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Integrated versus Segmented Markets: Implications for Export Pricing and Welfare

Abstract

This paper challenges the common assumption of market segmentation in international trade. To analyze export entry and pricing decisions of firms in integrated vs. segmented markets, we develop a novel tractable approach based on stochastic export costs that allows us to compare firm-level and aggregate outcomes under arbitrary market interdependence. We find that allowing for potential re-exporting arbitrage between countries imposes constraints on export prices of firms and has first-order implications for trade and welfare.

JEL-Codes: F120, F130, F140, F150.

Keywords: market segmentation, pricing constraints, gains from trade.

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1 Introduction

One of the most common assumptions in the trade literature is that firms choose profit-maximizing export prices separately for each market. This assumption is formally implemented by imposing that it is always cheaper to ship goods to customers in a market directly instead of via a third country - referred to as the triangle condition. This renders models substantially more tractable as interdependence between markets can be ignored in the price setting decision of firms.

In this paper, we relax the assumption of perfect market segmentation and examine optimal firm behavior when the triangle conditions are binding. We start with the empirical observation that firms are restricted in setting market-specific prices by the distance between export destinations. Conditional on direct trade costs, shorter distance between two export destinations is associated with lower price differentials that one firm charges for the same product. This suggests that the triangle condition is not universally true and it is important to understand the implications of trade liberalization in such a context. We refer to this case as *integrated markets* where firms need to take pricing constraints due to possible re-exporting arbitrage across countries into account. In contrast, we label perfect price discrimination across countries as *segmented markets*.

We develop a new mechanism that explicitly accounts for possible violations of the triangle condition and allows us to examine optimal export pricing of firms that face the associated pricing constraints. The mechanism is examined against the backdrop of the monopolistic competition trade model with heterogeneous firms and free entry as in Melitz (2003). For that, we modify an otherwise standard model by formulating stochastic market-specific export fixed costs such that (expected) aggregate profit is a continuously differentiable function. This allows us to address the main challenge of analyzing optimal behavior of firms under market interdependence when the decision to enter an export market is deterministic.[1]

To fix ideas, assume a single exporting country and two destination markets. Under CES preferences and monopolistic competition, direct trade costs are the only determinant of the differences in prices that firms from the exporting country

[1]In the standard monopolistic competition framework (e.g. Melitz, 2003) firms either export or not so we end up with case comparisons that amount to 2^J scenarios with J measuring the number of markets. This usually significantly complicates finding profit-maximizing export prices under market interdependence as the number of export markets itself depends on export prices.

charge at two destinations as long as the triangle condition holds. If arbitrage between destination markets is profitable for third parties, however, we find that firms optimally adjust their market-specific export prices such that arbitrage is no longer possible. This leads to *lower* consumer prices in the final destination and *higher* consumer prices in the potential hub market through which arbitrage would take place. These changes in optimal prices lead to inefficiently high (low) export entry in the final destination (hub) country. These two effects lead to lower welfare for both importers. Hence, binding pricing constraints imply first-order effects through export prices that are typically ignored in structural trade analysis.

We go beyond this simple three-country example and calibrate our model using data on 40 countries for the year 2014. We use the calibrated model to run two counterfactual experiments. In the first experiment, all international trade costs are reduced by 20 percent. In the second experiment, we reduce bilateral trade costs by 20 percent for the subset of EU countries participating in the Single Market. While in both experiments welfare effects are generally positive and larger for small countries, they are strikingly lower when we do not explicitly enforce the triangle condition to hold and allow for possible pricing constraints. A general message is that the assumption of segmented markets leads to significantly higher estimates of gains from trade. For the case of a uniform 20-percent reduction in trade costs this 'bias' amounts to 15 percent (unweighted average) for the ten countries with the largest welfare gains from trade. For some countries like Ireland or Luxembourg, this factor reaches nearly 50 percent. In sum, the results indicate that the assumption of market segmentation is far from innocuous and has important quantitative implications for structural trade analysis.

This paper is related to several strands of the literature. First, we relate to the literature on price convergence across international markets (see Taylor, 2002; Goldberg and Verboven, 2005) and the law of one price (see Atkeson and Burstein, 2008; Steinwender, 2018; Rogoff et al., 2019). Our focus, however, is different because we emphasize how violations of the triangle conditions vis-à-vis a single export country lead to convergence in export prices across import destinations. Our specification also nests uniform pricing as a special case when trade costs between export markets are negligible (DellaVigna and Gentzkow, 2019).

Second, as we suggest a modelling approach that uses a stochastic specification of fixed export costs, the paper complements existing work by Jia (2008) or Antràs et al. (2017) and provides tractable tools to study numerous other questions that necessarily imply interdependence between markets. For example, if firms are credit constrained the decision to export affects aggregate profits or wealth which in turn changes financing conditions and marginal costs (Holmstrom and Tirole, 1997). Under monopsonistic labor markets (Manning, 2013; Egger et al., 2019) or fairness preferences of workers (Akerlof and Yellen, 1990; Egger and Kreickemeier, 2012) export decisions feed back to firm profits, employment and thus firm-level wages. Learning from exporting is another example of such feedback effects, here channeling through firm productivity (De Loecker, 2013; Bai et al., 2017). A similar argument applies for investment decisions (e.g in physical capital stock or R&D) that is a function of all potential export destinations (Bustos, 2011). Finally, input-output linkages through global value chains imply a similar circularity between importing decisions and marginal costs (Antràs et al., 2017).

The paper is organized as follows. We start in Section 2 with a simple three country example to build intuition and present motivating evidence that price differentials across destination markets are a function of trade costs between these markets. Section 3 introduces the theoretical framework with stochastic fixed costs. We simulate the model in Section 4 for three markets before turning to calibration (Section 5) and counterfactual analysis (Section 6) to assess the differences in welfare effects of trade liberalization under segmented and integrated markets. Section 7 concludes.

2 Suggestive evidence

How does the degree of possible market price segmentation depend on the level of trade costs? Typically, trade models based on monopolistic competition assume that firms are able to price discriminate perfectly across different markets. In this section, we provide evidence that suggests that the assumption of perfect market segmentation does not come to grips with the data.

