign tax rate does not affect the cost structure of firms that export from other countries, but rather influences the toughness of competition. As local firms experience a decrease in effective production costs, exporters to this market face tougher competition. As a response, they drop high cost varieties from their exported product range and skew resources towards the better performing products. We highlight that these within-firm reallocations cannot be rationalized in a model with CES demand and cannot be explained by alternative channels such as profit shifting or the use of tax havens. We further show that our results are robust when controlling for the impact of trade costs, free trade agreements, foreign market size and other reforms, e.g. related to labor markets.

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# A Theoretical Appendix

## A.1 Firm behavior in closed economy

In the main text, we concentrate on the open economy scenario, since our main empirical predictions consider the export behavior of firms. However, for the sake of completeness, we provide a short derivation of the autarky scenario. A firm with cost draw $c$ generates domestic profits given by:

$$\pi(v) = (1-t)\left[p(v) - \Psi v\right] q(v), \tag{29}$$

where in analogy to the main text $\Psi = \frac{(1-t\beta)}{(1-t)} > 1$ is the tax factor in the country of analysis. Maximizing profits yiels optimal prices and quantities, whereby it has to hold that:

$$q(v) = \frac{L}{\gamma}\left(p(v) - \Psi v\right). \tag{30}$$

If the profit maximizing price $p(v)$ is above $p^{\max}$ defined in Equation (4), the variety will not be supplied. Hence, all firms with effective costs $\Psi v > p^{\max}$ have to exit the market. We denote $v_D$ as the cost cutoff where a variety just breaks even such that $p^{\max} = \Psi v_D$. In analogy to the main text, we express all firms performance measures as functions of $v_D$:

$$p(v) = \Psi \frac{v_D + v}{2}, \tag{31}$$

$$\lambda(v) = \Psi \frac{v_D - v}{2}, \tag{32}$$

$$q(v) = \frac{L\Psi}{2\gamma}\left(v_D - v\right), \tag{33}$$

$$r(v) = \frac{L\Psi^2}{4\gamma}\left(v_D^2 - v^2\right), \tag{34}$$

$$\pi(v) = (1-t)\frac{L\Psi^2}{4\gamma}\left(v_D - v\right)^2. \tag{35}$$

The intuition behind these measures is similar to the equations derived in the main text. Firms with costs $c < c_D$ will produce additional varieties as long as $v(m,c) < v_D$. Hence, the total number

of produced varieties of a firm with costs $c$ is given by:

$$M(c) = \begin{cases} 0 \text{ if } c > c_D, \\ \max(m | c \leq \omega^m c_D) + 1 \text{ if } c \leq c_D. \end{cases} \tag{36}$$

Total after-tax profits of a firm with costs $c$ can be written as:

$$\Pi(c) = \sum_{m=0}^{M(c)-1} \pi(v(m,c)). \tag{37}$$

We follow the assumptions of the main text and derive the following free entry condition:

$$\int_0^{c_D} \Pi_D(c)\, dG(c) = (1 - t\beta) f_E. \tag{38}$$

Assuming that marginal costs are Pareto distributed as in the main text, we solve for the cutoff for domestic production:

$$c_D = \left( \frac{\gamma \phi}{\Omega L \Psi} \right)^{\frac{1}{2+k}}, \tag{39}$$

where $\phi$ and $\Omega$ are defined as above. Finally, we derive the number of available varieties:

$$M = \frac{\alpha - \Psi v_D}{\Psi (v_D - \overline{v})} \frac{2\gamma}{\eta}. \tag{40}$$

## A.2 Model with CES preferences

In this section, we show how the implications of our model change, when consumers face CES preferences, with constant elasticity of substitution $\sigma > 1$. In this case, demand for a variety with cost $v$ is given by $q(v) = QP^{\sigma} p(v)^{-\sigma}$, where $Q = \left[ \int_{i \in \Lambda} q_i^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}$ and $P$ is the aggregate price index. We assume that exporting from country $h$ to destination $f$ involves iceberg trade costs $\tau_{hf} > 1$ and fixed export costs $f_{hf}$. As in the main text, tax policy is characterized by a corporate tax rate $t_l$ and a share of deductible expenses $\beta_l$, with $l \in h, f$. Maximization of after-tax profits as defined in Equation (6), leads to optimal prices and quantities for exported products with marginal costs $v$:

