CESifo WORKING PAPERS

9423
2021

November 2021

International Trade with Heterogeneous Firms: Theory and Evidence

Alessandra Bonfiglioli, Rosario Crinò, Gino Gancia

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University’s Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp

An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 9423*

International Trade with Heterogeneous Firms: Theory and Evidence

Abstract

International trade is dominated by a small number of very large firms. Models of trade with heterogeneous firms have been developed to study the causes and consequences of this observation. The canonical model of trade with heterogeneous firms shows that trade leads to between-firm reallocations and selection: it shifts employment towards firms with the best attributes and forces marginal firms to exit. The model also illustrates the role of heterogeneity, and its various sources, in explaining the volume of trade and the firm-level margins of adjustment. Consistent with the model, the empirical literature has documented that exporting is a rare activity, that exporting firms are larger and more productive than other firms, and that trade liberalization reallocates market shares towards the best-performing firms in various countries. Studies using transaction-level data have unveiled additional salient features of trade flows. First, sales by foreign firms are very heterogeneous and highly concentrated. Second, both the extensive margin (number of exporting firms) and the intensive margin (average export per firm) are important in explaining the level of exports and its changes over time. More heterogeneity in sales across firms is associated with a higher volume of trade along both margins. Third, increased foreign competition reallocates market shares towards top firms and hence can increase concentration from any country of origin. Numerous extensions of the benchmark model have been proposed to study other important aspects, such as the relevance of multi-product and multinational firms, the import behavior of firms, and the extent to which heterogeneity is endogenous to firms. choices, but some open challenges still remain.

JEL-Codes: E230, F120, F140, L110, R120.

Keywords: firm heterogeneity, top firms, selection, reallocation, margins of trade.

Alessandra Bonfiglioli
Queen Mary University of London / UK
a.bonfiglioli@qmu.ac.uk

Rosario Crinò
University of Bergamo / Italy
rosario.crino@unibg.it

Gino Gancia
Queen Mary University of London / UK
g.gancia@qmul.ac.uk

November 2021
Draft prepared for the Oxford Research Encyclopedia of Economics and Finance (https://oxfordre.com/economics). We thank the editor and two anonymous external reviewers for helpful comments.

1 Firms and International Trade

International trade is dominated by few large corporations. Bernard et al. (2018) show that the top 1% of firms account for more than 80% of US trade. Freund and Pierola (2015) find that the top-5 firms control on average 30% of total exports in a sample of 32 mostly developing countries. Gaubert and Itskhoki (2021) report that the largest firm in France accounts for 7% of all French manufacturing exports and that, within narrowly defined industries, the top exporter accounts on average for 28% of exports. Despite these striking observations on the extreme concentration of trade flows, differences in size across firms have been introduced into trade models only in the early 2000s. This article reviews the state of the literature on this topic, its main theoretical insights and empirical findings.

Ever since the works of Ricardo (1817) and Heckscher and Ohlin (1933), traditional models have focused on inter-sectoral trade. Yet, when product-level data became available, it soon became apparent that most of trade involves two-way flows of similar products within industries (Grubel and Lloyd, 1975). During the 1980s, new models where developed to explain this phenomenon. Their hallmarks were imperfect competition, increasing returns and a novel attention on firms. The change in perspective was so radical to deserve the name of "new" trade theory. Yet, these models focused on homogenous firms, not because economists were unaware of the stark asymmetries that characterize any industrial sector, but because these were considered unimportant for the aggregate implications.

In the late 1990s, once firm-level data became available, a new set of stylized facts emerged. In any country and sector, researchers found that only a minority of firms engage in export activities, and those that do are systematically larger and more productive than other firms (Bernard and Jensen, 1995). Moreover, trade is associated with reallocations across firms: as exporters expand their sales in foreign markets, other firms must scale down their business. The reallocation of sales towards exporters was also found to be an important determinant of aggregate productivity (Bernard and Jensen, 1999). These stylized facts demonstrated that firm heterogeneity is central to the understanding of the causes and consequences of international trade, and motivated the effort to incorporate it into existing models.

This article provides a selective overview of the literature that followed. It starts by presenting the canonical model of trade with heterogeneous firms based on Melitz (2003). The key assumptions are that firms pay an entry cost to draw their attributes such as productivity randomly, and that there are fixed costs of selling into different markets. As a result, firms with different size coexist in equilibrium, and only the firms with better attributes find it profitable to pay the higher costs of entering foreign markets. The most distinctive result of this class of models is that trade leads to between-firm reallocations and selection: more export opportunities and tougher competition shift employment in favor of the firms with the best attributes and can force marginal firms to exit. The model also clarifies the role of heterogeneity, and its various sources, in explaining the volume of trade and the firm-level margins of adjustment.

The second section of the article surveys the empirical literature on international trade with heterogeneous firms. After reviewing the initial observations that started this line of research, the section uses transaction-level data on US imports to summarize some of the most recent empirical findings. First, it shows how heterogeneity in US sales by foreign firms varies across manufacturing industries, and quantifies the importance of top firms. Second, the section discusses firm-level decompositions measuring the importance of the extensive margin (number of exporting firms) and the intensive margin (average export per firm) in explaining the level and changes in the volume of US imports. To illustrate the role of firm heterogeneity, it then investigates the relationship between each margin and a measure of dispersion in sales. Finally, the section considers the evidence on how foreign competition reallocates market shares towards top firms and can thereby be followed by an increase in industry concentration.

The last section reviews some of the most important extensions of the benchmark theoretical framework and some open challenges. Among these, it discusses models of multi-product firms, in which selection operates also within firms, models of selection into importing, in which input trade affects productivity, models of multinational firms, in which heterogeneity in attributes maps into alternative modes of organization, and models in which the extent of heterogeneity is endogenous to firms' choices.

2 Trade with Heterogeneous Firms: Theory

This section describes the workhorse model of trade with heterogeneous firms. The model was first developed in Melitz (2003), but the exposition here is closer to the multi-sector and multi-country synthesis in Melitz and Redding (2014) and Bernard et al. (2018). It builds on the seminal model of trade with monopolistic competition in Krugman (1980). The key innovation is that, after paying an entry cost, firms draw their attributes, in this version quality and productivity, from some known distribution. This introduces asymmetries between firms. Moreover, to sell in each destination, firms must incur both a fixed cost and a variable trade cost. The section starts by studying the effect of trade on selection and the role of firms for explaining trade flows when markups are constant. It then revisits trade-driven reallocations in the presence of pro-competitive effects.

2.1 The Benchmark Model

In any destination d, preferences over consumption of goods produced in I industries are:

$$U_d = \sum_{i=1}^{I} \beta_i \ln C_{di}, \quad \beta_i > 0, \quad \sum_{i=1}^{I} \beta_i = 1. \tag{1}$$

This implies that expenditure allocated to each industry, E_{di}, is a constant fraction β_i of income. Each industry $i \in \{1, ..., I\}$ comprises differentiated varieties and consumers have Constant Elasticity of Substitution (CES) preferences over these varieties:

$$C_{di} = \left\{ \int_{\omega \in \Omega_{di}} \left[\gamma(\omega) c_d(\omega)\right]^{\frac{\sigma_i - 1}{\sigma_i}} d\omega \right\}^{\frac{\sigma_i}{\sigma_i - 1}}, \quad \sigma_i > 1, \tag{2}$$

where $c_d(\omega)$ is quantity consumed of variety ω, $\gamma(\omega)$ is a demand shifter, Ω_{di} denotes the set of varieties available for consumption in market d in industry i, and σ_i is the elasticity of substitution between these varieties. The demand shifter $\gamma(\omega)$ can be interpreted as "quality", in that it measures the value of a product for a given quantity consumed. It is assumed to be an intrinsic attribute of the variety, although it could also be destination specific.

Denote by $p_d(\omega)$ the price of variety ω in destination d and by P_{di} the minimum cost of one unit of the consumption basket C_{di}:

$$P_{di} = \left\{ \int_{\omega \in \Omega_{di}} \left[\frac{p_d(\omega)}{\gamma(\omega)}\right]^{1-\sigma_i} d\omega \right\}^{\frac{1}{1-\sigma_i}}. \tag{3}$$

The price index P_{di}, which is an inverse measure of competition in a market, is decreasing in the number of varieties and increasing in their price. Demand for variety ω is:

$$c_d(\omega) = p_d(\omega)^{-\sigma_i} \gamma(\omega)^{\sigma_i - 1} P_{di}^{\sigma_i - 1} E_{di}, \tag{4}$$

which is a negative function of the price, with elasticity σ_i, and a positive function of quality.

In the benchmark model, labor is the only factor of production and market structure is monopolistic competition. Specifically, each variety ω in any industry is produced by a single firm which, being infinitesimal, takes the cost of labor and price indexes as given.[1] Varieties, i.e. firms, can be created after paying a fixed cost and entry continues as long as it is profitable. Upon entry, each firm randomly draws labor productivity, φ, and quality, γ, from a known distribution. As a result, in equilibrium firms with different attributes coexist.

[1] This assumption is relaxed in a later section where the number of firms is discrete.

