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Structural Gravity and the Gains from Trade under Imperfect Competition

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Structural Gravity and the Gains from Trade under Imperfect Competition[1]

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Abstract

We extend structural gravity models of bilateral trade flows to oligopolistic competition. We show that conventional gravity estimates do not only reflect trade costs but also market power. Our simple estimation procedure generalizes the standard gravity model and disentangles exogenous trade frictions and endogenous market power distortions. We use our estimated model to counterfactually increase trade costs by abolishing the European Single Market. We find that domestic firms' markups in EU member countries increase by 2 to 6 percent. Importantly, welfare effects of trade liberalization are much more pronounced due to the change in competition among domestic and foreign firms.

JEL-Classification: F10, F12.

Keywords: Trade, structural gravity, imperfect competition, market power.

1 Introduction

The gravity equation has been the most successful workhorse model in international trade that is able to explain trade patterns surprisingly well. It has been used to explain trade flows and the effects of geographical and cultural distance, trade agreements, trade policies, institutional quality and even the effects of sporting events, sanctions and conflicts. Started as an empirical workhorse borrowed from physics, it is now well established in its form as structural gravity where the gravity equation is derived in a consistent theory framework.[1] It has been shown that a variety of models like Armington, Ricardo, Heckscher-Ohlin, monopolistic competition and models of heterogeneous firms imply a structural gravity equation.[2] Furthermore, it is open to the level of aggregation and also allows for a sectoral decomposition of trade.[3] Its empirical strategy has been developed further such that best practices could be established (see Anderson, 2011, Head and Mayer, 2014, and Yotov et al., 2016).[4]

While structural gravity has been very successful, a main concern is that its theory relies on models of perfect or monopolistic competition. International trade, however, is driven by large firms: most firms do not export, and a small number of firms is responsible for a large fraction of exports.[5] Quantitative gravity models of international trade typically assume atomistic firms which operate in perfectly or monopolistically competitive markets and hence do not influence strategically the price level in their industry. These models are used to quantify the trade effects and welfare gains from trade liberalization via changes in trade costs, tariff reductions or trade agreements. Their results are used to inform and influence trade policy decisions. Critics of these quantitative studies argue that by not allowing for the oligopolistic nature of today's international trade, results are biased and therefore lead to wrong policy advice. Except for a few studies, the quantitative trade

[1] For the path-breaking contributions, see Anderson (1979), Anderson and van Wincoop (2003) and Eaton and Kortum (2002).

[2] See also Anderson and Yotov (2016), Arkolakis et al. (2012), Bergstrand (1985), Chaney (2008), Deardorff (1998), Helpman et al. (2008).

[3] See for example Anderson and Yotov (2016), Caliendo and Parro (2015), Chor (2010) and Costinot et al. (2012).

[4] For a recent critical review of the structural gravity approach, see Carrère et al. (2019).

[5] Bernard et al. (2007) find that only 4 percent of U.S. firms exported in 2000, and the top 10 percent of firms represent 96 percent of U.S. exports. This pattern is similar across the globe: in a sample of 32 countries, Freund and Pierola (2015) find that five firms account for a third of a country's exports.

literature has neglected oligopoly so far.[6] Therefore, it is crucial to understand whether quantitative trade models can accommodate oligopolistic market structures.

We show that if consumers have Dixit-Stiglitz (CES) preferences, gravity still holds for any oligopoly in prices or quantities. Thus, our results imply that researchers can still estimate trade costs and use their estimates to quantify the trade effects of changes in trade costs — without having to assume a monopolistically competitive market structure — if they are willing to (continue to) assume that preferences are of the Dixit-Stiglitz form. We show that the frictions estimated by standard gravity models are a combination of trade frictions and market power distortions in an oligopoly setting. Furthermore, guided by the theory, we are not only able to distinguish between market power frictions and geographical frictions, but also to disentangle them empirically. This is particularly important as the motivation for economic integration is often not only reducing trade costs, but also about increasing competition among exporters and domestic firms. Thus, our paper offers some guidance how these effects can be estimated in a theory-consistent way in models of oligopolistic competition.[7] We find that the interaction between endogenous markups and trade frictions also makes a crucial difference such that a reduction in trade frictions has a much stronger effect, even if the number of firms in a given market is large.

To our knowledge, this is the first paper that integrates oligopolistic behavior into a structural gravity framework. Furthermore, we explore the implications for quantitative trade models and find that the competition effect plays an important role, and in this respect our paper is close to Amiti et al. (2019), Atkeson and Burstein (2008), Bernard et al. (2007), and Edmond et al. (2015).[8] The innovation of our paper is that we can use the estimates of the structural gravity model to disentangle trade and market power frictions, and we can do so for both price and quantity competition in the same framework. In principle, our model can accomodate an economy with multiple sectors in which price competition prevails in some industries while other industries face binding capacity

[6] For an overview of the influence of oligopoly models on empirical trade studies, see Head and Spencer (2017). Head and Mayer (2019) compare the CES monopolistic competition approach with the random coefficients demand structures used in the industrial organization literature.

[7] Other papers have focused on alternative demand systems. Our paper thus complements Arkolakis et al. (2019), Mrázová and Neary (2014), Mrázová and Neary (2017) and Mrázová and Neary (2019) who consider trade costs for a wide variety of utility functions but assume that firms operate under monopolistic competition.

[8] Also Jaravel and Sager (2019) conclude that estimated markup responses to trade liberalization with China are much larger than standard models predict.

constraints. More generally, we show that strategic interactions in imperfectly competitive markets are important. Standard quantitative trade models of monopolistic competition cannot directly address the pro-competitive effects of trade liberalization.[9]

Using Belgian firm-level data, Amiti et al. (2019) show that domestic and foreign prices co-move and that the pass-through of cost increases is incomplete. Both results are in sharp contrast to models of monopolistic competition using CES demand structures. Their model exploits uniquely detailed data at the firm-product level for both Belgian and foreign firm sales in Belgium. While Amiti et al. (2019) focus on the total effect of cost shocks on firms' markups, we identify the individual effects of trade cost changes on markups. Our model is consistent with the empirical findings in Amiti et al. (2019) of interdependent markups across markets and incomplete pass-through. Our paper also complements the literature following Bernard et al. (2007), particularly Holmes et al. (2014) and Hsu et al. (2020). These papers use the model by Bernard et al. (2007) which assumes Bertrand competition between firms from different countries which are heterogeneous in productivity but produce a homogeneous good, whereas we model Bertrand competition between firms which produce differentiated varieties across countries with heterogeneous costs. We also consider Cournot competition (and monopolistic competition as the limiting case), and thus our paper also complements Edmond et al. (2015) who study Cournot competition in an intermediate goods sector based on the model of Atkeson and Burstein (2008).

This literature sheds light on the welfare consequences and allocation effects of trade liberalization across firms using estimated models which rely on detailed firm-level data which are typically only available for a single country. Instead, we use aggregate trade data for 43 countries as our focus lies on the third country and general equilibrium effects which are at the heart of the quantitative trade theory and gravity literature, and which are crucial for the evaluation of multilateral trade liberalization via discriminatory trade agreements such as the European Single Market. We follow the quantitative trade theory literature using aggregate data and compare the standard outcomes that assume monopolistic competition with the Cournot and Bertrand industry equilibria under the assumption that each country hosts one firm in each industry, and that all industries are symmetric. While this exercise may not do justice to the differences across industries, neither do monopolistic competition models using aggregate data, and it still allows us

[9] In particular, Arkolakis et al. (2019) show that these models that replace constant by variable markups may even lead to lower gains from trade.

to distinguish between market power and trade frictions. Furthermore, the assumption that each country hosts a "national champion" implies that 43 firms will be active in each industry, and thus our competition effects are a conservative estimate. Since the completion of the European Single Market was exactly supposed to encourage competition, we counterfactually increase trade costs by abolishing the European Single Market, and we show that welfare effects are much more pronounced even with 43 active firms in each industry. We are not the first to estimate the effect of the European Single Market (see for example, Felbermayr et al., 2018, and Mayer et al., 2019, for recent studies), but these papers employ a standard structural gravity approach. Our study emphasizes the difference implied by oligopoly, also because several studies have found that the Single Market has reduced markups substantially (see, Allen et al., 1998, and Badinger, 2007).

The remainder of this paper is organized as follows: Section 2 will develop the pricing outcomes when firms compete in a strategic environment of price or quantity competition. Section 3 develops the firm-level gravity equation for an exporting firm that is exposed to oligopolistic competition in a certain industry, and it shows how the welfare effects come about. Section 4 shows how the two frictions can be disentangled, and it demonstrates to which extent not modeling imperfect competition may lead to a substantial bias in the estimated welfare effects of trade agreements such as the European Single Market. Section 5 concludes.

2 Firm behavior under imperfect competition

This section scrutinizes oligopolistic competition among exporters and domestic firms if all countries have identical CES preferences where the upper tier utility function has a Cobb-Douglas form and the lower tier has a CES form. We exemplify oligopolistic competition by employing a simple model: we consider a world in which n countries may trade with each other, and we assume that each country hosts one firm in each industry (the "national champion") that produces for the home market and is a potential exporter to all other countries.[10] Furthermore, each country hosts a continuum of industries, and firms are large in the small, that is, they assume market power in their industry, but small in the large, that is, they take factor prices and incomes as given.[11] We are not the first to

[10]Our model can easily be extended to more firms in each country.

[11]These are the same assumptions as in Peter Neary's GOLE model; see for example Neary (2016).

scrutinize oligopolistic competition in the CES framework (see, for example, Amiti et al., 2019, and d'Aspremont and Dos Santos Ferreira, 2016), but we will develop an important proportionality property that will be very helpful for including oligopoly behavior into the structural gravity model.

We begin with considering the profits of a firm located in country i that operates in industry k. Sales are subject to institutional or other geographical frictions that have the form of iceberg trade costs of size τ_{ijk} where $\tau_{ijk} \geq 1$ measures the frictions of sales for exports from country i for country j.[12] In what follows, we will focus on the implications of oligopolistic competition as a more realistic alternative to monopolistic competition while we keep the standard assumptions for the demand side. There are many industries, and following the canonical Dornbusch-Fischer-Samuelson (DFS) model (see Dornbusch et al., 1977 and Dornbusch et al., 1980), we consider a continuum of industries that are defined over the interval $[0, 1]$. In particular, we assume that the utility of a representative household in any country j can be given by the Cobb-Douglas utility function $\ln W_j = \int_0^1 \alpha_k \ln U_{jk} dk$, $\int_0^1 \alpha_k = 1$, where U_{jk} denotes the subutility of the representative household in country j of goods produced in sector k. Country j's consumers will be served by its domestic firm and importers in each industry, and the subutility is given by

$$U_{jk} = \left(\sum_{i \in N_{jk}} q_{ijk}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $\sigma > 1$; q_{ijk} denotes the sales from country i to country j, so q_{jjk} is country j's internal trade. N_{jk} is the set of all firms of industry k that are active in country j. If $N_{jk} = \{1, \ldots, n\}$, all firms from all countries are active; if $N_{jk} \subset \{1, \ldots, n\}$, some firms will not serve this market. Note that $j \in N_{jk}$ as the local firm will always be active in its own market. The aggregate expenditure for goods in this industry are given by E_{jk}. As is well-known, utility maximization implies that expenditures for goods produced by industry k for country j are given by $E_{jk} = \alpha_k Y_j$, where Y_j denotes country j's aggregate expenditure.

For our analysis of strategic interaction, we assume that markets are segmented such that each firm can set prices or quantities without any arbitrage constraint. Later on,

[12] In general, the notation is organized from large to small, i.e., exporting country i, importing country j, industry k.

we will show that the Nash equilibria for segmented markets are in fact immune against arbitrage and thus also qualify for Nash equilibria in integrated markets.[13] In order to save on notation, we now drop the industry indexation k and consider a single industry for a target market j for which we also drop the indexation. Consequently, we write p_i for p_{ijk} and use a similar notation for all other variables and parameters in this part of the analysis. Without loss of generality, we also assume that all n firms are active in the target country. Our model can easily be extended to endogenous entry which we discuss at the end of this section.

We now scrutinize two different forms of strategic interaction, competition by prices and competition by quantities. These are the classic oligopolistic model setups, where price competition assumes that firms face no capacity constraints and can serve any demand that will result from price competition. Quantity or capacity competition is a setup in which firms cannot change outputs in the short term. It depends on the nature of production whether firms are more likely to compete by prices or by quantities. In case of price competition, denoted by B for Bertrand, each firm i maximizes its operating profit, that is, $\pi_i^B(p_i, p_{-i}) = (p_i - \tau_i c_i) q_i(p_i, p_{-i})$ w.r.t. p_i, where p_{-i} is an $(n-1)$ price vector that denotes the prices of all other active rivals, and c_i denotes the marginal production cost. The first-order condition as an optimal response to the optimal pricing decisions of all rivals determines the Nash equilibrium in prices and reads

$$\forall i : \frac{\partial \pi_i^B}{\partial p_i}(p_i^*, p_{-i}^*) = q_i(p_i^*, p_{-i}^*) + (p_i^* - \tau_i c_i)\, \frac{\partial q_i}{\partial p_i}(p_i^*, p_{-i}^*) = 0, \tag{2}$$

where p_i^* denotes the optimal price of firm i in country j, and p_{-i}^* denotes the $(n-1)$ vector of the optimal prices of all other firms. Since demand for firm i in country j is given by $q_i(p_i, p_{-i}) = E p_i^{-\sigma} / \sum_{j=1}^n p_j^{1-\sigma}$, we can rewrite the first-order conditions in terms of markups, denoted by μ_i^B and μ_j^B, respectively, and elasticities, denoted by ϵ_i^B and ϵ_j^B, respectively:

[13]Note that we use the notion of an integrated market not as a frictionless market, but as a market in which parallel trade may take place and is subject to the same trade frictions that producers face.

$$\begin{aligned} \forall i : p_i^* &= \mu_i^B \tau_i c_i, \mu_i^B = \frac{\epsilon_i^B}{\epsilon_i^B - 1}, \\ \epsilon_i^B &= \sigma - (\sigma - 1)\frac{\left(\mu_i^B \tau_i c_i\right)^{1-\sigma}}{\sum_{j=1}^n \left(\mu_j^B \tau_j c_j\right)^{1-\sigma}}. \end{aligned} \tag{3}$$

Let s_i^B denote the market share of firm i in market j which is given by $s_i^B = (\mu_i^B \tau_i c_i)^{1-\sigma} / \sum_{j=1}^n (\mu_j^B \tau_j c_j)^{1-\sigma}$. Not surprisingly, the Nash equilibrium in prices converges to the monopolistic competition outcome if s_i^B approaches zero.[14] In general, s_i^B reduces the elasticity of demand for firm i, and this effect is the stronger, the stronger the trade *and* market power frictions of this firm located in country i relative to the firms located in other countries, including the home firm.

