Love for Quality, Comparative Advantage, and Trade*

Esteban Jaimovich
Collegio Carlo Alberto

Vincenzo Merella
University of Cagliari

October 2011

Abstract

This paper proposes a theory of trade where comparative advantages reveal themselves gradually over the path of development. We work under a Ricardian framework with vertical and horizontal differentiation, and with two additional non-standard features. First, individuals' willingness to pay for quality rises with their income. Second, comparative advantages are stronger for goods of higher quality. Our theory predicts that the scope for trade widens and international specialisation intensifies as incomes grow and wealthier consumers raise the quality of their consumption baskets. Furthermore, we show that particular trade patterns develop linking richer importers to more specialised exporters. That is, our model leads to both import and export specialisation that become stronger as income rises. We provide empirical support for this prediction, showing that the share of imports originating from exporters exhibiting a comparative advantage in a given product correlates positively with the importer's GDP per head.

Keywords: International Trade, Nonhomothetic Preferences, Quality Ladders.
JEL Classifications: F11, F43, O40

*We would like to thank Arnaud Costinot, Pablo Fajgelbaum, Giovanni Mastrobuoni, Ignacio Monzon and Alessio Moro for comments and suggestions, as well as seminar participants at Collegio Carlo Alberto and the Workshop on Structural Change and Macroeconomic Performance (Univ. of Cagliari).

1 Introduction

Income is a key determinant of consumer choice. A crucial dimension where individuals' purchasing power influences this choice is the quality of consumption. As a matter of fact, people with very different incomes often consume commodities within the same category of goods, such as clothes, cars, wines, etc. Yet, the actual quality of the consumed commodities differs substantially when looking at poorer versus wealthier households. In an open-economy world, this entails that the average quality of imports will rise with the GDP per head of the economy; an implication that has been widely documented in the trade literature (Hallak, 2010). In this paper, we propose a theory of trade grounded on the hypothesis that comparative advantages are stronger for higher-quality varieties of goods, and study the consequences of quality upgrading of consumption on trade flows at different income levels. International specialisation and trade evolve over the growth path, as the continuing quality upgrading of imports exacerbates the degree of comparative advantage in different industries. In particular, both import and export specialisation will rise with growing incomes. This is the result of richer consumers shifting their spending towards high-quality varieties, which are precisely those subject to stronger comparative advantages.

We model a world economy with a continuum of horizontally differentiated goods, each of them available in two varieties: low and high quality. Countries' technologies differ in the cost of production of each specific commodity, with some countries being intrinsically better than others in producing certain goods. This is the traditional source of trade in Ricardian models, leading to specialisation along the horizontal dimension of the commodity space. Alongside this traditional feature, we assume that intrinsic productivity differentials (on the horizontal dimension) tend to become increasingly pronounced as production moves up (vertically) on the quality ladders of each good. In other words, a country may have, for example, a cost advantage in producing wine, while another country may have it in producing whisky, which would naturally lead them to exchange these two goods. Yet, in our model, productivity differences in the wine and whisky industries do not remain constant along the quality space, but become more intense at the upper levels of quality of both wines and whiskies. The main implication we draw from this is that the scope for international trade turns out to be wider for high-quality varieties of wines and whiskies than for low-quality ones.

We combine the above-mentioned production structure with nonhomothetic preferences by consumers whose willingness to pay for quality rises with their purchasing power. Such nonhomotheticity implies that, given market prices, richer individuals consume a larger set of horizontally differentiated goods in their higher quality varieties than poorer consumers do. Within this framework, we show that at low levels of income all sectors in the economy may be served to a large extent by local producers. The reason for this is that productivity differentials across producers from different economies are relatively narrow for goods offered in low quality varieties. However, in a context of secular growth, as individuals upgrade their quality of consumption, comparative advantages become stronger, which in turn leads to a gradual process of increasing international specialisation.

Our theory predicts changes on both the demand and supply sides of economies along the growth path, as trade flows react to the widening of cost advantages in the upper levels of quality of consumption. On the demand side, our model predicts that the quality of imports of given products responds positively to variations in incomes. In that respect, Fieler (2007) shows that import prices correlate positively with the level of income per head of the importer, and this occurs even when looking at specific commodities originating from the same exporter. In addition, studies based on household-level data also lend support to the presence of nonhomotheticities linked to quality of consumption, and their relevance in explaining the behaviour of imports. Using household income data for 26 countries in year 2000, Choi, Hummels and Xiang (2009) show that differences in importers' price distributions map into differences in their income distributions in a way consistent with rising willingness to pay for quality.[1]

On the supply side, our model predicts that exporters will adjust the quality of their production to serve markets with different income levels. This prediction is also widely supported in the data. For example, Verhoogen (2008) and Iacovone and Javorcik (2008) provide evidence of Mexican manufacturing plants selling higher qualities in US than in their local markets. Brooks (2006) establishes analogous results for Colombian manufacturing plants. Similarly, Manova and Zhang (2011) show that Chinese firms ship higher qualities of their exports to richer importers, while Bastos and Silva (2010) find the same result for Portuguese firms.[2] Finally, in a

[1] In particular, they show that "countries with high incomes consume goods with high prices; countries with greater variability of incomes over households have greater variability in prices for a particular good; and countries whose income distributions have fat or skewed tails have also price distributions with fat or skewed tails." See also related evidence in Francois and Kaplan (1996) and Dalgin, Trindade and Mitra (2008).

[2] Related evidence is presented by Artopoulos, Friel and Hallak (2011), who argue that the recent successful Argentinean exporters were those who managed to adjust the quality of their products to better appeal developed

cross-country study Hallak and Schott (2011) show that the quality gap in production between countries is significantly smaller than the gap in GDP per head, which suggests that poorer economies produce high-quality varieties for richer markets.

Our paper ties together the previous well-known stylised facts, referring separately to the demand and supply sides, within a model where Ricardian comparative advantages become increasingly apparent as firms upgrade the quality of their production to meet the demands of wealthier consumers.

In addition to that, our model also yields novel predictions that link different importers to specific exporters of given products, conditional on the level of GDP per head of the importer. In particular, by combining cost advantages that widen up along the quality ladders together with nonhomotheticities in quality of consumption, our model predicts that the share of imports originating from exporters exhibiting an advantage in a given product should grow with the income per head of the importer. This is the case because richer importers are exactly those who tend to buy high-quality varieties, while high-quality varieties are exactly those where Ricardian specialisation becomes highest. In that regard, in Section 5.1 we provide evidence consistent with the assumption that productivity differentials become more intense at higher levels of quality of production, while in Section 5.2 we show evidence in accord with the prediction that richer economies are more likely to buy their imports from producers with a comparative advantage.

