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 where consumers have non-homothetic preferences and firms compete oligopolistically. Firms choose their scope depending on the per capita income of the destination and on cannibalization effects. I derive a new formula for the welfare gains from trade that relates the change in the domestic market share of the typical domestic firm to the welfare change due to a reduction in trade costs. 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 firms producing multiple products (Bernard et al., 2011), and a few large exporters, or superstars, account for most of a country's exports (Freund and Pierola, 2015)[1]. 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[2], welfare largely depends on the number of varieties per firm, the so-called *product scope*. Consequently, studying the determinants of product scope has new implications for the welfare of consumers.

What are the determinants of the scope of large multiproduct exporters? To answer this question, 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. Doubling the per capita income of the destination increases the scope of large Mexican exporters by 11%. Multinationals such as Apple, H&M, Ikea, Samsung, and Zara behave similarly, and offer a larger set of varieties in online stores that serve richer economies. This stylized fact, which I refer to as *income effects* on product scope, combined with the finding that firms price discriminate based on consumer income (Simonovska, 2015), suggest that trade has a different effect on rich and poor economies.

Second, I document a non-monotone, hump-shaped relationship between the product scope of a firm and its market share in a destination[3]. To understand this stylized fact consider a firm that produces imperfect substitutes. Two opposing forces related to the level of competition within the firm and across firms shape the firm's optimal scope. First, when the firm introduces a new variety, that firm reduces, or cannibalizes, the sales from its existing varieties. This reduction in sales, called the *cannibalization effect*, limits the scope of the firm. The second force is the reduction in sales of other firms following the introduction of a new variety, which has a positive effect on the initial firm's scope. Which of the two forces dominates depends on the firm's market share. A small firm faces weak cannibalization effects, and its market share increases as its scope expands. Vice versa, a large firm faces stronger cannibalization effects and, thus, reduces its scope as it gains market share.

[1] The top 1% of US exporters accounts for 80% of total exports (Bernard et al., 2016). For other countries, see Ottaviano and Mayer (2007) and Freund and Pierola (2015).

[2] In the spirit of Freund and Pierola (2015), I refer to large multiproduct exporters as multiproduct superstars.

[3] Raff and Wagner (2013) document a hump-shaped relationship between the scope and productivity of German firms. For anecdotal evidence on cannibalization, see Copulsky (1976) and Kerin et al. (1978).

To rationalize the two stylized facts, I develop a tractable model that combines three main ingredients: 1) consumers have non-homothetic preferences, 2) firms compete oligopolistically, and 3) firms have a core competence and the marginal cost of a new variety increases the farther away it is from the core (Eckel and Neary, 2010). The combination of non-homothetic preferences and the core competence assumption drive the positive relationship between scope and the per capita income of the destination. In fact, firms begin by exporting 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 relative to the core[4]. The assumption of oligopoly generates the non-monotone, hump-shaped relationship found in the data between the scope and market share of a firm. Moreover, 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[5].

The model is consistent with several established regularities on multiproduct exporters. Firms only export a fraction of their domestic scope, as documented by Iacovone and Javorcik (2010). Moreover, core varieties are exported across more destinations than the non-core varieties (Arkolakis et al., 2014), and firms skew their sales toward the core products in destinations with stronger competition (Mayer et al., 2014). 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. Modeling cannibalization effects generates other predictions consistent with the empirical evidence: a firm with high market share has low pass-through of prices (Amiti 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 my model's predictions.

The model generates a parsimonious formula for the welfare gains from a small reduction in trade costs:

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

The change in welfare $d\ln W$ is related to 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 parameters: ϵ, which is related to the distribution of marginal costs across varieties within a firm, and ρ,

[4]Such a prediction is exemplified by Samsung: while Samsung offers its core varieties - smartphones - in all destinations, only richer economies have a wide choice of Samsung's accessories.

[5]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.

which is the average markup elasticity with respect to marginal costs. The welfare effects of a reduction in trade costs can be computed *ex-post* by observing the change in s and, *ex-ante*, by predicting the change in s after a change in trade costs.

The welfare formula is similar to those introduced by Arkolakis et al. (2012) and Arkolakis et al. (2015) (from now on ACR and ACDR) where the change in welfare is a function of the change in the expenditure share on domestic goods. Relative to 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 firms' productivities while in my model, ϵ controls the distribution of varieties' productivities 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, from (1), 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 domestic firms lose market share, they face weaker cannibalization effects giving firms incentives to expand their domestic scope, further increasing welfare. Such incentives have greater welfare consequences at larger values of s when firms face stronger cannibalization effects.

The two determinants of the scope of multiproduct superstars that I focus on - income and cannibalization effects - enter the welfare formula in a fundamental way: ignoring either one causes an incorrect measure of the welfare gains from trade. Gains are overestimated if we neglect the role of per capita income, which occurs in the literature in two ways. The first shuts down income effects by keeping the marginal utility of income constant (Feenstra and Ma, 2007; Eckel and Neary, 2010; Mayer et al., 2014). A model with no income effects ignores the reduction of consumers' demand on individual varieties due to a rise in the mass of varieties available for consumption; thus, overestimating the gains from trade. The second way to ignore income effects is to use homothetic preferences, which generates a positive relationship between scope and aggregate, rather than per capita, income of the destination (Bernard et al., 2011). As in ACDR, homothetic preferences cause an overestimate of the gains from trade because they do not allow for an increase in foreign exporters' markups.