To fix ideas, consider a firm ϕ in country i that selects export-market-specific prices to maximize profits. For simplicity, let us consider two potential export markets, k and j. The firm in i has to pay iceberg trade costs $\tau_{ij} \geq 1$ and $\tau_{ik} \geq 1$ to ship their product to consumers in the respective location. Typically, under monopolistic competition and CES preferences with the elasticity of substitution parameter σ, the firm would charge the following prices in the two markets:

$$p_{ij}(\phi) = \frac{\sigma}{\sigma - 1}\frac{w_i \tau_{ij}}{\phi} \text{ and } p_{ik}(\phi) = \frac{\sigma}{\sigma - 1}\frac{w_i \tau_{ik}}{\phi} \Rightarrow \frac{p_{ij}(\phi)}{p_{ik}(\phi)} = \frac{\tau_{ij}}{\tau_{ik}}, \tag{1}$$

where w_i is the wage in i and ϕ is used to index the product and productivity of a firm producing it. Under perfect market segmentation, the optimal prices in Eq. (1) are independent of τ_{kj} and τ_{jk}. However, if there is a threat of re-exporting, τ_{kj} and τ_{jk} become relevant because the following constraints must be satisfied to prevent it:

$$p_{ik}(\phi) \leq p_{ij}(\phi)\tau_{jk} \text{ and } p_{ij}(\phi) \leq p_{ik}(\phi)\tau_{kj} \Rightarrow \frac{1}{\tau_{jk}} \leq \frac{p_{ij}(\phi)}{p_{ik}(\phi)} \leq \tau_{kj}. \tag{2}$$

Combining Eqs. (1) and (2) suggests that perfect market segmentation is possible if

$$\tau_{ik} \leq \tau_{ij}\tau_{jk} \quad \text{and} \quad \tau_{ij} \leq \tau_{ik}\tau_{kj}. \tag{3}$$

These two inequalities are known as trade costs triangle inequality and are customarily assumed to hold in quantitative trade models.[2] If, however, the triangle inequality conditions are violated, firm ϕ will have to adjust $p_{ij}(\phi)$ and $p_{ik}(\phi)$ to eliminate possible re-exporting arbitrage. In this case, the difference between the prices that ϕ charges in markets k and j would depend on trade costs between the two markets. As this paper emphasizes the importance of the triangle condition for export entry and pricing, we do not allow for export platforms. Instead, we consider a situation where firms face a threat of re-export by a third party that would capture the entire variable markup. This threat is credible whenever the triangle condition is violated and it constrains firms in their export pricing decisions. To test this empirically, let's assume that τ_{jk} and τ_{kj} are symmetric and modify the relationship in equation (2):

$$\delta_{i,kj} \leq \tau_{kj}, \quad \text{where} \quad \delta_{i,kj}(\phi) = \max\left\{\frac{p_{ij}(\phi)}{p_{ik}(\phi)}, \frac{p_{ik}(\phi)}{p_{ij}(\phi)}\right\}. \tag{4}$$

The inequality in Eq. (4) suggests that if markets are not perfectly segmented the maximum difference between the price that firm ϕ charges in j and k must be increasing in τ_{kj}. To test this hypothesis, we need data on the difference in prices that the same firm charges for the same product in different export markets as well as data on direct trade costs from i to those markets. We use data from Simonovska

[2] In this paper, we also assume that $\tau_{ii} \leq \tau_{ij}\tau_{ji}$ for all i and j. This rules out the possibility of re-exporting back to the country of production.

(2015) that include prices charged in different markets for the same product by one of the largest apparel manufacturers from Spain.[3] The data set includes information on 245 different goods and 29 export markets. Importantly, the data also contain information on ad valorem type trade costs from Spain to each export market. We supplement the data set with the data on bilateral distance between j and k and a dummy for common language from CEPII. We then estimate the following regression for i = Spain:

$$\ln \delta_{\phi kj} = \gamma \ln(\text{distance}_{kj}) + \rho \ln(\text{language}_{kj}) + Z_{kj}\Gamma + \eta_\phi + \mu_k + \mu_j + \varepsilon_{\phi kj}, \quad (5)$$

where Z_{kj} is a vector of controls and $\varepsilon_{\phi kj}$ is the stochastic error term. We also include η_ϕ, μ_k, and μ_j that capture product-specific, market-j-specific and market-k-specific fixed effects. The dependent variable captures relative consumer prices as defined above, i.e. including ad valorem trade costs from i to j and k. The coefficients of interest are γ and ρ. If $\delta_{\phi kj}$ is positively related to τ_{kj}, we expect $\gamma > 0$ and $\rho < 0$.

Table 1: Estimation results

	(I)	(II)	(III)
$\log(\text{distance}_{kj})$	0.129	0.131	0.106
	(0.002)	(0.003)	(0.004)
$\log(\text{language}_{kj})$	-0.151	-0.120	-0.089
	(0.008)	(0.007)	(0.009)
Fixed Effects	No	Yes	Yes
Additional Controls	No	No	Yes
Adj-R^2	0.029	0.258	0.268
Obs.	185,220	185,220	185,220

Notes: This table displays the estimates of γ and ρ with standard errors in parenthesis. The standard errors are clustered at the product level. Specification (II) includes product-specific, market-i-specific, and market-j-specific fixed effects. Specification (III) includes additional bilateral controls as absolute (log) difference in real GDP per capita and population between k and j. The mean of the dependent variable is normalized to 1.

The results in Table 1 suggest that the relationship between the maximum price difference in markets k and j for the same product imported from the same firm from i is positively related to (log) distance and negatively related to the measure of common language. These results are robust across several specifications and suggest that the triangle conditions in Eq. (3) that guarantee perfect market segmentation

[3] We are thankful to Ina Simonovska for sharing her data for this paper.

are violated in the data. This means that optimal export prices would deviate from those specified in Eq. (1). Motivated by these insights, we develop a general equilibrium framework that allows us to examine the implications of binding pricing constraints for optimal firm behavior and welfare in integrated markets.

3 Theory

Consider a global economy with $i, j \in J$ countries that are endowed with L_i immobile workers supplying their labor inelastically. Heterogeneous firms produce distinct varieties of a differentiated good under monopolistic competition and increasing returns to scale. They can ship their products at iceberg trade costs and decide which markets to serve. We allow only for direct exporting, but there exists a threat of third parties exploiting price differences between any markets through arbitrage, which firms take into account.

3.1 Preferences and demand

Households in country j derive their utility from the consumption of a differentiated good according to standard constant elasticity of substitution (CES) preferences of the form

$$\max_{\{q_{ij}(\phi)\}_{i=1}^{J}} U_j = \left(\sum_{i \in J} \int_{\Omega_{ij}} q_{ij}(\phi)^{\frac{\sigma-1}{\sigma}} d\phi \right)^{\frac{\sigma}{\sigma-1}}, \tag{6}$$

where $q_{ij}(\phi)$ denotes the consumption level of variety ϕ produced in country i and consumed in country j, Ω_{ij} is the set of available goods and $\sigma > 1$ describes the constant elasticity of substitution. Maximizing Eq. (6) subject to the budget constraint yields optimal demand for variety ϕ:

$$q_{ij}(\phi) = \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}} L_j w_j, \tag{7}$$

where $p_{ij}(\phi)$ is the consumer price, w_j denotes the wage rate and P_j is the price index given by

$$P_j = \left(\sum_{i \in J} \int_{\Omega_{ij}} p_{ij}(\phi)^{1-\sigma} d\phi \right)^{\frac{1}{1-\sigma}}. \tag{8}$$

3.2 Technology and profits

In every country i, a mass of heterogeneous firms N_i produce a final good under monopolistic competition and free entry. Serving a market requires a fixed labor investment implying downward-sloping average costs and increasing returns to scale at the firm level, so every variety is produced in equilibrium by one firm only.