Related Literature

Nonhomothetic preferences are by now a common modelling choice in the trade literature. However, most of the past trade literature with nonhomotheticities has focused either on vertical differentiation [e.g., Flam and Helpman (1987), Stokey (1991) and Murphy and Shleifer (1997)] or horizontal differentiation in consumption [e.g., Markusen (1986), Bergstrand (1990) and Matsuyama (2000)].[3] Two recent articles have combined vertical and horizontal differentiation with preferences featuring income-dependent willingness to pay for quality: Jaimovich and Merella (2010) and Fajgelbaum, Grossman and Helpman (2011).

markets.

[3]For some recent contributions with horizontal differentiation and nonhomothetic preferences see, for example: Foellmi, Hepenstrick and Zweimuller (2010) where consumers are subject to a discrete choice between zero or one unit of consumption for each good, and Fieler (2011) who, using a CES utility function, ties the income elasticity of consumption goods across different industries to the degree of substitution of goods within the same industry.

Jaimovich and Merella (2010) study the possibility that trade may endogenously generate income disparities between countries when the scope for quality upgrading differs across the types of goods they export. That paper proposes a richer nonhomothetic specification, where budget reallocations with rising incomes take place both within and across horizontally differentiated of goods. However, in contrast with the present paper, it does not generate an endogenous and gradual evolution of international trade, as it assumes relative cost disparities that are independent of the quality of production.

Fajgelbaum et al. (2011) analyse how differences in income distributions between economies with access to the *same* technologies determine trade flows in the presence of increasing returns and trade cost. Like ours, their paper leads to an endogenous emergence of comparative advantages, which may have remained latent for quite some time (either due to trade costs being too high or countries' income distributions being too similar). Our paper, instead, sticks to the Ricardian tradition where trade is the result of *differences* in technologies featuring constant returns to scale, and our main mechanism differs from theirs in the following: comparative advantages and trade emerge gradually, not because trade costs obstruct the course of increasing returns, but because the demand for commodities displaying wider heterogeneity in terms of cost of production (i.e. high-quality goods) expands as incomes rise. In that respect, an important implication of our model is that specialisation and the quality of traded goods depend on the *world* income distribution, whereas in Fajgelbaum et al. (2011) they depend on countries' incomes distributions taken separately.[4]

A key assumption in our theory is the widening in productivity differentials at higher levels of quality. To the best of our knowledge, Alcala (2009) is the only other paper explicitly introducing a similar feature into a Ricardian model of trade. An important difference between the two papers is that Alcala's keeps the homothetic demand structure presented in Dornbusch, Fisher and Samuelson (1977) essentially intact. Nonhomotheticities in demand are in fact crucial to our story and its main predictions regarding the evolution of trade flows and specialisation along the path of development. Finally, our paper relates to Linder (1961) and Hallak (2010) views of quality as an important dimension in explaining trade flows between countries. In that regard, we propose a new mechanism that links together quality of production, income per

[4]More precisely, as world incomes rise, *all* economies in our model will adjust upwards their quality of production to cater wealthier consumers demand, which in turn leads to higher specialisation in the world economy owing to stronger of comparative advantage at higher levels of quality of production.

capita and trade at different stages of development.

The rest of the paper is structured as follows. Section 2 describes the setup of our model for the case of a closed economy, in order to cleanly depict the specificities of the assumed nonhomothetic preferences. Section 3 introduces trade within a two-country world economy where both economies are *ex-ante* identical in their productivities; this section represents the core of our paper. Section 4 extends our main results to situations with *ex-ante* heterogeneities in productivities across countries and with trade frictions. Section 5 presents a variety of illustrative empirical results consistent with the main predictions of our model. Section 6 concludes. All relevant proofs can be found in Appendix A.

2 The Model in Autarky

We consider an economy with a commodity space defined along two distinct dimensions: *horizontal* and *vertical*. The horizontal dimension refers to different types of goods, such as cars, wines, coffee beans, etc. The vertical dimension refers to the intrinsic *quality* of the each specific good. We order commodities horizontally by the good index z along the goods space $\mathbb{Z} = [0, 1]$, and vertically by the quality index $q \in \{0, 1\}$. In plain words, each good $z \in \mathbb{Z}$ is present in two levels of quality: a low-quality variety ($q = 0$) and a high-quality one ($q = 1$). Given this setup, we designate each particular commodity by a specific good-quality pair, namely: $(z, q) \in \mathbb{Z} \times \{0, 1\}$.

2.1 Production

In each sector $z \in \mathbb{Z}$, there is a continuum of firms that may produce good z. Production technology is idiosyncratic to the sector. In order to produce one unit of commodity (z, q), a firm in sector z needs to put in use $(1 + \eta_z q) / \kappa$ units of labour, where $\eta_z, \kappa > 0$. We interpret the parameter η_z as the cost of quality upgrading of good z. Henceforth, we assume that each η_z is independently drawn from a unit uniform distribution. The parameter κ applies identically to all sectors, and we interpret it as the total factor productivity in the economy. As such, increases in κ will capture the effects of aggregate growth and rising real incomes.

Since in each sector z there is a continuum of firms able to produce each commodity (z, q) at identical unit cost, in equilibrium, all commodities will be priced exactly at their unit cost:

$$p_{z,q} = \frac{1 + \eta_z q}{\kappa} w, \quad \text{for all } (z, q) \in \mathbb{Z} \times \{0, 1\}; \tag{1}$$

where w denotes the wage per unit of labour.

2.2 Consumption

The economy is inhabited by a continuum of individuals with unit mass. Individuals are endowed with one unit of time, which they supply in the labour market in exchange for w. All individuals have identical preferences defined over the commodity space $\mathbb{Z} \times \{0,1\}$. We let $x_{z,q}$ denote the (physical) quantity of consumption of good z in quality q. The consumption choice is binary: the individual may either consume one unit of a commodity (z,q), or not consume it at all. More precisely, $x_{z,q} \in \{0,1\}$ for all $(z,q) \in \mathbb{Z} \times \{0,1\}$.[5]

Individuals preferences are summarised by the following utility function, which is linearly additive across goods:

$$U = \int_0^1 C_z \, dz,$$
$$\text{where:} \quad C_z = \begin{cases} \sum_{q=\{0,1\}} q x_{z,q} & \text{if } x_{z,0} + x_{z,1} \geq 1, \\ -\infty & \text{if } x_{z,0} + x_{z,1} < 1. \end{cases} \tag{2}$$

The above utility function aims to capture two properties which are essential to our theory. First, quality is desirable to the consumer. Second, and more importantly, the willingness to pay for quality rises with the level of real income. This implies that the optimal consumption bundle will be income-dependent (in particular, it leads to a solution where richer individuals will purchase a larger fraction of goods in high-quality varieties).