In case of quantity competition, denoted by C for Cournot, each firm maximizes its operating profit $\pi_i^C(q_i, q_{-i}) = (p_i(q_i, q_{-i}) - \tau_i c)q_i$ w.r.t. q_i, and the first-order conditions determine the Nash equilibrium in quantities:

$$\forall i : \frac{\partial \pi_i^C}{\partial q_i}(q_i^*, q_{-i}^*) = p_i(q_i^*, q_{-i}^*) - \tau_i c_i + \frac{\partial p_i}{\partial q_i}(q_i^*, q_{-i}^*) q_i^* = 0, \tag{4}$$

where q_i^* denotes the optimal supply of firm i in country j, and q_{-i}^* denotes the $(n-1)$ vector of the optimal supplies of all other firms. The inverse demand function for firm i is given by $p_i(q_i, q_{-i}) = E q_i^{-\frac{1}{\sigma}} / \sum_{j=1}^n q_j^{\frac{\sigma-1}{\sigma}}$. Again, we can rewrite the first-order condition in terms of mark-ups, denoted by μ_i^C, and elasticities, denoted by ϵ_i^C, now as they follow from the Nash equilibrium in quantities:

$$\begin{aligned} \forall i : p_i(q_i^*, q_{-i}^*) &= \mu_i^C \tau_i c_i, \mu_i^C = \frac{\epsilon_i^C}{\epsilon_i^C - 1}, \\ \epsilon_i^C &= \frac{\sigma}{1 + (\sigma - 1)\frac{\left(\mu_i^C \tau_i c_i\right)^{1-\sigma}}{\sum_{j=1}^n \left(\mu_j^C \tau_j c_j\right)^{1-\sigma}}}. \end{aligned} \tag{5}$$

Again, the market share of firm i is given by $s_i^C = (\mu_i^C \tau_i c_i)^{1-\sigma} / \sum_{j=1}^n (\mu_j^C \tau_j c_j)^{1-\sigma}$ such that the Nash equilibrium in quantities converges to the monopolistic competition outcome

[14] In case of complete symmetry in terms of trade frictions and production costs, i.e., $\tau_i = \tau, c_i = c, \forall i$, $s_i^B = 1/n$, implying $\epsilon_i^B = \sigma - (\sigma - 1)/n$, also because symmetry implies equal markups $\mu_i^B = \mu^B$. This is, however, an unrealistic case in this context as it requires that either all trade is frictionless or that internal trade faces the same trade frictions as all external trade.

for s_i^C approaching zero, too. We show in Appendix A.1 that the sufficient conditions are fulfilled for both the Bertrand equilibrium (3) and the Cournot equilibrium (5) and that the industry equilibria exist and are unique. A crucial difference between Cournot and Bertrand competition is that Bertrand competition converges to perfect competition if $c_i = c$ and $\tau_i = \tau, \forall i$ when σ is increased while this is not the case for Cournot competition. For $\sigma \to \infty$, $\epsilon_i^B \to \infty$ and thus the markup μ_i^B becomes unity; as expected, the classic Bertrand paradox also holds in our context that marginal cost pricing emerges if firms compete by prices in a homogeneous goods market. This is not true for Cournot as $\epsilon_i^c \to 1/s_i^C$ for $\sigma \to \infty$.[15]

The type of competition has an impact on the market performance. We find:

Lemma 1. *(i) Prices are strategic complements in the sense of Bulow et al. (1985) in case of Bertrand competition. In case of Cournot competition, a firm i will increase (decrease) its output in response to an increase in rival output if* $q_i^{(\sigma-1)/\sigma} > (<) \sum_{\iota=1}^{n} q_\iota^{(\sigma-1)/\sigma}$. *(ii) For an identical market share, the markup is higher in case of Cournot competition than in case of Bertrand competition.*

Proof. For part (i), see Appendix A.2. For part (ii), $\epsilon_i^C > \epsilon_i^B$ for the same market share s_i implies $(1 - s_i)s_i(\sigma - 1)^2 > 0$ which is true. □

Note carefully that both prices and quantities are strategic neutrals in models of monopolistic competition due to its non-strategic nature, but they can be expected to respond in any strategic environment.[16] Lemma 1 shows that firms are potentially more aggressive when competing with prices than with outputs. The reason is that the elasticity of substitution between goods is relatively large, and a price decrease by one firm is always matched by a price decrease of other firms due to strategic complementarity, making competition more aggressive. In case of Cournot competition, an output increase may be moderated by output reductions of rival firms. However, a note of caution is in order

[15] Kreps and Scheinkman (1983) have shown in a very influential paper that Cournot competition is strategically equivalent to a game in which firms commit to capacities first and compete by prices in the second stage in a homogeneous goods model. Our model features product differentiation such that we do not claim that one model can be the outcome of the other when a capacity investment is added.

[16] We do not claim that firms in monopolistic competition models do not respond to price changes that change the overall price index, but this response is similar to firms that respond to price changes under perfect competition. di Giovanni et al. (2019) deal with the role of large firms in a monopolistic competition models where these firms transmit shocks that influence the business cycle.

now. First, a firm may increase output in response to output increases if its initial output is already large to begin with. Second, the second part of Lemma 1 applies to the case for which market shares are the same across competition modes. Our empirical analysis will show that changes to the markups do not necessarily follow the pattern of Lemma 1, and one reason is that the market shares are different across competition modes to begin with.[17]

A common feature of both competition modes is that the pass-through of trade frictions is not complete such that the markup decreases with the trade costs. In particular, we can show:

Proposition 1. *The markup of a firm decreases with its trade cost. Consequently, for both a Nash equilibrium in prices (Bertrand) and a Nash equilibrium in quantities (Cournot), any difference in a firm's equilibrium prices will be smaller than the trade costs.*

Proof. See Appendix A.1. □

In terms of immunity against parallel trade, our analysis so far has assumed that firms can set prices or quantities without any arbitrage restriction. Proposition 1 shows that the segmented market outcome is also the integrated market outcome as the price differences from one market to the other will always be smaller than the trade friction.[18]

In models of monopolistic competition, the price charged for one destination is proportionate to the price charged to other destinations, and the degree of proportionality is determined by the trade friction only. Surprisingly, we can now show that this is also true under imperfect competition when both the trade friction *and* the market power distortion are taken into account, although we know from Proposition 1 that the degree of proportionality must be smaller than the pure trade friction. For this purpose, let us reintroduce the general setup and write the equilibrium prices given by eqs. (3) and (5) as

[17] Another reason will be that the multilateral resistance terms, to be developed in Section 3, and their changes are different across competition modes.

[18] We consider integrated markets as being subject to the same frictions as in our model above, but integrated market allow for the possibility of parallel trade such that firms cannot exclude the resale of goods in one market that they delivered to another market. Any agent involved in this business, however, would have to carry the same trade friction as the firms do. In case of imperfect competition, an increase in trade frictions will be partially absorbed by firms.

$$p^*_{ijk} \;=\; \mu_{ijk}\tau_{ijk}c_i, \tag{6}$$

where we have dropped the superscript B for Bertrand and C for Cournot, as eqs. (3) and (5) have the details how μ_{ijk} comes about in the two cases. It should have become clear now that the markups under both Bertrand and Cournot are not constant and depend on both the trade frictions and the market power frictions. Thus, our model is able to explain why markups differ across destinations.[19]

Now consider an active firm i that serves two different countries j and k. We find:

Proposition 2. *For both a Nash equilibrium in prices (Bertrand) and a Nash equilibrium in quantities (Cournot), equilibrium prices of firm i to serve country $m \neq j$ can be written as proportionate to equilibrium prices serving country j where the factor of proportionality depends on markups and trade costs only.*

Proof.

$$p^*_{ijk} = \Gamma p^*_{imk}, \text{ where } \Gamma = \frac{\mu_{imk}\tau_{imk}}{\mu_{ijk}\tau_{ijk}}.$$

□

This proportionality result is remarkable as it shows that the only requirement is to include the markup in addition to the trade friction when we extend the model to oligopolistic competition. This result will prove to be very useful for developing the new gravity equation.

Where will firms be active across countries? Our model can easily determine the extensive margin of trade.[20] This is important as not all countries are served by all countries

[19]De Loecker et al. (2016) find that markups of Indian firms are heterogeneous, as well as their response to trade liberalization. De Loecker and Eeckhout (2018) find that world-wide, average markups have gone up, but they can only consider aggregate markups of firms but not across destinations. Both papers use a cost minimization approach and detailed firm-level data to estimate production functions. This allows them to infer production costs and ultimately markups without having to assume a specific market conduct. While these features are attractive for ex post single country studies of past liberalization episodes where these data are available, these approaches do not explicitly model consumer demand, making *ex ante* counterfactual analyses impossible, a key advantage of our more structural approach.

[20]Melitz and Redding (2015) show in a monopolistic competition model that endogenous entry implies larger gains from trade liberalization and smaller losses from trade deliberalization when firms are heterogeneous compared to homogeneous firms.

in detailed product-level data (see Armenter and Koren, 2014). Let F_{ijk} denote the fixed cost of exporting to country j that a firm in industry k located in country i has to bear where $F_{jjk} = 0$, but $F_{ijk} > 0$ for $i \neq j$: the national champion will always serve its own market, but foreign firms have to be able to recover their fixed costs. As common in the industrial organization literature, firms in each industry play a two-stage game: in the first stage, they decide on the export decision, and if they enter, they invest F_{ijk}, and in the second stage, they compete as described above either with prices or quantities. Thus, a firm i for which $(\mu_{ijk} - 1)\tau_{ijk}c_i \geq (<) F_{ijk}$ holds, will (will not) be active in country j, and the set of active firms is given by

$$N_{jk} = \{i | i \in \mathbb{N}, 1 \leq i \leq n \text{ and } (\mu_{ijk} - 1)\tau_{ijk}c_i \geq F_{ijk}\}. \tag{7}$$

Armed with these prerequisites, the next section will develop the new gravity equation.

3 The new gravity equation and the gains from trade

We consider a firm in industry k that is located in country i and serves country j. From eq. (6), we can compute the sales, denoted by x^*_{ijk}, as

$$x^*_{ijk} = p^*_{ijk} q^*_{ijk} = \left(\frac{p^*_{ijk}}{P_{jk}}\right)^{1-\sigma} E_{jk} = \frac{E_{jk}}{P^{1-\sigma}_{jk}} {t_{ijk}}^{1-\sigma} c_i^{1-\sigma}, \tag{8}$$

if $x^*_{ijk} > 0$, that is, if firm i of industry k is actively serving country j. $t_{ijk} = \mu_{ijk}\tau_{ijk}$ measures both the distortions that originate from market power and from trade frictions, and

$$P_{jk} = \left(\sum_{i \in N_{jk}} {p^*_{ijk}}^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \tag{9}$$

is the price index in the target market j. Aggregate sales of country i in industry k are equal to the sum of all trade, including to itself, i.e., $Y_{ik} = \sum_{j=1}^{n} x^*_{ijk}$. Let I_{ijk} denote an indicator variable for which $I_{ijk} = 1$ if $i \in N_{jk}$ and $I_{ijk} = 0$ otherwise. Hence we can write

$$Y_{ik} = \sum_{j=1}^{n} x^*_{ijk} = \sum_{j=1}^{n} \frac{I_{ijk} E_{jk}}{P^{1-\sigma}_{jk}} {p_{ijk}}^{1-\sigma} = c_i^{1-\sigma} \sum_{j=1}^{n} \frac{I_{ijk} E_{jk}}{P^{1-\sigma}_{jk}} {t_{ijk}}^{1-\sigma}. \tag{10}$$

Solving eq. (10) for $c_i^{1-\sigma} = Y_{ik} Q_{ik}^{\sigma-1}$ and plugging $c_i^{1-\sigma}$ into eq. (8), we can now write trade flows from country i to j in industry k as

$$x_{ijk}^* = \frac{Y_{ik} E_{jk}}{Y_k^W} \left(\frac{t_{ijk}}{Q_{ik} P_{jk}} \right)^{1-\sigma} = \frac{Y_{ik} E_{jk}}{Y_k^W} \left(\frac{\mu_{ijk} \tau_{ijk}}{Q_{ik} P_{jk}} \right)^{1-\sigma}, \quad \text{with} \tag{11}$$

$$Q_{ik}^{1-\sigma} = \sum_{j=1}^{n} I_{ijk} \frac{E_{jk}}{Y_k^W} \left(\frac{t_{ijk}}{P_{jk}} \right)^{1-\sigma} \quad \text{and} \quad P_{jk}^{1-\sigma} = \sum_{i \in N_{jk}} \frac{Y_{ik}}{Y_k^W} \left(\frac{t_{ijk}}{Q_{ik}} \right)^{1-\sigma}, \tag{12}$$

where Q_{ik} is the outward multilateral resistance term and Y_k^W are world sales of industry k. As in other gravity models, the outward multilateral resistance term measures the exposure of the firm in country i in industry k to frictions. In our context producers do not only face trade frictions, but also market power frictions from rival firms. P_{jk} can be interpreted as the inward multilateral resistance term which measures the impact of all frictions for consumers in country j, but again these frictions now include both trade and market power frictions. Equation (11) is the gravity equation under imperfect competition. It has a striking resemblance with the standard gravity equation from Anderson and van Wincoop (2003), however, with a key difference. Bilateral trade flows now not only depend on bilateral trade costs τ_{ijk} as in standard gravity models but also on markups charged by firms via the term μ_{ijk}.[21] From the perspective of our model, commonly estimated gravity equations do not specify the trade cost function τ_{ij} but specify the combined effect of markups and trade costs t_{ij}. Alternatively, standard gravity equations do not control for the bilateral varying markup, and hence the markup term μ_{ij} ends up in the error term of the regression. As markups depend on the level of trade costs (see Proposition 1), there exists a correlation between the error term and the regressors used to specify the trade cost equation, and hence estimated trade cost parameters will be biased. In this sense, this bias is similar to the bias introduced when omitting the multilateral resistance terms in standard gravity regressions: without properly controlling for the multilateral resistance terms, trade cost estimates are biased as they depend on the level of trade costs. We will demonstrate the empirical relevance of this omitted variable bias in our empirical application in Section 4.

[21] We develop an alternative representation of the gravity equation in which we aggregate sales across industries in Appendix A.3.

How does our model compare to standard quantitative models of trade for which Arkolakis et al. (2012) have shown that the gains from trade depend only on the change in the share of a country's expenditures of its own goods and the trade elasticity? In standard quantitative models of trade, the trade elasticity is regarded as an important measure to determine the welfare gains from trade (see, in particular, Arkolakis et al., 2012). In our model, the trade elasticity does not play this important role. Proposition 1 has shown that $d\mu_{ijk}/d\tau_{ijk} < 0$, and thus, from the gravity equation (11), the trade elasticity at the firm level is given by

$$\zeta_{ijk} = (1-\sigma)\left(1 + \frac{d\mu_{ijk}/\mu_{ijk}}{d\tau_{ijk}/\tau_{ijk}}\right), \tag{13}$$

which is smaller in absolute terms than the monopolistic competition elasticity $1-\sigma$ since $d\mu_{ijk}/d\tau_{ijk} < 0$. But this lower elasticity should not be taken to indicate that the welfare effects are smaller. The elasticity only shows how a single firm responds to a change of its market access conditions to a foreign country. What is more important is how the rival firms respond to this change.[22] Nevertheless, we can generalize the welfare result derived by Arkolakis et al. (2012) to oligopoly. Let $\widehat{\lambda}_{ijk}$ denote the change in the share of country j's expenditure on goods from industry k from country i. We find:

Proposition 3. *Assume that each country uses only labor as factor of production and the endowment of labor is equal to L_j for country j. Let Π_j^{*0} $\left(\Pi_j^{*1}\right)$ denote the aggregate profit of all firms located in country j before (after) trade liberalization. The gains from trade under oligopoly are given by*

$$\widehat{W}_j = \widehat{Y}_j \prod_k \widehat{\Lambda}_{jjk}^{\frac{\alpha_k}{1-\sigma}},$$

where $d\ln\Lambda_{jjk} = d\ln\lambda_{jjk} + (\sigma-1)d\ln\mu_{jjk}$ and $\widehat{Y}_j = \left(L_j + \Pi_j^{*1}\right) / \left(L_j + \Pi_j^{*0}\right)$.

Proof. See Appendix A.4. □

Proposition 3 shows that the welfare change can be measured by the change in GDP, $\widehat{Y}_j$, by the changes in expenditure shares for domestically produced goods, $d\ln\lambda_{jjk}$, by

[22] Edmond et al. (2015) model imperfect competition on the market for intermediate inputs while the final goods market is perfectly competitive, and they also find that the trade elasticity is smaller with variable markups.

the change in domestic markups, $d\ln\mu_{jjk}$ and by the elasticity $1/(1-\sigma)$, weighted by the respective expenditure shares.[23] The welfare change would be observationally the same as in Arkolakis et al. (2012) if $d\ln\mu_{jjk}$ were equal to zero and real income did not change, i.e., $\widehat{Y_j} = 1$, as the markup does not change in monopolistic competition models using CES preferences and profit is either zero with free entry or a constant share of revenues otherwise. However, in our model competition and strategic interaction are driving forces: first, a reduction in the expenditure share for the domestically produced good is due to a more aggressive pricing or output behavior of foreign firms, and second, competition changes the domestic markup. The last effect has more weight for welfare than the relative change in expenditure shares for domestically produced goods if $\sigma > 2$. Furthermore, real income changes due to changes in domestic profits can either amplify or reduce the welfare gains, depending on whether domestic profits increase or decrease.[24] Note carefully that a reduction in trade costs does not necessarily imply lower profits: while import competition will reduce domestic profits, easier access to foreign market will increase it, so it is not clear whether $\widehat{Y_j}$ is larger or smaller than unity.[25] Thus, Proposition 3 identifies another general equilibrium channel through which gains from trade may come about.