Firms need to pay entry costs equal to f_i^e units of labor to learn their total factor productivity ϕ which we also use as a firm identifier. To keep the model computationally tractable, we assume that ϕ is drawn from a country-specific (Pareto) distribution $\phi \sim g_i(\phi)$, with location parameter b_i and shape parameter β. Goods can be traded across markets subject to iceberg trade costs $\tau_{ij} \geq 1$, implying that τ_{ij} units of the good have to be shipped for one unit to arrive at the place of consumption.

In scenarios with deterministic market-specific fixed costs, a firm exports to market j with certainty if profits are non-negative. When pricing and export decisions depend on *all* markets, this results in a combinatorial problem with 2^J choices and quickly becomes intractable even with a moderate number of countries J. The binary endogenous outcome of exporting vs. non-exporting then implies non-monotonic and not continuously differentiable aggregate profit functions, which significantly complicates finding globally optimal export pricing and entry decisions. To overcome this obstacle, we assume that firms experience market-specific shocks $\epsilon_{ij} \in [a_i; \infty)$ for each potential market such that total export fixed costs are $w_i f_{ij}/\epsilon_{ij}$. A high level of ϵ_{ij} implies low fixed costs and higher profits earned from that market. To keep the model tractable, we assume that the distribution of ϵ_{ij} is Pareto with lower bound a_i and shape parameter α.[4] Converting export entry decisions into a probabilistic problem allows us to specify expected aggregate profits from all export markets as the following continuously differentiable function:

$$\max_{p_{ij}(\phi)} E_\epsilon\left(\Pi_i(\phi)\right) = \sum_j \mathbf{I}_{ij}(\phi)\left(\frac{1}{1+\alpha}V_{ij}(\phi)w_i f_{ij}\right) \tag{9}$$

$$\text{s.t.} \;\; p_{ij} \leq p_{ik}\tau_{kj} \;\;\forall\;\; k \neq i, j,$$

where $\mathbf{I}_{ij}(\phi)$ denotes the probability for firm ϕ producing in market i to serve market

[4]The corresponding density function and the cumulative distribution function are given by $h(\epsilon_{ij}) = \alpha a_i^\alpha/\epsilon_{ij}^{\alpha+1}$ and $H(\epsilon_{ij}) = 1-(a_i/\epsilon_{ij})^\alpha$.

j and we have defined

$$V_{ij}(\phi) \equiv \frac{\left(p_{ij}(\phi)^{1-\sigma} - p_{ij}(\phi)^{-\sigma}\frac{w_i \tau_{ij}}{\phi}\right) w_j L_j P_j^{\sigma-1}}{w_i f_{ij}}. \tag{10}$$

We provide derivation details in the Appendix.

The sufficient condition for firm ϕ to serve market j is to make non-negative profits, $\pi_{ij}(\phi) \geq 0$. Expressed in terms of the stochastic cost component, this determines the zero-profit cutoff realization of the shock

$$\epsilon_{ij} \geq \frac{1}{V_{ij}(\phi)}, \tag{11}$$

which holds with equality for the marginal firm. Notice that even the least productive firm can draw a sufficiently high ϵ_{ij} to be profitable in country j so the productivity cutoff is exogenously given by the lower bound of the distribution function. It is therefore meaningful to interpret $\mathbf{I}_{ij}(\phi)$ as the share of exporting firms with a given productivity

$$\mathbf{I}_{ij}(\phi) \equiv \Pr(\epsilon_{ij} \geq \epsilon_{ij}^*) = a^\alpha V_{ij}(\phi)^\alpha. \tag{12}$$

Notice that our general formulation of aggregate profits nests both perfect market segmentation and integrated markets. Each firm optimally sets p_{ij} to maximize this objective function subject to the constraints that $p_{ij} \leq p_{ik}\tau_{kj} \quad \forall k \neq i, j$. Assuming that none of these constraints are binding, we fall back to the perfect market segmentation case with profit-maximizing prices

$$p_{ij} = \frac{\sigma}{\sigma - 1}\frac{\tau_{ij} w_i}{\phi}.$$

When price setting depends on optimal prices in other markets, we move to numerical solutions. It is important to highlight that the probabilistic formulation of aggregate profits allows us to derive globally optimal prices while circumventing the combinatory problem of comparing 2^J cases.

3.3 General equilibrium

To describe the general equilibrium, we finally introduce goods market clearing, labor market clearing and the condition for free market entry.

Goods market clearing. The condition that income equals total sales in each location can be written as

$$w_i L_i = \sum_{j \in J} \lambda_{ij} w_j L_j, \tag{13}$$

where the expenditure share of country j for goods produced in i, λ_{ij}, is defined as the total value of country j's imports from country i (X_{ij}) relative to aggregate expenditures of j (X_j). The gravity equation for bilateral shipments is given by

$$X_{ij}(\phi) = w_j L_j P_j^{\sigma-1} N_i \int_\Phi \mathbf{I}_{ij}(\phi) p_{ij}(\phi)^{1-\sigma} g_i(\phi) d\phi, \tag{14}$$

where Φ denotes the support of ϕ and we can formulate

$$\lambda_{ij} = \frac{X_{ij}}{X_j} = \frac{N_i \int_\Phi \mathbf{I}_{ij}(\phi) p_{ij}(\phi)^{1-\sigma} g_i(\phi) d\phi}{P_j^{1-\sigma}}, \tag{15}$$

where $X_j = \sum_k X_{kj}$. The price index can then be written as:

$$P_j = \left[\sum_k N_k \int_\Phi \mathbf{I}_{kj}(\phi) p_{kj}(\phi)^{1-\sigma} g_i(\phi) d\phi \right]^{1/(1-\sigma)}. \tag{16}$$

Labor market clearing. Firms demand labor for entry costs f_i^e, market-specific fixed costs f_{ij} and production. The resulting market clearing condition can be stated as

$$L_i = N_i \left[f_i^e + \sum_j \int_\Phi \mathbf{I}_{ij}(\phi) \frac{p_{ij}(\phi)^{-\sigma} \tau_{ij}}{\phi} w_j L_j P_j^{\sigma-1} g_i(\phi) d\phi + \sum_j \int_\Phi \mathbf{I}_{ij}(\phi) f_{ij} g_i(\phi) d\phi \right]. \tag{17}$$

Free entry. Firms pay the upfront entry cost $f_i^e w_i$ to find out their productivity ϕ as long as expected profits are non-negative. Building on the formulation for expected profits from above, we get

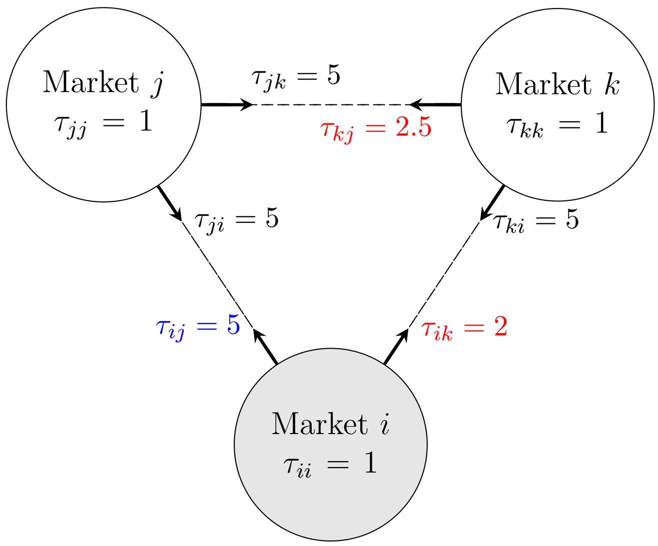
$$\frac{1}{\alpha+1} \sum_j \int_\Phi \mathbf{I}_{ij}(\phi) V_{ij} w_i f_{ij} g_i(\phi) d\phi = f_i^e w_i. \tag{18}$$

We close the model by combining free entry with labor market and goods market clearing to determine wages and the number of firms.