Given (1), individuals face the budget constraint:

$$\int_0^1 \left(\sum_{q=\{0,1\}} p_{z,q} x_{z,q} \right) dz = \frac{w}{\kappa} \int_0^1 \left[x_{z,0} + (1+\eta_z) \, x_{z,1} \right] dz = w. \tag{3}$$

A few remarks about the consumer problem are worth noting now. First, from (2) it immediately follows that individuals will consume (at most) one quality of each good $z \in \mathbb{Z}$. That is, for each z, an individual may choose either $x_{z,0} = 1$ (and $x_{z,1} = 0$), or $x_{z,1} = 1$ (and $x_{z,0} = 0$), but never $x_{z,0} = x_{z,1} = 1$. In addition, given (3), since all z enter symmetrically into $U = \int_0^1 C_z \, dz$, it must be straightforward to observe that, given two generic goods $z', z'' \in \mathbb{Z}$, if an individual

[5] Preferences where consumption is a binary choice between 0 and 1 units have been used in trade models with horizontally differentiated goods by Matsuyama (2000) and Foellmi et al. (2010). Our specification in (2) below also incorporates a vertical dimension by letting quality affect the level of utility obtained by the consumer.

chooses $x_{z',1} = 1$ and $x_{z'',0} = 1$, then commodity $(z', 1)$ must be cheaper than $(z'', 1)$; in other words, it must be the case that $\eta_{z'} < \eta_{z''}$.

For the remaining of this section we take labour as the *numeraire* of the economy, by setting $w = 1$. Moreover, in order to focus on cases where the consumer's optimisation problem is well-defined, hereafter we let $\kappa \geq 1$.[6] Finally, note that each particular good z may be characterised by their respective η_z. To save notation, we henceforth use the latter to index the goods, and drop the subscript z whenever doing so creates no confusion.

When $\kappa = 1$, the consumer will buy one unit of each good at the baseline quality level ($q = 0$), as otherwise he will fail to satisfy the subsistence level of consumption of some of the goods. The interesting cases arise when $\kappa > 1$, as the individual may actually buy some of the goods in high-quality varieties, while still meeting the subsistence level of consumption for all goods. More precisely, when $\kappa > 1$, the individual will use the "additional" real income $(\kappa - 1)$ to raise the quality of consumption of the subset of goods whose quality can be more easily upgraded. In other words, when $\kappa > 1$, there exists a threshold $\widehat{\eta} > 0$ such that the individual purchases all goods characterised by $\eta \leq \widehat{\eta}$ in high quality ($q = 1$), while buying those with $\eta > \widehat{\eta}$ in low quality ($q = 0$). Given the individual's budget constraint (3), the value of the threshold $\widehat{\eta}$ is then pinned down by the following condition:

$$\int_0^{\widehat{\eta}} \frac{1 + \eta}{\kappa} d\eta + \int_{\widehat{\eta}}^1 \frac{1}{\kappa} d\eta = 1. \tag{4}$$

where the integrals on the left-hand side represent spending on high-quality and low-quality commodities, respectively. Computing the integrals in (4), and multiplying both sides by κ, yields $1 + \widehat{\eta}^2/2 = \kappa$, from which we may finally obtain an expression linking $\widehat{\eta}$ to κ:

$$\widehat{\eta} = \widehat{\eta}(\kappa) \equiv \begin{cases} \sqrt{2(\kappa - 1)} & \text{if } 1 \leq \kappa \leq 3/2, \\ 1 & \text{if } \kappa > 3/2. \end{cases} \tag{5}$$

The function $\widehat{\eta}(\kappa)$ in (5) summarises the nonhomothetic behaviour of demand implied by (2). An increase in κ drives all prices (relative to the wage) down, implying a proportional rise in the consumer's real income. As consumers get richer, they begin raising the quality of some of the differentiated goods they consume, starting by those whose cost of quality upgrading is lower (that is, those carrying a relatively low η). Richer individuals thus consume a larger fraction of

[6] More precisely, if $\kappa < 1$ the economy will not be productive enough to allow individuals to meet the unit subsistence level of consumption of all horizontally differentiated goods.

goods in high-quality varieties, which is featured by the fact that $\widehat{\eta}(\kappa)$ is an increasing function of κ. Eventually, when $\kappa \geq 3/2$, individuals are rich enough so as to be able to afford all goods in the commodity set in their high-quality varieties.

3 A Symmetric Two-Country World Economy

We consider now a setting with two economies denoted by the letters H and F (standing for *Home* and *Foreign*, respectively). In each economy, there is a unit continuum of individuals, each of them endowed with one unit of labour time. Labour is immobile across countries. We take the wage in H as the numeraire, by setting $w_H = 1$, and denote by w_F the wage in F. All consumers in the world share identical preferences, given by (2). Both H and F are open to international trade, and we assume there exist no trading costs.

3.1 Production Side and Consumer Choice

Analogously to the autarky case, we assume that in country $c \in \{H, F\}$ there exist a continuum of firms that may transform $\left(1 + \eta_{z,c} q\right)/\kappa$ units of labour into one unit of commodity (z, q), where the parameter $\kappa \geq 1$ denotes now the common level of total factor productivity. Heterogeneities in sectoral productivity across countries arise from the fact that each $\eta_{z,c}$ is *independently* drawn from a unit uniform density function $g(\cdot)$; that is, $g(\eta) = 1$ for any $\eta \in [0, 1]$, while $g(\eta) = 0$ otherwise.[7] Note that each particular good z may be now characterised by the pair of realisations $\left(\eta_{z,H}, \eta_{z,F}\right) \in [0, 1] \times [0, 1]$. In what follows, for most of the paper we will use the realisations $\left(\eta_{z,H}, \eta_{z,F}\right)$ to designate good z. Once again, to save notation, we will drop the subscript z whenever doing so generates no confusion. Also for convenience in notation, we will often make use of the cumulative probability function $G(\cdot)$ associated to $g(\cdot)$, which is given by:[8]

$$G(\eta) = \begin{cases} 0 & \text{if } \eta \leq 0, \\ \eta & \text{if } 0 < \eta < 1, \\ 1 & \text{if } \eta \geq 1. \end{cases}$$

[7] The symmetry between H and F will stem from the fact that κ is common to both countries and each $\eta_{z,c}$ is drawn from an identical probability density function.

[8] In Appendix C (online appendix), we show how our main results in this section extend to a case with a general density function $g(\cdot)$ with full support on $\mathbb{R}_{++}$.

We assume that when producers from both H and F offer commodity $(z, q) \in \mathbb{Z} \times \{0, 1\}$ at the same price, consumers will randomly choose which firm to buy it from, among all those actively supplying it. Notice, as well, that given the zero trade cost assumption, whenever the price of a particular commodity (z, q) is strictly different across producers from different countries, an individual choosing to actively consume commodity (z, q) will then buy it from the country selling it at the lower price.