Moreover, this paper reconsiders the role of market structure on the welfare gains from trade: models that ignore cannibalization effects underestimate the welfare gains. 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 its own sales. Models of monopolistic competition, then, underestimate the welfare gains from trade because they overlook 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 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). Neglecting cannibalization effects underestimates the gains by 20%. There is considerable heterogeneity across industries: in relatively more concentrated industries, welfare gains are underestimated 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.

The remainder of this paper is organized as follows. Section 2 surveys the literature highlighting the contributions of the paper. Section 3 presents the model. In Section 4, I derive the welfare formula (1) and discuss the welfare contributions of income and cannibalization effects. Section 5 presents the two stylized facts on multiproduct superstars, and Section 6 concludes.

2 Relationship with the Literature

My baseline model is closely related to those of Feenstra and Ma (2007) and Eckel and Neary (2010) who study the effects of trade on large homogeneous multiproduct firms. This paper introduces income effects as a determinant of the scope of firms and abandons the integrated world economy of Feenstra and Ma (2007) and Eckel and Neary (2010) by examining a two-country model with iceberg transportation costs. Additionally, I derive a new welfare formula in the spirit of ACR and compare the welfare gains predicted by a wide class of models of multiproduct firms including the two just mentioned. This paper also relates to several branches of the literature, which I summarize in this section.

Income Effects. The positive relationship between the extensive margin of trade and per capita income is not new in the literature. In fact, Hummels and Klenow (2002) document a positive relationship between the number of varieties exported by a country and the per capita income of the destination. Models where consumers have non-homothetic preferences rationalize such findings (Matsuyama, 2000; Simonovska, 2015)[6]. However, this paper focuses

[6] For a survey of the role of non-homothetic preferences in trade theories, see Markusen (2013). An alternative theory is that of Hummels and Lugovskyy (2009) who rely on the heterogeneous preferences of consumers.

on the number of varieties exported by a firm: non-homothetic preferences drive the positive relationship between product scope - the within-firm extensive margin - and the per capita income of the destination. Models of multiproduct firms have so far ignored income effects on scope with quasilinear preferences (Feenstra and Ma, 2007; Mayer et al., 2014), by construction (Eckel and Neary, 2010)[7] or with homothetic preferences, in which case the scope of exporters depends on aggregate income (Bernard et al., 2011).

Cannibalization Effects. When a firm introduces a new variety, the demand for all existing varieties, produced by the same firm or by others, falls[8]. The demand system determines the extent of cannibalization: how much the demand for the firm's own varieties falls relative to the demand for other firms' varieties. The literature has examined two demand systems. The first system assumes that all the varieties available for consumption enter the utility function symmetrically (Feenstra and Ma, 2007; Baldwin and Gu, 2009; Eckel and Neary, 2010; Ottaviano and Thisse, 2011). When a firm introduces a new variety, the demand for all existing varieties falls by the same amount. The reduction in the firm's profits increases with the firm's market share: cannibalization effects are intrinsically linked to large firms. As a result, models of monopolistic competition with infinitesimally small firms neglect, by construction, cannibalization effects (Allanson and Montagna, 2005; Brambilla, 2009; Bernard et al., 2011; Manova and Zhang, 2012; Arkolakis et al., 2014; Mayer et al., 2014; Nocke and Yeaple, 2014).

The first demand system may seem unrealistic because we could expect a new variety to reduce the sales of its originating firm more than the sales of its competitors. A more realistic approach is that of Hottman et al. (2016), who add to the first system a nested preference structure where the elasticity of substitution across varieties within a firm is larger than the elasticity of substitution across firms. I show that such a preference structure affects only quantitatively the 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, as a result, limits its scope by a constant fraction[9]. My baseline model focuses on the first demand system in which cannibalization effects are a feature of large firms, and I leave the second channel to an extension in the appendix.

Welfare Gains from Trade. This paper relates to ACR, who showed that for a large class of models that include Krugman (1980) and Melitz (2003), the welfare gains from trade can be computed with a parsimonious formula that uses the expenditure share on domestic goods and the trade elasticity. In the context of infinitesimally small firms, the literature has extended

[7] Eckel and Neary (2010) assume that a firm is large in its own industry but small relative to the economy. Hence, the marginal utility of income can be kept constant.

[8] I abstract from the dynamic effects of cannibalization on product innovation studied by (Igami, 2015).

[9] 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.

ACR's results to other models of trade (Feenstra, 2014; Levchenko and Zhang, 2014; Arkolakis et al., 2015; Jung et al., 2015; Bertoletti et al., 2016). Following this line of research, I derive the first welfare formula for an oligopolistic model of multiproduct firms.

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, 2010)[10]. Recently, Edmond et al. (2015) study the welfare gains from trade in the Atkeson and Burstein (2008) model of heterogeneous single product firms that compete oligopolistically. The authors' rich model does not generate an analytical formula for the welfare gains. One study's result is in line with the analytical findings of this paper: the larger the market concentration, the larger the welfare gains from trade. As the model differs from mine in two key dimensions, I further investigate how the authors's welfare predictions compare with this paper.