We can easily illustrate the difference in outcomes between monopolistic competition and oligopoly in a simple Krugman model in which two symmetric countries, each hosting a single firm, will reduce bilateral trade costs. All industries are also completely symmetric and their marginal production costs are normalized to unity which allows us to consider the whole economy as consisting of one industry only as all trade liberalization effects will be symmetric across industries and countries. Both firms will be active in both countries, and the exercise we do is to reduce the bilateral and symmetric trade friction for each exporter. We confine the analysis to price effects (and thus set $\widehat{Y_j} = 1$) as to focus on the impact of oligopoly behavior on consumer prices. The simulations show the gains from trade from reducing $\tau_{ij} = \tau_{ji}$ to unity, i.e., free trade, for different levels of trade frictions

[23]Since the share of a country's expenditure on its own goods is equal to the market share of the national champion in equilibrium, we show in Appendix A.5 how one can also use the market share change to compute the marginal welfare effects.

[24]In this sense, Proposition 3 seems to be similar to the results of Arkolakis et al. (2019) who take into account incomplete pass-throughs and changes in the price indexes when preferences are not CES. The crucial difference is, however, that Proposition 3 deals with competition in an oligopoly framework that can include markup and profit changes as a result of strategic interactions.

[25]See, for example, Long et al. (2011) for a simple oligopoly model in which the size of these two effects is shown to depend on the initial trade costs.

to begin with.

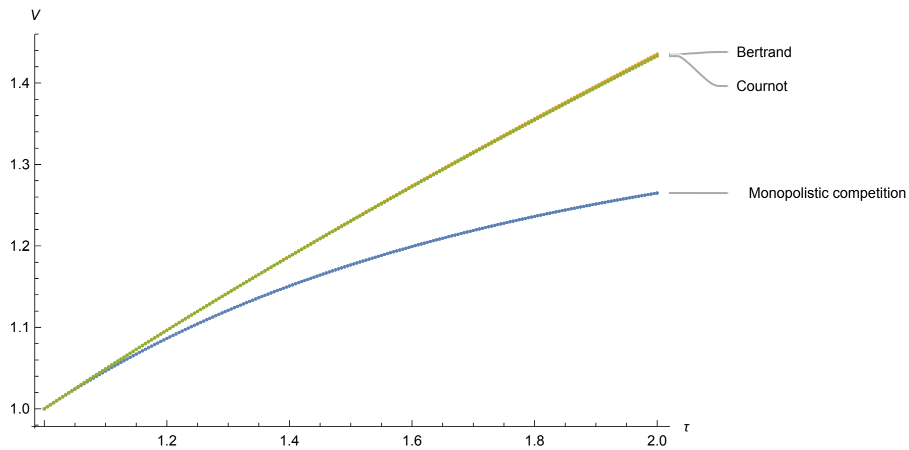

Figure 1: Welfare changes from trade liberalization in the Krugman model for $\sigma = 3$

Figures 1, 2 and 3 show the gains from trade liberalization measured by V as the ratio of welfare after to the welfare before trade liberalization on the vertical axis, and welfare is measured by the inverse of the price index in a country. τ on the horizontal axis gives the initial level of trade costs from which these trade costs are reduced to unity, so $V = 1$ for $\tau = 1$. Figure 1 assumes $\sigma = 3$, while Figures 2 and 3 assume $\sigma = 5$ and $\sigma = 7$, respectively. Each figure shows three different modes of competition: monopolistic competition, price competition (Bertrand) and quantity competition (Cournot). In case of monopolistic competition, the price setting behavior follows a simple markup behavior of size $\sigma/(1-\sigma)$ while price competition and quantity competition price setting behavior is given by the Nash equilibria (3) and (5), respectively.[26]

All figures show that the gains from trade are much larger if the price setting behavior is modeled in an oligopolistic fashion and trade frictions are not too small to begin with. Figure 1 shows that the gains from trade under duopoly behavior are not too different for a relatively low elasticity of substitution. While a low elasticity of substitution may be regarded as a case where the monopolistic competition markup is a not too bad approximation for firm behavior, Figure 1 also shows that the difference in the gains from trade can mount up to 20 percent. For larger elasticities of substitution, these differences become more pronounced. Both Figure 2 and Figure 3 show that the gains from trade are

[26]The corresponding Mathematica file that produced these simulations is available upon request.

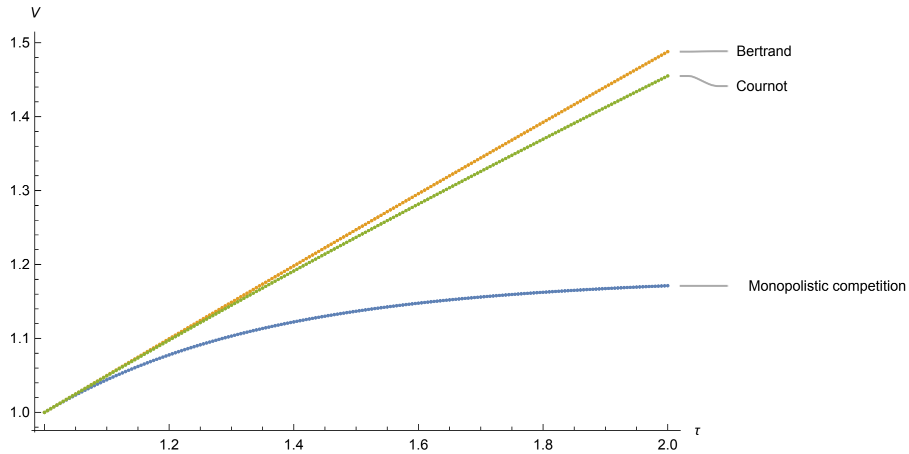

Figure 2: Welfare changes from trade liberalization in the Krugman model for $\sigma = 5$

larger under Bertrand than under Cournot since the reduction in trade frictions implies a reduction in the export price and a reduction in the home price in case of price competition. But the difference between Bertrand and Cournot is not as striking as the difference between these two and the prediction from monopolistic competition. More importantly, both figures show that the difference in welfare gains between duopoly and monopolistic competition can now mount up to 40 percent.

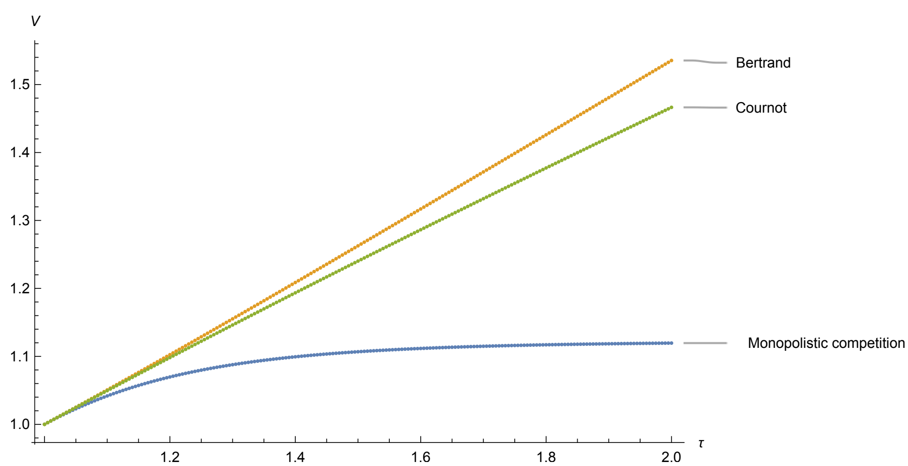

Figure 3: Welfare changes from trade liberalization in the Krugman model for $\sigma = 7$

Note carefully that Figures 1, 2 and 3 have illustrated the welfare *gains* from trade liberalization. It should be clear that the three different competition modes will imply different levels of welfare to begin with. Furthermore, it may be held against this exercise that we assume a duopoly, and the differences between the three competition modes should become smaller with an increase in the number of firms. We therefore explore the welfare effects of trade (de-)liberalization by estimating our model for a large number of asymmetric competitors in the next section where we show that the differences are still substantial.

4 Estimating the welfare and competition effects of the European Single Market

The last sections have shown how oligopolistic competition can be integrated into a structural gravity model, how trade and market power frictions can be disentangled in a theory-consistent way, and how the gains from trade can be computed. So why is the introduction of oligopoly important? First, market integration is not only about the reduction in trade frictions, but also about the increase in competition across countries. For example, the formation of the European Single Market had the main purpose to enhance competition within Europe by reducing non-tariff trade barriers, as tariffs had already been abolished before. Second, we will show in this section that quantitative trade models that do not take into account imperfect competition may lead to a substantial underestimation of the gains from trade liberalization. Thus, we show that including market power and in particular the change in market power leads to substantially larger welfare effects.

In this section, we offer some quantitative guidance on these effects. We do so by illustrating how to estimate a quantitative trade model that includes oligopoly, and we compare our results to those of a conventional structural gravity approach. As we want to focus squarely on the competition effects of trade liberalization, we do a *conditional* general equilibrium analysis in the language of structural gravity modeling (or what Head and Mayer, 2014, call the modular trade impact): we take into account the direct effects of frictions (which on its own would be a partial equilibrium analysis only) and the third-country effects as they arise from a change in the multilateral resistance terms. We keep aggregate income and wages fixed, i.e., we neither have to take a stance on the operation of the labor market nor on ultimate international firm ownership structures to calculate changes in aggregate profits.[27] We will compare the results of Bertrand and Cournot oligopoly behavior with the standard monopolistic competition result in order to demonstrate the difference in welfare implications. As we have emphasized the role of competition as a motivation for the creation of the European Single Market, our counterfactual exercise is to shut down the European Single Market.

In particular, in order to confront the three competition modes with the data, we estimate our model using trade data from the World Input-Output Database (WIOD).[28] A key advantage of WIOD is that it contains the necessary domestic trade data which allows us to calculate domestic market shares and markups. The use of domestic trade data has become standard in the structural gravity literature, see Heid et al. (2017). We use aggregate trade data between the 43 countries included in WIOD for the years 2000 to 2014. When doing so, we assume that many symmetric industries exist, that is, $\alpha_k = 1, \forall k$, such that the aggregate data are representative for each industry; the same assumption is implicitly made by perfect and monopolistic competition models using aggregate data. The innovation is that we now allow for market power such that each country hosts a national champion, making it 43 competitors for Bertrand and Cournot competition. Thus, we assume that $N_{jk} = \{1, \ldots, n\}, \forall j, k$, which seems a too large number of competitors, but will guarantee that the competition effects of trade (de-)liberalization are a conservative estimate. In particular, we estimate eq. (11) by specifying the combined trade and market power frictions as

$$t_{ijt}^{1-\sigma} = \mu_{ijt}^{1-\sigma} \tau_{ijt}^{1-\sigma} = \mu_{ijt}^{1-\sigma} \exp(\beta_1 EU_{ijt} + \beta_2 RTA_{ijt} + \xi_{ij}) = \mu_{ijt} \exp(\mathbf{x}_{ijt}' \boldsymbol{\beta}), \tag{14}$$

where we have introduced a time index as subscript t. Hence we estimate

$$X_{ijt} = \mu_{ijt}^{1-\sigma} \exp(\eta_{it} + \nu_{jt} + \beta_1 EU_{ijt} + \beta_2 RTA_{ijt} + \xi_{ij} + u_{ijt}), \tag{15}$$

where η_{it} and ν_{jt} are exporter×year and importer×year fixed effects to control for the multilateral resistance terms in eq. (11) and ξ_{ij} is a directional bilateral fixed effect to

[27]Note that the difference between the modular trade impact we use and the full general equilibrium trade impact which endogenizes wages is typically negligible, see discussion on p. 170 in Head and Mayer (2014). Still, in Appendix A.6, we show how our model can be extended by including a labor market clearing condition to do a full general equilibrium analysis if one is willing to take a stance on factor mobility across sectors.

[28]For a detailed description of the data, see Timmer et al. (2015).

control for the endogeneity of trade policy as suggested by Baier and Bergstrand (2007). Furthermore, EU_{ijt} is a dummy which is one for all international trade flows between member countries of the European single market (EU and EEA), and RTA_{ijt} is a dummy which is one for all international trade flows where the country pair is part of a regional trade agreement (including the EU, i.e., the effect of the EU common market is $\beta_1 + \beta_2$). For EU_{ijt} and RTA_{ijt}, we use Mario Larch's RTA data set, see Egger and Larch (2008).[29] In the following, we may sometimes refer to the EU as a short hand for the trade effect of the European Single Market where it is understood that the European Single Market also comprises the European Economic Area (EEA) countries. In our main results, we have opted to not include Switzerland in the European Single Market as it does not fully implement its four freedoms of the European Single Market and has access to the EU market only via a bilateral trade agreement with the EU.[30] For similar reasons, we ignore the customs union between the EU and Turkey. We present results which include both Switzerland and Turkey in the definition of EU_{ijt} in Appendix A.9.2. We estimate eq. (15) using PPML following the suggestion by Santos Silva and Tenreyro (2006) using the `ppmlhdfe` Stata package by Correia et al. (2019) and use $\mu_{ijt}^{1-\sigma}$ as an exposure variable.[31]

The question remains how to measure $\mu_{ijt}^{1-\sigma}$. For a given value of σ, the market share of each active firm is given by

$$s_{ijk} \equiv \frac{X_{ijk}}{\sum_{\iota \in N_{jk}} X_{\iota jk}} = \frac{t_{ijk}^{1-\sigma} c_i^{1-\sigma}}{\sum_{\iota \in N_{jk}} t_{\iota jk}^{1-\sigma} c_\iota^{1-\sigma}} < 1. \tag{16}$$

From the first-order conditions, we know that $\mu_{ijk} = \epsilon_{ijk}/[\epsilon_{ijk} - 1]$ where

[29]The dataset can be downloaded at `https://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html`. We use the version from 07 November 2018. Note that we set $EU_{ijt} = 0$ for domestic trade flows of EU member countries, to be consistent with RTA_{ijt} which also is equal to 0 for domestic trade flows. This implies that EU_{ijt} and RTA_{ijt} identify the international trade effects of these agreements, relative to domestic trade. Being real models, gravity models only allow to identify the trade cost reducing effect of policies by comparing international to domestic trade. For a more detailed discussion of gravity regressions with domestic trade flows, see Heid et al. (2017).

[30]See background on this on `https://www.europarl.europa.eu/factsheets/en/sheet/169/the-european-economic-area-eea-switzerland-and-the-north`.

[31]This can be easily done with `ppmlhdfe` by using its `exposure` option. When estimating a log-linearized eq. (15) by OLS, one can simply use the transformed dependent variable $\ln X_{ijt} - \ln \mu_{ijt}^{1-\sigma}$ to implement our estimation approach. For the OLS regressions, we use the `reghdfe` Stata package by Correia (2017).

$$\epsilon_{ijk} = \begin{cases} \sigma - (\sigma-1)s_{ijk} & \text{for Bertrand,} \\ \frac{\sigma}{1+(\sigma-1)s_{ijk}} & \text{for Cournot} \end{cases} \tag{17}$$

due to eqs. (3) and (5) which lead to

$$\mu^B_{ijk} = \frac{\sigma - (\sigma-1)s^B_{ijk}}{(\sigma-1)\left(1-s^B_{ijk}\right)} \quad \text{and} \quad \mu^C_{ijk} = \frac{\sigma}{(\sigma-1)\left(1-s^C_{ijk}\right)}, \tag{18}$$

where the superscript B and C denotes the mode of competition. Equation (18) shows that the monopolistic competition markup $\sigma/(\sigma-1)$ is smaller by factor $1-s^C_{ijk}$ than the Cournot markup. In general, both markups are larger than $\sigma/(\sigma-1)$, and thus we already know that the trade frictions will be smaller for any observed t_{ijk} compared to monopolistic competition. Importantly, eq. (18) allows us to calculate markups directly from the observed market shares in the trade data and hence we can estimate the adjusted gravity equation (15).[32] Also note that the markup μ_{ij} does not vary across destinations or origins and hence is captured by the fixed effects in standard gravity models. Hence our estimation procedure nests the standard gravity model in a monopolistic competition framework for which $\mu_{ijt} = \mu, \forall i, j, t$, and is strictly more general. To calculate $\mu^{1-\sigma}_{ijt}$, we use $\sigma = 5.03$, the preferred estimate of the literature survey in Head and Mayer (2014).