The last two considerations in the above paragraph have two important consequences. Firstly, given that low-quality varieties are produced with the same technology in both countries, a necessary condition for a low-quality variety to be produced in F (resp., in H) is that $w_F \leq 1$ (resp., $w_F \geq 1$). Formally, we let α_z denote the fraction of demand of the low-quality variety of z catered by producers from country H. (The complementary fraction, $1 - \alpha_z$, is then supplied by firms from F.) Utility maximisation by consumers implies that:

$$\alpha_z \begin{cases} = 1 & \text{when } w_F > 1, \\ \in [0, 1] & \text{when } w_F = 1, \\ = 0 & \text{when } w_F < 1. \end{cases} \tag{6}$$

From (6) we can readily observe that our model does not place any restrictions on α_z when $w_F = 1$. This implies that, if the general equilibrium solution delivers $w_F = 1$ (which, as we will see later on in Proposition 1, it is actually the case), then our model may actually sustain such equilibrium (relative) wage with an infinite number of different combinations of α_z across the set of goods $\mathbb{Z}$. For this reason, henceforth, we restrict the attention to symmetric cases, where all α_z take the *same* value in equilibrium; that is, to cases in which $\alpha_z = \alpha$ for all $z \in \mathbb{Z}$.[9]

Secondly, for goods offered in high qualities (that is, with $q = 1$), heterogeneity in the cost of quality upgrading also plays a role in determining specialisation. In particular, letting $c, c' \in \{H, F\}$, a necessary condition for the high-quality variety of a commodity characterised by the pair (η_H, η_F) to be actively produced in c is that:

$$\eta_c \leq (1 + \eta_{c'}) \frac{w_{c'}}{w_c} - 1. \tag{7}$$

From (7), by setting $c = F$ and $c' = H$ it follows that commodity (η_H, η_F) will be supplied only

[9] Essentially, if $\alpha_z = \alpha$ is consistent with a general equilibrium in this two-country world economy, then any combination of $\{\alpha_z\}_{z \in \mathbb{Z}}$ such that $\int_0^1 \alpha_z dz = \alpha$ will be so too. Such multiplicity of cases is of little interest for our theory, hence we choose to focus on the most straightforward case when all α_z are equal in equilibrium.

by F if and only if:

$$\eta_F < \frac{(1+\eta_H)}{w_F} - 1, \tag{8}$$

while (by setting $c = H$ and $c' = F$) the same commodity will be supplied only by H iff:

$$\eta_H < (1+\eta_F)\, w_F - 1. \tag{9}$$

Similarly to the closed-economy case, we may split the goods space $\mathbb{Z}$ into two distinct subsets: one comprising goods consumed in low qualities, and the other one comprising goods consumed in high qualities. However, this two-country world economy requires heavier notation than the closed-economy case. In particular, we can identify four thresholds (instead of only one, as in the closed-economy case), generically indicated by $\widehat{\eta}_{c'}^{c}$, where $c, c' \in \{H, F\}$. (Superscript c refers to the country of origin of the consumer, whereas subscript c' refers to the country of origin of the producer.) Such thresholds on the goods space may possibly differ along two distinct dimensions: *i*) across economies, thresholds may differ depending on the consumers' relative real income (i.e., $\widehat{\eta}_{c'}^{H}$ and $\widehat{\eta}_{c'}^{F}$ may possibly differ if incomes in H and F are not equal); *ii*) for a given economy, thresholds may also be different for locally produced and imported goods, depending on the relative wage paid by firms (i.e., $\widehat{\eta}_{H}^{c}$ and $\widehat{\eta}_{F}^{c}$ may possibly differ if wages in H and F are not equal). Formally, the thresholds are characterised in the following definition.

Definition 1 *Denote by $\widehat{\eta}_{H}^{c}$ and $\widehat{\eta}_{F}^{c}$ the thresholds in the commodity space for individuals from country $c \in \{H, F\}$, such that:*
i) whenever $\eta_H \geq \widehat{\eta}_{H}^{c}$ and $\eta_F \geq \widehat{\eta}_{F}^{c}$, then individuals from c consume the low-quality variety, buying it from producers from the country with the lower wage, or randomising between both countries when $w_F = 1$;
ii) whenever $\eta_F < \widehat{\eta}_{F}^{c}$ and condition (8) holds, then individuals from c consume the high-quality variety, buying it from producers from F;
iii) whenever $\eta_H < \widehat{\eta}_{H}^{c}$ and condition (9) holds, then individuals from c consume the high-quality variety, buying it from producers from H.

Notice that Definition (1) implies that a particular relationship exists between the two thresholds referring to consumers of a particular country of origin. More precisely, $\widehat{\eta}_{H}^{c}$ and $\widehat{\eta}_{F}^{c}$ are tied to one another by the following condition:

$$\widehat{\eta}_{F}^{c} = \left(1+\widehat{\eta}_{H}^{c}\right)/w_F - 1, \text{ where } c \in \{H, F\}. \tag{10}$$