The first difference between my model and that of Edmond et al. (2015) is the assumption of multiproduct firms. 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 reducing the average markup in the economy. In the presence of large multiproduct firms, trade additionally weakens cannibalization effects improving welfare. Second, for tractability, my model focuses on homogeneous firms while Edmond et al. (2015) consider heterogeneity in firms' productivities. To allow for a competition between large and small firms, while preserving tractability, I consider an extension to the baseline model where large firms coexist with a multiproduct competitive fringe. The main result of my baseline model persists: the larger the market share of the typical firm, the larger the gains from trade.

3 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 large firms engages in trade of varieties of a final good. 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. The baseline model can be interpreted as describing the behavior of multiproduct superstars. I later relax this assumption allowing for a competitive fringe to coexist with superstars[11].

The market structure is oligopolistic. I choose Cournot competition, which is more tractable

[10] 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.

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

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.

3.1 Consumers' Problem

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

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

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

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

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

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:

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

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

3.2 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[13].

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}[14]:

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

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

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

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

[13]Such an assumption is consistent with the empirical finding that firms' exports are skewed toward a few core varieties and core varieties tend to be sold in every market (Arkolakis et al., 2014). In addition, the distribution of within-firm sales is similar across destinations (Arkolakis et al., 2014).

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

$x_{kij}(\omega)$ 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.

The differences between this model and most of the literature are already evident at this stage. In models of monopolistic competition á la Krugman (1979), firms take λ_j as given $\left(\frac{\partial \lambda_j}{\partial x_{kij}(\omega)} = 0\right)$, hence they do not internalize cannibalization effects. 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[15]. In my model, increasing the supply of a variety reduces the demand for other varieties only via income effects.

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), then, simplifies to[16]:

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

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. The online appendix proves that 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 by the firm:

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

[15] Eckel and Neary (2010) can model cannibalization effects because of the non-additive component of the linear quadratic preferences. Ignoring that component yields the same results as those in this paper.

[16] The online appendix reports the steps that yield the solution and the second order conditions.

By the core competence assumption, the left-hand side of (12) increases with the mass of varieties δ_{kij}. All else constant, higher per capita income reduces λ_j, thus, increasing the mass of varieties exported. Hence, keeping the market share constant, firms export more varieties in richer economies[17]. Models that ignore the role of the per capita income of the destination, and feature a constant λ_j are not consistent with this stylized fact. On the other hand, all else constant, the larger the market share of the firm, the stronger the cannibalization effects it faces and the smaller the scope. A model of multiproduct firms that are monopolistically competitive, which assumes that $s_{kij} = 0$, lacks such a mechanism.

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 (14) 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).

3.2.1 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:

$$c_{kij}(\omega) = \tau_{ij} w_i c_{ki} \omega^{\theta} \tag{15}$$

where $\theta > 0$ and $\tau_{ii} = 1$. The marginal cost of a variety increases with its distance from the core competence ($\omega = 0$)[18]. θ is the elasticity of the marginal cost of a variety with respect to

[17] In the appendix, I discuss an extension in which products within-firm differ in terms of demand: firms export the most preferred varieties across all destinations and the least favored varieties only in richer economies.

[18] In the appendix, I study a variation of (15) that captures diseconomies of scope producing similar results.

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. In equilibrium, as firms from i are symmetric, such a parameter becomes c_i and captures the technological level in i.

Firm's revenues r_{kij} are proportional to the scope of the firm, as in Bernard et al. (2011):

$$r_{kij} = \frac{\theta L_j \delta_{kij}}{\lambda_j(\theta + 2)} \tag{16}$$

Hence, the market share of the firm equals the ratio of the firm's product scope to the total mass of varieties available for consumption $\Delta_j = \sum_v \sum_k \delta_{kvj}$:

$$s_{kij} = \frac{r_{kij}}{\sum_v \sum_k r_{kvj}} = \frac{\delta_{kij}}{\Delta_j} \tag{17}$$

A larger scope δ_{kij} increases the revenues of firm k and, hence, its market share s_{kij}. Using (17) and (7) into (12) yields an expression for the scope of a firm:

$$\delta_{kij} = \left[\frac{\theta + 2}{\theta \bar{q} w_i c_{ki} \tau_{ij}}\right]^{\frac{1}{\theta+1}} \; y_j^{\frac{1}{\theta+1}} \; \left[s_{kij}(1 - s_{kij})\right]^{\frac{1}{\theta+1}} \tag{18}$$

All else constant, the scope of a multiproduct superstar 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 (17), which features a positive relationship between δ_{kij} and s_{kij}. The second is the cost cutoff (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%.

3.3 Equilibrium

I consider the symmetric equilibrium in which identical firms supply the same mass of varieties and quantities for each variety. Since firms within a country are homogeneous, I drop firm subscript 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:
(i) Firms choose the mass of varieties they sell domestically and export according to (18).
(ii) Free entry drives profits Π_i to zero for $i = h, f$, and hence $w_i = y_i$[19].
(iii) The labor and goods market clear, and trade is balanced.

