Large Multiproduct Exporters Across Rich and Poor Countries: Theory and Evidence

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Abstract

Large multiproduct exporters dominate trade flows and their scope decisions have new implications for the welfare gains from trade. Guided by new evidence from the Exporter Dynamics Database, I build a model in which income and cannibalization effects drive the scope decisions of large firms. I derive a new formula for the welfare gains from trade where the change in welfare depends on the change and on the ex-ante level of the domestic market share of the typical domestic firm. Ignoring income or cannibalization effects causes mismeasurement of the US welfare gains by 20%.

Keywords: Multiproduct firms, Cannibalization Effects, Non-homotheticity, Oligopoly, Welfare gains from trade.

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1 Introduction

Recent empirical evidence has shown that world trade is dominated by multiproduct firms (Bernard et al., 2011), and a few large exporters, or superstars, account for most of a country's exports (Freund and Pierola, 2015). These findings challenge traditional models of trade in which infinitesimally small firms produce one variety each (Krugman, 1979; Melitz, 2003). In traditional models, changes in the number of varieties available for consumption or, equivalently, in the number of firms serving a destination, have major welfare implications (Krugman, 1980). In the presence of few large multiproduct exporters, welfare largely depends on the number of varieties per firm, the so-called *product scope*. The goal of this paper is to study the determinants of the scope of large firms and their effects on the welfare of consumers.

To study the determinants of the scope of large exporters, I use transaction-level data from the Exporter Dynamics Database and document two stylized facts for large multiproduct exporters. First, the product scope of superstars increases with the level of development of the destination proxied by per capita income. I refer to this stylized fact as *income effects* on scope. Second, I document a non-monotone, hump-shaped relationship between the product scope of a firm and its market share in a destination. This stylized fact can be rationalized by the presence of a *cannibalization effect* (Eckel and Neary, 2010).

Consider a firm that produces imperfect substitutes. Introducing a new variety has a twofold effect on the firm's sales. First, the new variety increases total firm's sales by reducing the demand faced by its competitors. Second, the new variety reduces, or cannibalizes, the sales of the firm's existing varieties. At a large market share, a firm faces strong cannibalization effects, and, thus, reduces its scope as it gains market share. Vice versa, a small firm faces weak cannibalization effects and introducing a new variety increases the firm's market share.

To study how the scope decisions of large firms affect the welfare of consumers, I build a model of large multiproduct firms based on Feenstra and Ma (2007) and Eckel and Neary (2010). The model rationalizes the two stylized facts documented and is consistent with several established empirical regularities. The main theoretical contribution of the paper is to generate a parsimonious formula for the welfare gains from a reduction in trade costs in the spirit of Arkolakis et al. (2012) and Arkolakis et al. (2015). Moreover, I generalize the results to a wide class of models of multiproduct firms, finding that ignoring either income or cannibalization effects causes an incorrect measure of the welfare gains from trade.

My model combines three main ingredients: 1) consumers have non-homothetic preferences, 2) firms compete oligopolistically, and 3) firms have a core competence and within-firm varieties are heterogeneous in their marginal cost of production. The scope of exporters is driven by income effects, cannibalization effects, and their interaction. The combination of non-homothetic preferences and the core competence assumption generates income effects on scope. Firms begin by exporting to a destination their core varieties, which have the lowest marginal cost and the highest markup. As consumer income rises, firms expand their scope introducing non-core varieties that have higher marginal costs and lower markups. The assumption of oligopoly generates the cannibalization effects on scope: the larger the market share of a firm, the stronger the cannibalization effects it faces, and the larger the firm's markups. Finally, there is a positive relationship between the market share of the firm and the per capita income of the destination: firms selling to richer economies face stronger cannibalization effects.

The model's predictions on product scope and markups are consistent with the empirical evidence documented in the literature. Due to trade costs, firms only export a fraction of their domestic scope (Iacovone and Javorcik, 2010), and they export their core products across more destinations than the non-core product (Arkolakis et al., 2014). By non-homothetic preferences, firms skew their sales toward the core products in destinations with stronger competition (Mayer et al., 2014). Furthermore, a decrease in trade costs reduces the domestic scope of small firms (Bernard et al., 2011), and it increases or leaves unchanged the scope of large firms (Baldwin and Gu, 2009; Lopresti, 2016), which is consistent with the presence of cannibalization effects. In line with the empirical evidence of De Loecker and Warzynski (2012) and De Loecker et al. (2016), the model predicts that the most productive firms and the core varieties within each firm have the highest markups. The model is also consistent with the findings of Simonovska (2015) whereby firms charge higher markups in richer economies. Finally, because of oligopolistic competition, a firm with high market share has low pass-through of prices (Amiti et al., 2014).

Arkolakis et al. (2012) (ACR) and Arkolakis et al. (2015) (ACDR) introduced a parsimonious formula to quantify the welfare gains from trade predicted by a wide class of models. Following this line of research, I derive a welfare formula for an oligopolistic model of multiproduct firms. The change in welfare $d \ln W$ from a small reduction in trade costs equals:

$$d \ln W = \frac{1}{\epsilon} \left[1 - \frac{\rho}{\epsilon + 1} \right] \left[1 + \frac{\epsilon s}{1 - s} \right] (-d \ln s) \tag{1}$$

where welfare depends on the change $d \ln s$ and to the current level s of the market share of the average domestic superstar. The formula depends on two firm-level parameters: ϵ, which is the inverse of the elasticity of the marginal cost of a variety with respect to its distance from the core, and ρ, which is the average markup elasticity with respect to marginal costs.

Relative to the formula proposed by ACDR and ACR, there are three main differences. First, the sufficient statistic required to compute the gains from trade changes: from the domestic expenditure share to the domestic market share of the typical domestic superstar. Second, the gains depend on the current level of the market share while the formula of ACR and ACDR only requires the change in the sufficient statistic. Finally, in ACDR, ϵ is the shape parameter of the Pareto distribution of productivity across firms while, in my model, ϵ is the shape parameter of the distribution of productivity across varieties within a firm.

What is the intuition behind the welfare formula (1)? As trade costs associated with reaching a destination decline, the number of imported varieties increases. Domestic firms become smaller relative to the market and their domestic market share falls: $-d\ln s > 0$. Therefore, a reduction in trade costs improves welfare: $d\ln W > 0$. Cannibalization and oligopoly directly affect the welfare gains from trade: given a change in s, the larger the current domestic market share of the typical domestic superstar, the larger the welfare gains. As firms lose market share, they face weaker cannibalization effects: firms have incentives to expand their domestic scope and reduce their markups, further increasing welfare. Such incentives have greater welfare consequences at larger values of s when firms face stronger cannibalization effects.

The literature on multiproduct firms has neglected income effects on scope by keeping the marginal utility of income constant (Feenstra and Ma, 2007; Eckel and Neary, 2010; Dhingra, 2013; Mayer et al., 2014). A model of large multiproduct firms without income effects, such as that of Eckel and Neary (2010), overestimates the gains from trade relative to my baseline model. By income effects, consumers' willingness to buy a given variety declines with the mass of varieties available for consumption. Trade increases the mass of varieties available for consumption and, through income effects, it reduces the demand for individual varieties. Ignoring income effects, thus, overestimates consumer's demand and welfare.

Models with homothetic preferences also ignore income effects because aggregate income, rather than per capita income, drives the scope of firms (Bernard et al., 2011). A model with homothetic preferences overestimates the welfare gains from trade relative to my baseline model for two reasons. The first reason is explained by ACDR: a model with homothetic preferences ignores the reduction in welfare brought about by an increase in exporters' markups. In this paper, I show a second reason that originates from the interaction of cannibalization and non-homothetic preferences. Regardless of the class of preferences, oligopoly is generally distortionary because it generates underconsumption of all varieties. However, non-homothetic preferences generate an additional distortion: low-markup varieties are overconsumed. Such a distortion, absent in a model with homothetic preferences, is partially reduced by cannibalization effects. Trade is welfare improving because it reduces the oligopoly distortions but, with non-homothetic preferences, it also exacerbates the underconsumption of low-markup varieties.

The welfare gains from trade in models of oligopoly have traditionally received less attention compared to the more tractable models of perfect or monopolistic competition (Neary, 2010b)[1]. The infinitesimally small firms of standard models of monopolistic competition do not face cannibalization effects: if a firm is atomistic, introducing a new variety has a negligible effect on

[1] Rosen (1981) provides an economic rationale for the emergence of superstars. The seminal work by Brander and Spencer (1985) and Eaton and Grossman (1986) focused on the optimal trade policy with oligopolies. Neary (2016) studies the welfare gains from trade in a model of oligopoly with single product firms.

its own sales. A model of monopolistically competitive multiproduct firms with non-homothetic preferences falls under the class of models studied by ACDR. Conditional on the same firm-level parameters, a model of monopolistic competition underestimates the welfare gains from trade because it overlooks the weakening of cannibalization effects.

How great is the mismeasurement of the welfare gains from trade when we ignore income and cannibalization effects? To answer to this question, I use industry level US Census data on the market share of domestic superstars and parameters estimated in the literature (Caliendo and Parro, 2015; Soderbery, 2015). According to my formula, US welfare improved by 4.3% between 2002 and 2007. Ignoring cannibalization effects, welfare would have improved by 3.5%, approximately 20% less than the result of my baseline formula. There is considerable heterogeneity across industries: ignoring cannibalization in more concentrated industries underestimates the gains by more than 50% while in more competitive industries ignoring cannibalization leaves the welfare gains almost unchanged. Ignoring income effects by using homothetic preferences overestimates the welfare gains from trade by 19% with significantly less heterogeneity across industries than with the previous case. Ignoring both cannibalization and income effects causes the gains to be underestimated in the more concentrated industries and to be overestimated in the more competitive industries.

This paper relates to Edmond et al. (2015) who study the welfare gains from trade in the Atkeson and Burstein (2008) model of heterogeneous oligopolists, each selling a single product. The gains predicted by a model of large multiproduct firms are larger than those arising from a model of large single product firms. In a world of large firms, trade generates pro-competitive gains by reducing the average markup in the economy. In the presence of large multiproduct firms, trade additionally weakens cannibalization effects, improving welfare.

The remainder of this paper is organized as follows. Section 2 presents the model. In section 3, I derive the welfare formula (1) and discuss the welfare contributions of income and cannibalization effects. Section 4 presents the two stylized facts on multiproduct superstars, and section 5 concludes.

2 Model

Consider two economies, home and foreign, with population L_h and L_f and per capita income y_h and y_f. In each country $i = h, f$, a discrete number M_i of firms engages in trade of varieties of a final good. I assume that the only active firms are superstars. I later relax this assumption allowing for a competitive fringe to coexist with superstars. For tractability, I assume that firms from the same country i are homogeneous but differ across countries. Each firm produces different varieties from other firms, but all firms from i have the same scope and sales[2].

The market structure is oligopolistic. I choose Cournot competition, which is more tractable than Bertrand and allows for a direct comparison with the model of Eckel and Neary (2010). The online appendix presents the results under Bertrand competition, which are qualitatively similar. Each firm k produces a continuum of varieties: from country i to country j firm k's varieties are indexed by $\omega \in [0, \delta_{kij}]$. δ_{kij} is the mass of varieties offered by a firm - the product scope. Exporting a variety requires an iceberg trade cost τ_{ij} with $\tau_{ii} = 1$. Firms pay a fixed cost, and free entry drives profits to zero.

2.1 Consumer's Problem

Consumers in both economies have identical Stone-Geary preferences (Simonovska, 2015) represented by the following utility function:

$$U_j = \sum_{i=h,f} \sum_{k=1}^{M_i} \int_0^{\delta_{kij}} [\ln(q_{kij}(\omega) + \bar{q}) - \ln \bar{q}] \, d\omega \tag{2}$$

where $q_{kij}(\omega)$ is the quantity consumed of variety ω produced by firm k in country i and sold in country j, and $\bar{q} > 0$ is a constant. This utility function is non-homothetic. The marginal utility is bounded from above, and, thus there exists a choke or reservation price for any level of consumer income: when the price of a good rises above the choke price, the demand for that good drops to zero. Since goods enter the utility function symmetrically, they can be ranked according to their prices from the cheapest necessity to the most expensive luxury[3]. The choke price is increasing with income: only richer consumers demand the most expensive goods.

Consumers maximize their utility subject to the following budget constraint:

$$\sum_{i=h,f} \sum_{k=1}^{M_i} \int_0^{\delta_{kij}} p_{kij}(\omega) q_{kij}(\omega) d\omega \leq y_j \tag{3}$$

which yields the inverse demand function:

$$p_{kij}(\omega) = \frac{1}{\lambda_j (q_{kij}(\omega) + \bar{q})} \tag{4}$$

where λ_j is the Lagrangian multiplier associated with the budget constraint and is interpreted

[2]Models of oligopoly tend to have homogeneous firms as in Feenstra and Ma (2007), Eckel and Neary (2010), and Ottaviano and Thisse (2011).

[3]Jackson (1984) finds evidence for this ranking using a cross section of consumers.

as the marginal utility of income of consumers in j. I derive λ_j by plugging (4) into (3):

$$\lambda_j = \frac{1}{y_j} \sum_{i=h,f} \sum_{k=1}^{M_i} \int_0^{\delta_{kij}} \frac{q_{kij}(\omega)}{q_{kij}(\omega) + \bar{q}} d\omega \tag{5}$$

λ_j is decreasing in per capita income: the richer a consumer is, the lower the marginal gain from an additional unit of income. Additionally, λ_j increases in the quantities of each variety and the scope of each firm.

Letting $x_{kij}(\omega) = L_j q_{kij}(\omega)$ be the aggregate demand for the variety ω, we can rewrite the inverse demand function and the marginal utility of income as:

$$p_{kij}(\omega) = \frac{L_j}{\lambda_j (x_{kij}(\omega) + L_j \bar{q})} \tag{6}$$

$$\lambda_j = \frac{1}{y_j} \left[\sum_{i=h,f} \sum_{k=1}^{M_i} \int_0^{\delta_{kij}} \frac{x_{kij}(\omega)}{x_{kij}(\omega) + L_j \bar{q}} d\omega \right] \tag{7}$$

2.2 Firms' Problem

Labor is the only factor of production and receives a wage rate w_i. Each firm pays a fixed cost of production F in domestic labor units, which is independent of scope and quantity. Since free entry drives profits to zero, the wage of a worker in country i equals the per capita income y_i. The marginal cost of production and delivery of one unit of a variety ω is a constant $c_{kij}(\omega)$, which includes the iceberg trade cost τ_{ij}. Each firm has a core competence and can introduce new varieties with minimum adaptation to the production process (Eckel and Neary, 2010; Arkolakis et al., 2014; Mayer et al., 2014). The first variety of a firm is produced at the lowest marginal cost, and the marginal cost of producing a variety $c_{kij}(\omega)$ is increasing in ω.