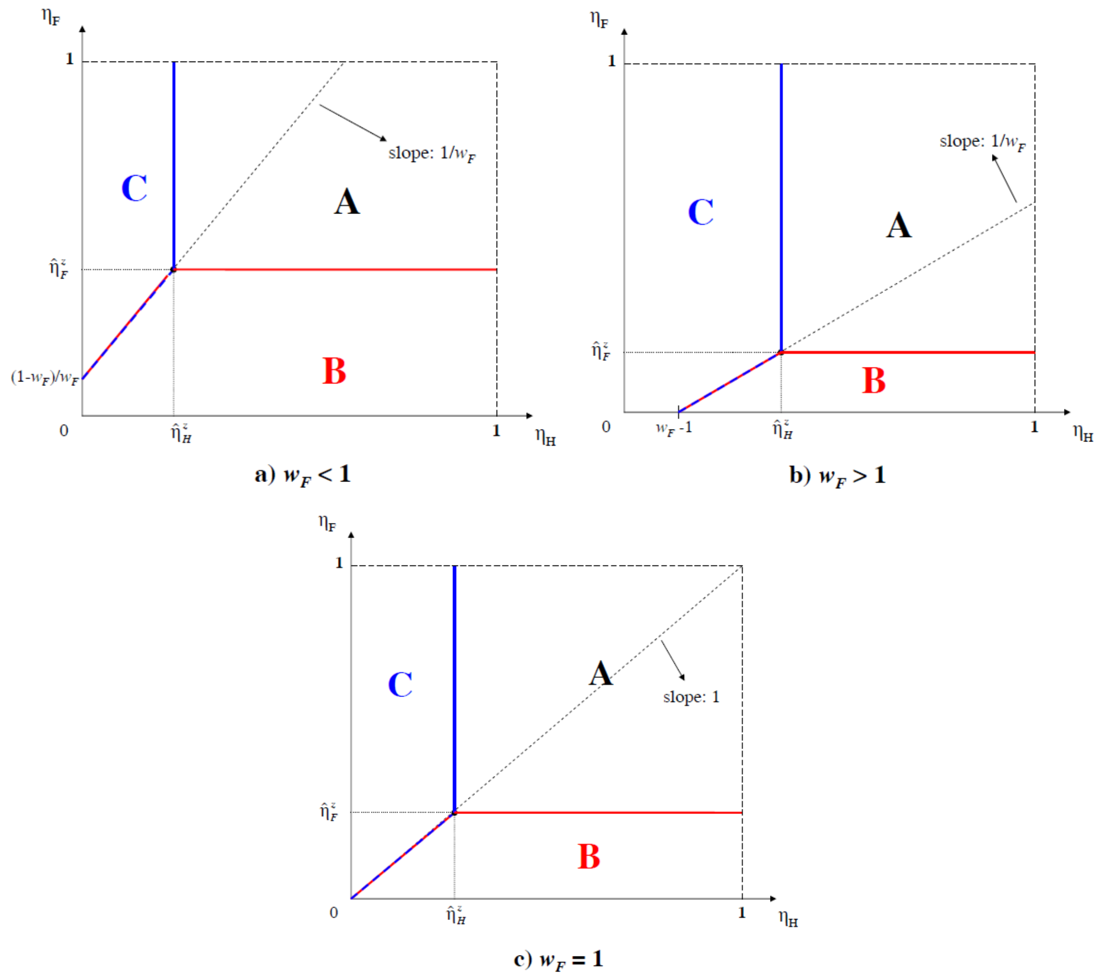

Figure 1: Quality thresholds for an individual from country c

Figure 1 plots a graphic representation of the thresholds $\widehat{\eta}_H^c$ and $\widehat{\eta}_F^c$ for a generic level of $\kappa > 1$. The figures split the space of joint realisations (η_H, η_F) that characterise consumption goods into three regions: A, B and C. Region A comprises the set of goods that are consumed by country c in $q = 0$ (a fraction α of these goods are supplied by producers from H according to (6), while the remaining fraction $1 - \alpha$ are supplied by F). Total spending on these goods amounts to:

$$\frac{1}{\kappa}\left[\alpha\left(1-\widehat{\eta}_H^c\right)\left(1-\widehat{\eta}_F^c\right)+(1-\alpha)\, w_F\left(1-\widehat{\eta}_H^c\right)\left(1-\widehat{\eta}_F^c\right)\right]. \tag{11}$$

Region B comprises the set of goods consumed by country c in $q = 1$ and supplied by producers from F. The total value of these goods equals:[10]

$$\frac{w_F}{\kappa}\int_0^{\widehat{\eta}_F^c}\left(1+\eta_F\right)\left[1-G\left(\left(1+\eta_F\right)w_F-1\right)\right]d\eta_F, \tag{12}$$

[10]Notice from Figure 1.a) that when $w_F < 1$, we have that $G\left(\left(1+\eta_F\right)w_F-1\right)=0$ for any $\eta_F \leq w_F^{-1}-1$.

Finally, region C consists of the set goods that also consumed by country c in $q = 1$, but supplied by producers from H. Total spending on these goods is equal to:[11]

$$\frac{1}{\kappa}\int_0^{\widehat{\eta}_H^c} (1+\eta_H)\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H. \tag{13}$$

The budget constraint for an individual from $c \in \{H, F\}$ then requires that the sum of (11), (12) and (13) must equal w_c, where $c \in \{H, F\}$.

3.2 Equilibrium

The general equilibrium in this two-country world economy requires that aggregate demand of goods produced by a country must equal aggregate supply of goods produced by the same country. Such market clearing condition can be shown to be identical to that of equilibrium trade balance, namely: the value of total exports by one country must equal the value of total imports by the same country. (In what follows, we primarily conduct our equilibrium analysis by looking at the trade balance equilibrium condition.)

From (6) and Definition 1, we may write down the equilibrium condition for the trade balance between H and F as follows:

$$\begin{aligned}&\int_0^{\widehat{\eta}_H^F}\left(\frac{1+\eta_H}{\kappa}\right)\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H + \frac{\alpha}{\kappa}\left(1-\widehat{\eta}_F^F\right)\left(1-\widehat{\eta}_H^F\right) = \\ &w_F\left[\int_0^{\widehat{\eta}_F^H}\frac{1+\eta_F}{\kappa}\left[1 - G\left((1+\eta_F)\, w_F - 1\right)\right] d\eta_F + \frac{1-\alpha}{\kappa}\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right)\right].\end{aligned} \tag{14}$$

The LHS of (14) equals the total value of exports by H to F, which is itself composed by two separate terms: the first with the total value of goods exported by H in high-quality varieties (these are goods with relatively low realisations of η_H); the second with the total value of goods exported by H in low quality varieties. Similarly, the RHS of (14) equals the total value of imports by H from F, which comprises two different terms: the first with the total value of goods imported by H in high-quality varieties (these are goods with relatively low realisations of η_F); the second with the total value of goods imported by H in low quality varieties.

The following lemma briefly characterises some important qualitative effects of changes of κ and w_F on the quality thresholds as introduced by Definition 1.

Lemma 1 *Let $c, c' \in \{H, F\}$. If, in equilibrium, $\widehat{\eta}_{c'}^c < 1$, then: i) $\partial\widehat{\eta}_{c'}^c/\partial\kappa > 0$; ii) $\partial\widehat{\eta}_{c'}^H/\partial w_F < 0$; iii) $\partial\widehat{\eta}_{c'}^F/\partial w_F > 0$.*

[11] Notice from Figure 1.b) that when $w_F > 1$, we have that $G\left((1+\eta_H)/w_F - 1\right) = 0$ for any $\eta_H \leq w_F - 1$.

The first part of Lemma 1 states that when the thresholds $\widehat{\eta}_{c'}^{c}$ are have not yet hit their upper-bounds, they all rise with the level of total factor productivity κ. The intuition behind this result is quite straightforward: as κ grows, real incomes rise both in H and F, leading to an expansion of the set of goods individuals consume in higher quality versions. The second and third parts of Lemma 1 state that a rise in w_F leads to an expansion of the set of goods consumed in $q = 1$ in F (that is, both $\widehat{\eta}_F^F$ and $\widehat{\eta}_H^F$ rise with w_F), while it leads to a reduction of such set in H (that is, both $\widehat{\eta}_F^H$ and $\widehat{\eta}_H^H$ fall with w_F). The reason for these opposing results lies in the asymmetric movements of real income generated by changes in w_F: the real income in F rises with w_F, while in H real income declines with w_F.

The next lemma deals with the specific case in which wages are the same in H and F.

Lemma 2 *If, in equilibrium, $w_F = 1$, then: $\widehat{\eta}_H^H = \widehat{\eta}_F^H = \widehat{\eta}_H^F = \widehat{\eta}_F^F = \widehat{\eta}$. In addition, the threshold $\widehat{\eta}$ is a non-decreasing function of κ. More rigorously:*

$$\widehat{\eta} = \begin{cases} \widehat{\eta}(\kappa) : [1, 4/3] \rightarrow [0, 1] & \text{if } 1 \leq \kappa \leq 4/3, \\ 1 & \text{if } \kappa > 4/3; \end{cases} \tag{15}$$

where $\widehat{\eta}(1) = 0$, $\widehat{\eta}(4/3) = 1$, and $\partial\widehat{\eta}(\kappa)/\partial\kappa > 0$ for all $1 \leq \kappa < 4/3$.