Let us consider the gravity equation generated by the model. Using (16), 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, 2014). 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.

The markup distribution in a destination is often important to understand the welfare results in models with non-homothetic preferences (ACDR). In this model, with two groups of symmetric firms serving a country, the average markup in the economy provides some insight into the welfare gains from trade. Following Edmond et al. (2015), I 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

[19] I ignore the integer problem as in Feenstra and Ma (2007), Eckel and Neary (2010) and Ottaviano and Thisse (2011). For a discussion of its consequences see Neary (2010).

from i to j, the sales-weighted geometric mean of markups equals:

$$\bar{\mu}_j = \left[\sum_{i=h,f} M_i s_{ij} \int_0^{\delta_{ij}} \frac{1}{\mu_{ij}(\omega)} \frac{r_{ij}(\omega)}{r_{ij}} d\omega \right]^{-1} = \frac{\theta + 1}{1 - H_j} \tag{19}$$

where $H_j = M_j s_{jj}^2 + M_i s_{ij}^2$ is the Herfindhal index of market concentration in country j. Cannibalization effects and market concentration are related: the stronger the cannibalization effects and the higher the market concentration, the larger the average markup in the economy.

3.3.1 Scope and Market Share Across Rich and Poor Countries

What is the effect of per capita income on the scope and market share of a firm? As the model cannot be solved in closed form, I use numerical methods to answer this question[20]. I choose the parameters so that there are at least two firms in each country and, thus, the scope increases with market share. First, I study the effects of increasing y_f keeping the size L_i and efficiency c_i constant. Home firms export a larger set of varieties δ_{hf} as y_f increases. As consumer income in the foreign economy increases, home firms introduce new non-core varieties. Moreover, the market share of home firms in the foreign economy s_{hf} expands, which further increases δ_{hf}.

The positive relationship between s_{hf} and y_f reveals a deeper connection between the level of development of the destination and market concentration or cannibalization effects[21]. As foreign consumer income increases, firms serving the foreign economy expand their product scope. As a result, entry into the foreign economy is limited as consumers purchase new non-core varieties from existing firms rather than varieties from new entrants. Consequently, market concentration rises: the market share s_{hf} increases. Hence, in partial equilibrium, firms face stronger cannibalization effects in richer economies. Increasing y_f would have a larger effect on δ_{hf} if cannibalization effects are ignored.

How do δ_{hf} and s_{hf} vary in general equilibrium? I consider the following two comparative statics exercises. First, I assume that both economies have the same size L and study the effects of changes in the efficiency of foreign firms c_f relative to home firms. Second, I assume that home and foreign firms have the same efficiency c and study the effects of changing the relative size of the two countries L_f/L_h, keeping $L_h + L_f$ constant.

A reduction in c_f has two opposing effects on the exported scope of home firms. First, as foreign firms become more productive, the foreign per capita income increases. Home firms

[20] Analytically, the results can be proven in the neighborhood of two symmetric country equilibrium. The online appendix shows the formal analysis and the simulation algorithm.

[21] I find support for this relationship using Mexican data. The ratio of exporters' revenues to household consumption of the destination is increasing in the destination per capita income controlling for size. The results are shown in the appendix.

would tend to export more varieties introducing to the foreign economy non-core expensive goods. Second, home exporters face stronger competition from foreign firms, and the market share of home firms in the foreign economy drops. Such a decrease puts downward pressure on the scope of home exporters. Of the two forces, the first dominates, and home firms export more varieties in the richer foreign economy.

Changing the relative size of the destination L_f has similar effects. On the one hand a relatively larger foreign economy also has a higher per capita income. In fact, as the population grows, more firms enter, and each firm focuses on its core competence increasing the average productivity and, hence, the per capita income. On the other hand, the entry of new firms into the foreign economy erodes the market shares of home firms abroad. The first effect dominates, and firms export more varieties in a bigger economy. This result depends on the increase in per capita income: keeping y_f constant, an increase in size reduces the scope of an exporter because it reduces its market share.

4 Welfare Gains from Trade

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[22].

4.1 A New Welfare Formula

The first step in deriving the welfare formula is to show that the indirect utility V_j is a function of the mass of varieties Δ_j available to consumers in country j.

$$V_j = \sum_{i=h,f} M_i \int_0^{\delta_{ij}} \ln\left(\frac{\delta_{ij}}{\omega}\right)^{\frac{\theta}{2}} d\omega = \frac{\theta}{2}\Delta_j \tag{20}$$

From the optimal scope of firms, the set of varieties available to consumers can be expressed as a function of the domestic market share of our multiproduct firm s_{jj}:

$$\Delta_j^{\theta+1} = \frac{\theta+2}{q\bar{c}_j\theta}(1-s_{jj})s_{jj}^{-\theta} \tag{21}$$

Taking the log of (20) and differentiating with respect to any change in the vector of trade costs

[22] I compute the welfare gains from a small reduction in the iceberg trade costs as the equivalent variation in the consumer's income that generates the same utility attained with the lower trade costs.