We present regression results in Table 1. Columns (1) to (3) show results for a log-linearized gravity equation regression using OLS for comparison reasons, whereas the remaining columns use PPML. Column (1) is the standard log-linearized gravity which assumes monopolistic competition (MC), i.e., constant markups. According to this specification, RTAs increase trade by approximately 13 percent.[33] The EU's trade creating effect in addition to the 13 percent of a standard RTA is 21 percent. In column (2), we use our adjusted gravity estimation and use the Bertrand markups. Results are similar to column (2) albeit we estimate slightly larger EU and RTA effects. In column (3), results increase further for both regressors. Remember that log-linearized gravities suffer from inconsistent estimates due to the heteroskedasticity of the trade data. We therefore prefer

[32] Note that our model can also accommodate multi-product firms and cannibalization effects which are found important in the industrial organization literature; see Head and Mayer (2019) and the cited literature. In Appendix A.7, we generalize the elasticity eq. (17) such that our model could easily be applied to multi-product firms if firm-product market share data, including domestic market shares, were available for a large set of countries. For a general modeling of multi-product firms using an aggregative games approach, see Nocke and Schutz (2018).

[33] In the following, we calculate marginal effects of dummy variables as $\exp(\beta_k - 1) \times 100$.

the PPML estimates in the remaining columns. Column (4) is again the benchmark gravity estimation which is the current best practice specification used in the literature. Now we find that typical RTAs increase trade on average by 15 percent. The EU now increases trade by 53 percent more than the typical RTA. In column (5), using our adjusted gravity estimation under Bertrand competition, we find an even larger trade-creating effect of the EU of 92 percent. Similarly, the effect of the typical RTA increases to 42 percent. Under Cournot competition, the estimated coefficients become even larger, with the EU increasing trade 183 percent more than the typical trade agreement with an effect of 67 percent. These increasing effects are due to the fact that markups under Cournot competition are higher *ceteris paribus* than under Bertrand competition (with markups being lowest under monopolistic competition). Controlling for the effect of $\mu_{ij}^{1-\sigma}$ becomes the more important the larger the markup: we estimate an RTA trade effect which is roughly three times larger than RTA effects estimated with conventional methods under Bertrand competition, and even larger under Cournot competition. In columns (7) to (9), we repeat the estimations from columns (5) to (7) but now also control for time-varying border effects, $INTER_{ijt}$, as suggested by Bergstrand et al. (2015) and Baier et al. (2019) to control for time trends in globalization-induced general reductions of international trade costs. Controlling for these general trends reduces the estimated trade effects of both the EU and trade agreements considerably. Using our new method, we still find sizeable trade effects of RTAs (+22 percent in column (8) and +26 percent in column (9)), and the EU increases trade 50 percent more than the typical RTA under Bertrand competition (+89 percent under Cournot competition).

We now use the estimated trade cost coefficients from columns (7) to (9) of Table 1 to calculate trade costs for the year 2014, the most recent year in our data set, and simulate our model. We follow the literature and set $\tau_{ii} = 1, \forall i$, such that domestic trade is frictionless. We proxy unit costs c_i by GDP per worker using GDPs in current U.S.-$ (PPP) from the Penn World Tables 9.0, see Feenstra et al. (2015), as provided in Gurevich and Herman (2018). Labor force data are from the World Bank's World Development Indicators (accessed 20 December 2019).[34]

As our counterfactual, we abolish the European Single Market. In terms of our trade cost specification, this means that we switch off the EU_{ijt} dummy as well as the according

[34]For Taiwan, we use labor force data from National Statistics of the Republic of China (Taiwan), `https://eng.stat.gov.tw/ct.asp?xItem=12683&ctNode=1609&mp=5` (accessed 20 December 2019).

Table 1: Trade cost parameter estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			PPML					
	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot
EU_{ijt}	0.187**	0.212**	0.267***	0.426***	0.651***	1.041***	0.332***	0.404***	0.635***
	(0.063)	(0.064)	(0.065)	(0.053)	(0.072)	(0.122)	(0.069)	(0.089)	(0.142)
RTA_{ijt}	0.122**	0.137**	0.160***	0.136***	0.352***	0.515***	0.065*	0.200**	0.228*
	(0.044)	(0.044)	(0.045)	(0.041)	(0.033)	(0.041)	(0.029)	(0.069)	(0.094)
$INTER_{ijt}$	NO	NO	NO	NO	NO	NO	YES	YES	YES
N	27735	27735	27735	27735	27735	27735	27735	27735	27735

Notes: † MC: Monopolistic competition. Table reports regression coefficients of estimating the adjusted gravity equation from eq. (15) by PPML using `ppmlhdfe`. All regressions include exporter×year, importer×year and directional bilateral fixed effects. Standard errors are robust to multiway clustering across exporters and importers. For comparison, we present standard gravity estimates in columns (1), (4), and (7). Columns (2), (5) and (8) use μ^B_{ijt} from eq. (18) and columns (3), (6) and (9) use μ^C_{ijt}.

values of the RTA_{ijt} dummy for the member countries of the European Single Market. We then calculate the endogenous, model-consistent markups implied by the fitted trade costs for the corresponding competition mode. This allows us to construct model-consistent t_{ij} for both the baseline and counterfactual scenario. Armed with these, we can solve the system of inward and outward multilateral resistance terms from eq. (12) for the baseline and counterfactual scenario, and calculate welfare and markup changes. We do these simulations for both Bertrand and Cournot competition as well as the benchmark of monopolistic competition.[35]

We present results in Table 2.[36] The first three columns of the table show the change in welfare from abolishing the European Single Market for monopolistic, Bertrand and Cournot competition, whereas the last two columns show the percentage change in the markup charged by domestic firms in their respective home country for Bertrand and Cournot competition. Under monopolistic competition, markups are unaffected by any change in trade costs. The monopolistic competition column shows the welfare effects of a conventional structural gravity model. As expected, members of the European Single Market see a reduction in their welfare when it is abolished, whereas most non-members gain.[37] This result is true for the benchmark monopolistic competition model as well as for our new gravity model using Bertrand or Cournot competition. Importantly, welfare effects are about 50 to 100 percent larger in absolute terms than in the benchmark model. This implies that standard welfare quantifications significantly underestimate the gains from trade liberalization episodes.

Generally, welfare effects are larger for Cournot competition than for Bertrand competition. However, this ranking is not true in all cases: for large economies of the European Single Market like France, Germany and Italy, welfare losses under Cournot competition

[35] We describe our solution procedure in detail in Appendix A.8.

[36] As we allow for asymmetric trade costs and unbalanced trade, we have to normalize the multilateral resistance terms, see Anderson and Yotov (2010). We follow the suggestion by Yotov et al. (2016), p. 72 and normalize by the value of the inward multilateral resistance term P_j for a country which should hardly be affected by our counterfactual exercise. We choose South Korea for our normalization.

[37] An exception is China that loses from removing the European Single Market. The reason is that China is already a large exporter to Europe. Removing the Single Market leads to trade diversion on aggregate, implying less exports from European countries and more exports from non-European countries to any European country. However, since aggregate imports will decline, imports from large importers may decline since an already large import level can be substituted out easier at the margin, overcompensating the trade diversion effect. Furthermore, China does not have an RTA with Europe but other non-member countries do.

Table 2: Welfare and markup changes of removing the European Single Market (in %)

Country	$\%\Delta\mathbf{W}_j$			$\%\Delta\boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.6	1.1	0.0	0.0
Austria	-5.3	-7.7	-10.3	0.3	3.8
Belgium	-4.4	-7.3	-10.1	0.2	1.9
Bulgaria	-4.0	-7.0	-9.0	6.6	13.5
Brazil	0.0	0.4	2.8	0.0	0.0
Canada	0.2	0.9	2.7	-0.0	0.0
Switzerland	1.3	2.3	3.6	0.0	0.0
China	-0.2	-0.5	-0.9	-0.0	-0.0
Cyprus	-5.0	-8.4	-9.2	4.7	9.5
Czech Republic	-4.4	-6.9	-8.9	1.4	7.1
Germany	-1.3	-1.1	-0.2	0.2	2.7
Denmark	-4.4	-7.1	-10.0	0.5	4.4
Spain	-1.9	-2.4	-4.5	2.3	10.6
Estonia	-4.6	-7.4	-10.0	0.9	5.4
Finland	-3.2	-4.5	-5.3	0.8	7.3
France	-2.9	-3.3	-3.1	0.5	4.2
United Kingdom	-2.0	-2.5	-3.2	0.5	4.1
Greece	-2.7	-4.3	-6.8	2.1	9.7
Croatia	-4.7	-7.3	-8.5	2.9	8.5
Hungary	-4.4	-6.6	-8.4	1.3	5.9
Indonesia	-0.1	0.0	0.1	-0.0	0.0
India	-0.1	0.1	1.1	-0.0	0.0
Ireland	-3.4	-4.3	-6.2	0.2	1.7
Italy	-1.6	-0.8	-0.1	0.8	8.0
Japan	-0.0	0.0	0.2	0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	-0.0
Lithuania	-3.8	-6.4	-8.8	0.9	5.3
Luxembourg	-5.3	-8.5	-11.0	0.2	1.4
Latvia	-3.9	-6.4	-8.7	1.2	5.6
Mexico	0.1	0.8	2.4	0.0	0.0
Malta	-5.4	-8.5	-9.4	2.9	8.4
Netherlands	-3.6	-5.2	-7.2	0.1	1.0
Norway	-4.1	-5.5	-4.4	0.2	3.2
Poland	-2.9	-4.5	-6.3	2.8	10.8
Portugal	-4.2	-6.9	-8.6	5.1	12.5
Romania	-2.8	-4.5	-6.6	4.5	12.4
Russia	0.2	0.6	3.3	0.0	0.0
Slovakia	-3.2	-5.0	-6.3	1.4	5.9
Slovenia	-5.3	-6.8	-7.7	1.1	6.3
Sweden	-4.2	-6.3	-7.9	0.5	5.1
Turkey	0.3	0.7	3.0	0.0	0.0
Taiwan	0.1	0.2	0.6	0.0	0.0
United States	0.1	0.6	2.4	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table 1: Monopolistic competition uses parameters from column (7), Bertrand competition from column (8), and Cournot from column (9).

Table 3: Average changes of markups (in %)

	Bertrand	Cournot
all countries		
average across all markets	0.01	0.03
average across all export markets	-0.01	-0.07
average across all domestic markets	1.10	4.33
EU members		
average across all EU domestic markets	1.62	6.42
average across all EU export markets	-0.03	-0.17
average across all non-EU export markets	-0.00	0.00
non-EU members		
average across all non-EU domestic markets	0.00	0.00
average across all EU export markets	0.01	0.02
average across all non-EU export markets	0.00	-0.00

Notes: Table reports average changes in markups of removing the European Single Market in percent. Estimated trade cost parameters used are from Table 1: Bertrand competition from column (8), and Cournot from column (9).

are smaller than under Bertrand competition.[38] What is the reason for this pattern? First, price competition implies that the removal of the European Single Market will increase prices of foreign importers and the price of the national champion. With Cournot competition, the response of the national champion to the decline in foreign supply depends on its initial market share. As Lemma 1 has shown, a large output to begin with may lead to a decline in domestic output, aggravating the welfare loss from reduced foreign supply. If the domestic market share is not too large to begin with, an increase in domestic output will moderate the aggregate foreign supply reduction. Furthermore, the market share distribution under Cournot is not the same than under Bertrand to begin with. While Lemma 1 gives us some guidance on the effects under different competition modes, our results demonstrate that the degree of heterogeneity across competition modes depends on the empirical application, particularly on trade costs and market shares across all markets. They also demonstrate that is is essential to model imperfect competition in a consistent structural general equilibrium model while allowing for third country effects.

We also see this heterogeneity in the markup changes. Abolishing the European Sin-

[38] Also Norway loses less under Cournot than under Bertrand competition.

Table 4: Welfare and markup changes of removing the European Single Market (in %) using the same monopolistic competition trade costs

Country	$\%\Delta\mathbf{W}_j$			$\%\Delta\boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.2	0.2	0.0	-0.0
Austria	-5.3	-5.3	-5.2	0.2	0.9
Belgium	-4.4	-4.1	-4.1	0.1	0.4
Bulgaria	-4.0	-4.4	-4.3	3.5	4.6
Brazil	0.0	0.0	0.1	0.0	-0.0
Canada	0.2	0.1	0.1	0.0	0.0
Switzerland	1.3	1.2	1.0	0.0	0.0
China	-0.2	-0.1	-0.1	0.0	-0.0
Cyprus	-5.0	-4.8	-4.5	2.6	4.0
Czech Republic	-4.4	-4.4	-4.4	0.7	2.3
Germany	-1.3	-1.5	-1.8	0.1	0.3
Denmark	-4.4	-4.4	-4.4	0.2	1.0
Spain	-1.9	-2.0	-2.7	0.6	1.9
Estonia	-4.6	-4.4	-4.1	0.5	1.9
Finland	-3.2	-3.3	-3.6	0.4	1.6
France	-2.9	-2.9	-3.2	0.2	0.8
United Kingdom	-2.0	-2.1	-2.5	0.2	0.8
Greece	-2.7	-2.8	-3.3	0.9	2.5
Croatia	-4.7	-4.8	-4.8	1.7	3.3
Hungary	-4.4	-4.2	-4.1	0.8	2.3
Indonesia	-0.1	-0.0	-0.0	0.0	0.0
India	-0.1	0.1	0.1	0.0	0.0
Ireland	-3.4	-3.3	-3.5	0.1	0.5
Italy	-1.6	-1.8	-2.3	0.2	0.9
Japan	-0.0	-0.1	-0.1	0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-3.8	-3.7	-3.7	0.5	1.9
Luxembourg	-5.3	-5.3	-5.2	0.1	0.4
Latvia	-3.9	-3.9	-3.9	0.7	2.3
Mexico	0.1	0.1	0.0	-0.0	0.0
Malta	-5.4	-5.0	-4.9	1.2	3.0
Netherlands	-3.6	-3.4	-3.5	0.0	0.3
Norway	-4.1	-4.0	-3.9	0.1	0.3
Poland	-2.9	-3.2	-3.8	1.3	3.1
Portugal	-4.2	-4.6	-4.9	1.9	3.4
Romania	-2.8	-3.5	-4.1	2.4	4.2
Russia	0.2	0.2	0.2	0.0	0.0
Slovakia	-3.2	-3.4	-3.7	0.9	2.4
Slovenia	-5.3	-5.1	-5.0	0.6	2.1
Sweden	-4.2	-4.2	-4.3	0.2	1.1
Turkey	0.3	0.2	0.2	-0.0	-0.0
Taiwan	0.1	0.0	0.0	0.0	0.0
United States	0.1	0.0	-0.1	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table 1, column (7), i.e., we use the same trade costs consistent with conventional structural gravity models for all competition modes.

gle Market shields domestic firms from foreign competition and hence allows them to increase their domestic markups. This effect is more pronounced under Cournot competition. Markup changes can be substantial: without the European Single Market, domestic markups in Bulgaria would be 13.5 percent larger. Similarly, other countries at the periphery of the European Single Market like Spain, Poland, Portugal and Romania all see their domestic markups increase by more than 10 percent. Hence our model confirms one of the central motivations behind the creation of the European Single Market: to increase competition in EU member countries' domestic markets. From this perspective, particularly peripheral EU countries benefit from the competition effects of the European Single Market, in line with earlier results by Badinger (2007). Conventional structural gravity models must remain silent on this.