Each firm k simultaneously chooses quantities $x_{kij}(\omega)$ for $\omega \in [0, \delta_{kij}]$ and mass of varieties δ_{kij} for $j = h, f$, taking other firms' choices as given, to maximize its profits Π_{ki}[4]:

$$\Pi_{ki} = \sum_{j=h,f} \int_0^{\delta_{kij}} \left(\frac{L_j}{\lambda_j (x_{kij}(\omega) + L_j \bar{q})} - c_{kij}(\omega) \right) x_{kij}(\omega) d\omega - w_i F \tag{8}$$

where λ_j is defined by (7). The first order condition with respect to $x_{kij}(\omega)$ equals:

$$\underbrace{\frac{L_j}{\lambda_j} \frac{L_j \bar{q}}{(x_{kij}(\omega) + L_j \bar{q})^2}}_{\text{Standard Marginal Revenues}} - \underbrace{\frac{L_j}{\lambda_j^2} \left[\int_0^{\delta_{kij}} \frac{x_{kij}(\omega)}{x_{kij}(\omega) + L_j \bar{q}} \right] \frac{\partial \lambda_j}{\partial x_{kij}(\omega)}}_{\text{Cannibalization effect}} = \underbrace{c_{kij}(\omega)}_{\text{Marginal cost}} \tag{9}$$

[4]Firms take the wage w_i as given: as labor is inelastically supplied, dealing with oligopsony is unfeasible.

A rise in the supply of $x_{kij}(\omega)$ increases firms' profits by the standard marginal revenues that arise in models with no cannibalization effects. Because of cannibalization effects, increasing $x_{kij}(\omega)$ also reduces the sales of the firm's existing varieties. Firms internalize cannibalization effects because, in Cournot competition, they take into account their effects on the marginal utility of income λ_j. Increasing the supply of a variety raises the marginal utility of income $\left(\frac{\partial \lambda_j}{\partial x_{kij}(\omega)} > 0\right)$: a consumer that faces a large supply values one additional unit of income more. A larger λ_j shifts down the inverse demand function (6) reducing the demand for all the varieties offered in the market at any given price.

I leave the derivations of the firms' problem to appendix 6.1.1. Let s_{kij} denote the firm's market share defined as the firm's total sales in j divided by the total sales of all firms in j. Our first order condition (9) simplifies to:

$$\frac{1}{\lambda_j} \frac{L_j^2 \bar{q}}{(x_{kij}(\omega) + L_j \bar{q})^2}(1 - s_{kij}) = c_{kij}(\omega) \tag{10}$$

The term $1 - s_{kij}$ reduces the marginal revenue of an additional unit of $x_{kij}(\omega)$. The larger the market share of the firm, the stronger the cannibalization effects it faces, and the lower the marginal revenues of an additional unit of $x_{kij}(\omega)$.

Let us now examine the first order conditions with respect to the mass of varieties δ_{kij}:

$$\frac{L_j}{\lambda} \frac{x_{kij}(\delta_{kij})}{x_{kij}(\delta_{kij}) + L\bar{q}}(1 - s_{kij}) - x_{kij}(\delta_{kij}) c_{kij}(\delta_{kij}) = 0 \tag{11}$$

On the one hand, profits from the new variety increase the aggregate profits of the firm. On the other hand, because of cannibalization effects, the sales from the firm's existing varieties fall. The larger s_{kij}, the stronger the cannibalization effects faced by firm k. A firm expands its scope until the demand for last variety becomes zero, that is $x_{kij}(\delta_{kij}) = 0$. Using this result in (10), I obtain an implicit equation that defines the optimal mass of varieties supplied:

$$c_{kij}(\delta_{kij}) = \frac{(1 - s_{kij})}{\bar{q}\lambda_j} \tag{12}$$

Using (12), the optimal supply and price of ω equal:

$$x_{kij}(\omega) = \bar{q} L_j \left[\left(\frac{c_{kij}(\delta_{kij})}{c_{kij}(\omega)} \right)^{\frac{1}{2}} - 1 \right] \tag{13}$$

$$p_{kij}(\omega) = \frac{[c_{kij}(\omega) c_{kij}(\delta_{kij})]^{\frac{1}{2}}}{1 - s_{kij}} = \underbrace{\frac{1}{1 - s_{kij}} \left(\frac{c_{kij}(\delta_{kij})}{c_{kij}(\omega)} \right)^{\frac{1}{2}}}_{\text{Markup}} c_{kij}(\omega) \tag{14}$$

Wide-scope firms produce a larger quantity of all their varieties. Markups vary across firms and across varieties of the same firm. In particular, the core variety has the highest markup, and markups fall as the distance from the core competence increases, which is consistent with the findings of De Loecker et al. (2016). Moreover, markups increase with the firm's productivity (De Loecker and Warzynski, 2012). Large multiproduct firms restrict their scope and quantities to charge higher markups: the stronger the cannibalization effects, the larger the markups. Evaluating prices at a market share of zero yields the monopolistic competition pricing of Simonovska (2015). The larger s_{kij}, the larger the deviation of markups from the monopolistically competitive markups in line with the findings of Hottman et al. (2016).

2.3 The Product Scope of Large Multiproduct Exporters

To gain a better understanding of the mechanism of the model, I introduce the following functional form for the marginal cost of production and delivery from i to j:

$$c_{kij}(\omega) = \tau_{ij} w_i c_{ki} \omega^{\theta} \qquad \omega \in [0, \delta_{kij}] \tag{15}$$

where $\tau_{ii} = 1$, and $\theta > 0$ is the elasticity of the marginal cost of a variety with respect to its distance from the core competence, and it captures how fast marginal costs rise with scope. The parameter c_{ki} represents the efficiency of firm k in country i.

Appendix 6.1.2 provides the detailed derivations. The market share of the firm equals the ratio of the firm's product scope to the total mass of varieties available for consumption $\Delta_j = \sum_v \sum_k \delta_{kvj}$:

$$s_{kij} = \frac{r_{kij}}{\sum_v \sum_k r_{kvj}} = \frac{\delta_{kij}}{\Delta_j} \tag{16}$$

A larger scope δ_{kij} increases the revenues of firm k and, hence, its market share s_{kij}. Using (16) and (7) into (12) yields an expression for the scope of a firm:

$$\delta_{kij} = \left[\frac{\theta + 2}{\theta \bar{q} w_i c_{ki} \tau_{ij}}\right]^{\frac{1}{\theta+1}} y_j^{\frac{1}{\theta+1}} \left[s_{kij}(1 - s_{kij})\right]^{\frac{1}{\theta+1}} \tag{17}$$

All else constant, the scope of a multiproduct superstar is declining in the iceberg trade costs τ_{ij} and is increasing in the per capita income of the destination y_j. By the non-homotheticity of preferences, only consumers in richer economies are willing to purchase the most expensive varieties. Hence, firms export their core varieties across all destinations, and their non-core varieties only in richer economies.

Moreover, there is a non-monotone, hump-shaped relationship between exporter scope and market share. Such a relation is an equilibrium condition derived from the intersection of two functions. The first is the definition of market share (16), which features a positive relationship between δ_{kij} and s_{kij}. The second is the first order condition with respect to δ_{kij} (12), in which δ_{kij} and s_{kij} are negatively related because of cannibalization effects. In equilibrium, the locus in which the two curves are both satisfied is hump-shaped. For small firms, which face weak cannibalization effects, a rise in the market share is associated with a rise in the product scope. For large firms, cannibalization effects cause the product scope to fall with the market share. Firms reach their maximum product scope at a market share of 50%. In partial equilibrium, there is an interaction between income and cannibalization effects: firms have a larger market share in richer economies and, thus, face stronger cannibalization effects[5].

Relationship with the Literature

In models of monopolistic competition à la Krugman (1979), with additively separable preferences, firms take λ_j as given, hence they do not internalize cannibalization effects (Allanson and Montagna, 2005; Brambilla, 2009; Bernard et al., 2011; Manova and Zhang, 2012; Arkolakis et al., 2014; Nocke and Yeaple, 2014). Moreover, in models with no income effects, λ_j is a constant (Eckel and Neary, 2010; Mayer et al., 2014). Such an assumption would not allow the study of cannibalization effects with the additive preferences used here. In my model, increasing the supply of a variety reduces the demand for other varieties only via income effects.

Using additively separable preferences may seem unrealistic in the context of multiproduct firms because we could expect a higher degree of substitution within-firm rather than across firms. A more realistic approach is that of Hottman et al. (2016) who use a nested preference structure. Nested preferences affect only quantitatively the supply and scope of firms, and the welfare gains from trade. In fact, the firm fully internalizes the higher degree of substitution of its own varieties and limits its supply and scope by a constant fraction[6].

In appendix 6.2, I outline several extensions to the baseline model. First, Bertrand competition produces similar results to Cournot competition with the main difference being that the highest scope is reached at a level of s_{kij} that depends on the parameters of the model. Second, assuming that firms have a quality-based core competence, as in Bernard et al. (2011), rather than cost-based, yields an identical scope to (17). Third, introducing to the model diseconomies of scope (Nocke and Yeaple, 2014) or brand differentiation (Hottman et al., 2016) only alters quantitatively the scope of exporters. Finally, in the presence of a fixed cost per variety and destination (Bernard et al., 2011), firms would also export a wider scope to larger economies.

[5]Using the Exporter Dynamics Database, I find evidence in support of this result. Controlling for the size of the destination, I find that Mexican firms' market shares, defined as sales over total household consumption of the destination, are larger in richer countries. Moreover, in the online appendix I describe how the scope reacts to changes in countries' relative productivities and sizes in general equilibrium.

[6]Similarly, Dhingra (2013) modifies the linear quadratic preferences to allow for a higher degree of substitution within a firm, which only affects quantitatively the relationship between scope and trade costs.

2.4 Equilibrium

I consider the symmetric equilibrium in which identical firms supply the same mass of varieties and quantities for each variety. Firms from i are symmetric in their technology: $c_{ki} = c_i$ for all firms k. The cost parametrization previously introduced (15) generates a simple expression of the profits of a firm:

$$\Pi_i = \frac{(s_{ii}^2 + \theta s_{ii})}{\theta + 1} y_i L_i + \frac{(s_{ij}^2 + \theta s_{ij})}{\theta + 1} y_j L_j - w_i F$$

Using our market shares, goods markets clear if

$$M_h s_{hi} + M_f s_{fi} = 1 \qquad i = h, f$$

and trade is balanced if

$$M_h s_{hf} y_f L_f = M_f s_{fh} y_h L_h$$

Without loss of generality, I normalize the per capita income in the home country to one. The equilibrium is a vector of home and foreign firms' product scope $[\delta_{hh}, \delta_{hf}, \delta_{ff}, \delta_{fh}]$, a vector of the number of firms in each country $[M_h, M_f]$, and a foreign per capita income y_f such that: 1) firms choose the mass of varieties they sell domestically and export according to (17), 2) free entry drives profits Π_i to zero for $i = h, f$, and hence $w_i = y_i$, and 3) labor and goods market clear, and trade is balanced.

3 Welfare

What are the welfare effects of trade in the presence of multiproduct superstars? To answer this question, I follow the example of ACR and ACDR and derive a formula for the welfare gains from trade.

3.1 A New Welfare Formula

The first step in deriving the welfare formula is to show that the indirect utility V_j is proportional to the mass of varieties Δ_j available to consumers in country j. I leave the algebra to appendix 6.1.2. Using (13) into (2) yields:

$$V_j = \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \left[\ln\left(q_{ij}(\omega) + \bar{q}\right) - \ln \bar{q}\right] d\omega = \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln\left(\frac{\delta_{ij}}{\omega}\right)^{\frac{\theta}{2}} d\omega = \frac{\theta}{2}\Delta_j \tag{18}$$

By the market share definition (16), $\Delta_j = \frac{\delta_{jj}}{s_{jj}}$. Hence, using the optimal scope of domestic firms (17), the set of varieties available to consumers can be expressed as a function of the domestic market share of our multiproduct firm s_{jj}:

$$\Delta_j = \left[\frac{\theta+2}{\bar{q}c_j\theta}\left(\frac{y_j}{w_j}\right)(1-s_{jj})s_{jj}^{-\theta}\right]^{\frac{1}{\theta+1}} \tag{19}$$

Because of the zero profit condition, $y_j = w_j$. Taking the log of (18) and (19), and differentiating with respect to any change in the vector of trade costs yields:

$$d\ln V_j = d\ln\Delta_j = \frac{\theta}{\theta+1}\left[1+\frac{s_{jj}}{\theta(1-s_{jj})}\right](-d\ln s_{jj}) \tag{20}$$

Models of monopolistic competition relate the change in the mass of varieties Δ_j to the change in the domestic expenditure share on domestic goods $\Lambda_{jj} = M_j s_{jj}$ (Jung et al., 2015; Bertoletti et al., 2016). Here, I consider the change in the market share: $d\ln s_{jj} = d\ln\Lambda_{jj} - d\ln M_j$. Models of monopolistic competition that feature a Pareto distribution of productivity predict that the mass of firms M_j only depends on the size of country j, and thus a trade shock leaves M_j unchanged (ACDR). In contrast, my model predicts that a change in trade costs varies the mass of firms M_j.

Moreover, for a given change in s_{jj}, the larger the current level of s_{jj}, the larger the change in Δ_j. In models of monopolistic competition, a reduction in the domestic market share s_{jj}, or equivalently in the domestic expenditure share Λ_{jj}, causes an increase in the mass available for consumption because of an increase in the mass of imported varieties. In a model of large multiproduct firms there is an additional effect: a reduction in s_{jj} weakens the cannibalization effects, which magnifies the increase in Δ_j.

To derive a welfare formula, I consider the equivalent variation in income EV_j (Bertoletti et al., 2016) such that the indirect utility attained after the trade shock (20) equals the indirect utility attained at pre-shock prices and at an income $W_j = y_j + EV_j$. By the envelope theorem, the log change in the indirect utility V_j with respect to W_j is given by:

$$d\ln V_j = \frac{\lambda_j W_j}{V_j} d\ln W_j = \frac{2}{\theta+2} d\ln W_j \tag{21}$$

Combining (21) and (20) and rearranging, we obtain the main result of the paper:

$$d\ln W_j = \frac{\theta(\theta+2)}{2(\theta+1)}\left[1+\frac{s_{jj}}{\theta(1-s_{jj})}\right](-d\ln s_{jj}) \tag{22}$$

The change in welfare can be computed given θ and a change in the domestic market share of the typical domestic superstar $d\ln s_{jj}$. While in ACR the welfare gains from trade depend on the change in the domestic expenditure share on domestic goods (Λ_{jj}), in a model of multiproduct superstars, the sufficient statistic becomes the domestic expenditure share on the goods produced by the typical domestic superstar (s_{jj}). Moreover, while ACR's formula only needs $d\ln\Lambda_{jj}$, my welfare formula requires both the change $d\ln s_{jj}$ and the level s_{jj} of the sufficient statistic. Appendix 6.1.3 derives a formula for any change in trade costs: (22) provides a good local approximation for the welfare gains from trade.

A reduction in trade costs increases the number of imported varieties. Domestic firms become smaller relative to the market, and their market share falls: $-d\ln s_{jj} > 0$. Therefore, a reduction in trade costs improves welfare: $d\ln W_j > 0$. Cannibalization and oligopoly directly affect the welfare gains from trade: given a change in s_{jj}, the larger the current s_{jj}, the larger the welfare gains. As domestic firms lose market share, they face weaker cannibalization effects, which have a positive impact on their product scope, further increasing welfare. This channel has larger welfare consequences when firms face stronger cannibalization effects, which occurs at larger values of s_{jj}[7].