The problem of the firm is solved backward: the behavior of existing firms is studied first, and the entry decision next. Since all firms with the same attributes (φ, γ) behave similarly, firms can be indexed by the pair (φ, γ). Given demand (4), the profit-maximizing price of a firm with attributes (φ, γ) serving market d from country o is:

$$p_{doi}(\varphi, \gamma) = \frac{\sigma_i}{\sigma_i - 1} \frac{\tau_{doi} w_o}{\varphi}, \tag{5}$$

where w_o is the wage in country o, $\tau_{doi} \geq 1$ is the variable (iceberg) cost of shipping from o to d in industry i and $\sigma_i/(\sigma_i - 1)$ is the markup over the marginal cost charged by the firm. There is no variable trade cost when selling to the domestic market, i.e., $\tau_{ooi} = 1$.

Equations (4) and (5) imply that revenue in market d is an increasing function of a synthetic measure of overall "appeal" of the firm, $\phi \equiv \varphi\gamma$:

$$r_{doi}(\phi) = E_{di} \left(P_{di} \frac{\sigma_i - 1}{\sigma_i} \frac{\phi}{\tau_{doi} w_o} \right)^{\sigma_i - 1}. \tag{6}$$

In order to sell to destination d, firms must pay a fixed cost of f_{doi} units of labor. This assumption recognizes the existence of costs related to the acquisition of information about demand, marketing, distribution and compliance with regulations, that do not depend on the volume of sales.[2] Without these costs, firms would sell to all destinations, irrespective of their attributes. In their presence, instead, firms choose to serve a market only if the revenue from it is sufficiently high to justify paying the fixed cost.

Given that prices are a constant markup over the marginal cost, profits earned in market d are a fraction σ_i of revenue minus the fixed cost $w_o f_{doi}$:

$$\pi_{doi}(\phi) = \frac{r_{doi}(\phi)}{\sigma_i} - w_o f_{doi}. \tag{7}$$

Since $r_{doi}(\phi)$ is an increasing function, a firm finds it profitable to serve market d (i.e., $\pi_{doi}(\phi) > 0$) if and only if ϕ is sufficiently high. Hence, it is possible to define ϕ^*_{doi} and r^*_{doi} as the minimum ϕ and the minimum revenue, respectively, such that a firm breaks even in market d:

$$\pi_{doi}(\phi^*_{doi}) = 0 \Longleftrightarrow r^*_{doi} = \sigma_i w_o f_{doi}. \tag{8}$$

In order to make sure that exporters are always a subset of the firms that operate locally, the costs of exporting, τ_{doi} and f_{doi}, are assumed to be sufficiently high to guarantee $\phi^*_{ooi} < \phi^*_{doi}$. In words, the domestic market is always more profitable than any other foreign market.

[2] Arkolakis (2010) provides a generalization of the model in which the cost of accessing a market depends on the number of customers that the firm wants to serve.

Firm attributes are determined at the entry stage. Upon paying an entry cost of F_{oi} units of labor, firms draw attributes from a known distribution. Although attributes are two-dimensional (φ, γ), the equilibrium allocation only depends on their product, ϕ, which was denoted as "appeal". Hence, it suffices to consider the distribution $G_{oi}(\phi)$ from which ϕ is drawn. After observing ϕ, the firm decides in which markets, if any, to sell. If $\phi < \phi^*_{ooi}$, the firm would make negative profits even in the domestic market and hence it exits immediately. For this reason, ϕ^*_{ooi} is called the exit cutoff. Similarly, the minimum appeal needed to make positive profits in a destination, ϕ^*_{doi}, is called the export cutoff for market $d \neq o$. Firms with better attributes (higher ϕ) can sell larger quantities and hence find it profitable to enter markets with higher fixed costs. As a result, they serve more destinations.

Entry decisions are made before knowing the realization of ϕ and hence depend on expected profits. In particular, expected profits from selling to market d are:

$$\mathbb{E}[\pi_{doi}] = \int_{\phi^*_{doi}}^{\infty} \pi_{doi}(\phi)\, \mathrm{d}G_{oi}(\phi). \tag{9}$$

For future reference, it is important to note that, other things equal, $\mathbb{E}[\pi_{doi}]$ is a negative function of the cutoff ϕ^*_{doi}. Intuitively, expected profits are lower from markets that are harder to reach, because firms have a lower probability to be able to serve them. Free entry implies that entry continues until the cost of creating a new firm, $w_o F_{oi}$, is equal to its expected value:

$$w_o F_{oi} = \mathbb{E}[\pi_{ooi}] + \sum_{d \neq o} \mathbb{E}[\pi_{doi}], \tag{10}$$

where the two terms on the right-hand side separate expected profits from domestic and foreign sales.

Combining the break-even condition for the marginal firm, $r(\phi^*_{ooi}) = \sigma_i w_o f_{ooi}$, with (6) and substituting expenditure $E_{oi} = \beta_i w_o L_o$, it is possible to solve for the price index:

$$P_{oi} = \frac{\sigma_i}{\sigma_i - 1} \left(\frac{\sigma_i f_{ooi}}{\beta_i L_o} \right)^{\frac{1}{\sigma_i - 1}} \frac{w_o}{\phi^*_{ooi}}, \tag{11}$$

where L_o is labor supply in country o. Equation (11) shows that a higher exit cutoff, i.e., more selection, implies lower prices. Solving (11) for w_o/P_{oi} also shows that the effect of the distribution of firm attributes on real wages is entirely summarized by its effect on the exit cutoffs. Notice that the wage w_o does not depend on the industry equilibrium. It may be pinned down by a sector producing a homogeneous good that is freely traded. Or it may be determined in general equilibrium by the equality between income and world expenditure on all the goods produced by the country.

2.2 Trade and Selection

Equation (6) can be used to express revenues as a function of the minimum level (r^*_{doi}) needed to serve the market and ϕ:

$$r_{doi}(\phi) = r^*_{doi}\left[\frac{\phi}{\phi^*_{doi}}\right]^{\sigma_i - 1}. \tag{12}$$

Using (12), (7) and (8) into the free-entry condition (10) yields:

$$F_{oi} = f_{doi}\sum_d \int_{\phi^*_{doi}}^{\infty}\left[\left(\frac{\phi}{\phi^*_{doi}}\right)^{\sigma_i - 1} - 1\right]\mathrm{d}G_{oi}(\phi). \tag{13}$$

Each element on the right-hand side is a negative function of the cutoff ϕ^*_{doi} only. This implies that if the export cutoffs fall, for instance due to trade liberalization, the exit cutoff, ϕ^*_{ooi}, must rise so as to satisfy the free-entry condition. This is the selection effect of trade: export opportunities force the least productive firms to exit. The intuition for this important result is that higher export profits induce more entry and hence tougher selection on the domestic market. Crucial for this result is the fact that the least productive firms serve the domestic market only, implying that their loss in domestic revenue due to more entry is not compensated by any gain in foreign markets.

In turn, expected profits from exporting depend solely on the cutoffs ϕ^*_{doi}, which can be obtained from (6) and (11):

$$\phi^*_{doi} = \tau_{doi}\left(\frac{f_{doi}}{f_{ddi}}\right)^{1/(\sigma_i - 1)}\left(\frac{w_o}{w_d}\right)^{\sigma_i/(\sigma_i - 1)}\phi^*_{ddi}. \tag{14}$$

The export cutoff is a positive function of the export costs, τ_{doi} and f_{doi}, and of competition in the destination market, as summarized by the exit cutoff of domestic firms in that market, ϕ^*_{ddi}. It is also a negative function of the competitiveness of origin o, as summarized by the wage relative to local firms in the destination, w_o/w_d. Given wages, equations (13) and (14) form an autonomous system that can be solved for all the cutoffs ϕ^*_{doi}.

The selection effect of trade raises welfare. As implied by equation (11), the real wage, expressed in terms of the price index of any sector i, is an increasing function of the exit cutoff in the sector. Hence, welfare increases with more selection, despite the loss of small domestic firms. Intuitively, trade liberalization lowers prices, which is good for consumers even if it forces some marginal firms out of business. The strength of the selection effect can vary across sectors and countries. It is stronger in sectors with better export opportunities, such as lower export costs, and in countries with lower wages.[3]

[3] By the same logic, adding differences in factor intensity across sectors and in factor abundance across

2.3 Firm Heterogeneity and the Volume of Trade

Firms characteristics have implications for the volume of trade. To see this, note that exports from origin o to destination d can be decomposed into an extensive margin N_{doi}, equal to the mass of exporters, and an intensive margin r_{doi}, equal to average export per firm:

$$X_{doi} = N_{doi} \cdot r_{doi}. \tag{15}$$

The extensive margin is given by the mass of active firms in o, N_{oi}, times the probability to export:

$$N_{doi} = N_{oi} \left[1 - G_{oi} \left(\phi^*_{doi}\right)\right]. \tag{16}$$

Using (12), (8) and (14), the intensive margin can be expressed as:

$$r_{doi} = \frac{(w_o \tau_{doi})^{1-\sigma_i}}{\Gamma_{di}} \int_{\phi^*_{doi}}^{\infty} \phi^{\sigma_i - 1} \frac{\mathrm{d}G_{oi}(\phi)}{1 - G_{oi}\left(\phi^*_{doi}\right)}, \tag{17}$$

where $\Gamma_{di} = (\phi^*_{ddi})^{\sigma_i - 1}/(\sigma_i w_d^{\sigma_i} f_{ddi})$ summarizes the toughness of competition in destination d.