The reduction in trade costs between EU members increases welfare in non-member states, but their domestic markups practically do not change. Table 2 does not show markup changes in the export markets of firms. We provide summary statistics of the markup changes across different markets in Table 3. The first three rows show the average change in markups across all markets, for both EU members and non-members, where the average is the simple average across all countries. On average, markups in the world hardly change (0.01 percent under Bertrand and 0.03 percent under Cournot). Markups fall slightly across export markets, but the majority of the markup changes happen in domestic markets. The next three rows of Table 3 show the markup changes for EU member countries. On average, the domestic markup of EU member country firms increases between 1.62 and 6.42 percent, depending on the competition mode. Even within the EU, markups in their export markets only fall by 0.03 to 0.17 percent after the increase of trade costs among themselves. Markups EU member firms' charge in non-member countries remain effectively constant. The last three rows of the table show the average markup changes of non-EU members. Non-EU members slightly increase their markups within EU member states but their other markups remain essentially constant. This implies that the welfare gains for non-EU members of abolishing the European Single Market stem overwhelmingly from the trade diversion caused by the exogenous change in trade costs, not from endogenous markup changes. For EU member states, the welfare changes are the combined effect of exogenous trade cost changes and endogenous markup changes.

Table 2 illustrates that the welfare effects of trade (de-)liberalization episodes are quite different from those of conventional monopolistic competition models. The difference in

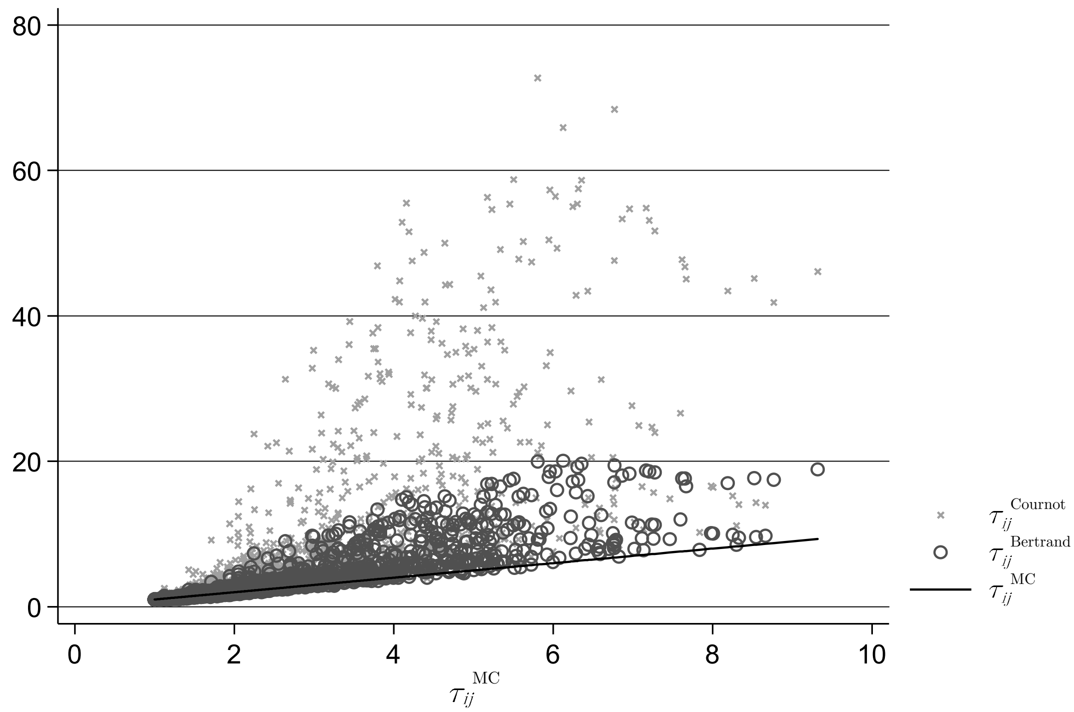

Figure 4: Comparison of estimated trade costs across different modes of competition

welfare results stems from two sources: (1) the different competition modes imply different price and output responses, and (2) the different competition modes imply different trade cost parameter estimates.[39] Therefore, a natural question is how would welfare effects differ across the different competition modes if the underlying trade cost parameters were the same. We therefore redo the simulations underlying Table 2 but use the same trade cost parameters for all three competition modes. We use the trade cost parameters from the conventional gravity estimation, i.e., for monopolistic competition. We present results of these counterfactuals in Table 4, which is organized in the same way as Table 2, and the results are the same in the monopolistic competition column. Welfare changes across the different competition modes are now more similar. Still sizeable differences remain, with many EU member countries suffering from a 10 to 20 percent larger welfare loss when

[39]This is reminiscent of the discussion in Simonovska and Waugh (2014) who stress that different trade models imply different parameter estimates, particularly trade elasticities, and hence different welfare effects.

abolishing the European Single Market. What becomes clear when comparing Tables 2 and 4 is that differences in welfare effects stem mostly from differences in the estimated trade costs. Figure 4 shows the different estimated trade costs for all country pairs for the three different competition modes: estimated trade costs under Bertrand competition are larger than under monopolistic competition, and trade costs implied by Cournot competition are even larger. Also the spread in trade costs increases, from monopolistic to Bertrand to Cournot competition. The intuition for this lies in the negative relationship between markups and trade costs: under monopolistic competition, the whole variance in trade flows has to come from trade costs (conditional on importer- and exporter-specific determinants), whereas under Bertrand and Cournot competition, trade costs can vary more as markups can adjust accordingly. As markups react more under Cournot than under Bertrand competition, the variance of trade costs is also larger under Cournot than under Bertrand. This highlights the importance of using estimated trade costs which are consistent with the underlying model when conducting counterfactual simulations. Our results stress the importance of taking into account the endogenous adjustments of markups when evaluating episodes of trade (de-)liberalization.

5 Concluding remarks

This paper has shown that the structural gravity model can be extended to include oligopolistic competition. Oligopolistic competition adds a market power distortion, but we could show that it is possible to empirically disentangle trade and market power frictions. Thus, the structural gravity model is much more universal and not restricted to models of perfect or monopolistic competition. This is an important development as a lot of markets are dominated by large firms, and thus an empirical analysis should also allow for strategic interactions and market power. We have demonstrated this extension by including standard price and quantity competition modes as an alternative to monopolistic competition. This has the advantage that the estimation strategy can use market shares as they determine markups. In general, however, more complex modes of competition, for example competition among multi-product firms, could also be accommodated if according data were available. Additionally, we have shown that our new gravity model can also include endogenous market entry and firm heterogeneity such that all exercises done so far in standard models can also be done using the new gravity approach we suggest.

Furthermore, this paper has addressed the concern that recent quantitative models do not take these market power effects into account and may thus not exactly model the purpose of market integration policies (or the opposite of it, protection). An example is the formation of the European Single Market which had the explicit purpose of intensifying competition by lowering non-tariff trade barriers. We have shown that monopolistic competition models are likely to underestimate the gains from trade liberalization. The reason is that these models employs orthogonal reaction functions and are thus limited in estimating pro-competitive effects. We demonstrate a simple empirical strategy to take into account these effects at both the estimation and counterfactual simulation stage, and we show by the example of the Single European Market that the welfare outcomes between standard monopolistic competition models and oligopoly models are substantially different. We thus find that the potential gains from trade are much larger than suggested.

We could also outline that welfare effects may also come about through changes in profits across countries. While standard models cannot accommodate these changes, since profits are either zero due to perfect competition or free entry or are a fraction of revenues, our model could show how these changes may affect a country's welfare. This is an important innovation in times in which large firms are dominant players in a lot of industries so that these effects should not be neglected. Thus, we hope that our framework will enable future research to take into account strategic firm responses when estimating and quantifying trade policy effects.

Appendix

A.1 Sufficient conditions, comparative static results, existence and uniqueness of the industry equilibrium

In what follows, we will employ the concept of aggregative games. Aggregative games are characterized by the property that the profit of each firm can be expressed such that it depends on the firm's own action and an aggregate of all firms' actions only.[40] We follow Anderson et al. (2019) to prove sufficiency, existence and uniqueness of the

[40] The concept of aggregative games was first developed by Cornes and Hartley (2007) for public goods games and has been generalized and extended to other applications, see for example Acemoglu and Jensen (2013), Anderson et al. (2019), Córchon (1994) and Martimort and Stole (2012). Nocke and Schutz (2018) develop an aggregative games approach for multi-product firms.

industry equilibrium and to demonstrate that the pass-through is incomplete, that is, that the markup decreases with the trade friction. We will proceed by showing that all four assumptions required by Anderson et al. (2019) are fulfilled for our industry equilibrium. We denote by a_i firm i's action, by A_{-i} the aggregate of all other firms' actions and by A the aggregate of all firms' actions for the Bertrand game, so the profit of firm i can be written as

$$(p_i - \tau_i c_i)\, q_i(\cdot) = (p_i - \tau_i c_i)\, \frac{E p_i^{-\sigma}}{\sum_{j=1}^{n} p_j^{1-\sigma}} = \left(a_i^{\frac{1}{1-\sigma}} - \tau_i c_i\right) \frac{E a_i^{-\frac{\sigma}{1-\sigma}}}{A_{-i} + a_i} = \widetilde{\pi}_i^B (A_{-i} + a_i, a_i), \tag{A.1}$$

where we have set $a_i = p_i^{1-\sigma}$. Expression (A.1) shows that the Bertrand game is an aggregative game, and that (A.1) strictly decreases with A_{-i} which fulfills Assumption 1 of Anderson et al. (2019). Furthermore, $\widetilde{\pi}_i^B(A_{-i}+a_i, a_i)$ is twice differentiable and strictly quasi-concave in a_i. Defining profit as a function of A and a_i, that is,

$$\breve{\pi}_i^B(A, a_i) = \left(a_i^{\frac{1}{1-\sigma}} - \tau_i c_i\right) \frac{E a_i^{-\frac{\sigma}{1-\sigma}}}{A}, \tag{A.2}$$

shows that $\breve{\pi}_i^B(A, a_i)$ is also twice differentiable and strictly quasi-concave in a_i. Furthermore, maximization of $\breve{\pi}_i^B(A, a_i)$ w.r.t. a_i is the same exercise as in monopolistic competition models in which A is regarded constant, and we know that the sufficient conditions are fulfilled in this setup. Thus, $\breve{\pi}_i^B(A, a_i)$ is strictly concave at the maximum, and hence Assumption 2 of Anderson et al. (2019) is fulfilled if the profit function $\widetilde{\pi}_i^B(A_{-i} + a_i, a_i)$ can be shown to be strictly concave at the profit maximum. To show this, we do not use the first-order condition (2), but the markup equation (3). Let $b_i = (\mu_i \tau_i c_i)^{1-\sigma}$ such that

$$\mu_i^B = \frac{b_i^{\frac{1}{1-\sigma}}}{\tau_i c_i} \text{ and } \mathcal{B}_{-i} = \sum_{j \neq i} b_j$$

so that we can write the markup equation (3) as an implicit function

$$\Psi(\cdot) = \frac{b_i^{\frac{1}{1-\sigma}}}{\tau_i c_i} - \frac{b_i + \mathcal{B}_{-i}\sigma}{(\sigma - 1)\mathcal{B}_{-i}} = 0.$$

Differentiation yields

$$\frac{\partial\Psi(\cdot)}{\partial b_i} = -\frac{\mathcal{B}_{-i}b_i^{\frac{1}{1-\sigma}} + b_i\tau_i c_i}{(\sigma-1)b_i\mathcal{B}_{-i}\tau_i c_i} < 0, \frac{\partial\Psi(\cdot)}{\partial\mathcal{B}_{-i}} = \frac{b_i}{\mathcal{B}_{-i}^2(\sigma-1)} > 0, \frac{\partial\Psi(\cdot)}{\partial\tau_i} = -\frac{b_i^{\frac{1}{1-\sigma}}}{\tau_i^2 c_i} < 0$$

and shows that (i) the profit function is strictly concave at the profit maximum, (ii) $\partial\Psi(\cdot)/\partial b_i - \partial\Psi(\cdot)/\partial\mathcal{B}_{-i} < 0$ and (iii) that an increase in the trade friction makes the firm less aggressive. Thus, Assumptions 2 and 3 are also fulfilled.

We now turn to the existence and the uniqueness of the Bertrand equilibrium. As shown by Anderson et al. (2019), continuity of the best response functions implies also continuity of the aggregate of the best response functions. If the individual strategy spaces are compact intervals, an equilibrium exists as an implication of Brouwer's fixed point theorem. The problem with Bertrand games in a CES environment is that compactness warrants to allow $p_i = 0$, implying a non-continuity of the profit function. Anderson et al. (2019) show that a condition on the aggregate of all best response functions guarantees the existence of an equilibrium, and this condition is fulfilled for CES demand functions.[41] As for uniqueness, we now turn to inclusive best reply functions and replace $b_i + \mathcal{B}_{-i}$ by $\mathcal{B}$. Solving for $\mathcal{B}$ and treating $\mathcal{B}$ as the inclusive inverse best reply function of b_i yields

$$\mathcal{B}(b_i) = b_i + \frac{b_i\tau_i c_i}{(\sigma-1)b_i^{\frac{1}{1-\sigma}} - \sigma\tau_i c_i}.$$

Since

$$\frac{d\mathcal{B}(b_i)}{db_i} = 1 + \frac{\sigma\tau_i c_i\left(b_i^{\frac{1}{1-\sigma}} - \tau_i c_i\right)}{\left((\sigma-1)b_i^{\frac{1}{1-\sigma}} - \sigma\tau_i c_i\right)^2}$$

and

$$\frac{d\mathcal{B}(b_i)}{db_i} - \frac{\mathcal{B}(b_i)}{b_i} = \frac{\tau_i c_i b_i^{\frac{1}{1-\sigma}}}{\left((\sigma-1)b_i^{\frac{1}{1-\sigma}} - \sigma\tau_i c_i\right)^2} > 0,$$

[41] See eq. (2) in Anderson et al. (2019) which requires $(\sum_{i=1}^n r_i(\mathcal{B}))/\mathcal{B} >> 1$ for small $\mathcal{B}$ where $r_i(\mathcal{B})$ denotes the inclusive best reply function of firm i.

Assumption 4 of Anderson et al. (2019) is fulfilled and thus the Nash equilibrium is unique.[42] Furthermore, since $\partial\Psi(\cdot)/\partial\tau_i < 0$, $b_i/\mathcal{B}$ must strictly decrease. Since $s_i = b_i/\mathcal{B}$ is the firm's market share, and the markup can also be written as a function of the market share, that is,

$$\mu^B(s_i^B) = \frac{\sigma - (\sigma-1)s_i^B}{(\sigma-1)(1-s_i^B)}, \frac{d\mu^B(s_i^B)}{ds_i^B} = \frac{1}{(\sigma-1)(1-s_i^B)^2} > 0, \tag{A.3}$$

where the derivative shows that the markup increases monotonically with the market share. Thus, a decline in market share reduces the markup, and (A.3) proves Proposition 1 for the Bertrand game.