τ, we obtain using (21):

$$d \ln V_j = d \ln \Delta_j = \frac{\theta(1 - s_{jj}) + s_{jj}}{(\theta + 1)(1 - s_{jj})}(-d \ln s_{jj}) \tag{22}$$

Finally, the derivative of the (log) indirect utility V_j with respect to (log) income W_j is:[23]:

$$d \ln V_j = \frac{2}{\theta + 2} d \ln W_j \tag{23}$$

Combining (23) and (22) and rearranging, we obtain the welfare formula:

$$d \ln W_j = \frac{\theta(\theta + 2)}{2(\theta + 1)} \left[1 + \frac{s_{jj}}{\theta(1 - s_{jj})} \right] (-d \ln s_{jj}) \tag{24}$$

Substituting $\theta = 1/\epsilon$ where ϵ is the trade elasticity in a model of monopolistic competition, and given that the average markup elasticity $\rho = 1/2$, we obtain the formula shown in the introduction. 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 can be computed using 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 welfare formula requires both the change $d \ln s_{jj}$ and the level s_{jj} of the sufficient statistic.

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}[24].

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 (19) 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

[23] By the envelope theorem $d \ln V_j = (W_j/V_j)\lambda_j d \ln W_j$ where λ_j is the marginal utility of income (5).

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

while the weight on the higher domestic markups falls bringing down the average markup[25].

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[26].

4.2 Cannibalization Effects, Income Effects, and Welfare

What are the welfare gains from trade when we ignore cannibalization effects? To answer this question, consider a model of multiproduct firms that are monopolistically competitive as in Bernard et al. (2011) and Mayer et al. (2014). In addition to the assumption of monopolistic competition, which by construction neglects cannibalization effect, the model is identical to the baseline model in Section 3.

The welfare gains from trade in such a model ($d \ln W_j^{MC}$) can be computed as follows[27]:

$$d \ln W_j^{MC} = \frac{\theta(\theta + 2)}{2(\theta + 1)}(-d \ln s_{jj}) \tag{25}$$

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[28]. Recall that the trade elasticity is $\epsilon = 1/\theta$ and $\rho = 1/2$. Rewriting (25) in terms of ϵ and ρ yields the same formula 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.

[25] In the online appendix, I study how welfare gains change across rich and poor countries. Although cannibalization effects are stronger in the more productive country, the less productive country gains more from trade. In addition, small economies gain more than large economies.

[26] 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.

[27] The formula is (24) evaluated at a market share s_{jj} of zero.

[28] In oligopolies, entry is not fixed and $d \ln s_{jj} = d \ln \lambda_{jj} - d \ln M_j$.

For a given $d\ln s_{jj}$ and θ, the welfare gains that arise in a model with cannibalization effects (24) dominate those generated by monopolistic competition (25). 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.

We can now compare the welfare gains that arise from my model to those generated by the model of Eckel and Neary (2010). The authors model firms that face cannibalization effects, but the marginal utility of income is constant and income effects on scope are assumed away. 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[29]. To obtain some intuition on the difference between the two models, I consider a version of (24) where I study the effects of a change in τ keeping the marginal utility of income constant but allowing the other variables to change:

$$d\ln W_j^{EN} = \frac{(\theta+2)}{2}\left[1 + \frac{s_{jj}}{\theta(1-s_{jj})}\right](-d\ln s_{jj}) = \left[1 + \frac{1}{\theta}\right] d\ln W_j \tag{26}$$

As new varieties enter the consumption bundle, by income effects,, consumers would demand less of each variety. As a result, ignoring income effects generates an upward bias in the estimated gains from trade of $1/\theta$[30].

4.3 Welfare Gains from Trade with Homothetic Preferences

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). Because of their constant elasticity of demand, CES preferences generate constant markups in standard models of monopolistic competition (Krugman, 1980). In contrast, models of non-homothetic preferences, as in this paper, generate variable markups. The choice of preferences affects the markups and the welfare gains from trade: ACDR showed that a model of non-homothetic preferences generates smaller welfare gains than a model with homothetic preferences. With

[29]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. In their baseline model, the authors do not assume free entry allowing for it only in an extension.

[30]In Feenstra and Ma (2007), $\theta \to 0$. In this case, (24) 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.

non-homothetic preferences, a reduction in trade costs increases the markups of foreign exporters reducing the welfare gains from trade. In this section, I examine whether the result of ACDR also holds in a world of large multiproduct exporters.

Consider an extension to the baseline model where consumers have CES preferences over the set of varieties available with elasticity of substitution $\sigma > 1$. Since with CES preferences the choke price is infinite, we need to add 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 3.

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. Details are in the online appendix.

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

Table 1 illustrates how the welfare gains from trade are affected by the different preferences assumed both under monopolistic competition (and no cannibalization effects) and under Cournot competition (which allows for cannibalization effects). 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 current level of the market share, the larger the welfare gains[31].

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

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

of CES preferences are larger than those arising in my model, and the difference between the two models increases with s_{jj}. Weakening cannibalization expands the scope of domestic firms in both models. However, with Stone-Geary preferences, the distortions generated by variable markups within a firm are exacerbated as the firm introduces varieties with high marginal costs.