Firm heterogeneity matters both for how the two margins react to variable trade costs and for the overall volume of exports. With homogeneous firms, as in Krugman (1980), the extensive margin is muted: all firms (or none of them) export, and any decline in variable trade costs increases average export per firm only. In the heterogeneous-firms model, a decline in variable trade costs induces more firms to export. However, the reaction of the extensive margin weakens the intensive margin: while existing exporters sell more, new exporters are less productive and hence export smaller quantities. This second effect tends to lower average export per firm. Which effect dominates depends on the distribution $G_{oi}(\phi)$. For instance, if $G_{oi}(\phi)$ is Pareto, the two effects exactly offset each other (Chaney, 2008). If it is Log-Normal, the first effect dominates, so that export per firm increases (Bas, Mayer and Thoenig, 2017, Fernandes et al., 2018).

The extent of heterogeneity is also a direct determinant of the volume of trade. More dispersion in the distribution $G_{oi}(\phi)$ shifts probability in the tails and this can increase the fraction of firms that are sufficiently productive to export. If this is the case, more heterogeneity will increase the extensive margin of trade. But heterogeneity can also increase the intensive margin of trade. To see this, note from equation (17) that export per firm is a convex function of ϕ when $\sigma_i > 2$. In this empirically plausible case, Jensen's inequality implies that r_{doi} increases with dispersion. The intuition for this result is that, if varieties are

countries, Bernard, Redding and Schott (2007) also show that selection is stronger in comparative advantage sectors.

sufficiently substitutable, consumers reallocate demand from less to more desirable varieties more than proportionally. In this case, more heterogeneity is also associated with a higher value of entry, more selection and higher welfare (see Bonfiglioli, Crinò and Gancia, 2020, and Epifani and Gancia, 2011).

2.4 Trade, Market Size and Pro-competitive Effects

In the benchmark model, market size does not affect selection. Moreover, neither market size nor international trade affect markups. This is because demand is CES and firms are infinitesimal. In reality, however, the number of firms is discrete and top firms have non-negligible market shares. In this case, markups become endogenous and depend on trade as shown, among others, by Atkeson and Burstein (2008), Eaton, Kortum and Sotelo (2013), Amiti, Itskhoki and Konings (2014, 2019), Edmond, Midrigan and Xu (2015) and Gaubert and Itskhoki (2021).[4]

Following this approach, this section considers a version of the model in which the number of firms is discrete. Firms play a Bertrand-Nash game whereby the price of a variety ω sold in destination d, $p_d(\omega)$, is chosen so as to maximize profits in the destination market, taking as given the prices of all competitors.[5] In equilibrium, the markup is an inverse function of the perceived demand elasticity, $\epsilon_d(\omega)$:

$$p_d(\omega) = \frac{\epsilon_d(\omega)}{\epsilon_d(\omega) - 1} \frac{\tau_d(\omega) w(\omega)}{\varphi(\omega)}. \tag{18}$$

The novelty is that, since firms are large, the perceived demand elasticity depends on the market share $s_d(\omega)$ captured by the variety:

$$\epsilon_d(\omega) = [1 - s_d(\omega)]\, \sigma_i + s_d(\omega), \tag{19}$$

where:

$$s_d(\omega) = \frac{[\gamma(\omega)/p_d(\omega)]^{\sigma_i - 1}}{\sum_{\omega \in \Omega_i} [\gamma(\omega)/p_d(\omega)]^{\sigma_i - 1}}. \tag{20}$$

Given the set of varieties in industry i, conditions (18)-(19)-(20) form a system of equations with a unique solution. In a sequential entry game where firms with better attributes enter destination markets first, there exists a unique cutoff ϕ^*_{doi} such that all firms from origin o with $\phi > \phi^*_{doi}$ sell to country d.

[4] An alternative way to make markups endogenous is to consider non-CES demand, as in Melitz and Ottaviano (2008), Mrazova and Neary (2017) or Arkolakis et al. (2019).

[5] Since ω already identifies the industry and origin of a variety, the indexes i and o can be omitted. However, the price of the same variety may differ across destination markets.

Firms with better attributes, i.e., a higher ϕ, capture larger market shares, charge higher markups, and make more profits. Moreover, the elasticity of the markup with respect to the market share is an increasing function of the market share itself:

$$-\frac{d\ln \epsilon_d(\omega)}{d\ln s_d(\omega)} = \frac{s_d(\omega)\,(\sigma_i - 1)}{\sigma_i - s_d(\omega)\,(\sigma_i - 1)}. \tag{21}$$

This means that the markups charged by large firms react more to any change in their market share.[6] The new result is that any increase in market size, by reducing the market share of each variety, causes firms to lower their markups. This is the so-called pro-competitive effect. Moreover, since better firms lower markups relatively more, market shares are also reallocated across firms. This also implies that, if foreign competition intensifies in any destination, sales from a given origin become more concentrated, even conditioning on selection (i.e., for a constant number of active firms).

3 Trade with Heterogeneous Firms: Evidence

The increased availability of micro-level data since the early 1990s sparked an enormous amount of empirical research on the role of firms in international trade. Using datasets that allow researchers to distinguish between exporting and non-exporting firms, the literature has unveiled important facts about the characteristics of exporters; moreover, leveraging episodes of trade liberalization, it has provided evidence on the selection effect and intra-industry reallocations induced by trade. The use of transaction-level datasets allowed researchers to uncover additional stylized facts and to test further implications of the model. The first part of this section summarizes the main findings in the empirical literature on exporter characteristics, selection and reallocation. The second part uses micro-level data on seaborne imports into the US to summarize some of the key results of the literature based on transaction-level datasets.

3.1 Firm-Level Data: Exporter Characteristics, Selection and Reallocation

The seminal paper by Bernard and Jensen (1995) unveils a number of important facts about exporting firms and export participation. First, in any given industry, only a minority of firms sell their products abroad: exporting is a rare activity. Second, exporters are not a random sample of the population of firms; rather, they are systematically larger and more productive than non-exporters. Both facts are confirmed by Bernard et al. (2018), who use

[6] Similarly, the markup elasticity with respect to the firm's own price and to the price of competitors is also increasing in the market share (see Amiti, Itskhoki and Konings, 2014, 2019).

data for the US in 2007. The authors document that exporters represent only 35% of US manufacturing firms and sell on average only 17% of their output abroad. Moreover, relative to non-exporting firms in the same industry, exporters are larger both in terms of employment (by 111%) and in terms of sales (by 135%). Exporters are also more productive than non-exporters, both in terms of value added per worker (by 19%) and in terms of Total Factor Productivity (by 4%).[7] Both the limited export participation and the better performance of exporters are confirmed by virtually all existing studies, not only for other industrialized countries but also for transition and developing economies.

The existence of a productivity premium for exporters is consistent with two explanations. Either exporting firms are more productive than non-exporters before entering international markets ("selection") or productivity improves after exporting ("learning-by-exporting"). Bernard and Jensen (1997) provide compelling evidence of the selection of more productive firms into exporting, by showing that productivity differences between future exporters and non-exporters antedate the moment in which exports begin. Similar evidence of selection has been found for many other countries. By contrast, evidence on learning-by-exporting is mixed. For instance, Clerides, Lach, and Tybout (1998) and Bernard and Jensen (1999) find no evidence of productivity gains from exporting, respectively, in Mexican, Colombian and Moroccan firms and in US firms. Conversely, Van Biesebroeck (2005) and De Loecker (2007) document productivity improvements after export market entry in Sub-Saharan and Slovenian enterprises, respectively. Overall, these facts suggest that exporting is a costly activity, which only some firms find it profitable to undertake. In particular, the evidence is consistent with the existence of fixed costs of exporting, which only the most productive firms can afford to incur.

As shown by the benchmark model, in the presence of heterogeneous firms and fixed costs of exporting, trade liberalization reduces sales of less productive firms, forcing the least productive ones to exit the market, and increases sales of more productive firms. The resulting reallocations of market shares raise aggregate industry productivity, providing an additional source of gains from trade. Some studies have investigated these effects exploiting large episodes of trade liberalization. Pavcnik (2002) examines the case of Chile, which underwent a rapid phase of tariff reductions between 1979 and 1986. Using data from the census of manufacturing plants with ten or more employees, the author shows that firm exit played an important role during the Chilean trade liberalization, with more than 35% of firms that were active in 1979 ceasing operations by 1986. Exiting firms were less productive than surviving firms, by 8% on average. Moreover, trade liberalization reallocated market shares in favor of more productive firms among the survivors. These reallocations accounted for two-thirds of

[7] Bernard et al. (2018) also find marked differences in terms of capital intensity, skill intensity, and average wages in favor of exporting firms.

the 19% increase in aggregate productivity experienced by the Chilean manufacturing sector over the study period. Both exit and reallocations were stronger in trade-oriented sectors than in non-traded sectors.[8]

Similar evidence of trade-induced reallocations was found for industrialized countries. In particular, Trefler (2004) documents reallocations of market shares among Canadian firms as a result of the tariff reductions brought about by the North American Free Trade Agreement. Similarly, Bernard, Jensen and Schott (2006), di Giovanni, Levchenko and Ranciere (2011), and di Giovanni and Levchenko (2012) document reallocations induced by trade liberalization and new export opportunities in the US, France, and the fifty largest economies in the world, respectively.

3.2 Transaction-Level Data: Export Concentration and Trade Margins

A related line of research, initiated by Bernard, Jensen and Schott (2009), has taken advantage of the increasing availability of transaction-level datasets to shed further light on the role of heterogeneity in trade. This research has also provided evidence on additional implications of the theory, especially those regarding the role of top firms in trade flows and the pro-competitive effect of trade.