We now turn to the Cournot game for which profits can be rewritten as

$$(p(\cdot) - \tau_i c_i)q_i = \left(\frac{Eq_i^{-\frac{1}{\sigma}}}{\sum_{j=1}^n q_j^{\frac{\sigma-1}{\sigma}}} - \tau_i c_i\right) q_i = \left(\frac{Ea_i^{-\frac{1}{\sigma-1}}}{A_{-i} + a_i} - \tau_i c_i\right) a_i^{\frac{\sigma}{\sigma-1}} = \widetilde{\pi}_i^B(A_{-i} + a_i, a_i), \tag{A.4}$$

where we now have set $a_i = q_i^{(\sigma-1)/\sigma}$. Expression (A.4) shows that the Cournot game is also an aggregative game, and that (A.4) strictly decreases with A_{-i} so Assumption 1 of Anderson et al. (2019) is fulfilled. Furthermore, $\widetilde{\pi}_i^B(A_{-i}+a_i, a_i)$ is twice differentiable and strictly quasi-concave in a_i Defining profit as a function of A and a_i, that is,

$$\breve{\pi}_i^B(A, a_i) = \left(\frac{Ea_i^{-\frac{1}{\sigma-1}}}{A} - \tau_i c_i\right) a_i^{\frac{\sigma}{\sigma-1}} \tag{A.5}$$

shows that $\breve{\pi}_i^C(A, a_i)$ is also twice differentiable and strictly quasi-concave in a_i. Furthermore, maximization of $\breve{\pi}_i^B(A, a_i)$ w.r.t. a_i is again the same exercise as in monopolistic competition models in which A is regarded constant, and we know that the sufficient conditions are fulfilled in this setup. Thus, $\breve{\pi}_i^B(A, a_i)$ is strictly concave at the maximum, and hence Assumption 2 of Anderson et al. (2019) is fulfilled if the profit function $\widetilde{\pi}_i^C(A_{-i} + a_i, a_i)$ can be shown to be strictly concave at the profit maximum, and we also show this by using the markup equation (5) instead of the first-order condition (4). We use b_i, $\mathcal{B}_{-i}$ and $\mathcal{B}$ as above and can write the markup equation (5) as an implicit function

[42] Anderson et al. (2019) use the inclusive best reply function $r_i(\mathcal{B})$, and their slope condition thus reads $dr_i(\mathcal{B})/d\mathcal{B} < r_i(\mathcal{B})/\mathcal{B}$. Since the inclusive best reply function is strictly monotone, we can use the inverse best reply function as we can solve explicitly for $\mathcal{B}$, but not for b_i.

$$\Omega(\cdot) = \frac{b_i^{\frac{1}{1-\sigma}}}{\tau_i c_i} - \frac{\sigma(b_i + \mathcal{B}_{-i})}{(\sigma-1)\mathcal{B}_{-i}} = 0.$$

Differentiation yields

$$\frac{\partial\Omega(\cdot)}{\partial b_i} = -\frac{\mathcal{B}_{-i} b_i^{\frac{1}{1-\sigma}} + \sigma b_i \tau_i c_i}{(\sigma-1) b_i \mathcal{B}_{-i} \tau_i c_i} < 0, \frac{\partial\Omega(\cdot)}{\partial\mathcal{B}_{-i}} = \frac{\sigma b_i}{\mathcal{B}_{-i}^2(\sigma-1)} > 0, \frac{\partial\Omega(\cdot)}{\partial\tau_i} = -\frac{b_i^{\frac{1}{1-\sigma}}}{\tau_i^2 c_i} < 0$$

and shows that (i) the profit function is strictly concave at the profit maximum, (ii) $\partial\Psi(\cdot)/\partial b_i - \partial\Psi(\cdot)/\partial\mathcal{B}_{-i} < 0$ and (iii) that an increase in the trade friction makes the firm less aggressive. Thus, Assumptions 2 and 3 are also fulfilled. Furthermore, the best response functions are continuous, implying also continuity of the aggregate of the best response functions, and the individual strategy line is compact, such that a Nash equilibrium exists. Existence were guaranteed if outputs were strategic substitutes, but Lemma 1 shows that this is not true in general. We can again prove uniqueness by solving for $\mathcal{B}$ and treating $\mathcal{B}$ as the inclusive inverse best reply function of b_i which yields

$$\mathcal{B}(b_i) = b_i \left(\frac{1}{1 - \frac{\sigma\tau_i c_i}{\sigma-1} b_i^{\frac{1}{\sigma-1}}} \right).$$

Since

$$\frac{d\mathcal{B}(b_i)}{db_i} = \frac{1 - (\sigma-2)\sigma\left(b_i^{\frac{1}{\sigma-1}}\tau_i c_i - 1\right)}{\left(1 + \sigma\left(b_i^{\frac{1}{\sigma-1}}\tau_i c_i - 1\right)\right)^2}$$

and

$$\frac{d\mathcal{B}(b_i)}{db_i} - \frac{\mathcal{B}(b_i)}{b_i} = \frac{\sigma b_i^{\frac{1}{\sigma-1}}\tau_i c_i}{\left(1 + \sigma\left(b_i^{\frac{1}{\sigma-1}}\tau_i c_i - 1\right)\right)^2} > 0,$$

Assumption 4 of Anderson et al. (2019) is fulfilled and thus the Nash equilibrium is also unique for Cournot competition. Again, since $\partial\Omega(\cdot)/\partial\tau_i < 0$, the market share $s_i = b_i/\mathcal{B}$ must strictly decrease. Rewriting the markup as a function of the market share implies

$$\mu^C(s_i^C) = \frac{\sigma}{(\sigma-1)(1-s_i^C)}, \frac{d\mu^C(s_i^C)}{ds_i^C} = \frac{\sigma}{(\sigma-1)(1-s_i^C)^2} > 0, \tag{A.6}$$

where the derivative shows that the markup increases monotonically with the market share. Thus, a decline in market share reduces the markup, and (A.6) proves Proposition 1 for the Cournot game.

A.2 Strategic complements and substitutes

In what follows, we consider firm i competing against firm $j \neq i$ in country j. For Bertrand competition, the first-order condition for firm i can be written as

$$\psi_i^B(\cdot) = 1 - \frac{(p_i - \tau_i c_i)}{p_i}\sigma + (\sigma-1)(p_i - \tau_i c_i)\frac{p_i^{-\sigma}}{\sum_j p_j^{1-\sigma}} = 0. \tag{A.7}$$

Strategic complementarity requires that $\partial\psi_i^B(\cdot)/\partial p_j > 0$ which is true:

$$\frac{\partial\psi_i^B(\cdot)}{\partial p_j} = (1-\sigma)^2(p_i - \tau_i c_i)\frac{p_i^{-\sigma}p_j^{-\sigma}}{(\sum_\iota p_\iota^{1-\sigma})^2} > 0. \tag{A.8}$$

For Cournot competition, we use the aggregative games approach of Appendix A.1. Differentiation of $\widetilde{\pi}_i^B(A_{-i}+a_i, a_i)$ in eq. (A.4) w.r.t. a_i yields the first-order condition for firm i as

$$\psi_i^C(\cdot) = \frac{\sigma a_i^{\frac{1}{\sigma-1}}\left(\frac{Ea_i^{-\frac{1}{\sigma-1}}}{a+A_{-i}} - c_i\tau_i\right)}{\sigma-1} - a_i^{\frac{\sigma}{\sigma-1}}\left(\frac{Ea_i^{-\frac{1}{\sigma-1}}}{(a_i+A_{-i})^2} + \frac{Ea_i^{-\frac{\sigma}{\sigma-1}}}{(\sigma-1)(a_i+A_{-i})}\right) = 0. \tag{A.9}$$

Strategic complementarity (substitutability) requires that $\partial\psi_i^C(\cdot)/\partial A_{-i} > (<)0$. We find:

$$\frac{\partial\psi_i^C(\cdot)}{\partial A_{-i}} = \frac{E(a_i - A_{-i})}{(a_i+A_{-i})^3}. \tag{A.10}$$

Thus, it is not clear whether Cournot competition implies strategic complementarity or strategic substitutability: if the output of firm i is large (small) such that

$$q_i^{(\sigma-1)/\sigma} > (<) \sum_{\iota\neq i}^{n} q_\iota^{(\sigma-1)/\sigma}, \tag{A.11}$$

firm i will increase (decrease) its output with an increase in rival output.

A.3 Alternative gravity equation

Without loss of generality, we set $c_i = 1$ in what follows. For developing an alternative gravity equation at the aggregate level, we observe that a firm also located in country i, but in industry κ, has sales of size

$$x^*_{ij\kappa} = \left(\frac{p^*_{ij\kappa}}{P_{j\kappa}}\right)^{1-\sigma} E_{j\kappa} = \frac{E_{j\kappa}}{P^{1-\sigma}_{j\kappa}} {t_{ijk}}^{1-\sigma} \left(\frac{t_{ij\kappa}}{t_{ijk}}\right)^{1-\sigma},$$

if $x^*_{ijk}, x^*_{ij\kappa} > 0$, where we have factored out the equilibrium price of the neighboring firm in industry k. The purpose of this exercise is to develop the pricing behavior as being proportionate to country GDPs and multilateral resistance terms. Let

$$\widetilde{Q}^{1-\sigma}_{ij\kappa} = \frac{E_{j\kappa}}{P^{1-\sigma}_{j\kappa} Y_j} {t_{ij\kappa}}^{1-\sigma} \tag{A.12}$$

define the alternative outward multilateral resistance term that differs from eq. (10) in that it considers the relative expenditures $E_{j\kappa}/Y_j$ instead of $E_{j\kappa}$. We can now use the outward multilateral resistance term to write the aggregate sales of *all* firms located in country i to country j, denoted by X^*_{ij}, as

$$X^*_{ij} = \int_0^1 x^*_{ijk} d\kappa = {p^*_{ijk}}^{1-\sigma} \frac{Y_j}{t^{1-\sigma}_{ijk}} \int_0^1 I_{ij\kappa} \widetilde{Q}^{1-\sigma}_{ij\kappa} d\kappa,$$

where $I_{ij\kappa}$ is an indicator variable for which $I_{ij\kappa} = 1$ if $i \in N_{j\kappa}$ and $I_{ij\kappa} = 0$ otherwise. The aggregate sales of all firms to all locations, including the home location i, are consequently given by

$$\sum_{\iota=1}^{n} X^*_{i\iota} = \frac{{p^*_{ijk}}^{1-\sigma}}{t^{1-\sigma}_{ijk}} \sum_{\iota=1}^{n} Y_\iota \int_0^1 I_{i\iota\kappa} \widetilde{Q}^{1-\sigma}_{i\iota\kappa} d\kappa = Y_i.$$

The model is closed by the general equilibrium condition that aggregate sales of country i to itself and all other countries, $\sum_{\iota=1}^{n} X^*_{i\iota}$, is equal to country i's total sales and income, Y_i. Since ${p^*_{ijk}}^{1-\sigma} = P^{1-\sigma}_{jk} x^*_{ijk}/E_{jk}$ and $E_{jk} = \alpha_k Y_j$, we find that

$$\frac{P^{1-\sigma}_{jk} x^*_{ijk}}{\alpha_k Y_j} = \frac{t^{1-\sigma}_{ijk} Y_i}{\sum_{\iota=1}^{n} Y_\iota \int_0^1 I_{i\iota\kappa} \widetilde{Q}^{1-\sigma}_{i\iota\kappa} d\kappa},$$

and rearranging yields

$$x_{ijk}^* = \frac{\alpha_k Y_i Y_j {t_{ijk}}^{1-\sigma}}{P_{jk}^{1-\sigma} \sum_{\iota=1}^{n} Y_\iota \int_0^1 I_{i\iota\kappa} \widetilde{Q}_{i\iota\kappa}^{1-\sigma} d\kappa}. \tag{A.13}$$

A.4 Proof of Proposition 3

As in Arkolakis et al. (2012), we assume that labor is the only factor of production with an endowment of size L_i in each country. Without loss of generality, we assume that one unit of labor is needed to produce one unit of output in each industry. The labor market is perfectly competitive. Let w_i denote the equilibrium wage rate, so the price index in country j for industry k is given by

$$P_{jk} = \left(\sum_{i \in N_{jk}} {p_{ijk}^*}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} = \left(\sum_{i=1}^{n} (w_i t_{ijk})^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \tag{A.14}$$

Furthermore,

$$x_{ijk}^* = p_{ijk}^* q_{ijk}^* = \left(\frac{p_{ijk}^*}{P_{jk}} \right)^{1-\sigma} E_{jk} = \frac{E_{jk}}{P_{jk}^{1-\sigma}} (w_i t_{ijk})^{1-\sigma} = \frac{\alpha_k Y_j}{P_{jk}^{1-\sigma}} (w_i t_{ijk})^{1-\sigma}. \tag{A.15}$$

Let λ_{ijk} denote the expenditure share in country j on goods produced by the national champion of country i as a fraction of expenditures in industry k:

$$\lambda_{ijk} = \frac{x_{ijk}^*}{Y_j} = \frac{(w_i t_{ijk})^{1-\sigma}}{P_{jk}^{1-\sigma}} \Leftrightarrow (w_i t_{ijk})^{1-\sigma} = \lambda_{ijk} P_{jk}^{1-\sigma}.$$

As in Arkolakis et al. (2012), we consider now a potential shock in all other countries except in country j, and we also use the country j's wage rate as the numeraire. In Arkolakis et al. (2012), profits are a constant share of revenues, and Arkolakis et al. (2012) can show that that $d \ln Y_j = d \ln w_j = 0$ holds in their setup (see also Dekle et al., 2007). This is not true in an oligopoly setup where

$$Y_j = L_j + \Pi_j^*, \Pi_j^* = \sum_{i=1}^{n} \int_0^1 \pi_{jik}^* dk \tag{A.16}$$

defines the income of the representative household with $w_j = 1$ used as the numeraire. In eq. (A.16), π_{jik}^* denotes the profit of the firm in industry k that is located in country j

and sells in country i. Thus, Π_j^* denotes the aggregate profits of all firms that are located in country j. Consequently, welfare changes come about through changes in income due to profit changes and due to changes in the price indexes. As for the price index changes, totally differentiating eq. (A.14) yields

$$d\ln P_{jk} = \sum_{i\in N_{jk}} \lambda_{ijk} \left(d\ln w_i + d\ln t_{ijk}\right)$$

and since

$$\frac{\lambda_{ijk}}{\lambda_{jjk}} = \left(\frac{w_i t_{ijk}}{w_j t_{jjk}}\right)^{1-\sigma},$$

$$\ln\lambda_{ijk} - \ln\lambda_{jjk} = (1-\sigma)(\ln w_i + \ln t_{ijk} - \ln w_j - \ln t_{jjk}).$$

Since w_j is the numeraire, $d\ln w_j = 0$. Contrary to Arkolakis et al. (2012), however, we cannot assume that $d\ln t_{jjk} = 0$, but only that $d\ln\tau_{jjk} = 0$. Therefore,

$$d\ln\lambda_{ijk} - d\ln\lambda_{jjk} = (1-\sigma)(d\ln w_i + d\ln t_{ijk} - d\ln t_{jjk}),$$

where $d\ln t_{jjk} = d\ln\mu_{jjk}$ is the relative change in the markup charged by the home champion in country j. Solving for $d\ln w_i + d\ln t_{ijk}$ leads to

$$d\ln w_i + d\ln t_{ijk} = \frac{d\ln\lambda_{ijk} - d\ln\lambda_{jjk}}{1-\sigma} + d\ln\mu_{jjk}. \tag{A.17}$$

Using eq. (A.17) implies

$$d\ln P_{jk} = \frac{d\ln\lambda_{jjk}}{1-\sigma} - d\ln\mu_{jjk}, \tag{A.18}$$

because $\sum_{i\in N_{jk}}\lambda_{ijk} = 1$ and thus $\sum_{i\in N_{jk}} d\ln\lambda_{ijk} = \sum_{i\in N_{jk}}(d\lambda_{ijk}/\lambda_{ijk}) = 0$. The overall consumer price index in our model is given by $P_j = \prod_k P_{jk}^{\alpha_k}$. We can derive the welfare change by defining $d\ln\Lambda_{jk} = d\ln\lambda_{jjk} + (\sigma-1)d\ln\mu_{jjk}$ as the combined relative change in domestic expenditures and domestic markups. Equation (A.18) then leads to the differential equation $dP_{jk}/d\Lambda_{jk} = -P_{jk}/[(1-\sigma)\Lambda_{jk}]$ and a solution

$$P_{jk} = \mathcal{C}\Lambda_{jk}^{-\frac{1}{1-\sigma}}$$

with $\mathcal{C}$ as a constant. Let the superscript 1 (0) denote after (before) the change. Since

$$\widehat{U}_{jk} = \frac{U^1_{jk}}{U^0_{jk}} = \frac{E^1_{jk}}{E^0_{jk}}\frac{P^0_{jk}}{P^1_{jk}} = \frac{Y^1_j}{Y^0_j}\left(\frac{\Lambda^0_{jk}}{\Lambda^1_{jk}}\right)^{-\frac{1}{1-\sigma}} = \widehat{Y}_j \widehat{\Lambda}^{\frac{1}{1-\sigma}}_{jk}, \widehat{W}_j = \widehat{Y}_j \prod_k \widehat{\Lambda}^{\frac{\alpha_k}{1-\sigma}}_{jjk}.$$

Using eq. (A.16) implies Proposition 3.