Let us discuss in detail the effects of a reduction in trade costs on the domestic scope of firms δ_{jj}. Two forces are at play. First, the weakening of cannibalization effects has a positive effect on δ_{jj}. At the same time, the stronger competition from foreign firms forces the domestic firms to focus on their core competence, shrinking δ_{jj}. In my model, the larger the market share s_{jj}, the stronger the first (positive) effect. When firms are small, a reduction in trade costs forces them to focus on their core varieties, in line with the evidence documented by Baldwin and Gu (2009), Bernard et al. (2011), and Lopresti (2016). When firms are large, they may reduce their scope to a lesser extent than small firms or even increase it. This prediction is consistent with the findings of Baldwin and Gu (2009) and Lopresti (2016). The former document that a reduction in tariffs has insignificant effects on the scope of large Canadian plants. The latter finds that a tariff reduction increases the scope of large US firms[8].

What happens to markups? The markup of domestic firms decreases as their market share s_{jj} shrinks. On the other hand, foreign firms' markups increase because their market share s_{ij} rises. However, the average markup in the economy falls after a reduction in τ: the reduction in domestic firms' markups dominates the increase in foreign firms' markups. The mechanism behind the result is similar to that of Edmond et al. (2015): the weight on the lower foreign markups increases while the weight on the higher domestic markups falls bringing down the average markup.

[7]In welfare terms, the weakening of cannibalization effects for domestic firms dominates the larger market power and stronger cannibalization effects of foreign exporters.

[8]An alternative explanation for the result is the presence of a fixed cost of product introduction (Qiu and Zhou, 2013): market integration may only increase the scope of the most productive firms.

3.1.1 Cannibalization Effects and Welfare

What are the welfare gains from trade when we ignore cannibalization effects? To answer to this question, consider a model of multiproduct firms that are monopolistically competitive as in Bernard et al. (2011) and Mayer et al. (2014), which by construction neglects cannibalization effects. Besides the market structure, the model is identical to the baseline model of section 2.

The welfare gains from trade in such a model ($d\ln W_j^{MC}$) can be computed as follows:

$$d\ln W_j^{MC} = \frac{\theta(\theta+2)}{2(\theta+1)}(-d\ln s_{jj}) \tag{23}$$

In a model of monopolistic competition, domestic market size and fixed cost of production pin down the total number of entrants. Hence, $d\ln s_{jj} = d\ln \Lambda_{jj}$ where Λ_{jj} is the domestic expenditure share on domestic goods.

For a given $d\ln s_{jj}$ and θ, the welfare gains that arise in a model with cannibalization effects (22) dominate those generated by monopolistic competition (23). In monopolistic competition, the gains from trade are derived only from the introduction of new imported varieties and from the change in the product scope of domestic producers that focus on their core varieties. In a model of oligopoly, there is a new channel through which trade benefits consumers: the weakening of cannibalization effects. Moreover, the average markup in a model of monopolistic competition is constant and independent of trade costs while in a model with cannibalization effects the average markup falls after a reduction in τ.

Welfare comparisons across models crucially depend on the moments chosen to calibrate the two models (Simonovska and Waugh, 2014a). The comparison here outlined between a model of monopolistic competition and a model of oligopoly relies on assuming the same change in the domestic market share of the typical domestic firm $d\ln s_{jj}$, and on the same firm-level parameter θ, which controls the shape of the distribution of productivity within a firm. I now relax these two assumptions. Details are in the online appendix.

Welfare Gains Conditional on Trade Shock

For a given $d\ln s_{jj}$ and θ, $\frac{d\ln W_j}{d\ln s_{jj}}$ is larger in a model that features cannibalization effects relative to a model of monopolistic competition. How does the change in the market share due to the same change in trade costs, $\frac{d\ln s_{jj}}{d\ln \tau}$, vary across the two models?

I consider the two models evaluated at the same level of market concentration: I hold constant the initial value of the domestic and exporters' market shares, s_{jj} and s_{ij}, as well as the parameter θ. The oligopoly model features cannibalization effects while the monopolistic competition model lacks the strategic interaction across firms. I find that $\left|\frac{d\ln s_{jj}}{d\ln \tau}\right|$ is larger in the model with cannibalization effects, which further amplifies the difference in welfare gains between the two models.

Welfare Gains Conditional on Trade Elasticity

ACR's and ACDR's welfare comparisons across international trade models rely on conditioning the welfare formulas to the same macro-level moments: the trade elasticity and the change in the sufficient statistics – in their case the change in the domestic expenditure share on domestic goods Λ_{jj}. The trade elasticity is defined as the elasticity of imports with respect to iceberg trade costs. In a model of monopolistic competition, the trade elasticity is $\epsilon = 1/\theta$. Moreover, the sales-weighted markup elasticity is $\rho = 1/2$ both in a model of oligopoly and in a model of monopolistic competition. I rewrite the two welfare formulas (23) and (22) in terms of ϵ and ρ:

$$d\ln W_j^{MC} = \frac{1}{\epsilon}\left[1 - \frac{\rho}{\epsilon+1}\right](-d\ln s_{jj})$$
$$d\ln W_j^{O} = \frac{1}{\epsilon}\left[1 - \frac{\rho}{\epsilon+1}\right]\left[1 + \frac{\epsilon s_{jj}}{(1-s_{jj})}\right](-d\ln s_{jj})$$

The formula for the model of monopolistic competition is identical to that derived by ACDR. The only difference is in the interpretation of the trade elasticity. In ACDR, ϵ is the shape parameter of the Pareto distribution of firms' productivity while, in my model $\epsilon = 1/\theta$, and θ is the elasticity of the marginal cost of a variety with respect to its distance from the core.

How do the welfare gains from trade differ across the two models when the change $d\ln W_j^{MC}$ is conditional on the same trade elasticity of a model of oligopoly? The trade elasticity in my baseline model can be computed as:

$$\varepsilon^O(\mathbf{s}, \mathbf{M}) = -\frac{d\ln\frac{\Lambda_{ij}}{\Lambda_{jj}}}{d\ln\tau_{ij}} \tag{24}$$

and depends on the vector of market shares $\mathbf{s}$ and on the vector of the number of firms $\mathbf{M}$. A tractable expression for the trade elasticity can be obtained in a symmetric country model. In such a model, $\varepsilon^O \leq \epsilon$ and ε^O is monotonically increasing in the iceberg trade costs $\tau_{ij} \in [1, \infty)$. In particular, the lower bound for the trade elasticity is $\underline{\varepsilon}^O = \epsilon\left[1 + \frac{\epsilon s_{jj}}{(1-s_{jj})}\right]^{-1}$, while the upper bound for the trade elasticity is $\bar{\varepsilon}^O = \epsilon$. Moreover, holding the iceberg trade costs constant, ε^O is decreasing in s_{jj}.

Conditional on the same trade elasticity ε^O, $d\ln W_j^{MC} < d\ln W_j^O$. Relative to the case in which I condition the formulas to the same θ, the difference in magnitude between the welfare predictions of the two models is reduced. The difference between the two models' welfare gains is minimized as trade becomes costless.

3.1.2 Income Effects and Welfare

What are the welfare gains from trade when we ignore income effects? To answer to this question, I compare the welfare gains that arise from my model to those generated by the model of Eckel and Neary (2010). These authors model firms that face cannibalization effects but abstract from income effects by assuming that firms are large in an industry but small relative to the economy. As a result, the authors are able to normalize the marginal utility of income, which carries income effects, to one. The assumption is analogous, in terms of its effect on the scope decisions of firms, to using quasilinear preferences, in which income effects are absorbed by the outside good (Feenstra and Ma, 2007; Mayer et al., 2014)[9]. With Stone-Geary preferences, such an assumption does not allow for any cannibalization effects. Those effects still arise in the model of Eckel and Neary (2010) because of the non-additive component of the linear quadratic preferences[10].

To obtain some intuition on the difference between the two models, I consider a version of (22) where I study the effects of a change in τ keeping the marginal utility of income constant but allowing the other variables to change:

$$d\ln W_j^{EN} = \frac{(\theta+2)}{2}\left[1+\frac{s_{jj}}{\theta(1-s_{jj})}\right](-d\ln s_{jj}) = \left[1+\frac{1}{\theta}\right] d\ln W_j \tag{25}$$

A reduction in trade costs increases the mass of varieties available for consumption as more imported varieties increase the bundle of available goods. By income effects, consumers' willingness to buy a given variety declines with the total number of varieties available. Thus, a reduction in trade costs has the partial effect, through income effects, of reducing the demand for any variety. Hence, neglecting this channel overestimates the consumption of individual varieties and, thus, the welfare gains from trade. In particular, ignoring income effects generates an upward bias in the estimated gains from trade of $1/\theta$.

Fixed Entry

In addition to ignoring income effects, the baseline model of Eckel and Neary (2010) differs from mine in that the authors assume a fixed number of firms. Because of the fixed number of firms, and the lack of free entry, per capita income y_j is different from the wage rate w_j. Hence, the term $\frac{y_j}{w_j}$ in (19) no longer equals one. In the presence of a fixed number of firms, income effects generate a new channel through which trade affects the welfare gains from trade. In fact, trade affects the ratio of per capita income to wages and, thus, the total mass of varieties

[9]In Feenstra and Ma (2007), $\theta \to 0$. In this case, (22) becomes $d\ln W_j^{FM} = \left[\frac{s_{jj}}{1-s_{jj}}\right](-d\ln s_{jj}) < d\ln W_j$: weaker cannibalization effects are the only source of gains from trade.

[10]In Eckel and Neary (2010), the indirect demand for a variety ω can be written as: $p_j(\omega) = a - bq(\omega) - cQ$ where Q is a quantity index that the firms take into account in the profit maximization problem.

available for consumption.

With a fixed number of firms, ignoring income effects yields to overestimate the gains from trade. In the online appendix, I consider the Eckel and Neary (2010) exercise of frictionless trade in an extension of my baseline model with a fixed number of firms. Trade causes an increase in international competition, which reduces firms' market power and, therefore, profits. A decline in profits reduces consumers' per capita income relative to wages. As consumers' income declines, the scope of firms and the total mass of varieties available for consumption also decline. Ignoring income effects on scope, thus, underestimates the change in scope, which overestimates the gains from trade.

Interaction between Cannibalization and Income

In partial equilibrium, income effects interact with cannibalization effects: firms in richer economies tend to have a larger market share and, thus, face stronger cannibalization effects. We may conclude that richer economies gain more from trade given that the market share of the typical firm is larger there. However, such a partial effect is dominated by general equilibrium effects that determine per capita income. Although cannibalization effects are stronger in the more productive countries, the less productive country gains more from trade. In addition, small economies gain more than large economies.

3.1.3 Homothetic Preferences and Welfare

Homothetic preferences of the Constant Elasticity of Substitution (CES) form are largely used in the international trade literature (Krugman, 1980; Melitz, 2003; Bernard et al., 2011). How do CES preferences affect the welfare gains from trade relative to my baseline model? Consider an extension to the baseline model where consumers have CES preferences with elasticity of substitution $\sigma > 1$. Since with CES preferences the choke price is infinite, we need a fixed cost per variety and destination f_{ij} for the optimal scope to be finite. Other than the fixed cost per variety, the problem of a firm is identical to that of the baseline model of section 2.

Relative to the baseline model, there are two key differences. First, a direct consequence of CES preferences is that markups are constant within a firm. Although markups increase with the market share of a firm, they are identical across the varieties produced by the same firm. Second, firms export more varieties in larger economies, regardless of their level of per capita income. In this sense, using CES preferences ignores income effects on scope. Details are in the online appendix.

Table 1 illustrates how the welfare gains from trade are affected by the different preferences, under monopolistic competition and Cournot competition. In a model of CES preferences, for a given value of $d \ln s_{jj}$, the welfare gains that arise in a model with cannibalization effects are larger than those arising in a model of monopolistic competition. Moreover, the larger the

Table 1: Welfare gains ($d \ln W_j$) with homothetic and non-homothetic preferences

	Homothetic (CES)	Non-Homothetic
No Cannibalization	$\frac{1}{\epsilon}(-d \ln s_{jj})$	$\frac{1}{\epsilon}\left[1-\frac{\rho}{\epsilon+1}\right](-d \ln s_{jj})$
Cannibalization	$\frac{1}{\epsilon}\left[1+\left(\frac{\epsilon\sigma}{\sigma-1}-1\right)\frac{s_{jj}}{1-s_{jj}}\right](-d \ln s_{jj})$	$\frac{1}{\epsilon}\left[1-\frac{\rho}{\epsilon+1}\right]\left[1+\frac{\epsilon s_{jj}}{1-s_{jj}}\right](-d \ln s_{jj})$

current level of the market share, the larger the welfare gains[11].

An alternative homothetic preference structure is that of Hottman et al. (2016). The authors assume that preferences are of the Nested-CES form where σ is the elasticity of substitution across firms, and η is the elasticity of substitution across the varieties within a firm. If $\eta > \sigma$, when a firm introduces a new variety, it reduces its own sales by more than its competitors. Under such preferences, the welfare formula is identical to the formula shown in Table 1 with $\epsilon = \left[\theta + \frac{\eta-\sigma}{(\sigma-1)(\eta-1)}\right]^{-1}$. ϵ depends on the distribution of marginal costs within a firm and on the differences in the elasticity of substitution within and across firms.

Welfare Gains Conditional on Trade Elasticity

For a given ϵ and $d \ln s_{jj}$, the welfare gains from trade in a model of homothetic preferences are larger under Cournot competition relative to monopolistic competition. How does the result change if we assume that ϵ in the ACR formula is the trade elasticity generated by a model of Cournot competition?

Conditioning the two formulas to the same trade elasticity reduces the difference between the two welfare predictions since the larger s_{jj}, the smaller the trade elasticity. Moreover, while with non-homothetic preferences welfare gains are always larger with Cournot competition, under homothetic preferences the welfare gains conditional on the trade elasticity under the two market structures are identical as the iceberg trade cost approaches one. This can partially explain the success of the ACR formula in models of large firms with CES preferences such as Edmond et al. (2015)[12]. Details are in the online appendix.

Comparison with Baseline Model

In a model of monopolistic competition, the welfare gains from trade can be computed using

[11] The term multiplying $\frac{s_{jj}}{1-s_{jj}}$ is positive.

[12] Edmond et al. (2015) also assume an integer number of firms and no free entry, which additionally reduces the difference between the ACR formula and the formula for the welfare gains under CES preferences and Cournot competition, for the reasons described in sections 3.1.2 and 3.3.3

the same formula of ACR and ACDR. The first row of Table 1 replicates ACDR's result with homogeneous multiproduct firms: the welfare gains in a model with non-homothetic preferences are smaller than those arising from a model of homothetic preferences. Such a result also holds in a world of cannibalization effects (second row of Table 1). With non-homothetic preferences, a reduction in trade costs increases the markups of foreign exporters reducing the welfare gains from trade relative to the CES model (ACDR).

However, the difference between my baseline model and a model of large firms with homothetic preferences goes beyond the difference highlighted by ACDR. In fact, cannibalization effects interact with the preferences chosen, and the difference between the two models increases with s_{jj}. To understand the intuition behind the result, I consider the distortions present in the two models. In the online appendix, I compare the allocation that emerges under Cournot competition to that of monopolistic competition and to that of a social planner.

With CES preferences, the market allocation is efficient under monopolistic competition (Melitz and Redding, 2015). However, the oligopolistic allocation is inefficient: all varieties are underconsumed relative to the planner's allocation. Large firms exploit their market power and charge higher markups and supply fewer varieties relative to monopolistically competitive firms. Trade reduces these distortions as domestic firms lose their market power and thus charge lower markups and face weaker cannibalization effects.