4 Simulation: A three-country example

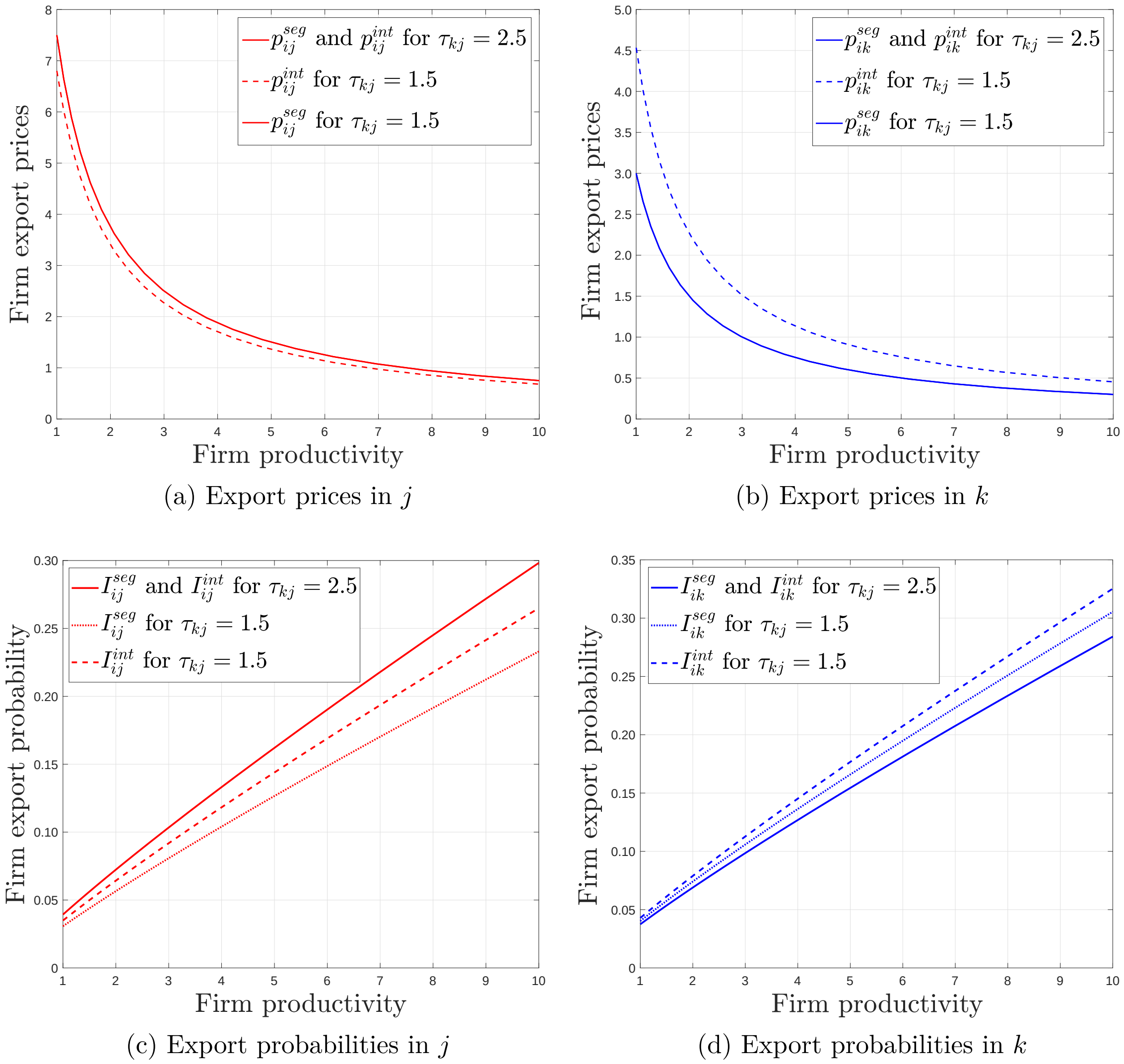
To build intuition, we first solve the model numerically for the simplest case of three countries. As shown in Figure 1, we choose initial trade cost levels such that the triangle conditions are satisfied for all country pairs. This means that arbitrage is not profitable. Notice that for market j the triangular condition holds with equality as $\tau_{ij} = \tau_{ik}\tau_{kj}$. We then reduce trade costs between k and j and explore how prices, export probabilities, and welfare respond under both segmented and integrated markets.

Figure 1: Three-country example



In a first step, we focus on optimal export prices and export propensities of firms in market i. Reducing trade costs to $\tau_{kj} = 1.5$ violates the triangle condition, so $\tau_{ij} > \tau_{ik}\tau_{kj}$, introducing a threat of arbitrage between markets k and j. This threat induces firms to deviate from the optimal export prices that they charge under perfect segmentation. Panels (a) and (b) of Figure 2 plot profit-maximizing export prices p_{ij} and p_{ik} as a function of firm productivity ϕ for these different scenarios. If the triangle condition holds ($\tau_{kj} = 2.5$), firms charge the same prices under both regimes as described by the solid lines, i.e. $p_{ij}^{seg} = p_{ij}^{int}$ and $p_{ik}^{seg} = p_{ik}^{int}$, where the superscripts denote the two market regimes. The figure further reveals that $p_{ij} > p_{ik}$ due to differences in bilateral trade costs and more productive firms charge lower prices, like e.g. in Melitz (2003). Reducing τ_{jk} to 1.5 has no effect on

Figure 2: Optimal export prices and export probabilities



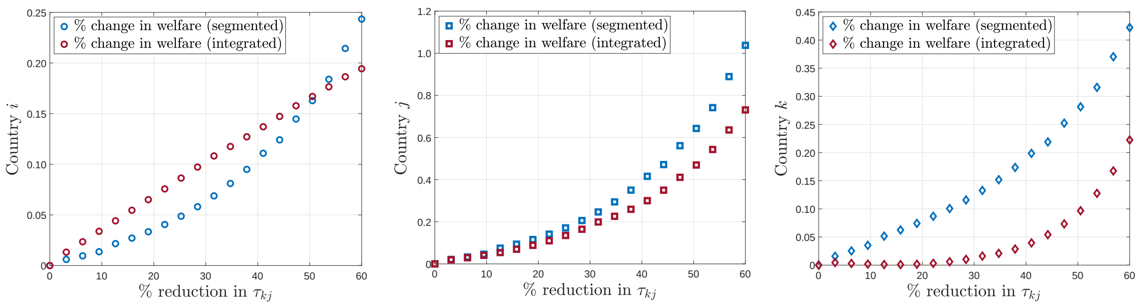
(a) Export prices in j (b) Export prices in k