A.5 Using market shares for welfare changes

In the national champions' model,

$$d\ln\Lambda_{jk} = d\ln\lambda_{jjk} + (\sigma-1)d\ln\mu_{jjk} = d\ln s_{jjk} + (\sigma-1)d\ln\mu_{jjk},$$

as the expenditure share in country j on goods produced by the national champion of country j is exactly s_{jjk}. The change in Λ_{jk} determines the change in welfare for $\widehat{Y}_j = 1$ (see Proposition 3 and Appendix A.4). We can now use eqs. (A.3) and (A.6), respectively, to compute $d\mu_{jjk}/\mu_{jjk}$ and determine $d\ln\Lambda_{jk}$. In case of Bertrand competition,

$$d\ln\Lambda_{jk} = d\ln s^B_{jjk}\left(1 + \frac{s^B_{jjk}(\sigma-1)}{(1-s^B_{jjk})((1-s^B_{jjk})\sigma + s^B_{jjk})}\right),$$

which shows that the effect of a reduction in domestic expenditures leads to an additional welfare effect due to the reduction in the markup. The same is true for Cournot competition for which we find

$$d\ln\Lambda_{jk} = d\ln s^C_{jjk}\left(1 + \frac{s^C_{jjk}(\sigma-1)}{1-s^C_{jjk}}\right).$$

A.6 Additional general equilibrium conditions

We make the same assumptions as in Appendix A.4 and include a perfectly competitive labor market. The first-order condition for Bertrand reads $q_{ijk}(\cdot) + (p^*_{ijk} - c_i\tau_{ijk})\partial q_{ijk}(\cdot)/\partial p_{ijk} = 0$ and the one for Cournot reads $p_{ijk}(\cdot) - c_i\tau_{ijk} + q^*_{ijk}\partial p_{ijk}(\cdot)/\partial q_{ijk} = 0$. Both can be rewritten to compute the maximized profit as $\pi^*_{ijk} = (p_{ijk} - c_i\tau_{ijk})q_{ijk} = -q^2_{ijk}\partial p_{ijk}/\partial q_{ijk} = (p_{ijk}q_{ijk})/\epsilon_{ijk} = x^*_{ijk}/\epsilon_{ijk}$ because $\partial p_{ijk}/\partial q_{ijk} = -p_{ijk}/(q_{ijk}\epsilon_{ijk})$. Without loss of generality, we ignore fixed costs and assume universal activity of each firm,[43] and thus our income equation can be written as

$$Y_i = w_i L_i + \sum_{j=1}^{n} \int_0^1 \pi^*_{ijk} dk = w_i L_i + \sum_{j=1}^{n} \int_0^1 \frac{x^*_{ijk}}{\epsilon_{ijk}} dk. \tag{A.19}$$

We now develop the market clearing condition. Sales are given by

$$x^*_{ijk} = \left(\frac{p^*_{ijk}}{P_{jk}} \right)^{1-\sigma} E_{jk}.$$

if $x^*_{ijk} > 0$. Aggregation yields

$$Y_{ik} = \sum_{\iota=1}^{n} x^*_{i\iota k} = {p^*_{ijk}}^{1-\sigma} \sum_{\iota=1}^{n} I_{i\iota k} \left(\frac{1}{P_{jk}} \frac{t_{i\iota k}}{t_{ijk}} \right)^{1-\sigma} E_{\iota k}$$

where we have factored out ${p^*_{ijk}}^{1-\sigma}$. Division by $Y^W_k = \sum_{i=1}^{n} Y_{ik}$ and using the outward resistance term leads to

$$\left(\frac{p^*_{ijk}}{t_{ijk}} Q_{ik} \right)^{1-\sigma} = (w_i Q_{ik})^{1-\sigma} = \frac{Y_{ik}}{Y^W_k}$$

and

$$\forall i : w_i = \frac{1}{Q_{ik}} \left(\frac{Y_{ik}}{Y^W_k} \right)^{\frac{1}{1-\sigma}}. \tag{A.20}$$

Note that $Y_i = \sum_{j=1}^{n} \int_0^1 x^*_{ijk} dk$, i.e., GDP equals aggregate sales, so the income definition can be rewritten as

$$w_i L_i = \sum_{j=1}^{n} \int_0^1 x^*_{ijk} \left(1 - \frac{1}{\epsilon_{ijk}} \right) dk.$$

Labor demand is equal to $\sum_{j=1}^{n} \int_0^1 \tau_{ijk} q^*_{ijk} dk$, and since $q^*_{ijk} = x^*_{ijk}/p^*_{ijk} = x^*_{ijk}/(t_{ijk} c_i)$, we find that the firm labor demand is given by

[43] Fixed costs can be included and activities can be endogenized by specifying market entry conditions in the spirit of eq. (7) that determine which firms enter which market and carry a corresponding fixed entry cost.

$$\tau_{ijk} q^*_{ijk} = \frac{x^*_{ijk}}{\mu_{ijk} c_i} = \frac{x^*_{ijk}}{\frac{\epsilon_{ijk}}{\epsilon_{ijk}-1} c_i} = \frac{x^*_{ijk}}{c_i}\left(1 - \frac{1}{\epsilon_{ijk}}\right), \tag{A.21}$$

where the last terms follow from eqs. (3) and (5). Equation (A.21) shows that adding up over all firm labor demand meets the labor endowment.

A.7 Extension to multi-product firms

Let the set of all produced varieties be denoted by $\mathcal{V}$, and the subset that is produced by firm i is given by $\mathcal{V}_i \subset \mathcal{V}$. In case of price competition, firm i maximizes its operating profit in country j, that is, $\pi_i^B(\cdot) = \sum_{i \in \mathcal{V}_i} (p_i - \tau_i c_i) q_i(\cdot)$ w.r.t. to all p_i, leading to the first-order conditions

$$\forall i \in \mathcal{V}_i : q_i(\cdot) + (p_i^* - \tau_i c_i) \sum_{\theta \in \mathcal{V}_i} \frac{\partial q_\theta}{\partial p_i}(\cdot) = 0.$$

The first-order condition can be rewritten in terms of markups as in the main text, except that

$$\widetilde{\epsilon}_i^B = \sigma - (\sigma - 1) \sum_{\theta \in \mathcal{V}_i} s_\theta \tag{A.22}$$

replaces the elasticity. It is now the sum of market shares that determines the overall elasticity and reduces, *ceteris paribus*, the elasticity compared to a single-product firm. The reason is the cannibalization effect that the firm wants to reduce. In case of quantity competition, firm i maximizes its operating profit $\pi_i^C(\cdot) = \sum_{i \in \mathcal{V}_i} (p_i(\cdot) - \tau_i c_i) q_i$ w.r.t. q_i, leading to the first-order conditions

$$\forall i \in \mathcal{V}_i : p_i(\cdot) - \tau_i c_i + \sum_{\theta \in \mathcal{V}_i} \frac{\partial p_\theta}{\partial q_i}(\cdot) q_\theta = 0.$$

Again, the first-order condition can be rewritten in terms of markups as in the main text, except that

$$\widetilde{\epsilon}_i^C = \frac{\sigma}{1 + (\sigma - 1) \sum_{\theta \in \mathcal{V}_i} s_\theta} \tag{A.23}$$

replaces the elasticity.

A.8 Description of the solution of the model for the counterfactual simulations

In the following, we describe the solution method used for the counterfactual simulations presented in Section 4 of the main text. After estimating our gravity given by eq. (15) using aggregate trade flows from WIOD, including domestic trade, we calculate model-consistent scaled trade costs as $\tau_{ijt}^{1-\sigma} = \exp(\mathbf{x}'_{ijt}\boldsymbol{\beta})$ for the last year 2014 in our data set and solve for τ_{ijt} using $\sigma = 5.03$ as recommended by Head and Mayer (2014).[44] We can then use eqs. (3) and (5) to solve for the matrix of markups μ_{ijt} consistent with the calculated trade costs for the case of Bertrand and Cournot competition, respectively. Note that for our counterfactual simulations, we use the markup eqs. (3) and (5) to allow for country-specific unit costs c_j which we proxy by GDP per worker. For monopolistic competition, all markups in all markets are given by $\sigma/(\sigma-1)$. With the model-consistent trade cost and markup matrices, we can then calculate model-consistent $t_{ijt} = \mu_{ijt}\tau_{ijt}$ and solve the system of (scaled) multilateral resistance terms in eq. (12).

For given trade costs and markups, i.e., for given values of t_{ijt}, the system of multilateral resistance terms in eq. (12) is identical to the system of equations in Anderson and van Wincoop (2003), and hence their discussion concerning existence and uniqueness of the equilibrium applies in our setting. Particularly, the solution to the system of equations in (12) is only defined up to scale; for a lucid discussion, see Anderson and Yotov (2010). We follow the suggestion by Yotov et al. (2016), p. 72, and normalize by the value of the inward multilateral resistance term P_j for a country which should hardly be affected by our counterfactual exercise. We choose South Korea for our normalization.[45]

For the counterfactual, we change the exogenous trade cost matrix τ_{ijt}, solve for the endogenous markups in the counterfactual scenario, again using eqs. (3) and (5), and then solve for the corresponding counterfactual multilateral resistance terms using eq. (12). We

[44] We set $\tau_{ii} = 1, \forall i$, and $\tau_{ij} = 1$ if our estimated trade cost is below unity. The functional form used in the literature, $\tau_{ijt}^{1-\sigma} = \exp(\mathbf{x}'_{ijt}\boldsymbol{\beta})$, does not enforce fitted trade costs to be larger than 1. This happens only for 49 country pairs (2.7 percent of all country pairs), mostly neighboring countries in Europe (e.g., Austria, Belgium, Germany) where international trade costs may be particularly low as the geographical distance between two countries is smaller than the average distance within a large country like Germany or France. This is then picked up by the bilateral fixed effect ξ_{ij}.

[45] For numerical stability, we follow Anderson (2011) and actually solve eq. (12) for $\mathbb{P}_j \equiv Y_j/Y^W P_j^{\sigma-1}$ and $\mathbb{Q}_i \equiv E_i/Y^W P_i^{\sigma-1}$. For an explicit depiction of eq. (12) in this form, see Appendix B in Heid and Larch (2016).

use observed sales and expenditure in our trade data to calculate E_j/Y^W and Y_i/Y^W.We then calculate welfare changes in country j as $\%\Delta W_j = (P_j^0/P_j^1 - 1) \times 100$ where we use the superscript 1 to denote the counterfactual and 0 the baseline scenario. Hence our welfare changes are equivalent to what Head and Mayer (2014) call the Modular Trade Impact.

A.9 Additional results on the European Single Market counterfactual

A.9.1 Using GDP per worker as cost proxy

In our results presented in Section 4 of the main body of the text, we use GDP per worker to proxy unit production cost c_j. In this section, we present counterfactual results which use GDP per capita as our production cost measure. GDPs in current U.S.-$ (PPP) and population data are from the Penn World Tables 9.0, see Feenstra et al. (2015), as provided in Gurevich and Herman (2018). In Table A.1, we present results from abolishing the European Single Market for the different competition forms using the respective estimated trade costs. In Table A.2, we use the estimated trade costs from monopolistic competition for all three competition modes. Results remain similar.

Table A.1: Welfare and markup changes of removing the European Single Market (in %)

Country	$\%\Delta W_j$			$\%\Delta \mu_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.6	1.1	0.0	0.0
Austria	-5.3	-7.7	-10.3	0.2	3.2
Belgium	-4.4	-7.3	-10.0	0.3	2.6
Bulgaria	-4.0	-7.0	-9.0	6.7	13.6
Brazil	0.0	0.4	2.8	-0.0	0.0
Canada	0.2	0.9	2.7	0.0	0.0
Switzerland	1.3	2.3	3.6	0.0	0.0
China	-0.2	-0.6	-0.9	0.0	0.0
Cyprus	-5.0	-8.1	-8.7	2.1	6.7
Czech Republic	-4.4	-6.9	-8.8	1.2	6.9
Germany	-1.3	-1.0	0.1	0.1	2.1
Denmark	-4.4	-7.1	-9.9	0.4	4.0
Spain	-1.9	-2.3	-4.3	2.0	10.3
Estonia	-4.6	-7.4	-10.0	0.9	5.3
Finland	-3.2	-4.5	-5.4	0.9	7.5
France	-2.9	-3.3	-3.3	0.6	4.8
United Kingdom	-2.0	-2.4	-3.0	0.4	3.7
Greece	-2.7	-4.5	-6.9	2.8	10.6
Croatia	-4.7	-7.4	-8.7	3.3	8.8
Hungary	-4.4	-6.6	-8.4	1.6	6.5
Indonesia	-0.1	0.0	0.1	0.0	0.0
India	-0.1	0.1	1.0	0.0	0.0
Ireland	-3.4	-4.3	-6.2	0.2	1.8
Italy	-1.6	-1.0	-1.2	1.2	9.3
Japan	-0.0	0.0	0.3	-0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-3.8	-6.4	-8.8	1.0	5.4
Luxembourg	-5.3	-8.5	-11.1	0.2	1.4
Latvia	-3.9	-6.4	-8.7	1.4	5.7
Mexico	0.1	0.8	2.4	0.0	0.0
Malta	-5.4	-8.4	-9.4	2.9	8.5
Netherlands	-3.6	-5.2	-7.2	0.1	0.8
Norway	-4.1	-5.5	-4.2	0.1	2.7
Poland	-2.9	-4.6	-6.4	3.0	11.0
Portugal	-4.2	-6.7	-8.4	4.6	12.2
Romania	-2.8	-4.5	-6.5	4.5	12.5
Russia	0.2	0.6	3.4	0.0	0.0
Slovakia	-3.2	-5.0	-6.3	1.3	5.7
Slovenia	-5.3	-6.8	-7.6	0.9	6.0
Sweden	-4.2	-6.2	-7.7	0.4	4.5
Turkey	0.3	0.7	2.8	-0.0	0.0
Taiwan	0.1	0.2	0.7	0.0	0.0
United States	0.1	0.7	2.5	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table 1: Monopolistic competition uses parameters from column (7), Bertrand competition from column (8), and Cournot from column (9).

Table A.2: Welfare and markup changes of removing the European Single Market (in %) using the same monopolistic competition trade costs

Country	$\%\Delta \mathbf{W}_j$			$\%\Delta \boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.3	0.2	0.0	-0.0
Austria	-5.3	-5.3	-5.3	0.1	0.6
Belgium	-4.4	-4.2	-4.2	0.1	0.5
Bulgaria	-4.0	-4.4	-4.3	3.2	4.3
Brazil	0.0	0.0	0.1	0.0	0.0
Canada	0.2	0.1	0.1	-0.0	0.0
Switzerland	1.3	1.2	1.0	0.0	0.0
China	-0.2	-0.1	-0.1	-0.0	0.0
Cyprus	-5.0	-4.8	-4.6	1.0	2.6
Czech Republic	-4.4	-4.4	-4.5	0.6	2.0
Germany	-1.3	-1.4	-1.8	0.0	0.2
Denmark	-4.4	-4.4	-4.5	0.2	0.8
Spain	-1.9	-2.0	-2.6	0.4	1.6
Estonia	-4.6	-4.4	-4.1	0.4	1.7
Finland	-3.2	-3.3	-3.6	0.3	1.5
France	-2.9	-3.0	-3.3	0.1	0.8
United Kingdom	-2.0	-2.2	-2.4	0.1	0.6
Greece	-2.7	-2.9	-3.4	0.9	2.5
Croatia	-4.7	-4.9	-4.9	1.8	3.3
Hungary	-4.4	-4.3	-4.1	0.9	2.4
Indonesia	-0.1	-0.0	0.0	0.0	0.0
India	-0.1	0.2	0.2	0.0	0.0
Ireland	-3.4	-3.4	-3.5	0.1	0.4
Italy	-1.6	-1.8	-2.4	0.2	1.2
Japan	-0.0	-0.1	-0.1	-0.0	-0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-3.8	-3.7	-3.7	0.5	1.9
Luxembourg	-5.3	-5.3	-5.2	0.1	0.4
Latvia	-3.9	-3.9	-3.9	0.7	2.2
Mexico	0.1	0.1	0.0	0.0	-0.0
Malta	-5.4	-5.1	-5.0	0.9	2.6
Netherlands	-3.6	-3.5	-3.5	0.0	0.2
Norway	-4.1	-4.0	-3.9	0.0	0.2
Poland	-2.9	-3.3	-3.9	1.3	3.0
Portugal	-4.2	-4.5	-4.9	1.3	3.0
Romania	-2.8	-3.5	-4.1	2.2	3.9
Russia	0.2	0.2	0.2	0.0	0.0
Slovakia	-3.2	-3.4	-3.7	0.7	2.2
Slovenia	-5.3	-5.2	-5.0	0.4	1.8
Sweden	-4.2	-4.2	-4.3	0.2	0.9
Turkey	0.3	0.3	0.4	-0.0	0.0
Taiwan	0.1	0.0	0.0	0.0	0.0
United States	0.1	0.0	-0.0	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table 1, column (7), i.e., we use the same trade costs consistent with conventional structural gravity models for all competition modes.