The intuition underlying Lemma 2 rests both on income and price effects associated to $w_F = 1$. In particular, when $w_F = 1$, H and F will enjoy the same real income. This implies that, given the set of prices, individuals from H and F must optimally choose the same consumption bundle, hence $\widehat{\eta}_H^H = \widehat{\eta}_H^F$ and $\widehat{\eta}_F^H = \widehat{\eta}_F^F$. In addition to that, $w_F = 1$ (together with the fact that all η_c, $c \in \{H, F\}$, are independently drawn from an identical probability distribution), implies that both economies may offer an equal mass of commodities in $q = 1$ at a price no larger than a certain threshold, therefore we also have that $\widehat{\eta}_H^H = \widehat{\eta}_F^H$ and $\widehat{\eta}_H^F = \widehat{\eta}_F^F$.

We can now determine the equilibrium (relative) wage in this symmetric two-country world economy.

Proposition 1 *In equilibrium, $w_F = 1$ for any feasible level of κ.*

Proposition 1 shows that, in this symmetric two-country world economy, the relative wage remains unchanged and equal to unity all along the growth path. This also implies that the real income in both H and F is always equal to their common κ. The reason for this result is the following: while κ grows, aggregate demands and supplies grow together at identical speed in

H and F. As a consequence, markets will constantly clear in the world economy, without the need of any adjustment in relative wages.

3.3 Specialisation and Trade along the Growth Path

The equiproportional aggregate variations implicit in Proposition 1 conceal the fact that, along the balanced growth path, economies also experience changes in their productive structure at the sectoral level. Such sectoral reallocations of labour stem from the interplay of demand and supply side factors. On the demand side, as real incomes grow with a rising κ, individuals start consuming a larger fraction of goods in their higher quality varieties.[12] On the supply side, heterogeneity in labour productivity across countries arise as producers intend to raise the quality of their output. Hence, the interplay between income-dependent willingness to pay for quality and the intensification of comparative advantage at higher levels of quality leads to a gradual process of sectoral specialisation over the growth path.

The implied process of sectoral specialisation displays some specific traits that deserve a more detailed analysis: our model predicts that richer economies will tend to buy a larger fraction of their consumption goods from producers who display a comparative advantage in those goods (that is, from producers with relatively low realisations of η). We can see this result more formally by looking at the average value of η from whom individuals (either from H or F) buy their consumption goods. More precisely, we may define the average degree of comparative advantage of producers catering to country c's demand as follows:

$$E\left[\eta^{c}\right|\text{demanded}] \equiv 2\int_{0}^{\widehat{\eta}(\kappa)} \eta\left(1-\eta\right)\, d\eta + \int_{\widehat{\eta}(\kappa)}^{1} \left[1-\widehat{\eta}\left(\kappa\right)\right]\eta\, d\eta; \tag{16}$$

where $c \in \{H, F\}$. The first term in (16) is integrating over the set of producers supplying goods in $q = 1$, while the second term is integrating over the set of producers supplying goods in $q = 0$. A lower value of (16) means that consumers are buying from producers displaying (on average) a lower η.

Proposition 2 *The level of* $E\left[\eta^{c}\right|$ *demanded*$]$*, as defined in (16), is non-increasing in* κ*. In particular:*

i) for all $1 \leq \kappa < 4/3$*,* $E\left[\eta^{c}\right|$ *demanded*$]$ *is strictly decreasing in* κ*, with* $E\left[\eta^{c}\right|$ *demanded*$] =$

[12] An alternative interpretation is that as the economies turn more productive with a rising κ resources become available to produce the more costly and more desirable high-quality varieties.

$E[\eta] = 1/2$ *when* $\kappa = 1$*, where* $E[\eta]$ *denotes the unconditional mean of* η*;*

ii) for all $\kappa \geq 4/3$*,* $E[\eta^c|\, \textit{demanded}] = 1/3$*.*

Proposition 2 refers to the average value of η calculated over the *entire* consumption bundle purchased by a consumer (either from H or from F), disregarding the origin of the producer selling the commodities. We can, however, easily extend that result to the average value of η taking into account only *imported* goods purchased by the consumer (again, either from H or from F). By analogy, the average degree of comparative advantage of *exporters* catering to country c's *imported* demand can written as follows:

$$E[\eta^c|\, \text{imported}] \equiv \frac{\int_0^{\widehat{\eta}(\kappa)} \eta (1-\eta)\, d\eta + \frac{1}{2}\int_{\widehat{\eta}(\kappa)}^1 \eta\, [1-\widehat{\eta}(\kappa)]\, d\eta}{\int_0^{\widehat{\eta}(\kappa)} (1-\eta)\, d\eta + \frac{1}{2}\int_{\widehat{\eta}(\kappa)}^1 [1-\widehat{\eta}(\kappa)]\, d\eta}. \tag{17}$$

Noting that $\int_0^{\widehat{\eta}(\kappa)} (1-\eta)\, d\eta + \frac{1}{2}\int_{\widehat{\eta}(\kappa)}^1 [1-\widehat{\eta}(\kappa)]\, d\eta = 1/2$, it follows that $E[\eta^c|\, \text{imported}] = E[\eta^c|\, \text{demanded}]$. As a result, all the statements in Proposition (2) identically apply to imported goods, as expressed below:

Proposition 2 (bis) *The level of* $E[\eta^c|\, \text{imported}]$*, as defined in (17), is non-increasing in* κ*. In particular:*

i) for all $1 \leq \kappa < 4/3$*,,* $E[\eta^c|\, \text{imported}]$ *is strictly decreasing in* κ*, with* $E[\eta^c|\, \text{imported}] = E[\eta] = 1/2$ *when* $\kappa = 1$*;*

ii) for all $\kappa \geq 4/3$*,* $E[\eta^c|\, \text{imported}] = 1/3$*.*

Proposition 2 (bis) deals with how imports shift towards producers with lower realisations of η as individuals get richer. A related result can be found when contrasting the comparative advantage of exporters (measured again by the relative level of η) in cases of exports in high quality versus exports in low quality. Essentially, the widening of heterogeneities in labour productivity at the upper level of qualities implies that exporters of goods in $q = 1$ will exhibit (on average) higher productivity than those exporting their products in $q = 0$. We define below the degree of comparative advantage of exporters from country c', conditional on the level of quality of their exports to country c:

$$E\left[\eta_{c'}^{\text{expo}}\middle|\, q=1\right] = \frac{\int_0^{\widehat{\eta}^c} \eta_{c'} (1-\eta_{c'})\, d\eta_{c'}}{\widehat{\eta}^c - \frac{1}{2}(\widehat{\eta}^c)^2} = \frac{\widehat{\eta}^c (1 - 2\widehat{\eta}^c/3)}{2-\widehat{\eta}^c}, \tag{18}$$

$$E\left[\eta_{c'}^{\text{expo}}\middle|\, q=0\right] = \frac{\int_{\widehat{\eta}^c}^1 \eta_{c'}\, d\eta_{c'}}{1-\widehat{\eta}^c} = \frac{1+\widehat{\eta}^c}{2}; \tag{19}$$

where (18) and (19) are already taking into account that $\widehat{\eta}^{c}_{c'} = \widehat{\eta}^{c}_{c} = \widehat{\eta}^{c}$ when $w_F = 1$. From (18) and (19), the following proposition straightforwardly obtains.