This section summarizes the main results in this literature. It does so with the help of rich transaction-level data on US imports from Piers, a database administered by IHS Markit. The version of Piers used in this article contains quantities and estimated values for the universe of seaborne manufacturing import transactions of the US, disaggregated by origin country, exporting firm, and 6-digit code of the Harmonized System product classification (HS6), in two years, 2002 and 2012.[9] In what follows, "varieties" are defined as firm-product pairs; they are assigned to industries by mapping each HS6 product exported by a foreign firm to the US into a 4-digit code of the Standard Industrial Classification (SIC). The final dataset comprises 1,311,835 observations at the firm-product-year level. Firms belong to 366

[8] The remaining one-third of productivity growth in Chile was due to improvements in within-firm productivity. While in the basic heterogeneous-firms model firm attributes are given, various studies have shown that trade liberalization could increase firm productivity by raising returns to investment in advanced technologies. See, in particular, Verhoogen (2008), Aw, Roberts and Xu (2011), Khandelwal and Topalova (2011), Lileeva and Trefler (2011), Bustos (2011), and Crinò and Epifani (2012) for empirical evidence on Mexico, Taiwan, India, Canada, Argentina, and Italy, respectively.

[9] Import values and HS6 codes are assigned by IHS Markit based on the product descriptions contained in the bills of lading. Product codes typically belong to the first (1992) version of the HS classification. To mitigate the risk of including transactions contaminated by possible outliers, extreme values have been removed as well as country-industry-year triplets with less than two varieties exported to the US. Unit values (defined as values divided by quantities) across countries and HS6 products from Piers are highly correlated with unit values in the official US Customs data. See Bonfiglioli, Crinò and Gancia (2020, 2021) for more details on the Piers data, and Flaanen et al. (2021) for a comprehensive discussion of the use of bill of lading data in international trade.

4-digit SIC manufacturing industries and 104 origin countries spanning the five continents. The average country-industry-year triplet has 43 firms, 53 varieties, and average export per variety approximately equal to \$1.2 million.[10]

3.2.1 Heterogeneity and Top Firms across Sectors

Existing studies have highlighted two important characteristics of trade flows. First, in any origin country, the value of exports to any destination market varies markedly across firms and products, even within the same narrowly-defined industry. Second, the vast majority of a country's exports in any industry is accounted for by very few and extremely large firms. This section summarizes these results and illustrates the main facts about heterogeneity and concentration in trade flows using the Piers data.

Bonfiglioli, Crinò and Gancia (2019) quantify the extent of heterogeneity in trade flows using official data on US imports at the product level for the 1989-2006 period and measuring heterogeneity by the standard deviation of log imports across products within each origin country and 4-digit industry. The results show that heterogeneity is high (1.94 on average in 2006) and has increased over time (by 6% on average over 1989-2006). Table 1 confirms this evidence using firm-level rather than product-level data. Heterogeneity is measured by the variance of log imports across varieties, and is computed separately for each origin country and 4-digit industry. Descriptive statistics for each 2-digit manufacturing sector are computed across all countries and 4-digit industries belonging to it. The last row of the table reports aggregate statistics for the entire manufacturing sector. In manufacturing as a whole, the variance of the log of US imports equals 3.5 on average in 2012, and has increased by an average 12% between 2002 and 2012. The variance of log imports is large in all sectors and has grown in most of them.

Table 1 provides additional empirical regularities about heterogeneity, in particular, by showing that its extent varies considerably across sectors. The variance of log imports is especially large in high-tech sectors—e.g., electronic equipment, machinery and computers, and precision instruments—and in sectors dominated by few large firms—e.g., chemicals, petroleum refining, and primary metal industries. Heterogeneity is instead more limited in traditional industries, such as food and kindred products, lumber and wood products, textile, and apparel. In light of the model, variation in heterogeneity across sectors reflects both technological characteristics, i.e., differences in the distributions $G_{oi}(\phi)$, but also varying degrees of firm selection into exporting.[11]

[10] Seaborne trade is the main mode of importing goods into the US. It accounts for 53% of total US merchandise imports in 2012, according to official data from the US Customs. Seaborne trade also accounts for 85% of overall US manufacturing imports for the median country-industry pair in the sample.

[11] See Helpman, Melitz and Yeaple (2004) and Bonfiglioli, Crinò and Gancia (2018) for additional evi-

Table 1: Heterogeneity and Top Firms across Sectors

	Variance of log exports across varieties			Share of exports by the top-4 varieties		
	Mean (2012)	Std. Dev. (2012)	Change (2002-2012)	Mean (2012)	Std. Dev. (2012)	Change (2002-2012)
	(1)	(2)	(3)	(4)	(5)	(6)
20 Food and kindred products	2.906	2.527	0.282	0.778	0.203	-0.015
21 Tobacco products	3.173	3.882	0.638	0.893	0.137	0.060
22 Textile mill products	3.206	2.385	0.199	0.792	0.216	0.036
23 Apparel products	3.382	3.000	0.238	0.707	0.272	0.024
24 Lumber and wood products	2.829	2.106	0.113	0.773	0.218	0.039
25 Furniture and fixtures	3.107	2.281	0.151	0.782	0.234	0.046
26 Paper and allied products	3.558	2.934	0.596	0.794	0.209	-0.016
27 Printing and publishing	3.291	2.754	-0.392	0.772	0.214	0.010
28 Chemical products	4.012	3.550	0.153	0.790	0.211	0.012
29 Petroleum refining	5.319	5.671	0.829	0.905	0.111	0.015
30 Rubber and plastics products	3.458	2.349	-0.131	0.744	0.232	0.008
31 Leather and leather products	3.363	2.870	0.088	0.755	0.231	-0.010
32 Non-metallic mineral products	3.353	2.873	-0.235	0.804	0.217	0.042
33 Primary metal industries	4.681	4.063	0.744	0.834	0.189	0.030
34 Fabricated metal products	3.526	2.602	-0.162	0.790	0.216	-0.008
35 Machinery and computer	3.849	3.651	0.181	0.782	0.221	-0.027
36 Electronic equipment	4.127	3.285	-0.120	0.820	0.201	-0.018
37 Transportation equipment	2.996	2.200	0.125	0.804	0.204	-0.003
38 Precision instruments	3.840	3.143	-0.182	0.826	0.205	-0.026
39 Miscellaneous manufacturing	3.281	2.736	-0.094	0.768	0.234	-0.013
20-39 Manufacturing	3.549	3.080	0.119	0.784	0.220	0.001

Notes. Source: Piers (IHS Markit), US seaborne import data by exporting firm and 6-digit HS product in 2002 and 2012. A variety is a firm-product pair. All statistics are computed across all origin countries and 4-digit SIC manufacturing industries belonging to a given sector. The sample includes 104 origin countries and 366 4-digit manufacturing industries.

The high heterogeneity in trade flows suggests that large and small exporters tend to coexist within any country-industry pair. The literature has also shown, however, that the vast majority of exports from any country is accounted for by a handful of top firms. In other words, trade flows are also extremely concentrated. Bernard et al. (2018) show that the top 1% of firms account for more than 80% of US trade. Freund and Pierola (2015) find that the top-5 firms account on average for 30% of total exports in 32 mostly developing countries. Gaubert and Itskhoki (2021) report that the largest firm in France accounts for 7% of all French manufacturing exports, and that within narrow industries the top exporter accounts for 28% of industry exports on average.

The remaining columns of Table 1 illustrate the concentration in trade flows by reporting statistics on the share of exports to the US accruing to the top-4 varieties in each origin country and 4-digit industry. Foreign sales in the US are highly concentrated: in the average

dence on the cross-sectoral variation in heterogeneity using data on aggregate sales for Europe and the US, respectively.

country-industry pair, the top-4 varieties account for 78% of US imports in 2012. While some variation exists across sectors, the share of exports by the top-4 varieties never falls below 70% (apparel products) and reaches a maximum of 91% in the most concentrated sector (petroleum refining).

Another interesting aspect highlighted by Table 1 is that concentration in trade flows has remained essentially constant over time. In manufacturing as a whole, the average change in the share of US imports accruing to the top-4 varieties was a meager 0.1 percentage points over 2002-2012. This fact sharply contrasts with the evolution of concentration among US firms, which has markedly increased over the same time period. Table 1 shows that two forces have contributed to keeping concentration in US imports stable. First, concentration has evolved differently across sectors, increasing in half of them and decreasing in the remaining ones. Second, and more importantly, changes in concentration have been quite small in most sectors.[12] Bonfiglioli, Crinò and Gancia (2021) dig deeper into the latter result. They show that the small changes in the concentration of US imports within sectors resulted from the opposing role played by the extensive and the intensive margin of trade. Pushing towards lower concentration, the number of exporting firms has grown and the number of exported products has fallen relatively more for top firms. On the contrary, the average revenue per product of top firms significantly increased relative to the population average. These results show that both entry and reallocations towards top firms are important to understand the distribution of sales across firms and the dynamics of concentration.

3.2.2 Heterogeneity and the Margins of Trade

As shown by the model, overall exports to any destination market can be decomposed into two margins: an extensive margin, capturing the mass of exporting firms, and an intensive margin, measuring average export per firm. Moreover, firm heterogeneity and selection affect both margins. This section considers three main empirical applications of the decomposition. The first is to unpack the sources of trade growth. In particular, the decomposition assesses to what extent the observed change in overall exports is driven by changes in the number of exported varieties or in average sales per variety. The second application is to quantify the sources of variation in trade flows across origin countries and industries. In other words, the decomposition measures the extent to which larger trade flows in some countries and industries depend on each margin. The third application of the decomposition is to assess the role of firm heterogeneity in driving the margins of trade.