(c) Export probabilities in j (d) Export probabilities in k

market $i's$ export prices under segmented markets as the triangle pricing restriction is ignored by assumption. With integrated markets, however, firms in market i respond by *lowering* p_{ij} and *raising* p_{ik} until the triangular condition holds again. The magnitude of price adjustments depends on the size of markets. If the hub market k is small, firms do not lose much profit if they increased p_{ik}. If that country is large relative to market j, however, firms would increase p_{ik} relatively less. These price responses imply that markups are no longer constant across markets. If variable trade barriers between k and j vanish entirely, i.e. $\tau_{kj} = 1$, exporters in market i would charge the same consumer prices in both j and k despite different bilateral trade costs.

Turning to export probabilities, panels (c) and (d) visually document how the stochastic shock on export fixed costs ensures that there is no export cutoff that separates firms into exporters and non-exporters. Instead, the propensity to export is positive and increasing in firm productivity. This feature of our model is in line with firm-level evidence presented in the next section (see Table 3 below). While $\mathbf{I}(\phi)$ is identical in both regimes for $\tau_{kj} = 2.5$ (solid lines), export propensities differ once the pricing constraint becomes binding. Under segmented markets, and in the opposite direction relative to prices, the reduction in bilateral trade costs between k and j reduces $\mathbf{I}_{ij}(\phi)$ and raises $\mathbf{I}_{ik}(\phi)$. For the former case, the reduction is less acute for the integrated case, whereas for the latter the opposite is true. These effects as well as the differences between the segmented and integrated cases are explained by two components. First, the reduction in τ_{kj} creates general equilibrium effects making exporters from i less competitive relative to exporters from k in market j. Second, some of these effects are mitigated by the reduction in export prices under market integration such that the reduction in p_{ij} in panel (c) is relatively less acute under market integration. The same logic applies to the results in panel (d). Reduction in τ_{kj} leads to increases in exporting probabilities form k to j under both regimes. However, the effect is magnified in the integrated case due to the additional price effect depicted in panel (b).

Figure 3: Welfare change



(a) Market i (b) Market j (c) Market k

With these insights at hand, we now compare the effects of lower trade costs between markets k and j for welfare of each country under both regimes.[5] As is evident from Figure 3, countries j and k experience *lower* welfare gains under integrated than segmented markets once the pricing constraint becomes binding. The intuition relies on the fact that additional constraints in the export pricing decision are sub-

[5]See Appendix for further details on wages and price indices.

optimal from the perspective of firms in i. Hence, even though firms from i charge lower prices in market j under integrated markets, they also face a lower probability of exporting to that market. These factors together lower consumer welfare via distortions in the optimal combination of the intensive and extensive margins of trade. A similar logic applies to market k. Though the individual directions of the price and export probability effects go in the opposite direction relative to market j, the combination of the two deviates from the optimum, which leads to relatively lower welfare. Figure 3 also suggests that the welfare in country i is higher in the integrated case relative to the segmented case for moderate reductions in τ_{kj}. The difference is quantitatively small and can be explained by the general equilibrium effects that lower the overall price index in country i relatively more when k and j are integrated.

As countries differ in several respects in the real world, we explore the role of country size by doubling population in each of the three markets at a time while sticking to the reduction in bilateral trade costs τ_{jk} from 2.5 to 1.5 as above. Table 2 summarizes the findings.

Table 2: Welfare changes and country size

	Market i	Market j	Market k
Baseline (seg)	0.11%	0.39%	0.19%
Baseline (int)	0.13%	0.30%	0.04%
$\Delta L_i = 100\%$ (seg)	0.06%	0.43%	0.20%
$\Delta L_i = 100\%$ (int)	0.09%	0.32%	-0.06%
$\Delta L_j = 100\%$ (seg)	0.13%	0.21%	0.32%
$\Delta L_j = 100\%$ (int)	0.16%	0.15%	0.14%
$\Delta L_k = 100\%$ (seg)	0.12%	0.56%	0.10%
$\Delta L_k = 100\%$ (int)	0.12%	0.39%	0.09%

Notes: This table displays the market-specific welfare changes when τ_{jk} declines from 2.5 from 1.5. The first row repeats the baseline results while rows 2-4 assume that country size doubles for one market at a time.

In the first experiment, where we double the country size of the relevant exporter i, we observe that k experiences negative welfare gains relative to the baseline case where countries are symmetric in size. This is intuitive since when L_i is high, country i is an important exporter for market k. Hence, distortions in i in the form of higher export prices have a more pronounced effect on country k. In the second experiment, we double the size of the destination country j. In this case, the gains of country k are higher than in the benchmark. The intuition behind this result lies in the relative changes in ij-specific and ik-specific prices and export probabilities. As producers in i view market j as relatively more important (due to its economic size) they react strongly in their changes towards that market, which means that the distortions relevant for market k are less severe. This is confirmed in the results of the third experiment, where we double the size of market k. Here the gains of market j are larger than in the baseline due to relatively lower ij-specific distortions in prices and export probabilities.

5 Calibration

We calibrate the model to the data on 40 OECD countries in 2014. For computational purposes, we assume that in the outset the triangle conditions are not binding. The trade data and country coverage are from the World Input-Output Database. We provide further details in the Appendix. In addition to the data on aggregate international trade, we use data on nominal GDP per capita from the World Development Indicators, which is interpreted as a measure of w_i.

First, we calibrate labor endowment in each country, L_i, using the trade balance condition and the data on trade flows and wages as follows:

$$L_i = \frac{\sum_j X_{ij}}{w_i}, \tag{19}$$

where X_{ij} and w_i are observed in the data. Based on the assumptions about the shape of the productivity distributions and the structure of the model, we inform the productivity scale parameter, b_i, using data on PPP-adjusted GDP per head of population from the OECD Compendium of Productivity Indicators. We set the shape parameter of the productivity distribution to $\beta = 4$ and the elasticity of substitution parameter to $\sigma = 3$.[6]

Second, we calibrate the shape parameter α of the Pareto distribution of ϵ_{ij} using the data on the share of exporters across different firm sizes from the OECD Structural and Demographic Business Statistics where we observe the data for 15 countries summarized in Table 3. We observe, in line with the prediction of the

[6] Our results are qualitatively robust to alternative values of β and σ.

theoretical model, that 4.4% of small firms with 1-9 employees export while almost all companies with more than 250 employees serve customers abroad (99%).