Proposition 3 *The average degree of comparative advantage of exporters from country c' is increasing in the level of quality of their exports. That is,*

$$E\left[\eta^{expo}_{c'}\middle| q=1\right] < E\left[\eta^{expo}_{c'}\middle| q=0\right]; \quad \textit{where } c' \in \{H, F\}.$$

Proposition 3 refers to exports by the *same* exporter in different levels of quality. However, since in this symmetric two-country world economy the general equilibrium delivers $w_F = 1$ and Lemma 2 thus applies, an identical result holds when comparing exports of different quality across exporters of different origin. The following proposition re-states the previous one in a more general way, so as to encompass comparisons across exporters of different nationalities.

Proposition 3 (bis) *The average degree of comparative advantage of exporters, regardless of their country of origin, is increasing in the level of quality of their exports. That is:*

$$E\left[\eta^{\text{expo}}_{c}\middle| q=1\right] < E\left[\eta^{\text{expo}}_{c'}\middle| q=0\right]; \quad \text{where } c, c' \in \{H, F\}.$$

4 Extensions

4.1 Cross-Country Inequality in a Two-Country World Economy

In this subsection we let total factor productivity be country specific. Namely, we let countries be characterised by their *own* technological parameter κ_c, with $c \in \{H, F\}$. To keep the analysis concise, we will focus on one specific case: $\kappa_H = 1$ and $\kappa_F > 1$. We maintain throughout the assumption that each η_c is independently drawn from a uniform density function with support on the unit interval.

The main intention here is to show that our results in Section 3.3 extend quite naturally to a setup in which the two economies differ in terms of their relative purchasing power at a given point in time. Section 3.3 has shown (in Proposition 2) that as countries turn richer when the common κ rises, their citizens gradually upgrade their quality of consumption, and this in turn shifts demand towards producers with lower realisations of η. The counterpart of this result is that the exporters who specialise in high-quality commodities are actually those with lower realisations of η (Proposition 3). In this subsection we show that analogous results hold when comparing a richer and a poorer economy: the former purchases a larger fraction of their consumption from producers with lower realisations of η (Proposition 5 below).

Let α denote again the fraction of demand for goods in low-quality varieties ($q = 0$) supplied by producers from country H. In this case, we have: $\alpha = 1$ when $w_F > \kappa_F$, $\alpha \in [0, 1]$ when $w_F = \kappa_F$, and $\alpha = 0$ when $w_F < \kappa_F$.

In addition, a commodity characterised by the pair (η_H, η_F) will be supplied only by F if and only if:

$$\eta_F < (1 + \eta_H)\,\frac{\kappa_F}{w_F} - 1;$$

while the same commodity will be supplied only by H if and only if:

$$\eta_H < (1 + \eta_F)\,\frac{w_F}{\kappa_F} - 1.$$

Take an individual from country $c \in \{H, F\}$. His budget constraint is given by:

$$\begin{aligned}(1 - \widehat{\eta}^c_H)\,(1 - \widehat{\eta}^c_F)\min\left\{1, \frac{w_F}{\kappa_F}\right\} + \int_0^{\widehat{\eta}^c_H} (1 + \eta_H)\left[1 - G\left(\frac{(1 + \eta_H)\,\kappa_F}{w_F} - 1\right)\right] d\eta_H \\ + \frac{w_F}{\kappa_F}\int_0^{\widehat{\eta}^c_F} (1 + \eta_F)\left[1 - G\left(\frac{(1 + \eta_F)\,w_F}{\kappa_F} - 1\right)\right] d\eta_F = w_c. \qquad (20)\end{aligned}$$

From (20) it follows that the equilibrium trade balance requires:

$$\begin{aligned}&\int_0^{\widehat{\eta}^F_H} (1 + \eta_H)\left[1 - G\left(\frac{(1 + \eta_H)\,\kappa_F}{w_F} - 1\right)\right] d\eta_H + \alpha\left(1 - \widehat{\eta}^F_F\right)\left(1 - \widehat{\eta}^F_H\right) = \\ &\frac{w_F}{\kappa_F}\left[\int_0^{\widehat{\eta}^H_F} (1 + \eta_F)\left[1 - G\left(\frac{(1 + \eta_F)\,w_F}{\kappa_F} - 1\right)\right] d\eta_F + (1 - \alpha)\left(1 - \widehat{\eta}^H_H\right)\left(1 - \widehat{\eta}^H_F\right)\right]. \qquad (21)\end{aligned}$$

The first result of this subsection deals with the relative wage.

Proposition 4 *Let $\kappa_H = 1$ and $\kappa_F > 1$. Then, in equilibrium, $1 < w_F \leq \kappa_F$.*

On the one hand, Proposition 4 shows that $w_F > 1$, hence income per head in F is always larger than in H. The reason is simply that when $\kappa_F > \kappa_H$ country F is (on average) more productive than H. As a consequence, w_F must rise above one, so as to allow H to export enough goods to F and comply with the equilibrium trade balance. In other words, should $w_F \leq 1$, then there would be excess demand of goods produced in F, which would push up w_F until the goods (and labour) markets clear. On the other hand, the upper-bound $w_F \leq \kappa_F$ simply reflects the fact that the relative wage between F and H cannot lie above the ratio between their total factor productivities ($\kappa_F/\kappa_H = \kappa_F$), as this would create an excess demand of goods produced in H.

An interesting implication that follows from $w_F > 1$ in Proposition 4 is that, in equilibrium, the thresholds dividing the goods space are such that: $\widehat{\eta}_H^F > \widehat{\eta}_H^H$ and $\widehat{\eta}_F^F > \widehat{\eta}_F^H$.[13] That is, given the supplier's origin, individuals from F buy a larger fraction of goods in their higher-quality varieties. By a similar reasoning as in Section 3.3, we may define the comparative advantage of producers catering to country c's demand as the average level of η among those producers from which individuals from c purchase their consumption. Using the same notation as in Section 3.3, we obtain the following result.[14]

Proposition 5 *Let $\kappa_H = 1$ and $\kappa_F > 1$. Then, $E\left[\eta^F \middle| \text{demanded}\right] < E\left[\eta^H \middle| \text{demanded}\right]$.*

The intuition for Proposition 5 is the same as that for Proposition 2 in the symmetric case. Richer individuals (in this case, those from F) buy a larger fraction of their consumption goods in the higher-quality versions. Hence, a larger share of F's aggregate demand goes to producers who may offer higher-quality commodities at lower prices (i.e., those with lower realisations of η).