$$p_{hf}(v) = \frac{\sigma}{\sigma - 1} \Psi_h \tau_{hf} v, \tag{41}$$

$$q_{hf}(v) = Q_f P_f^{\sigma} \left( \frac{\sigma}{\sigma - 1} \Psi_h \tau_{hf} v \right)^{-\sigma}, \tag{42}$$

where the tax factor is again defined as: $\Psi_l = \frac{1-t_l\beta_l}{1-t_l}$. In contrast to the model in the main text, relative export sales of two varieties with different marginal costs are independent of tax policy:

$$\frac{r_{hf}(v)}{r_{hf}(v')} = \left( \frac{v}{v'} \right)^{1-\sigma}. \tag{43}$$

The reason behind this result is that there is complete pass-through of corporate taxes into prices as shown in Equation (41). Hence, the result from Proposition 2 cannot be derived in a model with CES preferences. The marginal variety exported to the foreign destination is determined by a zero-profit condition $\pi_{hf}(c_{hf}) = 0$, which leads to the export cost cutoff:

$$c_{hf} = \frac{\sigma - 1}{\sigma \tau_{hf}} \Psi_h^{\frac{\sigma}{1-\sigma}} \left( \frac{\sigma f_{hf}}{Q_f P_f^{\sigma}} \right)^{\frac{1}{1-\sigma}}. \tag{44}$$

Analogously, the cost cutoff for domestic production ($\pi_{ll}(c_{ll}) = 0$) can be written as:

$$c_{ll} = \frac{\sigma - 1}{\sigma} \Psi_l^{\frac{\sigma}{1-\sigma}} \left( \frac{\sigma f_{ll}}{Q_l P_l^{\sigma}} \right)^{\frac{1}{1-\sigma}}, \tag{45}$$

where $f_{ll}$ denotes fixed costs for domestic production in the particular country. As in the main text, the equilibrium is characterized by a free entry condition, such that fixed entry costs $f_E$ have to equal expected profits before firms know their cost draw $c$ from a Pareto distribution. We follow the analysis in section 3.3. and consider a two-country case, which allows us to explicitly solve for the export cost cutoff:

$$c_{hf} = \frac{1}{\tau_{hf}} \left( \frac{\Psi_f}{\Psi_h} \right)^{\frac{\sigma}{\sigma-1}} \left( \frac{f_d}{f_x} \right)^{\frac{1}{\sigma-1}} \left( \frac{k - \sigma + 1}{\sigma - 1} \frac{f_E c_M^k}{\Omega f_d} \frac{1 - \tau_{fh}^{-k} \left( \frac{\Psi_h}{\Psi_f} \right)^{\frac{\sigma k}{\sigma-1}} \left( \frac{f_d}{f_x} \right)^{\frac{k-\sigma+1}{\sigma-1}}}{1 - \tau_{hf}^{-k} \tau_{fh}^{-k} \left( \frac{f_d}{f_x} \right)^{\frac{2(k-\sigma+1)}{\sigma-1}}} \right)^{\frac{1}{k}}. \tag{46}$$

For simplicity, we have assumed that fixed costs are symmetric, i.e. $f_{hh} = f_{ff} = f_d$ and $f_{hf} = f_{fh} = f_x$. From Equation (46) follows that the export cost cutoff increases in the foreign tax factor $\Psi_f$, as for the case of non-CES preferences, see Proposition 1.

### A.3 Effect of foreign corporate tax rate on the Theil index

The impact of a change in the foreign corporate tax rate on the Theil index can be decomposed into an intensive margin and an extensive margin effect:

$$\frac{dT_{hf}(c)}{d\Psi_f} = \underbrace{\frac{1}{M_{hf}(c)} \sum_{m=0}^{M_{hf}(c)-1} \left[1 + ln\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)\right] \frac{d\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)}{d\Psi_f}}_{\text{Intensive margin}} + \underbrace{\frac{dT_{hf}(c)}{dM_{hf}(c)} \frac{dM_{hf}(c)}{d\Psi_f}}_{\text{Extensive margin}}. \quad (47)$$