The same distortions are present in my baseline model. Trade reduces these distortions as it brings the oligopolistic allocation closer to the one emerging under monopolistic competition. However, the monopolistically competitive allocation with non-homothetic preferences is inefficient. In particular, high-markup varieties are underconsumed, and low-markup varieties are overconsumed. As a result, firms' scope is too wide relative to the planner's allocation. Dhingra and Morrow (2016) describe such inefficiency as a *business stealing bias*: monopolistically competitive firms do not internalize the business stealing effect of new varieties and produce too many of them.

Because of cannibalization effects, firms partially internalize the business stealing bias. As a result, firms under oligopoly produce fewer varieties relative to the allocation with monopolistic competition. The scope of oligopolistic firms may be larger, equal, or smaller than the planner's allocation depending on the strength of cannibalization effects. Hence, while oligopoly in the CES case is only distortionary, in my baseline model oligopoly partially reduces the business stealing bias that emerges in a model of monopolistic competition. As a result, there is an additional channel through which the gains from trade in a model of CES preferences are larger than those that emerge in my baseline model.

3.2 Quantifying the Mismeasurement

The previous section showed that neglecting income or cannibalization effects causes mismeasurement of the welfare gains from trade. In this section, I quantify the extent of the mismeasurement using US industry-level data for the period 2002 to 2007. I compare the formulas of the four models shown in table 1, conditional on the same parameters ϵ and σ, and on the level and change in s_{jj}. I measure the market share of the typical superstar s_{jj} as the average market share of the largest four US firms in a given manufacturing industry[13] where an industry is a 4 digit NAICS code. I compute the change in the market share of the typical superstar $d \ln s_{jj}$ from 2002 to 2007. In order to generate results comparable to the literature, I use the industry-specific trade elasticities ϵ estimated by Caliendo and Parro (2015) and the median σ by industry from Soderbery (2015)[14].

The market share of the typical superstar fell by 7% on average from 2002 to 2007. Such change varies considerably across industries: for cement and basic chemicals, s_{jj} rose by more than 40% while, within machinery manufacturing, it fell by more than 50%. I compute the industry-specific welfare changes predicted by the four models of Table 1. Table 2 reports the weighted average welfare change as well as the average difference in gains relative to the baseline model of section 2. I implicitly ignore any interactions across industries.

Table 2: Welfare Gains Across Models (2007-2002)

Model	$d \ln W$ (%)	% Difference rel. to Baseline
Non-Homothetic - Cannib.	4.28	(Baseline)
	(9.38)	
Non-Homothetic - Mon. Comp.	3.52	-20.21
	(8.34)	(12.96)
CES - Cannib.	5.13	18.58
	(11.33)	(7.06)
CES - Mon. Comp.	4.32	-7.90
	(10.38)	(20.38)

The table reports $d \ln W$ and the % Difference $(W_m/W_{Baseline} - 1)$ relative to the baseline model averaged across industries. Standard errors in parenthesis. All values are in percentages.

According to the baseline formula, welfare improved by 4.28% from 2002 to 2007. The relatively large standard deviations reflect the high heterogeneity in welfare changes across industries. In fact, welfare improved by more than 30% in commercial and service industry machinery and engine and turbine equipment as the market share of the typical superstar in

[13] In a given industry, $s_{jj} = \tilde{s}_{jj}\Lambda_{jj}$ where $\tilde{s}_{jj}$ is the average share of the largest four firms over total US shipments from the US Census of Manufacturers, and Λ_{jj} is industry-specific US domestic absorption. For robustness, I also use the market share of the eight largest firms as well as the share of the typical firm defined by Feenstra and Weinstein (2016) as $H_j\Lambda_{jj}$ where H_j is the Herfindhal index. Similar results are achieved if I focus only on consumer goods industries. Details are in the online appendix.

[14] Following Broda and Weinstein (2006), Soderbery (2015) provides HS 10 digit specific σ from 1993 to 2007.

these industries halved. At the other end of the spectrum, the production of cement recorded the largest fall in welfare (58%). Appendix 6.3 reports the full list of industry-level welfare changes.

Neglecting cannibalization effects but maintaining non-homothetic preferences underestimates the welfare gains from trade by 20% on average. The magnitude of the mismeasurement is large for industries that are more concentrated and with a larger trade elasticity: for pulp and paper, household appliances, and magnetic and optical media the difference between the baseline model and a model with no cannibalization effects is approximately 50%. The difference between the two models is significantly smaller in industries that are less concentrated or have smaller trade elasticities: for plastic products and metalworking machinery, the difference between the two models is approximately 2%.

Neglecting per capita income but maintaining the assumption of cannibalization overestimates the welfare gains by 19%[15]. The degree of heterogeneity is milder as the standard deviation of the mismeasurement is half that of the previous case.

Although ignoring cannibalization underestimates the gains by 20% and ignoring per capita income overestimates the gains by 19%, the two effects do not cancel each other out. In fact, the model with CES preferences and monopolistic competition predicts welfare gains that are 7.9% lower than the baseline model. Moreover, there is substantial heterogeneity across industries: the standard deviation of the mismeasurement is more than twice its average. In this case, the gains are underestimated in concentrated industries — in which cannibalization effects are strong — while they are overestimated in more competitive industries in which the role of income dominates that of cannibalization effects.

3.3 Model's Extensions

In this section, I study the welfare gains from trade under three extensions of my baseline model. First, I examine the contribution of cannibalization effects to the welfare gains from trade relative to a model of large single product firms (Edmond et al., 2015). Second, I consider a model where large firms compete with a competitive fringe (Parenti, 2016). Third, I take into account the integer problem. I leave the details to the online appendix.

[15] The numbers would be even larger if we assume away income effects by keeping the marginal utility of income constant. In such a case, the welfare gains from trade (25) are $1+\epsilon$ times larger than the baseline case. A trade elasticity of 5 (Head and Mayer, 2013a) implies that welfare gains would be six times larger than those predicted by the baseline model.

3.3.1 Single Product Firms

Consider the model of CES preferences discussed in section 3.1.3. Suppose that each firm only produces one variety[16]. The formula for the welfare gains from a small reduction in the iceberg trade costs becomes:

$$d \ln W_j = \left[\frac{1}{\epsilon} + \frac{s_{jj}}{1 - s_{jj}} \right] (-d \ln s_{jj}) \tag{26}$$

where $\epsilon = \sigma - 1$. Consistent with the results of Edmond et al. (2015), the larger the market share of the typical domestic firm, the larger the welfare gains from trade. A fall in trade costs yields pro-competitive welfare gains by reducing the average markup in the economy and, thus, improving consumers' welfare. If the market share of the typical firm is zero, the welfare formula is identical to that of the Krugman (1980) model as shown by ACR.

To highlight the contribution of cannibalization effects, I re-write the formula shown in Table 1 in the following way:

$$d \ln W_j = \left[\frac{1}{\epsilon} + \frac{s_{jj}}{1 - s_{jj}} + \left(\frac{1}{\sigma - 1} - \frac{1}{\epsilon} \right) \frac{s_{jj}}{1 - s_{jj}} \right] (-d \ln s_{jj}) \tag{27}$$

The presence of cannibalization effects improves the welfare gains from trade. A reduction in trade cost reduces markups and also weakens the cannibalization effects on the scope. The second term that multiplies $\frac{s_{jj}}{1-s_{jj}}$ has a nice interpretation. $\frac{1}{\sigma-1}$ is the consumer's love for variety or the marginal benefit from an additional variety (Benassy, 1996). $\frac{1}{\epsilon} = \theta$ represents the elasticity of marginal costs with respect to scope. Since the marginal benefit of the new variety is larger than the marginal cost, that is $\frac{1}{\sigma-1} > \frac{1}{\epsilon}$, weakening cannibalization effects is welfare improving.

3.3.2 Superstars VS Competitive Fringe

For tractability, the baseline model assumes that the large oligopolists are the only active firms. This section studies how the interaction between small and large multiproduct firms affect the welfare gains from trade. A model of heterogeneous oligopolists, as in Edmond et al. (2015), would not yield analytical expressions for the welfare gains from trade. Hence, I follow Parenti (2016) and add a multiproduct competitive fringe to my baseline model.

Let superscript o denote the variables of interest of large multiproduct firms and c those of the competitive fringe. An infinite number of perfectly competitive firms is producing in i and selling to j a continuum of varieties indexed by $\omega \in [0, \delta^c_{ij}]$. The marginal cost of producing a variety ω by the competitive fringe is $c^c_{ij}(\omega) = \tau_{ij} w_i c^c_i \omega^\theta$. Without loss of generality, I assume that θ is common across all firms and that $c^c_i > c^o_i$.

[16] A model of large single product firms with non-homothetic preferences does not yield a closed form expression for the welfare gains from trade.

Let the preferences of consumers in country j be represented by the following utility function:

$$U_j = \sum_{i=h,f} \left(\alpha \sum_{k=1}^{M_i} \int_0^{\delta^o_{kij}} \left[\ln(q^o_{kij}(\omega) + \bar{q}) - \ln(\bar{q}) \right] d\omega + (1-\alpha) \int_0^{\delta^c_{ij}} \left[\ln(q^c_{ij}(\omega) + \bar{q}) - \ln(\bar{q}) \right] d\omega \right)$$

where α is the weight on the goods produced by large multiproduct firms. If $\alpha = 1$, the model is the same as in section 2, whereas if $\alpha = 0$, all the varieties are produced by the competitive fringe.

The welfare change in country j from a small reduction in trade costs equals:

$$d \ln W_j = \underbrace{\mu^o_j \left[\frac{\theta(\theta+2)}{2(\theta+1)} \right] \left[1 + \frac{s_{jj}}{\theta(1-s_{jj})} \right] (-d \ln s_{jj})}_{\text{Large Multiproduct Firms}} + \mu^c_j \underbrace{\theta(-d \ln \Lambda^c_{jj})}_{\text{Competitive Fringe}} + \underbrace{\frac{\theta}{2} \mu^c_j d \ln \mu^c_j}_{\text{Interaction}} \qquad (28)$$

where the weight μ^o_j (μ^c_j) is the expenditure share in country j on goods produced by superstars (competitive fringe), both domestic and foreign. As in the baseline model, s_{jj} is the domestic market share of the typical large domestic firm. Λ^c_{jj} is the domestic expenditure share on goods produced by the domestic competitive fringe.

The welfare gains from trade can be decomposed in three components. The first is the welfare formula that arises in a model of large multiproduct firms weighted by the expenditure share on the goods of superstars μ^o_j. The second term is the welfare formula generated by a model of perfect competition weighted by μ^c_j. In addition, there is an interaction term whose sign depends on whether a reduction in trade costs increases or decreases the expenditure share on the competitive fringe's goods. The appendix shows that the contribution to welfare of the interaction and second term is positive.

The presence of a competitive fringe does not alter the welfare effects of large multiproduct firms. The larger the market share of the typical firm s_{jj}, the larger the gains from trade both because of the weakening of cannibalization effects and because of the larger share of goods produced by oligopolists in the consumption bundle μ^o_j.

3.3.3 Integer Number of Firms

The baseline model ignores the so-called integer problem (Neary, 2010a) as in Feenstra and Ma (2007), Eckel and Neary (2010), and Ottaviano and Thisse (2011). Free entry implies that profits are exactly equal to zero: for such a condition to be satisfied for any set of parameters, the number of firms M_i must be a real number. In this section, I discuss the welfare consequences of limiting the number of firms to an integer number.

Following Eaton et al. (2012), the equilibrium number of firms M_j is such that the profits of the M_j firms are positive or zero, and entry of an additional firm generates negative profits.

Since profits are no longer equal to zero, per capita income equals the sum of the labor wage and of the per capita profits:

$$y_j = w_j + \frac{\Pi_j M_j}{L_j}$$

As per capita income differs from the wage, the welfare formula becomes:

$$d \ln W_j = \underbrace{\frac{\theta(\theta+2)}{2(\theta+1)} \left[1 + \frac{s_{jj}}{\theta(1-s_{jj})}\right] (-d \ln s_{jj})}_{\text{Baseline Formula}} + \underbrace{\frac{\theta(\theta+2)}{2(\theta+1)} d \ln y_j}_{\text{Integer Problem}}$$

The welfare formula consists of two components. The first one is the baseline formula (22). The second component, which I label "Integer Problem", is the change in per capita income relative to the wage rate. Since per capita income is not equal to the wage, changes in y_j affect the mass of varieties available for consumption (19). The "Integer problem" component depends on the presence of income effects: a model with quasi-linear preferences would not feature it.

The sign of $d \ln y$ is ambiguous: accounting for the integer problem can yield larger or smaller gains from trade relative to the baseline model. The sign of $d \ln y_j$ depends on whether the trade shock generates a discrete change in the number of firms or if it leaves M_j constant. A reduction in trade costs reduces firms' profits: trade reduces domestic market shares and it increases the foreign market share. As firms charge higher markups in the domestic market relative to the export markets, trade reduces firms' profits. If M_j is continuous, a reduction in profits leads to firms' exit. With an integer number of firms, the reduction in trade costs may leave M_j constant.

If the reduction in trade costs leaves the number of firms unchanged, the reduction in profits due to trade causes a reduction in per capita income relative to the wage. As a result, welfare increases by a smaller amount relative to the baseline model. On the other hand, if the reduction in trade costs generates exit of firms, the surviving firms enjoy larger profits. When trade reduces the integer number of firms, per capita income increases, and the welfare gains from trade are larger than those predicted by the baseline model.

4 Test of the Hypothesis of the Model

This section tests the two main hypotheses of the theoretical model: that income and cannibalization effects drive the scope of large firms. The source for the data is the Exporter Dynamics Database, which reports data on export values at the product-firm-destination level (Fernandes et al., 2016). A product is a Harmonized System (HS) 6 digit good. As my model considers firms producing final goods, I restrict the sample to manufactured consumption goods according to the Broad Economic Category (BEC) classification. Details are in appendix 6.4.1.

The first hypothesis of the model is that income effects drive the scope of firms. By income effects, the model predicts a positive relationship between the scope of exporters and the per capita income of the destination. While the literature documented a positive relationship between the *aggregate* number of varieties exported by a country and the per capita income of the destination (Hummels and Klenow, 2002), I focus on the *within-firm* number of varieties exported. The results depend on the size of the firm: controlling for the size of the destination, I document that large firms export a wider scope in richer economies while small firms' scope is unaffected by per capita income.

Moreover, using data from the online stores of multinationals, I document that the effects of size and per capita income of the destination depend on distribution channels used. While in traditional distribution channels both per capita income and aggregate income affect the scope decisions of firms, in online retail only per capita income has an effect.

The second hypothesis of the model is the presence of cannibalization effects. The model highlights two opposing forces that influence the optimal scope of a firm. On the one hand expanding the firm's scope increases the firm's market share at the expenses of other firms. On the other hand, an increase in the firm's market share strengthens the cannibalization effects and, thus, reduces the firm's scope. In equilibrium, the two forces generate the non-monotone hump-shaped relationship between the scope and the market share of a firm. I test this prediction by tracing the hump-shaped relationship between a firm's scope across destinations and its market share across destinations, controlling for all observed and unobserved characteristics of the firm and the destination. Hence, the test of cannibalization effects is different than the one performed by Raff and Wagner (2013) who test cannibalization effects across firms finding a hump-shaped relationship between the scope and productivity of German firms[17].