Table 3: Share of exporters by firm size (2005)

	Firm employment			
	1-9	10-49	50-249	+250
Mean # of firms	1,227,733	179,304	40,109	8,674
(standard deviation)	(117,221)	(19,845)	(3,035)	(608)
Mean # of Exporters	54,535	57,456	24,524	8,590
(standard deviation)	(7,507)	(7,834)	(2,288)	(584)
Share of Exporters	4.44%	32.04%	61,14%	99.03%
# of countries	15	15	15	15

Notes: This table displays the average number of existing firms, exporting firms and the fraction of exporters for a set of $N = 15$ countries in 2005. The corresponding standard deviations are in parenthesis. The set of countries includes Austria, Czech, Denmark, Estonia, Finland, France, Hungary, Italy, Luxembourg, Latvia, Poland, Portugal, Slovak Republic, Slovenia and Sweden. *Source: OECD STAT, SDBS.*

We capitalize on the structure of the theoretical model that the employment size is proportional to firm-level productivity and make use of the relationship between average exporting probability in each bin relative to the productivity quantile. Let $\bar{I}(q)$ denote conditional average probability of exporting for firms with productivity higher than quantile q and let $H_{(\cdot)}^{-1}$ denote the inverse of the respective cdf. Then we can use the following identity to pin down the value of α:

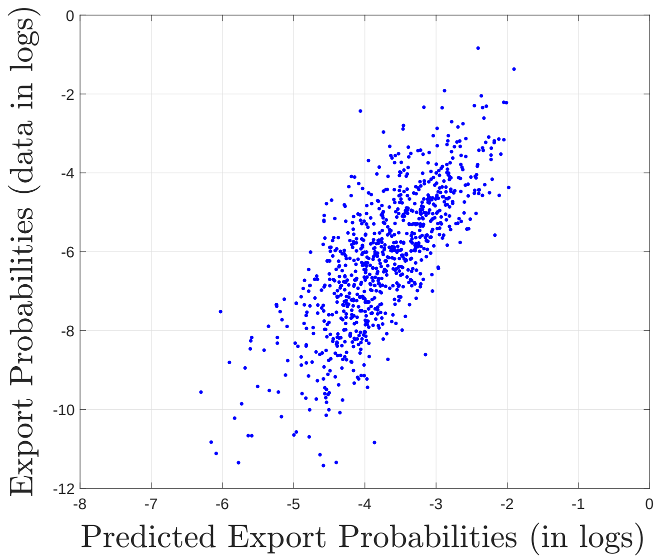
$$\left(\frac{\bar{I}(97)}{\bar{I}(84)}\right)^{\alpha(\sigma-1)} = \left(\frac{1-H_{97}^{-1}}{1-H_{84}^{-1}}\right)^{-\frac{1}{\beta}} \tag{20}$$

Given $\beta = 4$ and $\sigma = 3$, the calibrated value of α is 0.44. We set the scale parameter of the distribution of ϵ_{ij} to one.

Finally, we assume that fixed trade costs are proportional to bilateral distances taken from CEPII. Given this parameterization of f_{ij} and the structure of the model, we back out variable trade costs τ_{ij} given the observations on λ_{ij}.

Our calibration procedure allows us to fit the data on trade flows and wages perfectly. To check the fit of the calibrated model in a different dimension, we use the data on bilateral exporting probability calculated using the data on the number of exporters from the OECD's Trade by Enterprise Characteristics (TEC) database and the total number of enterprises from the OECD's Structural and Demographic Business Statistics (SDBS) database. These data include 878 observations. Comparing the model's predictions to the data in Figure 4 reveals that the calibrated model is able to match the moments of the data that were not targeted in the calibration. The correlation between the predicted and the actual bilateral average probability of exporting is 0.75.

Figure 4: CALIBRATION CHECK



6 Counterfactual experiments

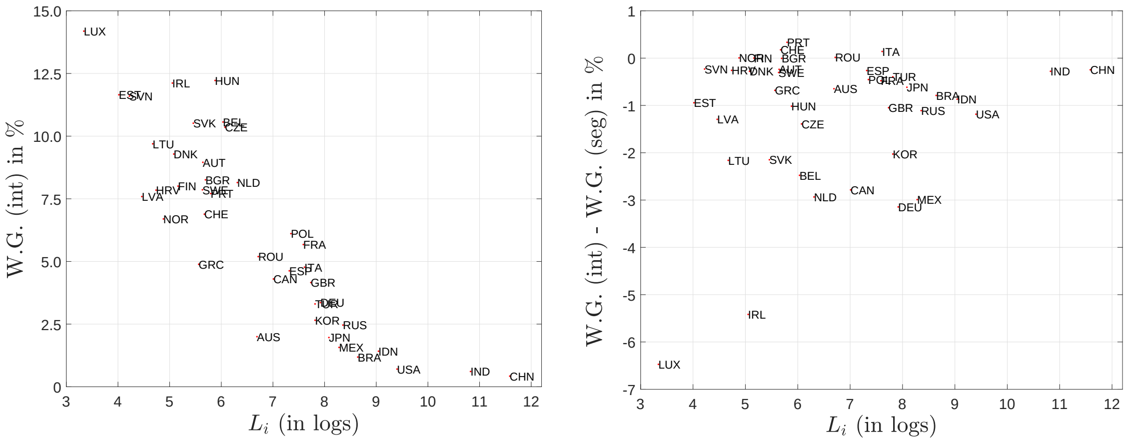
In this section, we use the calibrated model to predict welfare gains from trade under both integrated and segmented markets in two counterfactuals. First, we reduce bilateral trade costs between all 40 OECD countries by 20 percent. Second, we do the same experiment just for the subset of EU countries to study regional trade integration.

6.1 Uniform reduction of trade costs

Although uniform trade liberalization reduces bilateral frictions by the same percentage for all pairs, triangle conditions are affected in an asymmetric way because shipping via a hub country becomes relatively cheaper. While direct trade costs decline to 80% of the previous level, only $0.8^2 = 0.64\%$ of previous costs have to be paid for the indirect route.

Figure 5 summarizes the results. Panel (a) reveals that welfare gains under integrated markets are higher for smaller countries like Luxembourg and Slovenia compared to China, India or the US that experience relatively lower gains. Panel (b) plots the difference in the welfare gains between integrated and segmented markets in percentage points. While Switzerland benefits more from the trade cost reduction under integrated markets, almost all other countries fare worse. Relating the deviations to the initial levels, we observe that the assumption of segmented markets on average leads to an overestimation of the gains from the uniform reduction in trade costs. For the ten countries with the highest welfare gains in percent (top quartile) the unweighted average amounts to 22 percent. Luxembourg leads the list in this group with an upward 'bias' of 46 percent. If we increase the trade cost shock to 40 percent, the unweighted average for the same group of countries increases to 42 percent. Ireland shows the largest 'bias' in this case with 75 percent.