In a first step, we hold the number of exported varieties fixed and consider the intensive margin change of the Theil index. The effect of the foreign tax rate on relative sales can be written as:

$$\frac{d\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)}{d\Psi_f} = \left(\omega^{-2m} - \Phi(c)\right) 2c_{ff}\Psi_f \left(\frac{L_f M_{hf}(c)\tau_{hf}\Psi_h c}{4\gamma r_{hf}(v(m,c))}\right)^2 \frac{d(c_{ff}\Psi_f)}{d\Psi_f}, \quad (48)$$

where $\Phi(c) = \frac{1}{M_{hf}} \sum_{m=0}^{M_{hf}(c)-1} \omega^{-2m}$ defines the average costs of flexible manufacturing, and $\frac{d(c_{ff}\Psi_f)}{d\Psi_f} > 0$. Hence, $\frac{d\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)}{d\Psi_f} < 0$ for low cost varieties with $\omega^{-2m} < \Phi(c)$, and vice versa. Further note that the weight of this effect in Equation (48) is larger (lower) than one for low (high) cost varieties, which implies that the negative effect of low cost varieties dominates and leads to a decrease in the Theil-Index (see Proposition 2). In a second step, we consider the extensive margin effect on the Theil index, as shown in Equation (47):

$$\frac{dT_{hf}(c)}{dM_{hf}(c)} \frac{dM_{hf}(c)}{d\Psi_f} = \left[-T_{hf}(c) + \sum_{m=0}^{M_{hf}(c)-1} \left[1 + ln\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)\right] \frac{d\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)}{dM}\right] \frac{dlnM_{hf}(c)}{d\Psi_f},$$

where we exploit that revenues of the marginal variety are zero. We use the definition of the Theil index and take into account that the extensive margin effect on relative sales can be written as $\frac{d\left(\frac{r_{hf}(v(m,c))}{\bar{r}_{hf}(c)}\right)}{dM_{hf}(c)} = \frac{r_{hf}(v(m,c))}{M_{hf}(c)\bar{r}_{hf}(c)}$. This leads to: $\frac{dT_{hf}(c)}{dM_{hf}(c)} \frac{dM_{hf}(c)}{d\Psi_f} = \frac{1}{M_{hf}(c)} \frac{dM_{hf}(c)}{d\Psi_f} > 0$, where $\frac{dM_{hf}(c)}{d\Psi_f} > 0$. By inserting both effects into Equation (47), and exploiting the effect of the foreign tax rate on the exported product scope in Equation (24), it is straightforward to show that the importance of the extensive margin reaction (relative to the intensive margin) decreases in $M_{hf}(c)$.

# B Empirical Appendix

## B.1 Data Appendix

Figure B1: Discontinuous corporate tax rate changes in 45 countries - year of the tax reform