4.1 The Product Scope of Mexican Exporters

To test income effects on scope, I consider the following regression model based on (17):

$$\ln(\#\ \text{Products}_{kMjt}) = \beta_0 + \beta_y \ln(\text{Pc. Income}_{jt}) + \beta_L \ln(\text{GDP}_{jt}) + \beta_\tau \tau_{Mjt} + f_k + g_t + \epsilon_{kMjt} \quad (29)$$

The dependent variable is the log of the number of products exported by firm k from Mexico to country j in year t. The relevant independent variable is real per capita GDP from WDI. In addition, I control for the size of the destination using real GDP[18]. β_y can be interpreted as the effect of per capita income on the scope of an exporter conditional on the size of the

[17] Other than Raff and Wagner (2013), the evidence on cannibalization effects in the literature is scarce and mainly anecdotal (Copulsky, 1976; Kerin et al., 1978)

[18] Similar results are achieved using $\ln(\text{Population})_{jt}$. However, comparing the coefficients between GDP and per capita GDP is more immediate.

destination. τ_{Mjt} is a vector of trade barriers from CEPII (Head et al., 2010) that includes the log of bilateral distance, dummies for the presence of a shared border, commonality of language, and destination specific dummies for islands and landlocked countries. I control for firms' productivity with firm-level fixed effects (f_k) and for year shocks with year fixed effects (g_t). ϵ_{kMjt} is the error term[19].

I consider three different subsamples of my data. For each year, I divide multiproduct exporters in percentiles by their total sales across all varieties and destinations as a proxy for productivity. I estimate (29) with OLS on the bottom 95% of multiproduct exporters as well as the top 5% and 1%. Table 3 shows the results.

Multiproduct firms export more varieties in larger economies as the coefficient on GDP is positive and statistically significant in all samples. This result is consistent with a model that features a fixed cost per variety and destination. Conditional on size, superstars export more varieties in richer economies. The coefficient on per capita income, in fact, is positive and statistically significant for the top 5% and 1% of multiproduct exporters. Doubling the per capita income of the destination increases the scope of the top 1% of exporters by 11%. The coefficient on per capita income is close to zero and insignificant for small firms, which suggests that fixed costs per variety have a larger effects on small firms[20].

Table 3: Per Capita Income and Product Scope of Mexican Multiproduct Exporters

	Bottom 95%	Top 5%	Top 1%
Log(Pc.income)	0.027	0.065***	0.113***
	(0.023)	(0.023)	(0.037)
log(GDP)	0.056***	0.102***	0.161***
	(0.014)	(0.015)	(0.023)
Log(Distance)	-0.198***	-0.357***	-0.550***
	(0.062)	(0.072)	(0.102)
Border	0.259*	0.357**	0.265
	(0.149)	(0.167)	(0.168)
Comm. Language	0.150**	0.329***	0.549***
	(0.074)	(0.087)	(0.124)
Island	0.023	0.046	0.085
	(0.043)	(0.062)	(0.097)
Landlocked	0.015	-0.093	-0.167*
	(0.033)	(0.057)	(0.101)
R^2	0.60	0.59	0.67
# Observations	80718	14157	4380

Results from OLS of equation (29). Robust std. error in parenthesis. Cluster: destination. ***: significant at 99%, ** at 95%, * at 90%. Column (1): bottom 95% of MPF, (2): top 5%, (3): top 1%.

As the model predicts, firms' scope negatively depends on trade costs. Among the geograph-

[19] Although the model features symmetric firms, the optimal scope (17) is derived for asymmetric firms.

[20] In appendix 6.4.3 I additionally document the interaction between per capita income and market share: the market share of exporters increases with the per capita income of the destination as predicted by the model.

ical barriers that proxy trade costs, distance and the commonality of language are the more statistically and economically significant[21]. The empirical relevance of the language dummy suggests that Mexican exports are strongly determined by cultural variables and long-run persistence of taste across countries as argued by Head and Mayer (2013b)[22].

To test for the presence of cannibalization effects, I use the following regression model:

$$\ln(\#\text{ Products}_{kMjt}) = \beta_1 s_{kMjt} + \beta_2 s^2_{kMjt} + f_k + d_{jt} + \epsilon_{kMjt} \tag{30}$$

where the dependent variable is the log of the number of products exported by firm k from Mexico to country j in year t. Following Amiti et al. (2014), the market share of a Mexican firm k in destination j is defined as $s_{kMjt} = \ln(1 + \frac{\text{Export}_{kMjt}}{\text{Tot Export}_{Mjt}})$ where Tot Export$_{Mjt}$ is the total exports of Mexico to j in the industry of firm k[23], and s^2_{kMjt} is the orthogonalized squared market share[24]. Guided by the model, I include firm-level fixed effects to control for firms' productivity. Moreover, to control all the observed and unobserved destination variables and trade costs, I use destination-year fixed effects d_{jt}.

Table 4: Multiproduct Firms and their Market Share

	Bottom 95%	Top 5%	Top 1%
s_{kij}	0.209***	0.343***	0.318***
	(0.012)	(0.025)	(0.056)
s^2_{kij}	-0.148***	-0.478***	-0.497***
	(0.014)	(0.047)	(0.099)
R^2	0.63	0.69	0.82
# Observations	82602	14184	4224

Results from OLS of equation (30). Robust std. error in parenthesis. Cluster: destination country. ***: significant at 99%, ** at 95%, * at 90%. The ratio of firms' exports to total exports is normalized by the year sample average.

Table 4 confirms the hump-shaped relationship between scope and market share of the firm in a destination. In each subsample, the estimated coefficient on s_{kMjt} is positive and statistically significant while the estimated coefficient on s^2_{kMjt} is negative and statistically significant.

[21] A corollary of the first fact confirmed by the data is that firms exports their core varieties across all destinations and export their non-core varieties in the richer economies. Details are in the online appendix.

[22] The coefficients on distance and commonality of language are larger, in absolute value, for the larger firms. Through the lens of the model, the result suggests that larger firms have a lower θ and hence feature a better flexibility in the introduction of new varieties. The difference in coefficients across sample is not robust to analyzing the full sample of firms or of countries in the Exporter Dynamics Database.

[23] An industry is an HS Section. Results are robust to alternative definitions of industries.

[24] s^2_{kMjt} is orthogonalized to avoid multicollinearity issues between the linear and quadratic market share (Montgomery et al., 2013). There are several techniques to orthogonalize polynomials (Montgomery et al., 2013). Here, I regress the market share squared on s_{kMjt} and firm and year fixed effects and record the residuals as s^2_{kMjt}. Results are robust to using the non-orthogonalized market share squared.

I consider two additional tests of non-monotonicity. First, I use the Lind and Mehlum (2010) methodology, which tests whether the slope of the relationship is positive for small sample values of s_{kMjt} and negative for large sample values of s_{kMjt}. In other words, the test verifies the presence of the upward and downward sloping part of (30) within the sample of observed market shares[25]. As documented in appendix 6.4.2, for the top 5% and 1% of multiproduct exporters, the hump-shaped relationship robustly passes the Lind and Mehlum (2010) test for non-monotone relationships.

The second test of non-monotonicity is non-parametric. I regress the scope of exporters on destination-year fixed effects and firm-level fixed effects. The residual of the regression is the scope of exporters conditional on firm and destination characteristics. Similarly, I regress the market share of exporters on destination-year fixed effects and firm-level fixed effects and record the residual. I then study the relationship between the residual scope and the residual market share using a kernel-weighted local polynomial regression smoothing. Figure 3 in appendix 6.4.2 further supports the non-monotonicity of the relationship.

4.2 Robustness Analysis

This section briefly summarizes the robustness analysis, leaving all results to the online appendix. In addition to Mexico, the Exporter Dynamics Database covers ten source countries: Albania, Burkina Faso, Bulgaria, Guatemala, Jordan, Malawi, Peru, Senegal, Uruguay, and Yemen from 1993 to 2011. The results of this section continue to hold when considering the entire sample of source countries. The results so far presented rely on real per capita GDP as measure of per capita income. Following Simonovska (2015), I repeat the analysis using different measures of per capita income: nominal per capita GDP, PPP-adjusted per capita GDP, GNI measured according to the Atlas method, GNI, and household consumption, finding similar results. Results are also robust to allowing for changes in the set of geographical controls and definitions of distance. Moreover, results are similar when I use alternative distributions of firms[26] or measures of s_{kMj}[27].

The scope of an exporter has so far been represented by the number of HS 6 digit goods exported by a firm. Although common in the literature (Arkolakis et al., 2014), such a classification could cause some measurement errors as it hides the number of varieties exported by

[25]The test has been used by Rodrik (2016) to verify the presence of a hump-shaped relationship between manufacturing employment and time and by Galor and Klemp (2014) in the context of the hump-shaped relationship between fecundity and reproductive success in the long run.

[26]I divide firms in percentiles according to 1) lagged total sales, 2) sales in the US, which is the top destination for Mexican firms, and 3) by industry. Additionally, I consider the sample of all firms (not only multiproduct), and I control for entry and exit.

[27]I use s_{kMj} defined as the ratio of firm k exports to j relative to total and industry-level imports of j and household consumption in j

a firm within a HS 6 digit product, thus, potentially biasing the results. To address the issue, I analyze the two stylized facts with two alternative datasets in the Appendix. Following the example of Simonovska (2015) and Cavallo et al. (2014), I create an original dataset with the number of varieties of mobile products sold by Samsung in 50 countries in 2015. In addition, I use the dataset built by Cavallo et al. (2014), which provides the total number of varieties sold by Apple, H&M, Ikea, and Zara in their online stores. These large multinationals offer more varieties in richer economies while the effect of market size on scope is negligible. To verify the robustness of the second stylized fact, I use the data on the sales of car models in five European economies provided by Goldberg and Verboven (2005). The dataset supports the finding of a non-monotone hump-shaped relationship between scope and market share. The results are shown in appendix 6.5.

5 Conclusion

I have argued that the level of development of the destination and the competition among the varieties produced by a firm - cannibalization effects - are relevant determinants of the scope of large multiproduct exporters. The model showed that both determinants play a key role in measuring the welfare gains from trade. For the United States, neglecting cannibalization effects, as in traditional models of monopolistic competition, underestimates welfare gains by 20% on average. The more concentrated the industry, the larger the underestimation. On the other hand, neglecting income effects overestimates welfare gains for the United States by 19%.

Recent work by Freund and Pierola (2015) highlights the relevance of export superstars, and this paper is the first to study their effects on welfare. Future avenues of research could examine the reasons why superstars emerge or further explore the role of cannibalization effects in the context of input-output linkages across industries or within-country income inequality.

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6 Appendix

6.1 Model's Derivations

6.1.1 Firms' Problem

In the main text, I derived the first order conditions with respect to $x_{kij}(\omega)$ and δ_{kij}:

$$\frac{1}{\lambda_j}\frac{L_j^2\bar{q}}{(x_{kij}(\omega)+L_j\bar{q})^2}(1-s_{kij})-c_{kij}(\omega)=0 \tag{31}$$

$$\frac{L_j}{\lambda_j}\frac{x_{kij}(\delta_{kij})}{x_{kij}(\delta_{kij})+L_j\bar{q}}(1-s_{kij})-x_{kij}(\delta_{kij})c_{kij}(\delta_{kij})=0 \tag{32}$$

where $x_{kij}(\delta_{kij})=0$ satisfies (32). Let us prove that $x_{kij}(\delta_{kij})=0$ is solution to (32). By contradiction suppose instead $x_{kij}(\delta_{kij})>0$. Then we can simplify (32).

$$\frac{L_j}{\lambda_j}\frac{1}{x_{kij}(\delta_{kij})+L_j\bar{q}}(1-s_j)=c_j(\delta_{kij})$$

$$x_{kij}(\delta_{kij})=\frac{L_j(1-s_j)}{\lambda c_j(\delta_{kij})}-L_j\bar{q} \tag{33}$$

Substituting this result in the first order condition with respect to quantity (31) yields:

$$L_j\left[\frac{\bar{q}(1-s_j)}{\lambda c_j(\delta_{kij})}\right]^{\frac{1}{2}}-L_j\bar{q}=\frac{L_j(1-s_j)}{\lambda_j c_j(\delta_{kij})}-L\bar{q}$$

$$c_j(\delta_{kij})=\frac{(1-s_j)}{\bar{q}\lambda_j}$$

Substituting it into the pricing equation yields:

$$p_{kij}(\delta_{kij})=\frac{1}{\lambda_j\bar{q}}$$

By evaluating the inverse demand function at $q_j(\omega)=0$, the choke price p_j^{max} equals:

$$p_j^{max}=\frac{1}{\lambda_j\bar{q}} \tag{34}$$

Hence, $p_{kij}(\delta_{kij})=p_j^{max}$, and therefore $x_{kij}(\delta_{kij})=0$, a contradiction with the hypothesis $x_{kij}(\delta_{kij})>0$. To conclude the argument, let us consider the second order condition with respect to δ_{kij}:

$$\frac{\partial^2\Pi_j}{\partial\delta_{kij}^2}=-\frac{L_j}{\lambda_j^2}\frac{x_{kij}(\delta_{kij})}{x_{kij}(\delta_{kij})+L_j\bar{q}}(1-s_j)\frac{\partial\lambda_j}{\partial\delta_{kij}}-\frac{L_j}{\lambda_j}\frac{x_{kij}(\delta_{kij})}{x_{kij}(\delta_{kij})+L_j\bar{q}}\frac{\partial s_j}{\partial\delta_{kij}}-x_{kij}(\delta_{kij})\frac{\partial c_j(\delta_{kij})}{\partial\delta_{kij}}$$

where the terms multiplying $\frac{\partial x_{kij}(\delta_{kij})}{\partial \delta_{kij}}$ are equal to zero by the first order conditions with respect to $x_{kij}(\omega)$ and, thus, are ignored here. The second order condition is zero at the equilibrium, but it is negative for $x_{kij}(\delta_{kij}) > 0$. In fact, $\frac{\partial \lambda_j}{\partial \delta_{kij}} > 0$. In addition, since $\left[\int_0^{\delta_{kij}} \frac{x_{kij}(\omega)}{x_{kij}(\omega)+L_j\bar{q}}\right]$ is increasing in the mass of varieties, so is the market share.