Panel a) of Table 2 shows results for the first application. To this purpose, the panel

[12] Consistent with Table 1, Freund and Sidhu (2017) find that global industrial concentration did not increase and, if anything, actually declined in most industries. Yet, they do so combining national data. Hence, they study concentration among producers in the world, not in any destination market.

quantifies the contributions of the extensive and the intensive margin to the growth in overall exports to the US within each country-industry pair. Reported figures are averages computed across all country-industries in the sample. In the average country-industry, overall exports to the US increased by 0.046 log points over 2002-2012. This growth has resulted from two opposing forces: while average export per variety fell by 0.113 log points, the number of exported varieties increased more than proportionately, by 0.159 log points. Hence, the two margins have contributed differently to the growth in overall exports to the US in the average country-industry pair: while the intensive margin pushed towards a reduction in exports, the extensive margin worked in the opposite direction, and the latter effect has dominated the former.

This finding is consistent with an increase in the number of small exporters, and illustrates once again the importance of selection and firm heterogeneity for understanding trade flows. Data by destination market, rather than by origin country, confirm this interpretation. For instance, using US export data, Bernard et al. (2009) show that the negative effect of distance on bilateral trade flows is accounted for by the extensive margin. Using French export data, Eaton, Kortum and Kramarz (2011) find that the number of firms selling to a market increases with market size, and that firms selling to more and smaller destinations also have higher sales in France. The importance of the extensive margin was also stressed by Helpman, Melitz and Rubinstein (2008), who recognized that models with heterogenous firms provide a rationale for the prevalence of zeros in bilateral trade flows, with important implications for the estimation of the effect of trade frictions.

The remainder of Table 2 reports results for the second application of the decomposition, by breaking down the variation in exports to the US across origin countries and industries into the two margins. Panel b) focuses on export levels. It reports coefficients and standard errors obtained by regressing the log of each margin on the log of overall exports to the US, across all country-industry-year triplets in the sample. The properties of OLS imply that the coefficients obtained from the two regressions add up to one. Thus, each coefficient provides the percentage contribution of the corresponding margin to explaining the variance of overall exports to the US across triplets. The results show that the two coefficients have roughly the same size. Hence, each margin accounts for approximately half of the variation in overall exports: triplets characterized by larger exports display both a larger number of exported varieties and greater average export per variety, with the contributions of the two margins being roughly equivalent in the data.[13] Panel c) performs a similar variance decomposition for the change in exports. Reported figures are coefficients and standard errors obtained by regressing the log change in each margin on the log change in overall exports to the US, across

[13] While the two margins are correlated, by the properties of OLS this decomposition allocates the covariance equally between the two terms.

Table 2: Margins of Trade

	a) Margins of export growth	
	Change in log N. of varieties	Change in log average export per variety
Mean	0.159	-0.113
	b) Variance decomposition, levels	
	Log N. of varieties	Log average export per variety
ln tot. exp.	0.466***	0.534***
	[0.003]	[0.003]
	c) Variance decomposition, changes	
	Change in log N. of varieties	Change in log average export per variety
Δ ln tot. exp.	0.235***	0.765***
	[0.005]	[0.005]

Notes. Panel a) reports averages, computed across country-industry pairs, of the variables indicated in the columns' headings. Panel b) reports coefficients and heteroskedasticity-robust standard errors from OLS regressions, estimated across country-industry-year triplets (24,693 observations), of the variables indicated in the columns' headings on log total exports. Panel c) reports coefficients and heteroskedasticity-robust standard errors from OLS regressions, estimated across country-industry pairs (9,864 observations), of the variables indicated in the columns' headings on the change in log total exports. ***, **, *: denote significance at the 1, 5 and 10% level, respectively.

all country-industry pairs in the sample. The results show that roughly three fourths of the variance of export growth across country-industries are explained by the intensive margin, with the remaining one fourth being accounted for by the extensive margin.

The above results are consistent with several decomposition exercises in the literature. In particular, Hummels and Klenow (2005) were the first to document the importance of both the intensive and the extensive margin at the product level for the volume of trade. Other papers have confirmed these results using firm-level data for various countries (Fernandes, Freund and Pierola, 2016, Bernard et al. 2018, Fernandes et al., 2018, Bonfiglioli, Crinò and Gancia, 2020).

The third application of the decomposition is to study the role of firm heterogeneity in explaining the volume of trade. In the benchmark model, heterogeneity can increase trade along both margins. The results are summarized in Table 3. Panel a) reports coefficients from regressions of log total exports to the US, log number of exported varieties, and log average export per variety on log heterogeneity, measured by the variance of log sales; each regression is estimated across all country-industry-year triplets in the sample. The specifications in columns (1)-(3) do not include control variables, while the regressions in columns

Table 3: Heterogeneity and Trade

	(1)	(2)	(3)	(4)	(5)	(6)
	a) Regressions in levels					
	Log total exports	Log N. of varieties	Log avg. export per variety	Log total exports	Log N. of varieties	Log avg. export per variety
ln heterogeneity	0.883***	0.355***	0.527***	0.599***	0.138***	0.461***
	[0.019]	[0.007]	[0.014]	[0.016]	[0.005]	[0.014]
Obs.	23888	23888	23888	23888	23888	23888
R2	0.23	0.11	0.20	0.54	0.66	0.39
Country-year FE	No	No	No	Yes	Yes	Yes
Industry-year FE	No	No	No	Yes	Yes	Yes
	b) Regressions in changes					
	Change in log total exports	Change in log N. of varieties	Change in log avg. export per variety	Change in log total exports	Change in log N. of varieties	Change in log avg. export per variety
Δ ln heterogeneity	0.586***	0.102***	0.484***	0.546***	0.075***	0.470***
	[0.024]	[0.006]	[0.021]	[0.023]	[0.006]	[0.021]
Obs.	9581	9581	9581	9581	9581	9581
R2	0.18	0.03	0.17	0.34	0.41	0.28
Country FE	No	No	No	Yes	Yes	Yes
Industry FE	No	No	No	Yes	Yes	Yes

Notes. Heterogeneity is the variance of log exports across firm-product pairs within a country-industry-year triplet. Regressions are estimated with OLS across country-industry-year triplets (panel a) or country-industry pairs (panel b). Dependent variables are indicated in columns' headings. Standard errors, reported in square brackets, are robust to heteroskedasticity. ***, **, *: denote significance at the 1, 5 and 10% level, respectively.

(4)-(6) control for country-year and industry-year fixed effects. All coefficients are positive and very precisely estimated, confirming that greater heterogeneity is associated with larger exports, more exported varieties, and greater export per variety. Up to 75% of the correlation between heterogeneity and overall exports is explained by the intensive margin, with the remaining fraction being due to the extensive margin. Panel b) performs a similar exercise, but with variables in changes rather than in levels. Also in this case, an increase in heterogeneity within a country-industry pair is associated with increases in the number of exported varieties, in average export per variety, and hence in overall exports. The intensive margin contributes approximately 85% to the relationship between changes in heterogeneity and changes in overall exports. These results are consistent with Redding and Weinstein (2017) and Bonfiglioli, Crinò and Gancia (2020), who provide structural decompositions showing that more heterogeneity in firm attributes is associated with higher average sales per firm.

It is important to recognize that these exercises document the importance of firm heterogeneity, but do not study where it comes from. A set of papers has studied the origin of firm heterogeneity by providing structural decompositions of the distribution of firm sales into the contributions of costs (the parameter φ in the model), demand shifters (γ), markups ($\epsilon(\omega)/(\epsilon(\omega)-1)$) and product scope (the number of varieties per firm). These papers show that product scope, entry/exit and demand shifters explain a large fraction of the variation in the data, with a minor role for prices (hence, costs and markups). In particular, using US barcode data, Hottman, Redding and Weinstein (2016) find that 50-70% of the variance in firm sales can be attributed to differences in firm appeal, about 20-25% to differences in product scope, and less than 25% to costs. Using US import data, Redding and Weinstein (2017) find that around 50% of the cross-section (90% of the time-series) variation in comparative advantage is accounted for by variety and average demand/quality, with average prices contributing less than 10%.

3.2.3 International Competition and Export Concentration

The evidence discussed so far suggests that trade flows are dominated by a small number of large firms. As shown in the theory section, in such a granular world, market power is likely to be endogenous and to vary across firms. In that case, intensified foreign competition in a destination market induces firms to lower their markups. However, the reaction is asymmetric. Since top firms cut their markups more, competition reallocates market shares towards these firms. This implies that, in models with heterogeneous firms, more international competition can lead to lower markups but also more concentration in sales from any given origin country.

Evidence on the pro-competitive effect was initially focused on average markups. Tybout (2003) surveys earlier studies showing that markups generally fall with import competition. Another strand of research using transaction-level data aimed at identifying heterogeneity in the reaction of firms and their aggregate consequences. Using Belgian firm-product-level data, Amiti, Itskhoki and Konings (2014, 2019) find that small firms have nearly complete exchange rate and cost pass-through to prices. In contrast, prices charged by large firms respond to both competitor price changes and own cost shocks, with roughly equal elasticities of around one half. The authors also find that these asymmetries in markup variability across firms is important for explaining the aggregate markup response to international shocks. Other papers have studied the effect of import competition on reallocations. Amiti and Heise (2021), using firm-level data from the US census, show that import competition causes an increase in domestic market concentration. Contrary to papers using national data only, the authors also find that market concentration remained stable, or even fell over time, when foreign imports are included. Similarly, Bonfiglioli, Crinò and Gancia (2021) show that international competition in the US market reallocated market shares towards the top exporters in each origin country and industry, thereby raising the concentration of exports among national firms. Overall, this evidence supports the prediction of heterogeneous-firms models that, in global markets, stronger competition can coexist with growing national concentration.