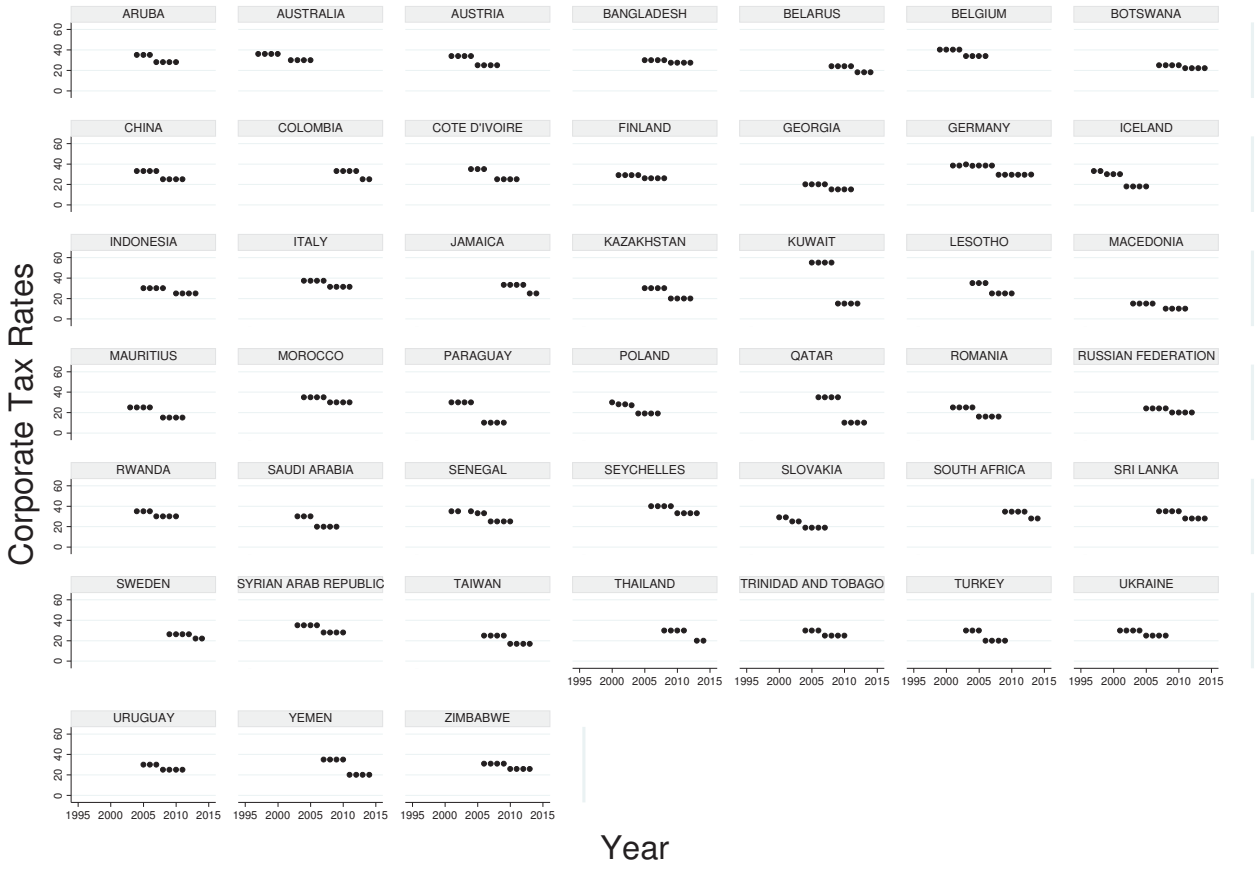

Table B1: Effects of corporate tax reforms on $\log Scope_{hft}$ using the full sample

| | Sample including all origin countries (exports from $h$ to world) | | Sample including all origin and destination countries (exports from $h$ to $f$) | |
|---|---|---|---|---|
| Dependent variable: | $\log Scope_{ht}$ | | $\log Scope_{hft}$ | |
| | (1) | (2) | (3) | (4) |
| $\log CorpTax_{ht}$ | -0.202*** | -0.0722** | | |
| | (0.0388) | (0.0360) | | |
| $\log GDP_{ht}$ | | 0.451*** | | |
| | | (0.0377) | | |
| $\log CorpTax_{ft}/CorpTax_{ht}$ | | | 0.0349** | 0.0386** |
| | | | (0.0163) | (0.0163) |
| $\log GDP_{ft}$ | | | | 0.0811*** |
| | | | | (0.0117) |
| Constant | yes | yes | yes | yes |
| Origin FE | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes |
| Origin-Year FE | no | no | yes | yes |
| Origin-Destination FE | no | no | yes | yes |
| Observations | 578 | 578 | 35,703 | 35,703 |
| R-squared | 0.908 | 0.928 | 0.809 | 0.810 |
| Number of origin countries | 64 | 64 | 64 | 64 |
| Number of origin-destination pairs | - | - | 4471 | 4471 |

Note: *** indicates 1% significance, ** 5% significance, and * 10% significance.
The coefficients in columns 1 and 2 refer to the estimation of the following equation:
$\log Scope_{ht} = \beta_1 \log CorpTax_{ht} + \log GDP_{ht} + \rho_h + \upsilon_t + \varepsilon_{ht}$,
where $\log Scope_{ht}$ is the log average firm scope of firms in origin country $h$ in year $t$, $\rho_h$ are origin country fixed effects and $\upsilon_t$ are year fixed effects.

The coefficients in columns 3 and 4 refer to the estimation of the following equation:
$\log Scope_{hft} = \beta_1 \log \frac{CorpTax_{ft}}{CorpTax_{ht}} + \mathbf{X}_{hft} + \rho_{hf} + \upsilon_t + \mu_{ht} + \varepsilon_{hft}$,
where $\log Scope_{hft}$ is the log average firm scope of firms in origin country $h$ exporting to destination country $f$ in year $t$, $\rho_{hf}$ are interacted origin-destination country fixed effects, $\mu_{ht}$ are home-year and $\upsilon_t$ are year fixed effects. $\mathbf{X}_{hft}$ is a vector of time-varying control variables, such as destination country size ($\log GDP_{ft}$) and trade agreements ($RTA_{hft}$ and $FTA_{hft}$).