6.1.2 Characterization of the Equilibrium

This section shows the derivations of the equilibrium condition of the model. Recall the implicit equation that defines the scope of a firm from i to j:

$$c_{ij}(\delta_{ij}) = \frac{(1-s_{ij})}{\bar{q}\lambda_j} \tag{35}$$

Using our functional form for the marginal cost $c_{ij}(\omega) = y_i\tau_{ij}c_i\omega^\theta$, we obtain:

$$\tau_{ij}w_ic_i\delta_{ij}^\theta = \frac{1-s_{ij}}{\bar{q}\lambda_j}$$

We can express both quantities and prices as functions of the marginal cost of the last variety:

$$x_{ij}(\omega) = \bar{q}L_j\left[\left(\frac{c_{ij}(\delta_{ij})}{c_{ij}(\omega)}\right)^{\frac{1}{2}} - 1\right] = \bar{q}L_j\left[\left(\frac{\delta_{ij}}{\omega}\right)^{\frac{\theta}{2}} - 1\right] \tag{36}$$

$$p_{ij}(\omega) = \frac{[c_{ij}(\omega)c_{ij}(\delta_{ij})]^{\frac{1}{2}}}{1-s_{ij}} = \frac{w_i\tau_{ij}c_i[\omega\delta_{ij}]^{\frac{\theta}{2}}}{1-s_{ij}}$$

Revenues and total variable costs to produce in i and sell to j are:

$$r_{ij} = \int_0^{\delta_{ij}} p_{ij}(\omega)x_{ij}(\omega)d\omega = \frac{\bar{q}L_jw_i\tau_{ij}c_i}{1-s_{ij}}\int_0^{\delta_{ij}}\left[\delta_{ij}^\theta - (\delta_{ij}\omega)^{\frac{\theta}{2}}\right]d\omega = \frac{\theta\bar{q}L_jw_i\tau_{ij}c_i\delta_{ij}^{\theta+1}}{(1-s_{ij})(\theta+2)}$$
$$C_{ij} = \int_0^{\delta_{ij}} c_{ij}(\omega)x_{ij}(\omega)d\omega = \bar{q}L_jw_i\tau_{ij}c_i\int_0^{\delta_{ij}}\left[(\delta_{ij}\omega)^{\frac{\theta}{2}} - \omega^\theta\right]d\omega = \frac{\theta\bar{q}L_jw_i\tau_{ij}c_i\delta_{ij}^{\theta+1}}{(\theta+1)(\theta+2)}$$

Hence, since $r_{ij} = s_{ij}y_jL_j$,

$$C_{ij} = \frac{r_{ij}(1-s_{ij})}{\theta+1} = \frac{s_{ij}y_jL_j(1-s_{ij})}{\theta+1}$$

The operating profits of a firm from i to j are:

$$\pi_{ij} = r_{ij} - C_{ij} = \frac{s_{ij}^2+\theta s_{ij}}{\theta+1}y_jL_j \tag{37}$$

Let us now look at our definition of market share. First, note that using our cutoff condition (35), we can re-write the revenues of a firm as:

$$r_{ij} = \frac{\theta \bar{q} L_j w_i \tau_{ij} c_i \delta_{ij}^{\theta+1}}{(1-s_{ij})(\theta+2)} = \frac{\theta L_j \delta_{ij} \bar{q} c_{ij}(\delta_{ij})}{(\theta+2)(1-s_{ij})} = \frac{\theta L_j \delta_{ij}}{\lambda_j(\theta+2)}$$

Let the mass of varieties available for consumption be denoted by $\Delta_j = \sum_i M_i \delta_{ij}$. Firm's market share equals the ratio between that firm's scope and Δ_j:

$$s_{ij} = \frac{r_{ij}}{M_j r_{jj} + M_i r_{ij}} = \frac{\delta_{ij}}{M_j \delta_{jj} + M_i \delta_{ij}} = \frac{\delta_{ij}}{\Delta_j} \tag{38}$$

Finally, the marginal utility of income λ_j is given by:

$$\begin{aligned}\lambda_j &= \frac{1}{y_j}\left[\sum_{i=h,f} M_i \int_0^{\delta_{ij}} \frac{x_{ij}(\omega)}{x_{ij}(\omega) + L_j \bar{q}} d\omega\right] = \frac{1}{y_j}\left[\sum_{i=h,f} M_i \int_0^{\delta_{ij}} \left(1 - \left(\frac{\omega}{\delta_{ij}}\right)^{\frac{\theta}{2}} d\omega\right)\right] \\ &= \frac{1}{y_j}\left[\sum_{i=h,f} M_i \frac{\theta \delta_{ij}}{\theta+2}\right] = \frac{\theta}{\theta+2}\frac{\Delta_j}{y_j} \end{aligned} \tag{39}$$

Using (38) into (39) yields:

$$\lambda_j = \frac{\theta}{\theta+2}\frac{\delta_{ij}}{s_{ij} y_j} \tag{40}$$

Using (40) in the cutoff condition (35) gives us the scope of a firm:

$$\delta_{ij} = \left[\frac{\theta+2}{\theta \bar{q} w_i c_i \tau_{ij}}\right]^{\frac{1}{\theta+1}} y_j^{\frac{1}{\theta+1}} \left[s_{ij}(1-s_{ij})\right]^{\frac{1}{\theta+1}} \tag{41}$$

We can express the equilibrium of the model in terms of the firms' market shares, which yields easier equations, and it is faster to solve numerically. Using (38) into (17) we obtain:

$$w_j c_j s_{jj}^{\theta} \Delta_j^{\theta+1} = y_j \frac{\theta+2}{\bar{q}\theta}(1-s_{jj}) \tag{42}$$

$$\tau_{ij} w_i c_i s_{ij}^{\theta} \Delta_j^{\theta+1} = y_j \frac{\theta+2}{\bar{q}\theta}(1-s_{ij}) \tag{43}$$

Dividing (42) by (43) yields:

$$w_j c_j s_{jj}^{\theta}(1-s_{ij}) = \tau c_i w_i s_{ij}^{\theta}(1-s_{jj}) \tag{44}$$

Using (37), the zero profit condition equals:

$$(s_{jj}^2 + \theta s_{jj}) y_j L_j + (s_{ji}^2 + \theta s_{ji}) y_i L_i = F(\theta+1) w_j \tag{45}$$

Market clearing implies that:

$$M_i r_{ii} + M_j r_{ji} = y_i L_i$$

$$M_i s_{ii} + M_j s_{ji} = 1 \tag{46}$$

Trade balance requires:

$$\begin{aligned} M_j r_{ji} &= M_i r_{ij} \\ M_j s_{ji} y_i L_i &= M_i s_{ij} y_j L_j \end{aligned} \tag{47}$$

Goods market clearing and the zero profit conditions satisfy labor market clearing. Labor market in country i clears when:

$$\begin{aligned} y_i L_i &= M_i(w_i F + C_{ii} + C_{ij}) \\ y_i L_i &= M_i(w_i F - w_i F + r_{ii} + r_{ij}) \quad \text{by Zero profit condition} \\ y_i L_i &= M_i r_{ii} + M_j r_{ji} \quad \text{by Trade Balance} \end{aligned}$$

which is the goods market clearing condition. Normalizing home per capita income to 1, the equilibrium is a vector of market shares $[s_{hh},\ s_{hf},\ s_{ff},\ s_{fh}]$, of masses of firms $[M_h,\ M_f]$ and foreign per capita income y_f such that equations (44), (45), (46), and (47) are satisfied.

Finally, recall that $q_{ij}(\omega) = \frac{x_{ij}(\omega)}{L_j}$ where $x_{ij}(\omega)$ is given by (36). The indirect utility function equals

$$\begin{aligned} V_j &= \sum_{i=h,f} M_i \int_0^{\delta_{ij}} [\ln(q_{ij}(\omega) + \bar{q}) - \ln \bar{q}]\, d\omega = \\ &= \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \left[\ln \left(\bar{q} \left(\frac{\delta_{ij}}{\omega} \right)^{\frac{\theta}{2}} - \bar{q} + \bar{q} \right) - \ln \bar{q} \right] d\omega = \\ &= \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln \left(\frac{\delta_{ij}}{\omega} \right)^{\frac{\theta}{2}} d\omega = \frac{\theta}{2} \sum_{i=h,f} M_i \int_0^{\delta_{ij}} [\ln \delta_{ij} - \ln \omega] d\omega \\ &= \frac{\theta}{2} \sum_{i=h,f} M_i \delta_{ij} = \frac{\theta}{2} \Delta_j \end{aligned}$$

where Δ_j can be expressed as a function of the domestic market share of domestic firms from equation (42):

$$\Delta_j = \left[\frac{\theta + 2}{\bar{q} c_j \theta} \left(\frac{y_j}{w_j} \right) (1 - s_{jj}) s_{jj}^{-\theta} \right]^{\frac{1}{\theta+1}}$$

Let us consider the sales-weighted geometric mean of markups $\bar{\mu}_j$ in an economy j. Letting $\mu_{ij}(\omega)$ be the markup on a variety ω from i to j, the sales-weighted geometric mean of markups equals:

$$\bar{\mu}_j = \left[\sum_{i=h,f} M_i s_{ij} \int_0^{\delta_{ij}} \frac{1}{\mu_{ij}(\omega)} \frac{r_{ij}(\omega)}{r_{ij}} d\omega \right]^{-1} = \frac{\theta + 1}{1 - H_j} \tag{48}$$

where $H_j = M_j s_{jj}^2 + M_i s_{ij}^2$ is the Herfindahl index of market concentration in country j.

Finally, let us consider the gravity equation generated by the model. The export trade share of country i to country j, denoted by Λ_{ij}, equals:

$$\Lambda_{ij} = \frac{M_i r_{ij}}{\sum_{v=h,f} M_v r_{vj}} = \frac{M_i \left(\frac{1-s_{ij}}{c_i w_i \tau_{ij}}\right)^{\frac{1}{\theta}}}{\sum_{v=h,f} M_v \left(\frac{1-s_{vj}}{c_v w_v \tau_{vj}}\right)^{\frac{1}{\theta}}}$$

Ignoring cannibalization effects, which is equivalent to setting $s_{ij} = 0$, generates the traditional gravity equation that emerges in models of monopolistic competition (Simonovska and Waugh, 2014b). In such a case, the trade elasticity would be $\epsilon = 1/\theta$ and, thus, would depend on the distribution of marginal costs of the varieties within a firm.

6.1.3 Welfare Formula for a Large Change in Trade Costs

Let us now consider the welfare formula for any (large) change in trade costs. First, I derive the equivalent variation in income EV_j (Bertoletti et al., 2016) such that the indirect utility attained after the trade shock equals the indirect utility attained at pre-shock prices and at an income $W_j = y_j + EV_j$. Let the vector of pre-shock prices be P_j. First, I derive $V_j(W_j, P_j)$. By the consumer's problem, the quantity demanded is a function of the marginal utility of income and price:

$$q_{ij}(\omega) = \frac{1}{\lambda_j p_{ij}(\omega)} - \bar{q}$$

The marginal utility of income can be written as a function of the total mass of varieties available for consumption and prices:

$$\lambda_j = \frac{\Delta_j}{y_j + EV_j + \bar{q} P_j}$$

where P_j is a price index. Using (12), the price of a variety ω (14) can be written as:

$$p_{ij}(\omega) = \frac{[c_{kij}(\omega) c_{kij}(\delta_{kij})]^{\frac{1}{2}}}{1 - s_{kij}} = \frac{1}{\bar{q}\lambda_j} \left(\frac{c_{ij}(\omega)}{c_{ij}(\delta_{ij})}\right)^{\frac{1}{2}} = \frac{1}{\bar{q}\lambda_j} \left(\frac{\omega}{\delta_{ij}}\right)^{\frac{\theta}{2}}$$

The price index at the pre-shock prices ($EV_j = 0$) can then be computed as:

$$\bar{q} P_j = \sum_{i=h,f} M_i \int_0^{\delta_{ij}} p_{ij}(\omega) = \frac{2\Delta_j}{\bar{q}\lambda_j(\theta + 2)} = \frac{2}{\theta} y_j$$

Therefore, the marginal utility of income equals:

$$\lambda_j = \frac{\Delta_j}{\left(\frac{\theta+2}{\theta}\right) y_j + EV_j}$$

The indirect utility function is then equal to:

$$
\begin{aligned}
V_j &= \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \left[\ln(q_{ij}(\omega) + \bar{q}) - \ln \bar{q}\right] d\omega = \\
&= \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln\left(\frac{1}{\bar{q}\lambda_j p_{ij}(\omega)}\right) d\omega = \\
&= -\Delta_j \ln(\bar{q}\lambda_j) - \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln(p_{ij}(\omega)) d\omega \\
&= -\Delta_j \ln\left(\bar{q}\Delta_j\right) + \Delta_j \ln\left(\left(\frac{\theta+2}{\theta}\right) y_j + EV_j\right) - \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln(p_{ij}(\omega)) d\omega
\end{aligned}
$$

Let us now derive the log change in the indirect utility $V_j(W_j, P_j)$ with respect to W_j. First, holding prices constant,

$$
\frac{dV_j}{dW_j} = \frac{dV_j}{dEV_j} = \frac{\Delta_j}{\left(\frac{\theta+2}{\theta}\right) y_j + EV_j}
$$

Then, using the fact that at the pre-shock prices $V_j = \frac{\theta}{2}\Delta_j$, we obtain

$$
d\ln V_j = \frac{dV_j}{dW_j}\frac{W_j}{V_j} d\ln W_j = \frac{2W_j}{2y_j + \theta W_j} d\ln W_j \tag{49}
$$

For a small change in trade cost, we can evaluate (49) at $W_j = y_j$, which yields the expression obtained in the main text using the envelope theorem.

Let us denote the proportional change in a variable x from x^0 to x^1 as $\hat{x} = x^1/x^0$. The proportional change in the indirect utility $\hat{V}_j$ due to a large trade shock is given by integrating (20) for $s \in [s_{jj}^0, s_{jj}^1]$ where superscript 0 denotes the pre-shock level and superscript 1 denotes the after-shock level.

$$
\begin{aligned}
\ln \hat{V}_j = \ln \hat{\Delta}_j &= -\frac{\theta}{\theta+1}\left[\int_{s_{jj}^0}^{s_{jj}^1} \left(1 + \frac{s}{\theta(1-s)}\right) d\ln s\right] \\
&= -\frac{\theta}{\theta+1}\left[\int_{s_{jj}^0}^{s_{jj}^1} \left(1 + \frac{s}{\theta(1-s)}\right) \frac{ds}{s}\right] = -\ln\left[\hat{s}_{jj}\left(\frac{1-s_{jj}^0}{1-\hat{s}_{jj}s_{jj}^0}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{\theta+1}}
\end{aligned} \tag{50}
$$

The equivalent variation in income is obtained by integrating (49) for $t \in [y_j, W_j]$:

$$
\ln \hat{V}_j = \int_{y_j}^{W_j} \frac{2t}{2y_j + \theta t} d\ln t = \ln\left[\frac{\theta \hat{W}_j + 2}{\theta + 2}\right]^{\frac{2}{\theta}} \tag{51}
$$

Combining (50) with (51) yields a general formula for the change in welfare due to a large trade shock:

$$\hat{W}_j = \frac{\theta+2}{\theta}\left[\hat{s}_{jj}\left(\frac{1-s^0_{jj}}{1-\hat{s}_{jj}s^0_{jj}}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta^2}{2(\theta+1)}} - \frac{2}{\theta} \tag{52}$$

The online appendix shows that local approximation yields virtually identical changes in welfare compared to the exact change in welfare obtained by the general formula.

6.2 Extensions to the Baseline Model

This section briefly summarizes how the scope of exporters is affected by alternative assumptions on the demand and supply side of the model. Details are in the online appendix.

Bertrand Competition

Under Bertrand competition, firms maximize their profits by choosing prices instead of quantities. The optimal scope of exporters is qualitatively similar to (17). The main difference is that the maximum scope is reached at a level of the market share greater that depends on the parameters of the model and it is greater than 50%. Moreover, the pass-through of prices with respect to per capita income in Bertrand competition is U-shaped with respect to the market share of the firm, in line with the findings of Auer and Schoenle (2016).

Luxuries and Necessities

The cost-base core competence assumption used in the paper rationalizes the robust empirical finding that sales within firms are skewed towards a few successful products, and most of the scope adjustment within-firm occurs at the bottom of the distribution (Arkolakis et al., 2014). To generate the same stylized fact we could adopt the following modified Stone-Geary preferences: $U_j = \int_{\Sigma_j}[\ln(q_j(\omega)+\bar{q}(\omega)) - \ln\bar{q}(\omega)]\,d\omega$ where $\bar{q}(\omega)$ is variety-specific. $\bar{q}(\omega)$ controls the vertical intercept of the Engel curve: the higher the $\bar{q}(\omega)$, the lower the intercept[28].