This section provides evidence on the relationship between international competition and reallocation towards top firms using regression analysis similar to the one in Bonfiglioli, Crinò and Gancia (2021). The dependent variable is the log change in the concentration of US imports from origin country o in industry i over 2002-2012; concentration is measured by the import share accruing to the top-4 varieties, $CRI_{oi} = X_{oi}^{top4}/X_{oi}$. A larger value of $\Delta \ln CRI_{oi}$

indicates that, in industry i, imports from country o are becoming more concentrated at the top.[14] This measure, which varies across origin-industry pairs, is regressed on various proxies for competition.

The results, to be interpreted as conditional correlations, are reported in Table 4. In column (1), $\Delta \ln CRI_{oi}$ is regressed on a number of variables defined at the origin-industry level: the log change in the number of varieties exported to the US from country o in industry i, $\Delta \ln N_{oi}$; the log change in the average price per variety exported from country o in industry i, $\Delta \ln p_{oi}$; the log value of initial concentration in the country-industry pair, $\ln CRI_{oi,2002}$; and the initial log share of country o in US imports within industry i, $\ln SHI_{oi,2002}$. All specifications include country fixed effects.[15] While the coefficient on $\Delta \ln p_{oi}$ is imprecisely estimated, the coefficients on $\Delta \ln N_{oi}$, $\ln SHI_{oi,2002}$ and $\ln CRI_{oi,2002}$ are all negative and highly statistically significant. The coefficient on $\Delta \ln N_{oi}$ suggests that concentration declines with entry of competitors from the same origin country. The coefficient on $\ln SHI_{oi,2002}$ suggests that concentration falls more in countries capturing larger initial shares of US imports in any given industry. The coefficient on $\ln CRI_{oi,2002}$ indicates instead that, in country-industries where concentration is initially higher, there is a greater tendency for mean reversion.

To search for evidence consistent with the pro-competitive effect, the next columns add industry-level controls. Column (2) includes the log change in the number of varieties exported to the US in industry i from origin countries other than o, $\Delta \ln N_{i-o}$; the log change in the share of industry i in total US imports, $\Delta \ln SHI_i$; and the log change in the overall concentration of US imports in industry i, as measured by share of US imports in i accruing to the top-4 varieties exported from any origin country, $\Delta \ln CRI_i$. As indicated by the coefficients on $\Delta \ln N_{i-o}$ and $\Delta \ln SHI_i$, which are both positive and very precisely estimated, concentration in an origin country o increases with entry of competitors from other countries and in expanding sectors. These results are consistent with the pro-competitive effect highlighted in the model: both foreign entry and industry growth indicate higher competitive pressure, lower market shares for existing firms, and hence more concentrated sales. As in the model, this happens even conditioning on selection (i.e., holding constant $\Delta \ln N_{oi}$). The positive coefficient on $\Delta \ln CRI_i$ points instead to the existence of common trends in concentration across origin countries.

Column (3) further controls for the elasticity of substitution in industry i, $\ln \sigma_i$.[16] The

[14] Similar results hold when measuring concentration using the Herfindahl-Hirschman index instead of CRI_{oi}.

[15] The country fixed effects allow focusing on cross-industry variation within countries and control for country-specific characteristics that do not vary across industries (e.g., distance from the US, institutional quality, etc.).

[16] The elasticity of substitution is estimated using the Reverse-Weighting estimator introduced by Redding and Weinstein (2016). Since estimates of this parameter are not available for all industries, the number of observations is reduced.

Table 4: International Competition and Export Concentration

	(1)	(2)	(3)	(4)
$\Delta \ln N_{oi}$	-0.202***	-0.219***	-0.225***	-0.201***
	[0.005]	[0.006]	[0.007]	[0.006]
$\Delta \ln p_{oi}$	0.004	-0.003	-0.006	-0.009**
	[0.004]	[0.004]	[0.005]	[0.004]
$\ln CRI_{oi,2002}$	-0.317***	-0.328***	-0.336***	-0.495***
	[0.012]	[0.012]	[0.014]	[0.014]
$\ln SHI_{oi,2002}$	-0.033***	-0.037***	-0.041***	-0.054***
	[0.002]	[0.002]	[0.002]	[0.002]
$\Delta \ln N_{i-o}$		0.034***	0.030***	0.226**
		[0.008]	[0.010]	[0.092]
$\Delta \ln SHI_i$		0.025***	0.030***	
		[0.005]	[0.006]	
$\Delta \ln CRI_i$		0.040***	0.054***	
		[0.006]	[0.007]	
$\ln \sigma_i$			0.039***	
			[0.006]	
Obs.	7198	7195	5461	7195
R2	0.40	0.41	0.43	0.50
Country FE	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes

Notes. All regressions are estimated with OLS across origin countries (o) and industries (i). The dependent variable is the log change (over 2002-2012) in the share of US imports accruing to the top-4 varieties in each country-industry pair, $\Delta \ln CRI_{oi}$. N_{oi} is the number of varieties exported to the US from country o in industry i. p_{oi} is the average price per variety exported to the US from country o in industry i. $CRI_{oi,2002}$ is the initial value of the share of US imports accruing to the top-4 varieties in each country-industry pair. $SHI_{oi,2002}$ is the initial value of the share of country o in US imports within industry i. $N_{i\text{-}o}$ is the number of varieties exported to the US in industry i from origin countries other than o. SHI_i is share of industry i in total US imports. CRI_i is the share of US imports in industry i accruing to the top-4 varieties exported from any origin country. σ_i is the elasticity of substitution in industry i, estimated using the Reverse-Weighting estimator (Redding and Weinstein, 2016). Standard errors, reported in square brackets, are robust to heteroskedasticity. ***, **, *: denote significance at the 1, 5 and 10% level, respectively.

positive and statistically significant coefficient on this variable suggests that concentration increases more in sectors where varieties are more substitutable. This also is consistent with the pro-competitive effect, as the latter should skew the distribution of sales towards top firms more in industries with a high elasticity of substitution. Finally, column (4) replaces the industry-level variables with industry fixed effects. The results confirm the negative correlation between changes in concentration and changes in the number of competitors from the same origin country, $\Delta \ln N_{oi}$. Moreover, the coefficient on the log change in average price per variety, $\Delta \ln p_{oi}$, is now negative and precisely estimated, suggesting growing concentration to be associated with declining prices. The results also confirm the positive association between changes in concentration and entry of foreign competitors, $\Delta \ln N_{i-o}$.

4 Additional Results

This section reviews some of the most important extensions of the benchmark theoretical framework and discusses their empirical support. Due to space limitations, this overview is inevitably selective, but it includes references to further readings and more comprehensive surveys.

4.1 Multi-product firms

One of the reasons why top firms are so large is that they sell multiple products. These multi-product firms are even rarer than exporters, but they are nonetheless quantitatively very important. For example, Bernard et al. (2018) show that US firms exporting more than ten (HS10) products represent just 8.4% of all exporters but account for 83.9% of total export value. Although the benchmark model identifies firms with products, it can be extended to include multiproduct firms. A simple way to do so, proposed by Bernard, Redding and Schott (2011), is to interpret the I sectors in equation (1) as different products, such as cars or computers, each available in differentiated varieties ω that are produced by competing firms. Upon entry, a firm draws a single productivity φ, which applies to any product line, and a set of "product attributes" γ_i, one for each product line.

Following the logic of the basic model, a firm finds it profitable to sell product i as long as $\varphi\gamma_i$ is sufficiently high. Hence, firms select not only the markets to serve, but also the products to sell. The extended model implies that more productive firms enter more destinations and sell more products, which is precisely what is observed in the data. Moreover, the selection effect now operates also within firms, in that more competition induces firms to drop their marginal products. Bernard, Redding and Schott (2011) also provide evidence in support of this mechanism. They show that firms that were more exposed to the tariff cuts induced by the Canada–US Free Trade Agreement reduced their products relative to less exposed firms.

Similarly, Mayer, Melitz and Ottaviano (2014, 2021) find evidence of the pro-competitive effect at work within firms. Using French data, they find that tougher competition and demand shocks in an export market induced firms to skew their export sales toward their best-performing products.