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[32].

4.3.1 How Large is 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 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[33] 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. Finally, I use the industry-specific trade elasticities ϵ estimated by Caliendo and Parro (2015) and the median σ by industry from Soderbery (2015)[34].

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 3. I implicitly ignore any interactions across industries.

[32]Using nested non-homothetic preferences is highly intractable: I can modify the baseline preferences used in this paper to allow for brand differentiation. The results are analogous to the Nested-CES case. Details are available in online appendix.

[33]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.

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

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 these industries halved. At the other end of the spectrum, the production of cement recorded the largest fall in welfare (58%)[35].

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%[36].

Neglecting per capita income but maintaining the assumption of cannibalization overestimates the welfare gains by 19%[37]. The degree of heterogeneity is milder as the standard

[35] The appendix reports the full list of industry-level welfare changes.

[36] Here, I am comparing $\frac{d\ln W_j}{d\ln s_{jj}}$ across models. An alternative question is how $\frac{d\ln s_{jj}}{d\ln\tau}$ varies across models. Answering this question is not feasible with the available data: $\frac{d\ln s_{jj}}{d\ln\tau}$ requires information on foreign exporters' market shares. However, the online appendix shows, theoretically, that for the same $d\ln\tau$, s_{jj}, s_{ij} and θ, $\left|\frac{d\ln s_{jj}}{d\ln\tau}\right|$ is larger in the model with cannibalization effects, which further amplifies the difference in welfare gains between the two models.

[37] 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 (26) 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

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 - where cannibalization effects are strong - while they are overestimated in more competitive industries in which the role of income dominates that of cannibalization effects.

4.4 Welfare Gains with Large Single Product Firms

In this section, I study the contribution of cannibalization effects to the welfare gains from trade relative to a model of large single product firms (Edmond et al., 2015). I consider the model of CES preferences discussed in Section 4.3. However, I assume now that firms are only producing one variety[38]. The formula for the welfare gains from a small reduction in the iceberg trade costs becomes:

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

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:

$$d\ln W_j = \left[\frac{1}{\epsilon} + \frac{s_{jj}}{1-s_{jj}} + \left(\frac{1}{\sigma-1} - \frac{1}{\epsilon}\right)\frac{s_{jj}}{1-s_{jj}}\right](-d\ln s_{jj}) \tag{28}$$

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

predicted by the baseline model.

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

variety is larger than the marginal cost, that is $\frac{1}{\sigma-1} > \frac{1}{\epsilon}$, weakening cannibalization effects are welfare improving.

4.5 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. The strategy I choose is to add to the large oligopolists of the baseline model a competitive multiproduct fringe.

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 $\omega \in [0, \delta^c_{kij}]$. The marginal cost of producing a variety ω by the competitive fringe is $c^c_{kij}(\omega) = \tau_{ij} w_i c^c_i \omega^\theta$. Without loss of generality I assume that θ is common across all firms and that $c^c_i > c^o_i$.

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

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

where α is the weight on the goods produced by large multiproduct firms. If $\alpha = 1$, the model is the same as in Section 3, whereas if $\alpha = 0$, all the varieties are produced by the competitive fringe. I leave the solutions of the model and derivations to the online appendix to the paper, and focus here on the welfare formula for the welfare gains from trade.

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

$$d\ln W_j = \underbrace{\mu^o_j \left[\frac{\theta(\theta+2)}{2(\theta+1)}\right] \left[1 + \frac{s_{jj}}{\theta(1-s_{jj})}\right] (-d\ln s_{jj})}_{\text{Large Multiproduct Firms}} + \mu^c_j \underbrace{\theta(-d\ln\Lambda^c_{jj})}_{\text{Competitive Fringe}} + \underbrace{\frac{\theta}{2}\mu^c_j d\ln\mu^c_j}_{\text{Interaction}} \tag{29}$$

where the weight μ^o_j (μ^c_j) is the expenditure share in country j on goods produced by domestic and foreign superstars (competitive fringes). 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 τ 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_j^o.

5 Testing the Hypotheses of the Model

This section tests whether the scope of exporters is determined by income and cannibalization effects. Let us take logs of the optimal scope (18) of firm k from i to j:

$$\ln \delta_{kij} = \text{Constant}_k + \frac{1}{\theta+1} \ln y_j \ + \frac{1}{\theta+1} \ln(s_{kij} - s_{kij}^2) - \frac{1}{\theta+1} \ln \tau_{ij} \tag{30}$$

The product scope of an exporter is decomposed in several determinants: a firm-level constant productivity, per capita income of the destination, a non-monotone, hump-shaped function of the firm's market share, and bilateral trade costs. After describing the data I use, I document that the scope of a superstar:

1. increases in the per capita income of the destination,
2. exhibits a non-monotone, hump-shaped relationship with respect to the firm's market share in the destination.

5.1 Mexican Multiproduct Exporters and Superstars

I use transaction-level customs data for Mexico from 2000 to 2006. 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)[39]. A product is a Harmonized System (HS) 6 digit good, the same classification used in Arkolakis et al. (2014)[40]. As my model considers firms producing final goods, I restrict the sample to manufactured consumption goods according to

[39] 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.