Assuming that the marginal costs of all varieties within a firm are identical, and that $\bar{q}(\omega) = \bar{q}\omega^{\theta}$ yield the same optimal scope of the baseline model, the only difference between the two models is in the price distribution within a firm. When the core competence of a firm is cost-based, there is a negative correlation between prices and sales within a firm, whereas the correlation is positive with demand-based core competence. Using Mexican data, Eckel et al. (2015) find the cost-based explanation to hold in homogeneous-goods sectors, while the demand-based core competence is consistent with differentiated-goods sectors.

Brand Differentiation

In the model, the effect of a scope expansion of one firm on its existing sales is identical to the effect on all other firms' sales. To generate a more realistic framework in which the introduction of a new variety by a firm reduces its own sales more than the sales of other firms, we could adopt the following preferences: $U_j = \sum_{i=h,f}\sum_{k=1}^{M}\int_0^{\delta_{kij}}\left[\ln\left(\frac{q_{kij}(\omega)}{\delta^{\gamma}_{kij}}+\bar{q}\right)-\ln\bar{q}\right]d\omega$. This specification is similar in spirit to those that introduce product quality as a weight on the quantities in the utility function (Manova and Zhang, 2012; Eckel et al., 2015). If $\gamma > 0$, the larger the scope of a firm, the smaller the utility from an additional quantity consumed. In such

[28] Consider a two-good example where $\bar{q}_1 < \bar{q}_2$. While good 1 is consumed at any level of income, good 2's consumption is positive if the income is high enough. An alternative interpretation is that good 1 is a necessity while good 2 is a luxury.

a framework however the optimal scope of firms is qualitatively similar to the scope predicted by the baseline model.

Fixed Cost per Variety and Destination

Suppose that firms must pay a fixed cost $f_{k,ij}(\omega)$ per variety, and that $f_{k,ij}(\omega)$ is weakly increasing in ω. A firm introduces varieties until the profits from the last variety, discounted by the cannibalization effects, barely cover the fixed cost per variety. The introduction of a fixed cost generates a positive relationship between the product scope of the firm and size of the destination: larger markets yield higher revenues that can cover a larger fixed cost. A fixed cost of entry per variety replicates, at the firm level, what Eaton et al. (2011) achieved at the aggregate level. The authors introduced a fixed cost of entry per firm to rationalize the positive relationship between extensive margin of trade and size of the destination.

To further clarify the role played by the fixed cost of entry, consider a scenario in which marginal costs $c_{k,ij}(\omega)$ are zero for all varieties. Per capita income and size of the destination have then identical effects on the scope of firms: $\delta_{k,ij} f(\delta_{k,ij}) = s_{k,ij}(1 - s_{k,ij}) y_j L_j$. To summarize, fixed costs per variety generate a positive relationship between scope and size of the destination whereas non-homothetic preferences and the core competence assumption yield a positive relationship between scope and per capita income of the destination. Such a result extends nicely to a model where firms produce multiple product lines.

Diseconomies of Scope

With a minor modification of (15) we could consider (dis)economies of scope as in Nocke and Yeaple (2014) where each variety is produced at the same marginal cost, but the larger the scope, the larger the marginal cost. Consider $c_{k,ij}(\omega) = \delta_{k,ij}^{\gamma} \tau_{ij} y_i c_{k,i} \omega^{\theta}$. If $\gamma > 0$, firm's technology exhibits diseconomies of scope: the same variety ω is produced at a higher marginal cost if the product scope expands. Vice versa if $\gamma < 0$, firm's technology exhibits economies of scope: the marginal cost of producing a variety falls with the scope. Such a functional form only changes quantitatively the optimal scope of the firm found in the baseline model.

6.3 Welfare Gains from Trade by Industry

Table 5 shows the welfare change from 2002 to 2007 at the industry level. The table reports $d \ln W$ as computed in equation (22). In addition, it provides the extent of the mismeasurement of welfare gains that arises from models that ignore cannibalization effects or per capita income.

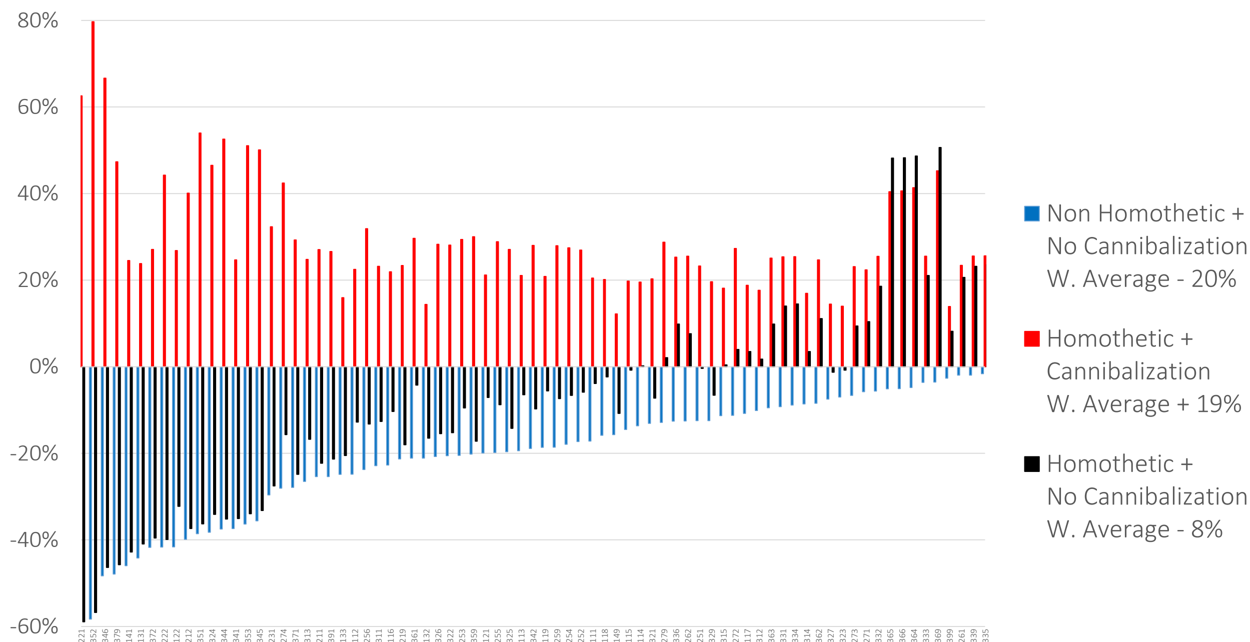
Table 5: Industry Level Welfare Gains Across Models (2007-2002) (%)

					% Diff. rel to baseline	
Code	Industry	s_{jj2002}	$d\ln s$	$d\ln W$	No Cann.	No Pc. Income
3221	Pulp, paper, & paperboard mills	8.4	-10.9	1.6	-60.1	33.6
3352	Household appliance	9.8	-19.9	3.6	-58.3	48.2
3346	Reproducing magnetic & optical media	6.7	6.1	-0.9	-48.3	40.5
3379	Other furniture related prod.	7.4	11.6	-1.9	-47.9	17.2
3141	Textile furnishings mills	9.5	-30.1	6.5	-46.0	12.4
3131	Fiber, yarn, & thread mills	8.9	21.8	-4.6	-44.2	12.2
3372	Office furniture (including fixtures)	5.2	-1.3	0.2	-41.7	12.1
3222	Converted paper prod.	4.1	-6.6	0.7	-41.6	24.2
3122	Tobacco	21.4	3.3	-1.9	-41.6	11.6
3212	Veneer, plywood, & eng. wood prod.	5.5	-21.3	3.0	-39.9	15.0
3351	Electric lighting eq.	4.6	-27.9	3.4	-38.6	33.1
3324	Boiler, tank, & shipping container	8.1	-8.3	1.8	-38.2	29.9
3344	Semiconductor & other electronic component	4.4	-2.2	0.3	-37.5	32.3
3341	Computer & peripheral eq.	4.4	-13.4	1.6	-37.4	11.3
3353	Electrical eq.	4.2	-45.3	5.3	-36.3	31.4
3345	Control instruments	4.1	-27.0	3.1	-35.6	30.9
3231	Printing & related support activities	2.5	24.3	-2.0	-29.6	18.0
3274	Lime & gypsum prod.	13.9	-2.2	1.1	-28.1	25.7
3371	Household & furniture & kitchen cabinet	3.3	-7.0	0.8	-27.9	11.8
3313	Alumina & aluminum prod. & processing	9.9	-12.7	4.6	-26.5	13.2
3211	Sawmills & wood preservation	2.9	-8.5	1.0	-25.4	11.1
3391	Medical eq. & supplies	3.8	-4.7	0.7	-25.4	16.7
3133	Textile finishing & coating mills	3.9	-31.2	4.8	-24.9	9.4
3112	Grain & oilseed milling	11.2	7.2	-3.1	-24.8	13.4
3256	Soap, cleaning compound, & toilet prep.	9.1	6.4	-2.4	-23.8	18.2
3311	Iron & steel mills & ferroalloy	8.3	11.7	-4.1	-22.8	13.2
3116	Animal slaughtering & processing	10.1	-10.9	4.6	-22.7	13.6
3219	Other wood prod.	2.3	2.8	-0.3	-21.3	10.0
3361	Motor vehicle	12.7	-25.5	14.5	-21.1	17.7
3132	Fabric mills	3.2	8.8	-1.3	-21.1	8.9
3326	Spring & wire prod.	3.6	-28.2	4.8	-20.8	19.3
3322	Cutlery & h&tool	3.6	-36.3	6.1	-20.6	19.1
3253	Pesticide & fertilizer	7.6	-14.8	5.2	-20.5	17.6
3359	Other electrical eq. & component	1.9	8.4	-0.8	-20.2	19.1
3121	Beverage	8.7	-5.9	2.4	-19.9	13.9
3255	Paint, coating, & adhesive	7.3	-5.9	2.0	-19.8	17.5
3325	Hardware	3.4	-4.5	0.7	-19.6	18.6
3113	Sugar & confectionery prod.	8.4	-5.6	2.3	-19.4	14.0
3342	Communications eq.	5.6	-38.2	10.7	-18.9	17.9
3119	Other food	8.0	-9.3	3.8	-18.6	14.0
3259	Other chemical prod. & preparation	6.8	-38.3	13.2	-18.6	17.2
3254	Pharmaceutical & medicine	6.5	-22.4	7.7	-17.9	17.1
3252	Resin, rubber, & artificial synthetic fibers	6.3	-1.8	0.6	-17.3	17.0
3111	Animal food	7.3	4.9	-2.0	-17.2	14.2
3118	Bakeries & tortilla	6.7	-23.0	9.0	-15.8	14.3
3149	Other textile prod. mills	2.2	1.8	-0.2	-15.7	8.1
3115	Dairy prod.	6.1	-6.1	2.3	-14.5	14.5
3114	Fruit & vegetable preserving	5.7	-15.9	6.1	-13.6	14.6
3321	Forging & stamping	2.1	34.2	-5.3	-13.1	14.6
3279	Other nonmetallic mineral prod.	5.8	-23.9	9.7	-12.9	21.1
3336	Engine, turbine, & power transmission eq.	9.0	-53.4	33.5	-12.6	18.3
3262	Rubber prod.	7.9	-14.8	8.2	-12.5	20.7
3251	Basic chemical	4.3	43.2	-13.9	-12.5	16.1
3329	Other fabricated metal prod.	2.0	-4.4	0.7	-12.4	14.2
3315	Foundries	3.7	1.1	-0.3	-11.3	13.2
3272	Glass & glass prod.	5.0	11.0	-4.4	-11.2	20.6
3117	Seafood prod. prep.& pack.	4.4	21.6	-8.0	-10.8	14.9
3312	Steel prod. from purchased steel	3.3	8.6	-2.6	-10.1	13.2
3363	Motor vehicle parts	5.4	-51.7	25.6	-9.5	19.7
3331	Agriculture, construction, & mining machinery	6.6	-8.0	4.8	-9.2	20.2

Code	Industry	s_{jj2002}	$d\ln s$	$d\ln W$	% Diff. rel to baseline No Cann.	No Pc. Income
3334	Heating & air-conditioning	6.3	-9.3	5.6	-8.8	20.5
3314	Nonferrous metal prod. & proc.	2.8	-1.4	0.4	-8.6	13.2
3362	Motor vehicle body & trailer	4.8	-6.5	3.2	-8.4	19.9
3327	Machine shops & screw, nut, & bolt	1.1	-27.3	4.0	-7.5	11.2
3323	Architectural & structural metals	1.1	16.7	-2.4	-7.0	10.9
3273	Cement & concrete prod.	2.9	58.6	-22.2	-6.6	19.2
3271	Clay prod. & refractory	2.5	3.1	-1.2	-5.8	18.9
3332	Industrial machinery	3.9	3.1	-1.8	-5.6	22.4
3365	Railroad rolling stock	12.1	-8.4	14.6	-5.1	37.3
3366	Ship & boat building	12.0	-14.5	25.1	-5.1	37.5
3364	Aerospace prod. & parts	11.5	-6.9	11.9	-4.8	38.4
3333	Commercial & service industry machinery	2.5	-65.0	37.0	-3.6	23.5
3369	Other transportation eq.	8.6	11.8	-20.1	-3.5	43.1
3399	Other miscellaneous	0.7	2.8	-0.7	-2.7	12.4
3261	Plastics prod.	1.2	2.6	-1.3	-1.9	22.7
3339	Other general purpose machinery	1.3	-4.2	2.4	-1.9	24.5
3335	Metalworking machinery	1.1	25.5	-14.2	-1.6	24.7

The table reports $d\ln W$ of the baseline model and the % Difference $(W_m/W_{Baseline} - 1)$ relative to the baseline model averaged across industries. The averages are weighted by the industry absorption. All values are in percentages.

Figure 1: Welfare Gains: % Difference from Baseline Model by Industry



6.4 Empirical Evidence

6.4.1 Data Description

The source for the data is the Exporter Dynamics Database, which reports data on export values at the product-firm-destination level (Fernandes et al., 2016). The sources for the data for each country are detailed in the Annex of Cebeci et al. (2012). The data was collected by the Trade and Integration Unit of the World Bank Research Department as part of their efforts to build the Exporter Dynamics Database.

A product is a Harmonized System (HS) 6 digit good. As an example, consider a firm that produces seven varieties (confidentiality prevents me from specifying its destinations and sales). The varieties are: "Candles, Tapers, and the Like" (340600), "Wooden frames for paintings, photographs, mirrors, or similar objects" (441400), "Statuettes and other ornaments of wood" (442010), "Other ceramic articles" (691490), "Other Articles of Iron or Steel" (732690), "Other Statuettes and Other Ornaments, of Base Metal" (830629), "Wooden Furniture of a Kind Used in the Bedroom" (940350).

I drop all firms and products which are not classified ("OTH") and all duplicates. Following Freund and Pierola (2015), I drop firms with less than \$1000 worth of export and drop Chapter 27 according to the HS classification: mineral fuels, oils, and product of their distillation. I match each HS 6 digit good with the corresponding BEC category and keep only the BEC categories that according to UN Comtrade correspond to consumption goods: 112, 122, 522, 61, 62, and 63.