4.2 Heterogeneous Importers

Besides export decisions and the product mix, trade opportunities can also affect the import behavior of firms. Work using transaction-level data has shown that the majority of trade is between firms and that importing firms display similar features as exporting firms. For instance, Bernard et al. (2018) report that importers are relatively rare, accounting for around 20% of US manufacturing firms in 2007. As in the case of exporters, importing firms are also larger and more productive than other firms. Moreover, export and import activities tend to be positively correlated: 41% of exporters also import, and 79% of importers also export. To rationalize these findings, Bernard et al. (2018) assume that firms must incur a fixed sourcing cost to be able to import intermediate inputs from a foreign country. These inputs are also subject to an iceberg variable trade costs. As a result, only the most productive firms find it profitable to pay the import cost.[17]

Despite the clear similarities, existing export models cannot always be applied directly to analyze foreign sourcing. As shown in Antràs, Fort and Tintelnot (2017), selection into importing exhibits complementarities across source markets: since access to foreign inputs increases productivity, a firm's decision to import from one market may also affect whether it is optimal to import from another market.[18] Likewise, access to foreign inputs may induce firms to enter more export markets. Building on these insights, Bernard et al. (2021) develop a model of heterogeneous firms and network formation where firms search for and sell to downstream buyers and buy inputs from upstream suppliers. Firms vary in their productivity and relationship capability. Using data on firm-to-firm transactions in Belgium, they find that heterogeneity in size across firms is mostly driven by differences in the number of customers.[19]

[17] Amiti and Davis (2012) and Kasahara and Lapham (2013) where among the first to introduce a fixed cost of importing.

[18] The effect of foreign inputs on productivity can be quantitatively large. For instance, in an application to French data, Blaum, Lelarge and Peters (2018) find that input trade reduces the prices of manufacturing products by 27%. Similarly, Amiti and Konings (2007) find that reductions in input tariffs in Indonesia in the 1990s were associated with an increase in productivity of approximately 12% for firms that import their inputs.

[19] Bernard and Moxnes (2018) provide a survey of the literature on firm-to-firm trade.

4.3 Multinational Firms

Another striking feature of international markets is the quantitative importance of multinational firms. For instance, about 90% of US exports and imports flow through multinational firms, with almost one-half of US imports taking place within multinationals (Bernard et al., 2009). Compared to other exporting firms, multinationals are even larger and more productive. Multinationals can be introduced into the benchmark model of trade with heterogeneous firms in various ways. Helpman, Melitz and Yeaple (2004) allow firms to serve the foreign market through local production by a subsidiary rather than through exporting. The assumption that the fixed cost of opening a foreign subsidiary is higher than the fixed cost of exporting yields a proximity-concentration trade-off: by producing locally, multinational firms save on the variable trade costs, but must incur the higher fixed cost of running multiple plants. Since the variable-cost saving of multinational production increases with the volume of sales, only the most productive firms find it profitable to open subsidiaries. The predictions of the model are borne out in the data. Specifically, Helpman, Melitz and Yeaple (2004) find that sales by foreign subsidiaries of US multinationals, relative to exports, are higher in sectors with higher trade costs, lower plant-level fixed costs, and a higher dispersion in sales, which indicates a larger proportion of bigger firms.

Firms replicating the production process in different countries so as to save on transport costs are called "horizontal" multinationals. However, firms may also locate different stages of the production process across countries to take advantage of cost differences. These firms are called "vertical" multinationals. To allow for this possibility, Antras and Helpman (2004) assume that production requires an input that can be sourced either domestically or from a low-wage country. Moreover, foreign inputs can be bought from an independent supplier ("outsourcing") or from a subsidiary ("multinational production"). In equilibrium, firms choose the model of operation by comparing their variable and fixed costs, and differences in productivity map into alternative organizational choices. As long as multinational production faces the highest fixed cost (due to the need of opening subsidiaries in foreign countries), but the lowest variable cost (due to lower wages and contractual frictions), it is chosen by the most productive firms. An excellent survey of these theories is provided by Antras and Yeaple (2014).

4.4 The Origin of Firm Heterogeneity and Industrial Concentration

Finally, these models are well-suited to study the determinants of industrial concentration. In particular, they can help to shed light on how globalization has contributed to the recent phenomenon of the rise of superstar firms. While it is understood that giant companies such as Apple could not have reached their size without a global market, the exact role of international trade is debated.[20] The models discussed in this article suggest that one reason for concentration is that the margins of firm participation in international markets are systematically correlated with one another. For example, as shown in Bernard et al. (2018), large firms export to more markets, export more products, export more of each product to each market, import from more countries, import more inputs, import more of each input, and so on. Yet, all these models show how exogenous differences in firm attributes, coupled with trade opportunities, yield the endogenous distributions of firm size and sales that are observed in the data. They do not study how differences in attributes arise in the first place.

A line of research investigates the possible origins of firm heterogeneity and how it interacts with trade, focusing the attention on the innovation process. In models of firm dynamics such as König, Lorenz and Zilibotti (2016) and Benhabib, Perla and Tonetti (2017), the productivity distribution is the resultant of the endogenous decision to invest in costly innovation or adoption. Innovation stretches the distribution, while adoption compresses it. In Bonfiglioli, Crinò and Gancia (2018), firms can endogenously decide to invest in larger and riskier innovation projects, which generate more heterogeneity. Interestingly, in both cases, trade can change the productivity distribution. The key intuition is that export opportunities, by shifting expected profits to the tail, increase the reward to investing in innovation (Perla, Tonetti and Waugh, 2021) and in riskier projects (Bonfiglioli, Crinò and Gancia, 2018). Consistently, Bonfiglioli, Crinò and Gancia (2019) find that the dispersion in sales across products is positively correlated with measures of comparative advantage in a large panel of countries and industries.

5 Conclusions and Future Directions

This article has reviewed the research studying the role of firms in international trade. The development of theoretical models has followed closely the discovery of new empirical facts made possible by the availability of ever more detailed micro data about the operation of firms in international markets. This process is likely to continue. The literature has been successful at explaining why only a minority of firms engage in international trade, why they differ from other firms, what are the firm-level margins of adjustment, and how trade reallocates resources towards the most productive firms. This rich apparatus provides a natural framework for studying a broad set of questions, from economic development to industrial and trade policy.

Yet, a number of open challenges remain. Among these, two appear of particular relevance. First, while the quantitative importance of top firms is undisputed, there is still a limited understanding on how they emerge in the first place. Second, while reallocations towards

[20] See Alessandria, Arkolakis and Rhul (2021) for a survey of the literature that studies the dynamics of firms in foreign markets.

these top firms can be the result of an efficient process of growth and specialization, there is also a concern that it may lead to excessive concentration or that it may be the outcome of anti-competitive practices. Investigating these questions is an important direction for future research.

References

[1] Alessandria, G., Arkolakis, C., and Ruhl, K. (2021). "Firm Dynamics and Trade." *Annual Review of Economics* 13: 253–280.

[2] Amiti, M., and Davis, D. (2012). "Firms, Trade, and Wages: Theory and Evidence." *Review of Economic Studies* 79(1): 1–36.

[3] Amiti, M., and Heise, S. (2021). "U.S. Market Concentration and Import Competition." *CEPR Discussion Paper No. 16126.*

[4] Amiti, M., Itskhoki, O., and Konings, J. (2014). "Importers, Exporters, and Exchange Rate Disconnect." *American Economic Review* 104(7): 1942–1978.

[5] Amiti, M., Itskhoki, O., and Konings, J. (2019). "International Shocks, Variable Markups, and Domestic Prices." *Review of Economic Studies* 86(6): 2356–2402.

[6] Amiti, M., and Konings, J. (2007). "Trade Liberalization, Intermediate Inputs, and Productivity." *American Economic Review* 97(5): 1611–1638.

[7] Antràs, P., Fort, T. C., and Tintelnot, F. (2017). "The Margins of Global Sourcing: Theory and Evidence from US Firms," *American Economic Review* 107(9): 2514–2564

[8] Antras, P., and Helpman, E. (2004). "Global Sourcing." *Journal of Political Economy* 112(3): 552–580.

[9] Antras, P., and Yeaple, S. (2014). "Multinational Firms and the Structure of International Trade." In *Handbook of International Economics* (Gopinath, Helpman, and Rogoff, eds.), 4: 55–130.

[10] Arkolakis, C. (2010). "Market Penetration Costs and the New Consumers Margin in International Trade." *Journal of Political Economy* 118(6): 1151–1199.

[11] Arkolakis, C., Costinot, A., Donaldson, D., and Rodríguez-Clare, A. (2019). "The Elusive Pro-Competitive Effects of Trade." *Review of Economic Studies* 86(1): 46–80.

[12] Atkeson, A., and Burstein, A. (2008). "Pricing to Market, Trade Costs, and International Relative Prices." *American Economic Review* 98(5): 1998–2031.

[13] Aw, B. Y., Roberts, M. J., and Xu, D. Y. (2011). "R&D Investment, Exporting, and Productivity Dynamics." *American Economic Review*, 101(4): 1312–1344.

[14] Bas, M., Mayer, T., and Thoenig, M. (2017). "From Micro to Macro: Demand, Supply and Heterogeneity in the Trade Elasticity." *Journal of International Economics* 108: 1–19.

[15] Benhabib, J., Perla, J., and Tonetti, C. (2017). "Reconciling Models of Diffusion and Innovation: A Theory of the Productivity Distribution and Technology Frontier." *NBER Working Paper No. 23095.*

[16] Bernard, A. B., Dhyne, E., Magerman, G., Manova, K., and Moxnes, A. (2021). "The Origins of Firm Heterogeneity: A Production Network Approach," *Journal of Political Economy* forthcoming.

[17] Bernard, A., and Jensen, B. (1995). "Exporters, Jobs and Wages in U.S. Manufacturing, 1976-87." *Brookings Papers on Economic Activity: Microeconomics*, 1995: 67–119.

[18] Bernard, A., and Jensen, B. (1997). "Exporters, Skill Upgrading and the Wage Gap." *Journal of International Economics* 42(1-2): 3–31.