[40] 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).

the Broad Economic Category (BEC) classification[41].

Mexican firms have often been the subject of empirical research on multiproduct firms, which makes them a reasonable choice to document the stylized facts predicted by the paper. For instance, Iacovone and Javorcik (2010) confirm a theoretical prediction common across models of multiproduct firms: Mexican firms only export a fraction of the varieties produced domestically, and the domestic scope shrinks after a trade liberalization. Eckel et al. (2015) documented that Mexican exporters in differentiated goods industries exhibit a quality-based core competence while firms producing homogeneous goods exhibit a cost-based core competence.

Mexican export flows are dominated by multiproduct firms: from 2000 to 2006, firms that sell at least two products in a destination 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 Freund and Pierola (2015).

5.2 Product Scope across Rich and Poor Countries

The first prediction of the model is a positive relationship between the number of exported varieties per firm and the per capita income of the destination. To test such a prediction, I consider the following regression model based on (30):

$$\ln(\#\ \text{Products}_{kMjt}) = \beta_0 + \beta_y \ln(\text{Pc. Income}_{jt}) + \beta_L \ln(\text{GDP}_{jt}) + \beta_\tau \tau_{Mjt} + f_k + g_t + \epsilon_{kMjt} \quad (31)$$

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[42]. β_y can be interpreted as the effect of per capita income on the scope of an exporter conditional on the size of the 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

[41] 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; etc. 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.

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

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.

As the model represents export superstars, 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 (31) 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. 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%.

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 (31). 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%.

The coefficient on per capita income is close to zero and insignificant for small firms. The model suggests a possible explanation for such a result, as size and per capita income of the destination affect the scope of an exporter through different channels[43]. Non-homothetic preferences, combined with the core competence assumption, generate a positive relationship between scope and the per capita income of the destination. On the other hand, if firms pay a fixed cost of entry per variety, their scope increases with size of the destination. Table 3 suggests

[43]The Appendix shows an extension to the model that features fixed costs per variety. In presence of fixed costs, firms export more varieties in larger economies.

that fixed costs per variety have a larger effects on small firms. While investigating the source of such a difference goes beyond the purpose of the paper, possible explanations are economies or scope or heterogeneity in the ability to introduce new products across firms.

As the model predicts, firms' scope negatively depends on trade costs. Among the geographical barriers that proxy trade costs, distance and the commonality of language are the more statistically and economically significant[44]. 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)[45].

5.3 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 strengthen 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 the firm. In this section I trace such a relationship in the data.

I use the following regression model:

$$\ln(\#\text{ Products}_{kMjt}) = \beta_s s_{kMjt} + \beta_{s^2} s^2_{kMjt} + f_k + d_{jt} + \epsilon_{kMjt} \tag{32}$$

where the dependent variable is the log of the number of products exported by firm k from Mexico to country j in year t. Since cannibalization effects are a within-firm characteristic, I control for all the observed and unobserved destination variables and trade costs using destination-year fixed effects d_{jt}. 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[46], and s^2_{kMjt} is the orthogonalized squared market share[47]. Similarly to the previous stylized fact, I focus on three samples of the data: the bottom 95% of multiproduct exporters, the top 5% and 1%.

[44]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.

[45]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. Such a result is however less evident when I analyze the full sample of firms, or when I consider the entire sample of countries in the Exporter Dynamics Database.

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

[47] 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.

Table 4: Multiproduct Firms and their Market Share

	Bottom 95%	Top 5%	Top 1%
s_{kMjt}	0.209***	0.343***	0.318***
	(0.012)	(0.025)	(0.056)
s^2_{kMjt}	-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 (32). Robust std. error in parenthesis. Cluster: destination country. ***: significant at 99%, ** at 95%, * at 90%. The ratio of firm's exports to imports 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. Moreover, 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[48]. A kernel-weighted local polynomial regression smoothing further supports such hypothesis.

5.4 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. As these countries are low and middle income economies, a potential concern is that their exporters are not engaging in trade of differentiated goods. Hence the choice of Mexico, whose multiproduct exporters have been the subject of empirical research in trade of differentiated goods (Iacovone and Javorcik, 2010; Eckel et al., 2015). Nevertheless, the results of this section are robust to 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 changes in the set of geographical controls and definitions of distance. Moreover, results are

[48] Lind and Mehlum (2010) develop a proper test for a non-monotone relationship. 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 on reproductive success in the long run. Details on the test and results are available in the online appendix.

similar when I use alternative distributions of firms[49] or measures of s_{kMj}[50].

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 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.

6 Concluding Remarks

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.

[49] 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.

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

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7 Appendix

7.1 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 (18). The main difference is that the maximum scope is reached at a market share greater than 50%, and which depends on the parameters of the model. 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: $U_j = \int_{\Sigma_j} \left[\ln(q_j(\omega) + \bar{q}(\omega)) - \ln \bar{q}(\omega)\right] d\omega$, 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[51].

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: $U_j = \sum_{i=h,f} \sum_{k=1}^{M} \int_0^{\delta_{kij}} \left[\ln\left(\frac{q_{kij}(\omega)}{\delta_{kij}^{\gamma}} + \bar{q}\right) - \ln \bar{q}\right] d\omega$. 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

[51]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.

larger the scope of a firm, the smaller the utility from an additional quantity consumed. In such 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.