Mexican export flows are dominated by multiproduct firms, which account for 83% of Mexican exports. Such feature of export markets is common across countries: Bernard et al. (2007) discover a similar result for the US, and Goldberg et al. (2010) for India. The distribution of export sales across firms is highly skewed: a small fraction of large multiproduct firms sells a large proportion of total exports. 40% of total export of consumption goods originates from the top 1% of multiproduct exporters while 63% arises from the top 5%. Multiproduct superstars dominate Mexican trade flows, in line with the findings of Ottaviano and Mayer (2007), Freund and Pierola (2015), and Bernard et al. (2016) for other countries.

6.4.2 Test of Non-Monotonicity

The Lind and Mehlum (2010) test works as follows. The null hypothesis is that the relationship (30) is monotone or U-shaped, and the alternative is that it is hump-shaped. The null hypothesis is rejected if either or both the following conditions are rejected:

$$\beta_1 + 2\beta_2 \ln(1 + s_L) \leq 0$$
$$\beta_1 + 2\beta_2 \ln(1 + s_H) \geq 0$$

where s_L and s_H are some lower and upper bounds. We reject the null hypothesis if the slope of the curve is negative at the beginning and/or positive at the end. I choose for the lower bound s_L, the minimum value of market share in the sample, the 5th percentile and the 10th percentile. For the upper bound s_H, I choose the maximum, the 95th percentile and the 90th percentile. The hump-shaped relationship is confirmed (Table 6), and the results are especially robust for the top 5% and 1% of Mexican multiproduct exporters.

An additional test of the non-monotone, hump-shaped relationship is to use local polynomial regressions. For each group of firms, I regress $\ln(\#\ \text{Products}_{kMjt})$ on firm and destination-year fixed effects and record the residual. Then I plot the local polynomial relationship between such residual and $\ln(1 + s_{kMjt})$ for the year 2005. Figure 2 shows the result. For each group of firms, there is a non-monotone hump-shaped relationship. The presence of large market shares for the bottom 95% of exporters should not surprise as few of them tend to be the only exporters in a given industry and destination. Following Robinson (1988), I repeat the

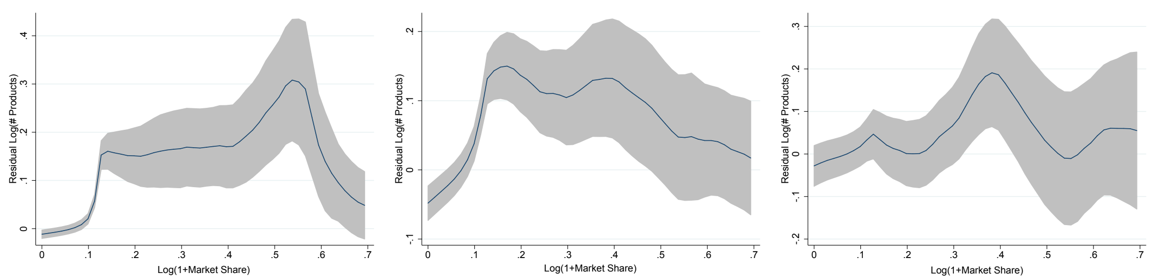
Table 6: Lind and Mehlum (2010) Test

	Bottom 95%	Top 5%	Top 1%
s_{kij}	0.209***	0.343***	0.318***
	(0.012)	(0.025)	(0.056)
s_{kij}^2	-0.148***	-0.478***	-0.497***
	(0.014)	(0.047)	(0.099)
R^2	0.63	0.69	0.82
# Observations	82602	14184	4224
Hump-Shaped t-value {min, max}	8.87***	8.50***	3.84***
Hump-Shaped t-value {5^{th}pct, 95^{th}pct}	5.97***	8.16***	3.73***
Hump-Shaped t-value {10^{th}pct, 90^{th}pct}	0.98	7.47***	3.48***

Results from OLS of equation (30). Robust std. error in parenthesis. Cluster: destination country. ***: significant at 99%, ** at 95%, * at 90%. s_{kMjt} and s_{kMjt}^2 are normalized by their year sample average. Hump-shape t-test: t-value and significance of Lind and Mehlum (2010) test evaluated at s_{kMjt} ={min, max}, {5^{th}pct, 95^{th}pct} and {10^{th}pct, 90^{th}pct}. N.A.: the extremum is outside the sample. In the Hump-Shaped test for {5^{th}pct, 95^{th}pct} and {10^{th}pct, 90^{th}pct}, I drop the destinations served by only one firm.

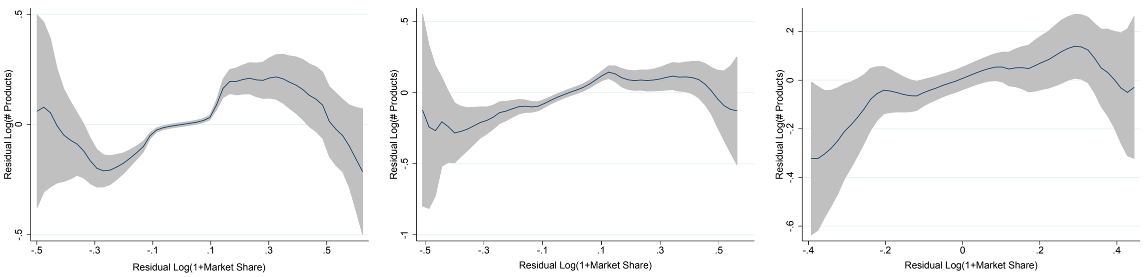
analysis, by plotting, for the year 2005, the local polynomial relationship between the residuals from regressing ln(# Products$_{kMjt}$) on firm and destination-year fixed effects, on the residuals from regressing $\ln(1 + s_{kMjt})$ on firm and destination-year fixed effects. Although the hump-shaped relationship is less prominent, the results are robust to this alternative specification (Figure 3).

Figure 2: Residual Scope on Market Share: Local Polynomial Smoothing



In order: Bottom 95%, Top 5%, and Top 1%. Alternative Epanechnikov kernel function with bandwidth=0.12 and degree=0. The grey area is the 95% C.I.

Figure 3: Residual Scope on Residual Market Share: Local Polynomial Smoothing



In order: Bottom 95%, Top 5%, and Top 1%. Alternative Epanechnikov kernel function with bandwidth=0.12 and degree=0. The grey area is the 95% C.I.

6.4.3 Market Share and Per Capita Income

To asses whether the market share of Mexican Exporters varies with the per capita income of the destination, I run the following regression:

$$\ln(s_{kMjt}) = \beta_0 + \beta_y \ln(\text{Pc. Income}_{jt}) + \beta_L \ln(\text{GDP}_{jt}) + \beta_\tau \tau_{Mjt} + f_k + g_t + \epsilon_{kMjt} \tag{53}$$

where s_{kMjt} is the ratio of firm's k export to j over total household consumption in j from WDI[29]. Similar to (29) the relevant independent variable is real per capita GDP from WDI. I control for the size of the destination using real GDP. τ_{Mjt} is a vector of trade barriers from CEPII (Head et al., 2010) that includes the log of bilateral distance, dummies for the presence of a shared border, commonality of language, and destination specific dummies for islands and landlocked countries. f_k and g_t are firm and year fixed effects, and ϵ_{kMjt} is the error term.

Table 7 reports the results from the regression. Controlling for size, the richer the destination, the larger the market share of Mexican exporters. Trade costs and size of the destination negatively affect the market share of exporters.

6.5 Alternative Datasets

The scope of an exporter has so far been represented by the number of HS 6 digit good exported by a firm. Although common in the literature (Arkolakis et al., 2014), such a classification could cause some measurement errors as it hides the number of varieties exported by a firm within the HS 6 digit products, thus potentially biasing the results. To address the issue, I analyze the two stylized facts with two alternative datasets.

6.5.1 Online Stores of Large Multinationals

Following the example of Simonovska (2015) and Cavallo et al. (2014), I create an original dataset with the number of varieties of mobile products sold by Samsung in 50 countries in 2015. In addition, I use the dataset built by Cavallo et al. (2014), which provides the total

[29] I argue that this is the relevant measure of market share to capture the relationship between cannibalization effects and per capita income. Results are not robust to using s_{kMjt} as the ratio of firm's k export to j over total imports in j.

Table 7: Per Capita Income and Market Share

	(MPF)	(All)
Log(Pc.income)	0.214***	0.174***
	(0.073)	(0.059)
log(GDP)	-0.686***	-0.722***
	(0.049)	(0.041)
Log(Distance)	-0.574***	-0.455***
	(0.152)	(0.134)
Border	0.772*	0.560*
	(0.426)	(0.333)
Comm. Language	0.608**	0.517**
	(0.258)	(0.218)
Island	-0.050	-0.080
	(0.164)	(0.143)
Landlocked	-0.195	-0.233*
	(0.150)	(0.123)
R^2	0.72	0.76
# Observations	94736	160436

Results from OLS of equation (53). Robust std. error in parenthesis. Cluster: destination. ***: significant at 99%, ** at 95%, * at 90%. MPF: Sample of Mexican multiproduct exporters. All: Sample of all Mexican exporters.

number of varieties sold by Apple, Ikea, Zara, and H&M in their online stores[30]. While this dataset provides the most detailed description of the number of varieties offered by a firm, it lacks information on sales or market shares and, thus, it cannot be used to study cannibalization effects.

I estimate the empirical model (29) with no year fixed effects. Given that the origin of the varieties is unobserved, I cannot use bilateral proxies for trade cost and, thus, control for the average MFN tariff applied by the destination for the categories produced by each firm. In addition, I use dummies for islands and landlocked countries[31].

The coefficient on per capita income is positive and statistically significant for all multinationals (Table 8). Given the size of the destination, doubling its per capita income increases the scope offered online by almost 20% in the pooled regression. Apple is the firm with the highest coefficient, 47%, while Ikea has the smallest, 5%. Interestingly, the coefficient on GDP is close to zero and insignificant, suggesting that the fixed cost of selling online is negligible relative to the standard retail markets.

[30]All details on the data collection are provided in the authors' paper. The authors collected daily data and to minimize the possibility of errors in the scraping algorithm, I focus on the average number of varieties offered in 2013, the year with the largest sample of countries.

[31]Given the role of per capita income in shaping the product scope choices of firms, I also controlled for income inequality in the destination with the Gini Index from WDI (Bekkers et al., 2012), finding insignificant effects. For Samsung and Apple, I use the tariff on HS 8517: electrical apparatus for line telephony, telephone sets, parts. For Zara and H&M, I use tariffs on HS 62: articles of apparel and clothing accessories not knitted or crocheted. For Ikea, I used HS 94: furniture, bedding, cushions, lamps, lighting fittings nesoi, illuminated signs, nameplates and the like, prefabricated buildings.

Table 8: Per Capita Income and Online Product Scope of Large Multinationals

	Apple	Zara	H&M	Ikea	Samsung	Pooled
Log(Pc.Income)	0.470***	0.078**	0.083***	0.050*	0.185**	0.209***
	(0.047)	(0.038)	(0.028)	(0.026)	(0.071)	(0.054)
Log(GDP)	0.051	-0.037	-0.004	0.011	0.039	-0.006
	(0.041)	(0.022)	(0.015)	(0.012)	(0.055)	(0.023)
Island	0.013	-0.246**	-0.024	-0.042	-0.183	-0.144
	(0.123)	(0.100)	(0.067)	(0.048)	(0.242)	(0.117)
Landlocked	0.008	-0.064	-0.022	0.023	-0.066	-0.063
	(0.153)	(0.123)	(0.062)	(0.041)	(0.247)	(0.071)
Tariff	-0.043*	0.004	0.006	0.002	-0.019	0.003
	(0.023)	(0.008)	(0.005)	(0.011)	(0.026)	(0.009)
R^2	0.83	0.20	0.25	0.24	0.22	0.92
# Observations	36	46	35	28	50	195

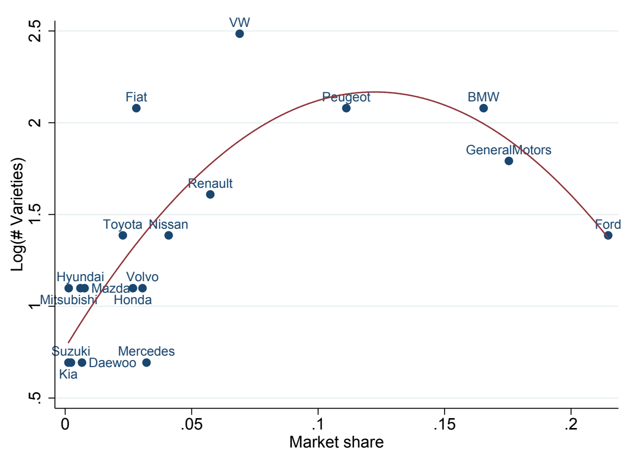
Results from OLS of equation (29). ***: significant at 99%, ** at 95%, * at 90%. For Apple, Zara, H&M, and Ikea the dependent variable is the log of daily average number of products offered online per firm per destination in 2013. The pooled regression uses firm level fixed effects, and errors are clustered at the destination level. Per capita income and population in the Samsung regression are the latest available.

6.5.2 European Car Market

To verify the robustness of the second stylized fact, I use the data on the sales of car models in five European economies provided by Goldberg and Verboven (2005). The economies considered are Belgium, Germany, Great Britain, France, and Italy from 1970 to 1999. Given the presence of large firms and the accuracy of the measure of market share, this dataset proves ideal to test cannibalization effects. However, we cannot use it to test the first stylized fact because of the limited number of destinations.

As an illustrative example, Figure 4 shows the hump-shaped relationship between product scope and market share of the firms selling to the United Kingdom in 1995. Even though Ford attains the largest market share, it produces fewer varieties than other car companies with a smaller market share, such as Fiat or Peugeot.

Figure 4: Product Scope of Exporters and their Market Share



For each destination I run the following regression:

$$\ln(\#\text{ Car models}_{k,ijt}) = f_k + d_{jt} + \beta_s s_{k,ijt} + \beta_{s^2} s^2_{k,ijt} + \epsilon_{k,ijt} \tag{54}$$

where f_k is a firm fixed effect, d_{jt} is a destination-year fixed effect, and $\epsilon_{k,ijt}$ is the error term. Since our baseline geographical controls are time invariant, they are captured by the firm level fixed effect. In the pooled regression I include origin-destination fixed effects to control for geographical barriers. The market share $s_{k,ijt}$ is the share of firm's k sales in j in year t divided by the total sales by all firms' in the sample in the same destination j in year t.

Table 9 shows that cannibalization effects are present in the European car market. The Lind and Mehlum (2010) test confirms the hump-shaped relationship in the pooled regression.

Table 9: European Car Market: Scope of Exporters and Their Market Share

	BEL	FRA	DEU	ITA	GBR	Pooled
s_{kijt}	0.82***	0.83***	1.24***	0.80***	0.80***	0.35***
	(0.16)	(0.13)	(0.19)	(0.28)	(0.13)	(0.07)
s^2_{kijt}	-0.57**	0.02	-0.70***	-0.29	-0.34**	-0.24***
	(0.21)	(0.26)	(0.22)	(0.28)	(0.16)	(0.04)
R^2	0.83	0.85	0.82	0.86	0.82	0.87
# Observations	587	518	512	449	538	2601

Results from OLS of equation (54). Robust std. error in parenthesis. Cluster: year for single destination, destination in pooled regression. ***: significant at 99%, ** at 95%, * at 90%. The ratio of car's sales to total sales is normalized by the average in the sample.