[19] Bernard, A., and Jensen, B. (1999). "Exceptional Exporter Performance: Cause, Effect, or Both?" *Journal of International Economics* 47(1): 1–25.

[20] Bernard, A., Jensen, B., Redding, S., and Schott, P. (2009). "The Margins of US Trade." *American Economic Review Papers and Proceedings* 99(2): 487–493.

[21] Bernard, A., Jensen, B., Redding, S., and Schott, P. (2012). "The Empirics of Firm Heterogeneity and International Trade," *Annual Review of Economics* 4(1): 283–313.

[22] Bernard, A., Jensen, B., Redding, S., and Schott, P. (2018). "Global Firms." *Journal of Economic Literature* 56(2): 565–619.

[23] Bernard, A., Jensen, B., and Schott, P. (2006). "Trade Costs, Firms and Productivity." *Journal of Monetary Economics* 53(5): 917–937.

[24] Bernard, A., Jensen, B., and Schott, P. (2009). "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods" in *Producer Dynamics: New Evidence from Micro Data* (Dunne, Jensen, and Roberts, eds.), NBER.

[25] Bernard, A., and Moxnes, A. (2018). "Networks and Trade." *Annual Review of Economics* 10: 65–85.

[26] Bernard, A., Redding, S., and Schott, P. (2007). "Comparative Advantage and Heterogeneous Firms." *Review of Economic Studies* 74(1): 31–66.

[27] Bernard, A., Redding, S., and Schott, P. (2011). "Multi-Product Firms and Trade Liberalization." *Quarterly Journal of Economics* 126(3): 1271–1318.

[28] Blaum, J., Lelarge, C., and Peters M. (2018). "The Gains from Input Trade with Heterogeneous Importers." *American Economic Journal: Macroeconomics* 10 (4): 77–127.

[29] Bonfiglioli, A., Crinò, R., and Gancia, G. (2018). "Betting on Exports: Trade and Endogenous Heterogeneity." *Economic Journal* 128(609): 612–651.

[30] Bonfiglioli, A., Crinò, R., and Gancia, G. (2019). "Trade, Finance and Endogenous Heterogeneity." *Journal of the European Economic Association* 17(1): 79–130.

[31] Bonfiglioli, A., Crinò, R., and Gancia, G. (2020). "Firms and Economic Performance: A View from Trade." *CEPR Discussion Paper No. 12829.*

[32] Bonfiglioli, A., Crinò, R., and Gancia, G. (2021). "Concentration in International Markets: Evidence from US Imports." *Journal of Monetary Economics* 121: 19–39.

[33] Bustos, P. (2011). "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms." *American Economic Review* 101(1): 304–340.

[34] Chaney, T. (2008). "Distorted Gravity: The Intensive and Extensive Margins of International Trade." *American Economic Review* 98(4): 1707–1721.

[35] Clerides, S. K., Lach, S., and Tybout, J. R. (1998)."Is Learning by Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco." *Quarterly Journal of Economics* 113(3): 903–947.

[36] Crinò, R., and Epifani, P. (2012). "Productivity, Quality and Export Behaviour." *Economic Journal* 122(565): 1206–1243.

[37] De Loecker, J. (2007). "Do Exports Generate Higher Productivity? Evidence from Slovenia." *Journal of International Economics* 73(1): 69–98.

[38] di Giovanni, J., and Levchenko, A. (2012). "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies." *Journal of Political Economy* 120(6): 1083–1132.

[39] di Giovanni, J., Levchenko, A., and Ranciere, R. (2011). "Power Laws in Firm Size and Openness to Trade: Measurement and Implications." *Journal of International Economics* 85(1): 42–52.

[40] Eaton J., Kortum, S., and Kramarz, F. (2011). "An Anatomy of International Trade: Evidence From French Firms." *Econometrica* 79(5): 1453–1498.

[41] Eaton, J., Kortum, S., and Sotelo, S. (2013). "International Trade: Linking Micro and Macro" in Advances in Economics and Econometrics (Acemoglu, Arellano and Dekel, eds.), Tenth World Congress of the Econometric Society: 329–370.

[42] Edmond, C., Midrigan, V. and Xu, D. Y. (2015). "Competition, Markups, and the Gains from International Trade." *American Economic Review* 105(10): 3183–3221.

[43] Epifani P., and Gancia, G. (2011). "Trade, Markup Heterogeneity and Misallocations." *Journal of International Economics* 83(1): 1–13.

[44] Fernandes, A., Freund, C., and Pierola, M. D. (2016). "Exporter Behavior, Country Size and Stage of Development: Evidence from the Exporter Dynamics Database." *Journal of Development Economics* 119: 121–137.

[45] Fernandes, A., Klenow, P., Meleshchuk, S., Pierola, M. D., and Rodríguez-Clare, A. (2018). "The Intensive Margin in Trade." *NBER Working Paper No. 25195.*

[46] Flaaen, A., Haberkorn, F., Lewis, L., Monken, A., Pierce, J., Rhodes, R., and Yi, M. (2021). "Bill of Lading Data in International Trade Research with an Application to the COVID-19 Pandemic." *Finance and Economics Discussion Series 2021-066*. Washington: Board of Governors of the Federal Reserve System.

[47] Freund, C., and Pierola, M. D. (2015). "Export Superstars." *Review of Economics and Statistics* 97(5): 1023–1032.

[48] Freund, C., and Sidhu, D. (2017). "Global Competition and the Rise of China." *PIIE Working Paper No. 17-3*.

[49] Gaubert, C., and Itskhoki, O. (2021). "Granular Comparative Advantage." *Journal of Political Economy* 129(3): 871–939.

[50] Grubel, H. G., and Lloyd, P. J. (1975). *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products* (London: Macmillan Press).

[51] Heckscher, E., and Ohlin, B. (1933). *Interregional and International Trade* (Cambridge MA: Harvard University Press).

[52] Helpman, E., Melitz, M. J., and Rubinstein, Y. (2008). "Estimating Trade Flows: Trading Partners and Trading Volumes." *Quarterly Journal of Economics* 123(2): 441–487.

[53] Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). "Export Versus FDI with Heterogeneous Firms." *American Economic Review* 94(1): 300–316.

[54] Hottman, C., Redding, S., and Weinstein, D. (2016). "Quantifying the Sources of Firm Heterogeneity." *Quarterly Journal of Economics* 131(3): 1291–1364.

[55] Hummels, D., and Klenow, P. (2005). "The Variety and Quality of a Nation's Exports." *American Economic Review* 95(3): 704–723.

[56] Kasahara, H., and Lapham, B. (2013). "Productivity and the Decision to Import and Export: Theory and Evidence." *Journal of International Economics* 89(2): 297–316.

[57] Khandelwal, A., and Topalova, P. (2011). "Trade Liberalization and Firm Productivity: The Case of India." *Review of Economics and Statistics* 93(3): 995–1009.

[58] König, M., Lorenz, J., and Zilibotti, F. (2016). "Innovation vs. Imitation and the Evolution of Productivity Distributions." *Theoretical Economics* 11(3): 1053–1102.

[59] Krugman, P. (1980). "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review* 70(5): 950–959.

[60] Lileeva, A., and Trefler, D. (2010). "Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants." *Quarterly Journal of Economics* 125(3): 1051–1099.

[61] Mayer, T, Melitz, M. J., and Ottaviano, G. (2014). "Market Size, Competition, and the Product Mix of Exporters." *American Economic Review* 104(2): 495–536.

[62] Mayer, T, Melitz, M. J., and Ottaviano, G. (2021). "Product Mix and Firm Productivity Responses to Trade Competition." *Review of Economics and Statistics* 103(5): 1–18.

[63] Melitz, M. J. (2003). "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71(6): 1695–1725.

[64] Melitz, M. J., and Ottaviano, G. (2008). "Market Size, Trade, and Productivity." *Review of Economic Studies* 75(1): 295–316.

[65] Melitz, M. J., and Redding, S. (2014). "Heterogeneous Firms and Trade." In *Handbook of International Economics* (Gopinath, Helpman, and Rogoff, eds.), 4: 1–54.

[66] Mrazova, M., and Neary, P. (2017). "Not So Demanding: Demand Structure and Firm Behavior." *American Economic Review* 107(12): 3835–3874.

[67] Pavcnik, N. (2002). "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants." *Review of Economic Studies* 69(1): 245–276.

[68] Perla, J., Tonetti, C., and Waugh, M. E. (2021). "Equilibrium Technology Diffusion, Trade, and Growth." *American Economic Review* 111(1): 73–128.

[69] Redding, S., and Weinstein, D. (2016). "A Unified Approach to Aggregate Price and Welfare Measurement." *NBER Working Paper No. 22479*.

[70] Redding, S., and Weinstein, D. (2017). "Accounting for Trade Patterns." *CEPR Discussion Paper No. 13459*.

[71] Ricardo, D. (1817). *On the Principles of Political Economy and Taxation* (London: John Murray).

[72] Trefler, D. (2004). "The Long and Short of the Canada–U.S. Free Trade Agreement." *American Economic Review* 94(4): 870–895.

[73] Tybout, J. R. (2003). "Plant- and Firm-Level Evidence on 'New' Trade Theories." In *Handbook of International Economics* (Choi, and Harrigan, eds.), 13: 388–435.

[74] Van Biesebroeck, J. (2005). "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms." *Journal of International Economics* 67(2): 373–391.

[75] Verhoogen, E. (2008). "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector." *Quarterly Journal of Economics* 123(2): 489–530.