7.2 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 (24). In addition, it provides the extent of the mismeasurement of welfare gains that arises from models that ignore cannibalization effects or per capita income.

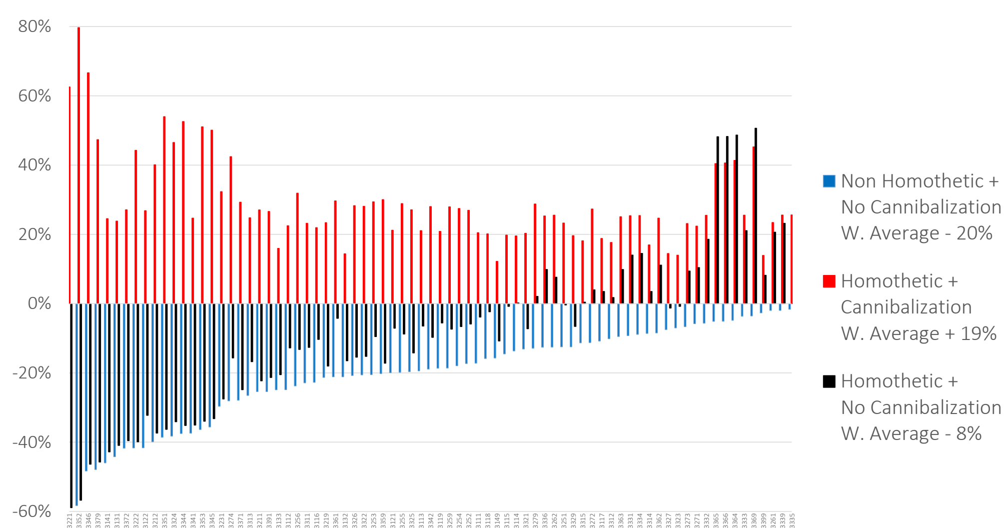
Table 5: Industry Level Welfare Gains Across Models (2007-2002) (%)

Code	Industry	s_{jj2002}	$d\ln s$	$d\ln W$	% Diff. rel to baseline 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

Code	Industry	s_{jj2002}	$d\ln s$	$d\ln W$	% Diff. rel to baseline	
					No Cann.	No Pc. Income
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
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 weigthed by the industry absorption. All values are in percentages.

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



7.3 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:

$$\ln(s_{kMjt}) = \beta_0 + \beta_y \ln(\text{Pc. Income}_{jt}) + \beta_L \ln(\text{GDP}_{jt}) + \beta_\tau \tau_{Mjt} + f_k + g_t + \epsilon_{kMjt} \qquad (33)$$

where s_{kMjt} is the ratio of firm's k export to j over total household consumption in j from WDI[52]. Similar to (31) 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 6: 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 (33). 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.

Table 6 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.

[52] 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

7.4 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.

7.4.1 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 number of varieties sold by Apple, Ikea, Zara and H&M in their online stores[53]. 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.

Table 7: 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 (31). ***: 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.

I estimate the empirical model (31), 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

[53] 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

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[54].

The coefficient on per capita income is positive and statistically significant for all multinationals (Table 7). 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.

7.4.2 European Car Market

To verify the robustness of the second stylized fact, I use the data on the sales of cars 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 2 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.

For each destination I run the following regression:

$$\ln(\#\text{ Car models}_{k,ijt}) = f_k + d_{jt} + \beta_s s_{k,ijt} + \beta_{s^2} s^2_{k,ijt} + \epsilon_{k,ijt} \tag{34}$$

where f_k is a firm fixed effect, d_{jt} is a destination-year fixed effects 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 8 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.

[54]These are standard controls in the literature that uses scraped data (Simonovska, 2015). Given the role of per capita income in shaping the product scope choices of firms, I also controlled for income inequality in the destination (Bekkers et al., 2012). However, given the data availability adding the Gini Index from WDI reduces an already small sample of destinations. 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.

Figure 2: Product Scope of Exporters and their Market Share

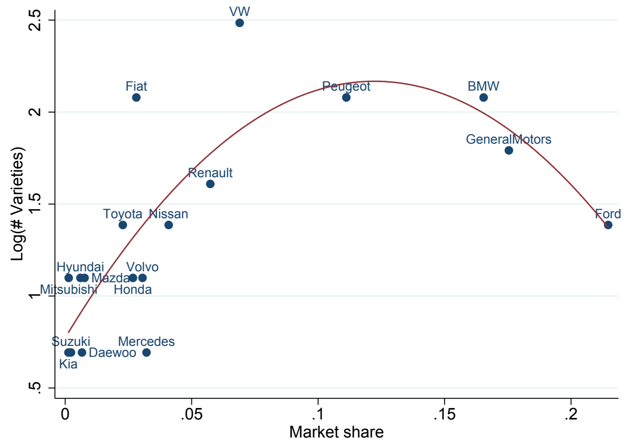


Table 8: European Car Market: Scope of Exporters and Their Market Share

	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 (34). 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.