Figure 5: Welfare Effects of Uniform Liberalization



(a) Welfare Gains (integrated)

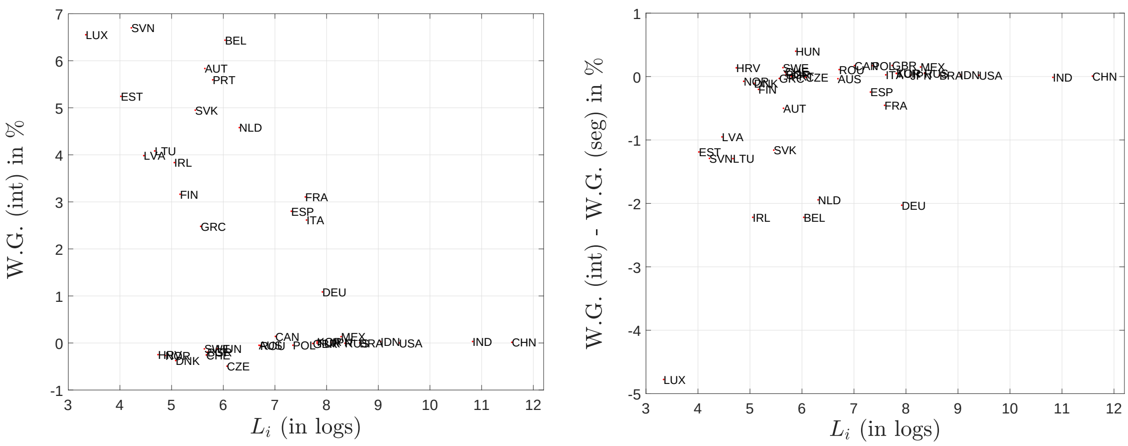
(b) Welfare Gains Difference

Notes: Based on uniform reductions in bilateral trade costs by 20%, panel (a) plots welfare gains for each country in percent. Panel (b) shows the difference in welfare gains between integrated and segmented markets measured in percentage points.

6.2 European trade integration

In the second exercise, we reduce bilateral trade costs within the European Single Market[7] by the same magnitude as above (20%) while leaving all other trade frictions unchanged. We find, in line with intuition, that European countries experience the highest welfare gains, albeit at lower levels compared to the first experiment as trade frictions only decline for a subgroup. Again, smaller countries like Luxembourg (+6.6 percent) or Slovenia (+6.7 percent each) benefit relatively more. Many Non-EU economies even lose (mildly) due to trade diversion effects. Comparing segmented to integrated markets, we find the same pattern as in Section 6.1 that welfare gains are *lower* when we allow for pricing constraints (integrated markets). With 20 percent lower trade frictions, the upward 'bias' for the ten economies experiencing the largest welfare gains amounts to 31 percent. This measure rises to 52 percent when trade costs decline by 40 percent.

Figure 6: WELFARE EFFECTS OF FURTHER EU INTEGRATION



(a) Welfare Gains (int.) (b) Welfare Gains Difference

Notes: Based on reductions in bilateral trade costs between EU countries by 20%, panel (a) plots welfare gains for each OECD country in percent. Panel (b) shows the difference in welfare gains between integrated and segmented markets measured in percentage points.

[7]These countries include Austria, Belgium, Germany, Spain, Estonia, Finland, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, the Netherlands, Portugal, Slovakia, and Slovenia.

7 Conclusions

In this paper, we have extended the standard monopolistic competition trade model with heterogeneous firms to structurally evaluate export pricing decisions in situations where arbitrage between countries imposes restrictions on the market-specific pricing strategies. To this end, we have introduced market-specific shocks at the firm level that affect export fixed costs and give rise to a continuous export probability function that is increasing in firm productivity. Even if firm-level decisions depend on *all* markets, this approach ensures tractability.

We show that assuming market segmentation is far from being innocuous. Comparing welfare changes in response to a uniform reduction of bilateral trade costs of 20 percent reveals that ignoring potential pricing constraints delivers higher welfare gains for almost all OECD countries compared to integrated markets. For the ten countries with the highest gains, the ratio of welfare gains between the segmented and the integrated regime amounts to 22 percent, reaching close to 50 percent for some countries. We conclude that accounting for pricing constraints is important for the correct evaluation of the effects of falling trade costs on trade and welfare.

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Appendix

Derivation of export propensity

To derive $\mathbf{I}_{ij}(\phi)$, we start with the condition that a firm needs to draw a sufficiently high ϵ_{ij} to earn non-negative profits from exporting. This is guaranteed if

$$\left(p_{ij}(\phi)^{1-\sigma} - p_{ij}(\phi)^{-\sigma}\frac{w_i\tau_{ij}}{\phi}\right) w_j L_j P_j^{\sigma-1} \geq \frac{1}{\epsilon_{ij}} w_i f_{ij}$$

leading to the sufficient condition to export

$$\epsilon_{ij} \geq \frac{w_j f_{ij}}{\left(p_{ij}(\phi)^{1-\sigma} - p_{ij}(\phi)^{-\sigma}\frac{w_i\tau_{ij}}{\phi}\right) w_j L_j P_j^{\sigma-1}}$$

We can derive the probability for a firm with productivity ϕ to export from market i into market j by noting that

$$\mathbf{I}_{ij}(\phi) = \Pr(\epsilon_{ij} \geq \epsilon_{ij}^*) = 1 - H\left(\frac{1}{V_{ij}(\phi)}\right) = 1 - \left(1 - \frac{a^\alpha}{\epsilon_{ij}^{*\alpha}}\right) = a^\alpha V_{ij}(\phi)^\alpha,$$

where we have used the relationship $\epsilon_{ij}^* = 1/V_{ij}(\phi)$.

Derivation of expected profits

We derive expected total profits conditional on ϵ_{ij} as

$$\mathbb{E}_\epsilon(\Pi_i(\phi)) = \sum_j \mathbf{I}_{ij}(\phi)\left[V_{ij} w_j f_{ij} - \mathbb{E}_\epsilon\left(\frac{1}{\epsilon_{ij}}|\epsilon_{ij} \geq \epsilon_{ij}^*\right) w_i f_{ij}\right].$$

Using $\mathbf{I}_{ij}(\phi) = \Pr(\epsilon_{ij} = \epsilon_{ij}^*) = a^\alpha/\epsilon^{\alpha^*} = a^\alpha V_{ij}^\alpha$, this expression becomes

$$\mathbb{E}_\epsilon(\Pi_i(\phi)) = \sum_j a^\alpha V_{ij}^\alpha \left[V_{ij} w_j f_{ij} - \mathbb{E}_\epsilon\left(\frac{1}{\epsilon_{ij}}|\epsilon_{ij} \geq \epsilon_{ij}^*\right) w_i f_{ij}\right].$$