A.9.2 Including Switzerland and Turkey in the European Single Market Dummy

In our results presented in Section 4 of the main body of the text, Switzerland is not considered to be part of the European Single Market as it only implements part of the four freedoms of the EU within bilateral agreements with the EU. Table A.3 presents regression results when including Switzerland in the EU_{ijt} dummy, and Tables A.4 and A.5 show results of abolishing the European Single Market when Switzerland is considered part of the single market.

Finally, Turkey has a customs union with the EU but does not otherwise participate in the European Single Market. Table A.6 presents regression results when, in addition to Switzerland, we include also Turkey in the EU_{ijt} dummy, and Tables A.7 and A.8 show results of abolishing the European Single Market when considering both Switzerland and Turkey part of the single market. Now, as expected, Switzerland (and Turkey) lose from abolishing the European Single Market. Results for other countries remain similar.

Table A.3: Trade cost parameter estimates, including Switzerland in EU_{ijt}

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			PPML					
	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot
EU_{ijt}	0.177**	0.203**	0.258***	0.426***	0.650***	1.040***	0.331***	0.401***	0.631***
	(0.064)	(0.065)	(0.066)	(0.054)	(0.073)	(0.123)	(0.069)	(0.089)	(0.143)
RTA_{ijt}	0.121**	0.137**	0.160**	0.136***	0.352***	0.515***	0.065*	0.200**	0.228*
	(0.044)	(0.044)	(0.046)	(0.041)	(0.033)	(0.041)	(0.029)	(0.069)	(0.094)
$INTER_{ijt}$	NO	NO	NO	NO	NO	NO	YES	YES	YES
N	27735	27735	27735	27735	27735	27735	27735	27735	27735

Notes: † MC: Monopolistic competition. Table reports regression coefficients of estimating the adjusted gravity equation from eq. (15) by PPML using `ppmlhdfe`. All regressions include exporter×year, importer×year and directional bilateral fixed effects. Standard errors are robust to multiway clustering across exporters and importers. For comparison, we present standard gravity estimates in columns (1), (4), and (7). Columns (2), (5) and (8) use μ_{ijt}^{B} from eq. (18) and columns (3), (6) and (9) use μ_{ijt}^{C}.

Table A.4: Welfare and markup changes of removing the European Single Market (in %), including Switzerland in EU_{ijt}

Country	$\%\Delta\mathbf{W}_j$			$\%\Delta\boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.6	1.2	-0.0	0.0
Austria	-5.5	-8.0	-10.6	0.3	3.8
Belgium	-4.4	-7.4	-10.3	0.2	1.9
Bulgaria	-4.1	-7.2	-9.2	6.6	13.5
Brazil	0.0	0.4	3.0	0.0	0.0
Canada	0.2	1.0	2.8	0.0	0.0
Switzerland	-4.2	-5.5	-5.8	0.7	5.8
China	-0.2	-0.6	-1.0	0.0	0.0
Cyprus	-5.1	-8.5	-9.5	4.7	9.5
Czech Republic	-4.5	-7.1	-9.0	1.4	7.1
Germany	-1.5	-1.3	-0.4	0.2	2.6
Denmark	-4.5	-7.2	-10.1	0.5	4.4
Spain	-2.0	-2.5	-4.7	2.3	10.6
Estonia	-4.6	-7.5	-10.1	0.9	5.3
Finland	-3.3	-4.6	-5.4	0.8	7.3
France	-3.0	-3.5	-3.4	0.5	4.2
United Kingdom	-2.1	-2.6	-3.3	0.5	4.1
Greece	-2.9	-4.5	-7.2	2.1	9.7
Croatia	-4.8	-7.4	-8.6	2.9	8.5
Hungary	-4.4	-6.7	-8.5	1.3	5.9
Indonesia	-0.1	0.0	0.1	-0.0	-0.0
India	-0.1	0.1	1.2	0.0	0.0
Ireland	-3.5	-4.5	-6.4	0.2	1.7
Italy	-1.7	-0.9	0.1	0.8	8.0
Japan	-0.0	0.0	0.2	0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-3.8	-6.4	-8.9	0.9	5.3
Luxembourg	-5.4	-8.6	-11.1	0.2	1.4
Latvia	-4.1	-6.7	-9.1	1.2	5.6
Mexico	0.1	0.8	2.5	0.0	0.0
Malta	-5.5	-8.7	-9.6	2.9	8.3
Netherlands	-3.7	-5.3	-7.3	0.1	1.0
Norway	-4.0	-5.5	-4.3	0.2	3.1
Poland	-2.9	-4.6	-6.3	2.8	10.7
Portugal	-4.3	-7.0	-8.8	5.1	12.5
Romania	-2.9	-4.7	-6.7	4.4	12.4
Russia	0.2	0.6	3.3	0.0	0.0
Slovakia	-3.3	-5.1	-6.4	1.4	5.9
Slovenia	-5.4	-6.9	-7.8	1.1	6.3
Sweden	-4.2	-6.4	-8.0	0.5	5.1
Turkey	0.3	0.7	3.1	0.0	0.0
Taiwan	0.1	0.2	0.6	0.0	0.0
United States	0.1	0.7	2.6	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table A.3: Monopolistic competition uses parameters from column (7), Bertrand competition from column (8), and Cournot from column (9).

Table A.5: Welfare and markup changes of removing the European Single Market (in %), including Switzerland in EU_{ijt} using the same monopolistic competition trade costs

Country	$\%\Delta\mathbf{W}_j$			$\%\Delta\boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.3	0.3	0.2	0.0	0.0
Austria	-5.5	-5.5	-5.4	0.2	0.9
Belgium	-4.4	-4.2	-4.2	0.1	0.4
Bulgaria	-4.1	-4.5	-4.4	3.5	4.6
Brazil	0.0	0.0	0.1	-0.0	0.0
Canada	0.2	0.1	0.1	0.0	0.0
Switzerland	-4.2	-4.3	-4.5	0.2	1.0
China	-0.2	-0.1	-0.1	-0.0	0.0
Cyprus	-5.1	-4.9	-4.6	2.6	4.0
Czech Republic	-4.5	-4.5	-4.5	0.7	2.3
Germany	-1.5	-1.6	-2.0	0.1	0.3
Denmark	-4.5	-4.4	-4.5	0.2	1.0
Spain	-2.0	-2.1	-2.8	0.6	1.9
Estonia	-4.6	-4.4	-4.1	0.5	1.9
Finland	-3.3	-3.4	-3.6	0.4	1.6
France	-3.0	-3.0	-3.3	0.2	0.8
United Kingdom	-2.1	-2.2	-2.5	0.2	0.8
Greece	-2.9	-2.9	-3.4	0.9	2.5
Croatia	-4.8	-4.9	-4.9	1.7	3.3
Hungary	-4.4	-4.2	-4.1	0.8	2.3
Indonesia	-0.1	-0.0	-0.0	0.0	0.0
India	-0.1	0.1	0.1	-0.0	-0.0
Ireland	-3.5	-3.4	-3.6	0.1	0.5
Italy	-1.7	-1.9	-2.4	0.2	0.9
Japan	-0.0	-0.1	-0.1	0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-3.8	-3.7	-3.8	0.5	1.9
Luxembourg	-5.4	-5.3	-5.3	0.1	0.4
Latvia	-4.1	-4.0	-4.0	0.7	2.3
Mexico	0.1	0.1	0.0	0.0	0.0
Malta	-5.5	-5.1	-4.9	1.2	3.0
Netherlands	-3.7	-3.4	-3.5	0.0	0.3
Norway	-4.0	-3.9	-3.9	0.1	0.3
Poland	-2.9	-3.3	-3.9	1.3	3.1
Portugal	-4.3	-4.7	-5.0	1.9	3.4
Romania	-2.9	-3.5	-4.1	2.4	4.2
Russia	0.2	0.1	0.1	0.0	0.0
Slovakia	-3.3	-3.4	-3.8	0.9	2.4
Slovenia	-5.4	-5.2	-5.0	0.6	2.1
Sweden	-4.2	-4.2	-4.4	0.2	1.1
Turkey	0.3	0.2	0.2	-0.0	0.0
Taiwan	0.1	0.1	0.0	0.0	0.0
United States	0.1	-0.0	-0.1	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table A.3, column (7), i.e., we use the same trade costs consistent with conventional structural gravity models for all competition modes.

Table A.6: Trade cost parameter estimates, including Switzerland and Turkey in EU_{ijt}

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			PPML					
	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot	MC†	Bertrand	Cournot
EU_{ijt}	0.169**	0.199**	0.258***	0.433***	0.675***	1.081***	0.338***	0.425***	0.667***
	(0.061)	(0.063)	(0.065)	(0.055)	(0.073)	(0.122)	(0.069)	(0.089)	(0.143)
RTA_{ijt}	0.120*	0.135**	0.159**	0.135**	0.352***	0.514***	0.065*	0.200**	0.229*
	(0.045)	(0.044)	(0.046)	(0.041)	(0.033)	(0.042)	(0.029)	(0.069)	(0.094)
$INTER_{ijt}$	NO	NO	NO	NO	NO	NO	YES	YES	YES
N	27735	27735	27735	27735	27735	27735	27735	27735	27735

Notes: † MC: Monopolistic competition. Table reports regression coefficients of estimating the adjusted gravity equation from eq. (15) by PPML using `ppmlhdfe`. All regressions include exporter×year, importer×year and directional bilateral fixed effects. Standard errors are robust to multiway clustering across exporters and importers. For comparison, we present standard gravity estimates in columns (1), (4), and (7). Columns (2), (5) and (8) use μ^B_{ijt} from eq. (18) and columns (3), (6) and (9) use μ^C_{ijt}.

Table A.7: Welfare and markup changes of removing the European Single Market (in %), including Switzerland and Turkey in EU_{ijt}

Country	$\%\Delta \mathbf{W}_j$			$\%\Delta \boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.4	0.7	1.3	0.0	0.0
Austria	-5.6	-8.3	-10.8	0.3	3.9
Belgium	-4.6	-7.7	-10.6	0.2	1.9
Bulgaria	-4.5	-7.9	-9.7	6.9	14.1
Brazil	0.0	0.5	3.3	0.0	-0.0
Canada	0.2	1.1	3.1	0.0	0.0
Switzerland	-4.2	-5.6	-5.9	0.7	6.0
China	-0.2	-0.6	-1.1	-0.0	-0.0
Cyprus	-5.6	-9.2	-10.0	4.9	9.8
Czech Republic	-4.6	-7.3	-9.2	1.4	7.4
Germany	-1.6	-1.4	-0.3	0.2	2.8
Denmark	-4.6	-7.5	-10.3	0.5	4.5
Spain	-2.0	-2.6	-4.7	2.4	11.1
Estonia	-4.8	-7.7	-10.4	1.0	5.6
Finland	-3.4	-4.7	-5.4	0.9	7.7
France	-3.1	-3.6	-3.3	0.5	4.4
United Kingdom	-2.3	-2.8	-3.3	0.5	4.3
Greece	-2.7	-4.3	-7.1	2.2	10.1
Croatia	-5.0	-7.7	-8.8	3.0	8.8
Hungary	-4.5	-6.9	-8.6	1.4	6.2
Indonesia	-0.1	0.1	0.1	-0.0	-0.0
India	-0.1	0.1	1.3	-0.0	0.0
Ireland	-3.6	-4.7	-6.6	0.2	1.8
Italy	-1.8	-0.8	0.5	0.8	8.3
Japan	-0.0	0.0	0.3	0.0	0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-4.0	-6.7	-9.1	1.0	5.5
Luxembourg	-5.5	-8.8	-11.4	0.2	1.5
Latvia	-4.2	-7.0	-9.3	1.3	5.8
Mexico	0.2	0.9	2.8	0.0	0.0
Malta	-5.9	-9.3	-10.0	3.0	8.7
Netherlands	-3.8	-5.5	-7.4	0.1	1.1
Norway	-4.0	-5.6	-4.3	0.2	3.3
Poland	-3.0	-4.7	-6.4	2.9	11.2
Portugal	-4.4	-7.3	-9.0	5.3	13.0
Romania	-3.1	-4.8	-6.8	4.6	12.9
Russia	0.2	0.7	3.6	0.0	0.0
Slovakia	-3.3	-5.2	-6.5	1.5	6.2
Slovenia	-5.6	-7.2	-8.0	1.1	6.5
Sweden	-4.3	-6.6	-8.1	0.5	5.3
Turkey	-1.3	-2.8	-6.6	3.9	13.0
Taiwan	0.1	0.2	0.7	0.0	0.0
United States	0.1	0.8	2.8	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table A.6: Monopolistic competition uses parameters from column (7), Bertrand competition from column (8), and Cournot from column (9).

Table A.8: Welfare and markup changes of removing the European Single Market (in %), including Switzerland and Turkey in EU_{ijt} using the same monopolistic competition trade costs

Country	$\%\Delta\mathbf{W}_j$			$\%\Delta\boldsymbol{\mu}_{jj}$	
	Monop. Comp.	**Bertrand**	**Cournot**	**Bertrand**	**Cournot**
Australia	0.4	0.3	0.3	0.0	0.0
Austria	-5.6	-5.6	-5.6	0.2	0.9
Belgium	-4.6	-4.3	-4.3	0.1	0.5
Bulgaria	-4.5	-5.0	-4.9	3.6	4.8
Brazil	0.0	0.0	0.1	0.0	-0.0
Canada	0.2	0.1	0.1	0.0	0.0
Switzerland	-4.2	-4.3	-4.5	0.2	1.0
China	-0.2	-0.1	-0.1	0.0	0.0
Cyprus	-5.6	-5.4	-5.0	2.7	4.2
Czech Republic	-4.6	-4.6	-4.6	0.7	2.3
Germany	-1.6	-1.7	-2.1	0.1	0.3
Denmark	-4.6	-4.6	-4.6	0.2	1.1
Spain	-2.0	-2.2	-2.9	0.6	2.0
Estonia	-4.8	-4.5	-4.3	0.5	1.9
Finland	-3.4	-3.5	-3.8	0.4	1.6
France	-3.1	-3.1	-3.5	0.2	0.8
United Kingdom	-2.3	-2.3	-2.7	0.2	0.8
Greece	-2.7	-2.8	-3.5	0.9	2.6
Croatia	-5.0	-5.0	-5.1	1.7	3.4
Hungary	-4.5	-4.3	-4.2	0.8	2.3
Indonesia	-0.1	-0.0	-0.0	0.0	0.0
India	-0.1	0.1	0.1	-0.0	-0.0
Ireland	-3.6	-3.5	-3.7	0.1	0.5
Italy	-1.8	-1.9	-2.5	0.2	1.0
Japan	-0.0	-0.1	-0.1	-0.0	-0.0
Korea, South	0.0	0.0	0.0	0.0	0.0
Lithuania	-4.0	-3.9	-3.9	0.5	2.0
Luxembourg	-5.5	-5.4	-5.4	0.1	0.5
Latvia	-4.2	-4.2	-4.2	0.8	2.4
Mexico	0.2	0.1	0.0	0.0	0.0
Malta	-5.9	-5.5	-5.3	1.3	3.1
Netherlands	-3.8	-3.5	-3.6	0.0	0.3
Norway	-4.0	-3.9	-3.9	0.1	0.3
Poland	-3.0	-3.4	-4.0	1.4	3.2
Portugal	-4.4	-4.8	-5.1	1.9	3.6
Romania	-3.1	-3.8	-4.5	2.5	4.3
Russia	0.2	0.2	0.3	0.0	0.0
Slovakia	-3.3	-3.5	-3.9	0.9	2.4
Slovenia	-5.6	-5.4	-5.2	0.7	2.2
Sweden	-4.3	-4.4	-4.5	0.2	1.2
Turkey	-1.3	-1.6	-2.4	0.9	2.5
Taiwan	0.1	0.1	0.0	0.0	0.0
United States	0.1	-0.0	-0.1	0.0	0.0

Notes: Table reports welfare changes of removing the European Single Market in percent. Estimated trade cost parameters used are from Table A.6, column (7), i.e., we use the same trade costs consistent with conventional structural gravity models for all competition modes.

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