Further, the conditional density function ensures that only firms with non-negative profits serve a market. We obtain the pdf conditional on exporting as

$$h(\epsilon_{ij}|\epsilon_{ij} \geq \epsilon_{ij}^*) = \frac{h(\epsilon_{ij})}{1 - H(\epsilon_{ij}^*)} = \frac{\alpha a^\alpha}{\epsilon_{ij}^{\alpha+1}}\left(\frac{a^\alpha}{\epsilon^{*\alpha}}\right)^{-1} = \frac{\alpha}{\epsilon_{ij}^{\alpha+1}} V_{ij}^{-\alpha}$$

and we we get the conditional expectation of the respective term $1/\epsilon_{ij}$ as

$$\mathbb{E}_\epsilon\left(\frac{1}{\epsilon_{ij}}|\epsilon_{ij} \geq \epsilon_{ij}^*\right) = \int_{\epsilon_{ij}^*}^{\infty} \frac{1}{\epsilon_{ij}} h(\epsilon|\epsilon_{ij} \geq \epsilon_{ij}^*))d\epsilon = \int_{\epsilon_{ij}^*}^{\infty} \frac{1}{\epsilon_{ij}} \frac{\alpha}{\epsilon_{ij}^{\alpha+1}} V_{ij}^{-\alpha} d\epsilon$$

We use this relationship as follows

$$\begin{aligned}
\mathbb{E}_\epsilon(\Pi_i(\phi)) &= \sum_j \mathbf{I}_{ij}(\phi)\left[V_{ij}w_j f_{ij} - \mathbb{E}_\epsilon\left(\frac{1}{\epsilon_{ij}}|\epsilon_{ij} \geq \epsilon_{ij}^*\right) w_i f_{ij}\right] \\
&= \sum_j a^\alpha V_{ij}^\alpha \left[V_{ij}w_j f_{ij} - \left(\int_{\epsilon_{ij}^*}^{\infty} \frac{1}{\epsilon_{ij}} \frac{\alpha}{\epsilon_{ij}^{\alpha+1}} V_{ij}^{-\alpha} d\epsilon\right) w_i f_{ij}\right] \\
&= \sum_j a^\alpha V_{ij}^\alpha \left[V_{ij}w_i f_{ij} - w_i f_{ij} V_{ij}^{-\alpha}\alpha\left[\frac{1}{-\alpha-1}\epsilon_{ij}^{-\alpha-1}\Big|_{1/V_{ij}}^{\infty}\right]\right] \\
&= \sum_j a^\alpha V_{ij}^\alpha \left[V_{ij}w_i f_{ij} - w_i f_{ij} V_{ij}^{-\alpha}\alpha\left(0 - \frac{1}{-(\alpha+1)}V_{ij}^{\alpha+1}\right)\right] \\
&= \sum_j a^\alpha V_{ij}^\alpha \left[V_{ij}w_i f_{ij} - \frac{\alpha}{\alpha+1}V_{ij}w_i f_{ij}\right]
\end{aligned}$$

which can further be simplified by using $\Pr(\epsilon_{ij} > \epsilon_{ij}^*) = a^\alpha V_{ij}^\alpha$ to get the expression for export probabilities.

Country List

The country list includes: Australia, Austria, Belgium, Bulgaria, Brazil, Canada, Switzerland, China, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Greece, Croatia, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Lithuania, Luxembourg, Latvia, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Sweden, Turkey, USA.

Details of the three-country example

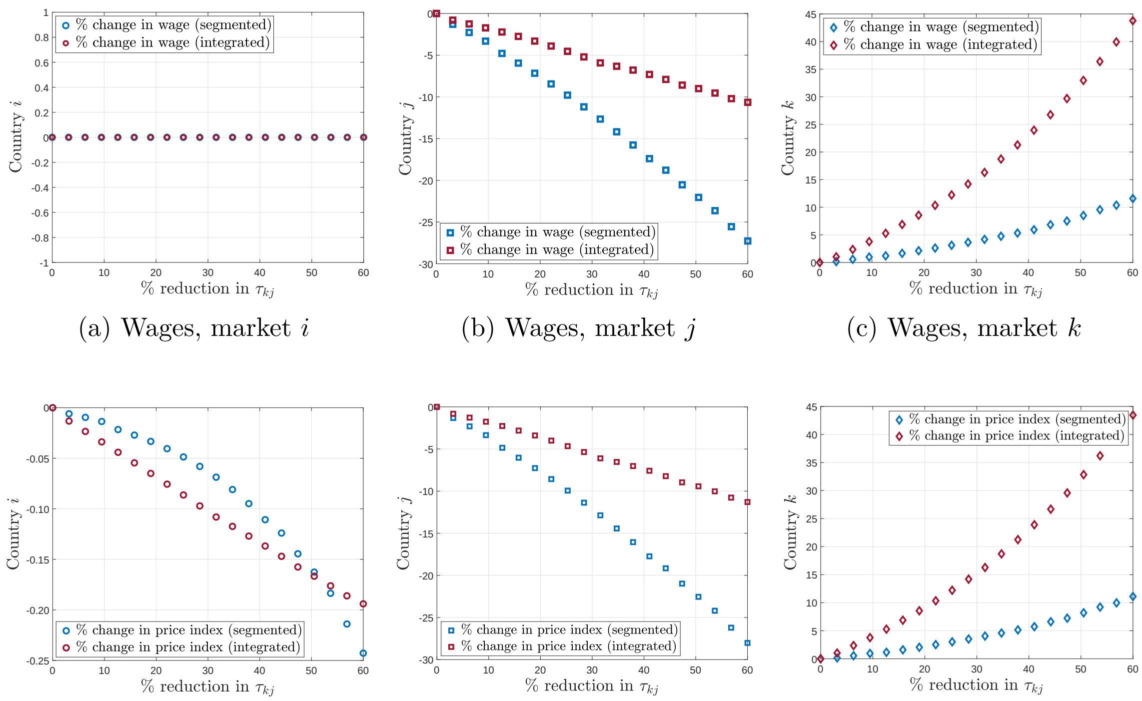
In this subsection, we provide details on the parameterization of the three country model in the main text. In the outset, all countries are symmetric with $L_i = 100$, $a_i = 1$, $b_i = 1$ for all i. We also set $\sigma = 3$, $\alpha = 0.44$, and $\beta = 4$. The variable and fixed trade costs matrices are set as follows:

$$\mathbb{T} = \begin{pmatrix} 1 & 5 & 2 \\ 5 & 1 & 5 \\ 5 & 2.5 & 1 \end{pmatrix}; \quad \mathbb{F} = \begin{pmatrix} 0.001 & 100 & 100 \\ 100 & 0.001 & 100 \\ 100 & 100 & 0.001 \end{pmatrix},$$

where exporters and importers are sorted according to rows and columns, respectively. The initial trade cost matrix is constructed such that the triangular condition is not violated for any market. To see how violation of the triangularity condition affects $\{i, j, k\}$ we reduce trade costs between k and j so that firms in i become price constraint with respect to market j via the potential hub market k.

We report the welfare effects in the main text in Figure 3. Here, we report additional details by decomposing the total effect into the wage and price effects in Figure A1.

Figure A1: Wages, price indices, and trade flows



(a) Wages, market i (b) Wages, market j (c) Wages, market k

(d) Price index, market i (e) Price index, market j (f) Price index, market k