4.2 Trade Costs in a Two-Country World Economy

In this subsection we introduce trade costs in our benchmark model. These take the form of a unit 'iceberg' cost to selling goods abroad: for each commodity $(z, q) \in \mathbb{Z} \times \{0, 1\}$, producers must export τ units of it, where $\tau \in (1, 2)$, for one unit to arrive at the importer's market. For this extension, $\kappa \geq 1$ denotes again the level of common total factor productivity, and we keep the assumption that each good is characterised by a pair (η_H, η_F) whose elements are drawn independently from a unit uniform distribution.

The introduction of trade costs implies that an individual in country H (resp., from F) imports low-quality commodities only if $w_F < 1/\tau$ (resp., if $w_F > \tau$). It also entails that

[13] This result can be seen as an immediate extension of Lemma 1. Rigorously speaking, that lemma cannot be directly applied in this case, as the budget constraints (20) are not exactly the same as in Section 3. However, notice that the partial derivatives $\partial\widehat{\eta}_{c'}^H/\partial w_F < 0$ and $\partial\widehat{\eta}_{c'}^F/\partial w_F > 0$ take κ_F as a constant, hence the same (qualitative) result would obtain for (20) following the same reasoning as in the proof of Lemma 1.

[14] Full mathematical expressions for $E\left[\eta^F \middle| \text{demanded}\right]$ and $E\left[\eta^H \middle| \text{demanded}\right]$ are provided in proof of Proposition 5 in the Appendix.

high-quality goods are imported by consumers in H if:

$$\eta_F < \psi(\eta_H) \equiv \frac{1+\eta_H}{\tau w_F} - 1; \tag{22}$$

whereas they are imported by consumers in F if:

$$\eta_H < \varphi(\eta_F) \equiv \frac{(1+\eta_F)\, w_F}{\tau} - 1. \tag{23}$$

Note that $\varphi^{-1}(\eta_H) \neq \psi(\eta_H)$: that is to say, the set of commodities that are bought locally by consumers in F does not coincide with the set of goods imported by consumers in H, and vice versa.[15]

All this considered, the budget constraint for an individual from H can be now written as:

$$\left[\alpha^H + \tau w_F \left(1-\alpha^H\right)\right]\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right) + \int_0^{\widehat{\eta}_H^H} (1+\eta_H)\left[1-G(\psi(\eta_H))\right] d\eta_H$$
$$+ \tau w_F \int_0^{\widehat{\eta}_F^H} (1+\eta_F)\left[1-G\left(\psi^{-1}(\eta_F)\right)\right] d\eta_F = \kappa;$$

where: $\alpha^H = 1$ when $w_F > 1/\tau$, $\alpha^H = 0$ when $w_F < 1/\tau$, and $\alpha^H \in [0,1]$ when $w_F = 1/\tau$. The budget constraint for an individual from F, instead, reads:

$$\left[\frac{\tau}{w_F}\alpha^F + \left(1-\alpha^F\right)\right]\left(1-\widehat{\eta}_H^F\right)\left(1-\widehat{\eta}_F^F\right) + \int_0^{\widehat{\eta}_F^F} (1+\eta_F)\left[1-G(\varphi(\eta_F))\right] d\eta_F$$
$$+ \frac{\tau}{w_F} \int_0^{\widehat{\eta}_H^F} (1+\eta_H)\left[1-G\left(\varphi^{-1}(\eta_H)\right)\right] d\eta_H = \kappa;$$

where: $\alpha^F = 1$ when $w_F > \tau$, $\alpha^F = 0$ when $w_F < \tau$, and $\alpha^F \in [0,1]$ when $w_F = \tau$.

Finally, the equilibrium trade balance in this alternative setup is as follows:

$$\int_0^{\widehat{\eta}_H^F} \frac{1+\eta_H}{\kappa}\left[1-G\left(\varphi^{-1}(\eta_H)\right)\right] d\eta_H + \frac{\alpha^F}{\kappa}\left(1-\widehat{\eta}_H^F\right)\left(1-\widehat{\eta}_F^F\right) =$$
$$w_F \int_0^{\widehat{\eta}_F^H} \frac{1+\eta_F}{\kappa}\left[1-G\left(\psi^{-1}(\eta_F)\right)\right] d\eta_F + w_F \frac{1-\alpha^H}{\kappa}\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right). \tag{24}$$

In the presence of 'iceberg' trade cost, (24) still delivers the general equilibrium solution $w_F = 1$, since at that relative wage we have that: $\widehat{\eta}_H^F = \widehat{\eta}_F^H$, $\varphi^{-1}(\cdot) = \psi^{-1}(\cdot)$, and $\alpha^H = \left(1-\alpha^F\right) = 1$.

[15] It should be apparent now that the upper-bound on the 'iceberg' cost is imposed to leave enough room for trade of high-quality varieties when $w = 1$. To better understand the rationale of this upper-bound, recall that the highest possible value taken by η_H (resp. by η_F) is one. As a consequence, if we let $\tau > 2$, conditions (22) and (23) below will fail to hold for any feasible realisation of η_F (resp. by η_F) when $w = 1$, and no international trade will take place at such wage.

In our benchmark model in Section 3, we have seen that economies experience changes in their productive structure at the sectoral level. In particular, as incomes rise, sectoral specialisation increases in those sectors where economies display a comparative advantage. However, at the aggregate level, the ratios of total imports and exports to GDP remain constant all along the growth path. When selling goods abroad entails a unit 'iceberg' cost, our model instead predicts that countries start off and remain autarkic until they become productive enough to make international trade profitable.

The reason why the model with trade frictions predicts this particular evolution of the imports and exports to GDP ratios is similar to the one given for the rise in specialisation at a sectoral level: richer individuals consume a larger set of horizontally differentiated goods in their higher quality varieties. As a result, since sectoral productivity differentials become stronger as production moves up on the quality space, the scope for international trade widens with rising total factor productivity. In the presence of trade costs, however, a *new* feature emerges compared to our benchmark model. At first, when individuals are poor, they demand only low-quality varieties, which are always supplied cheaper domestically (since the equilibrium relative wage equals one) and, thus, no international trade takes place. Goods begin to be exchanged internationally only when individuals are sufficiently rich to start importing certain types of high-quality goods.

In this respect, it should be noted that international trade emerges *only* after total factor productivity has grown large enough to ensure that the marginal benefits offered by imported goods overtake the marginal costs. Formally, when $\kappa \in (1, \underline{\kappa}]$, with $\underline{\kappa} = (\tau - 1)^2 + 1$, individuals are indeed rich enough to demand some high-quality varieties.[16] In particular, individuals from country c choose high-quality varieties for the subset of goods such that $0 < \eta_c \leq \eta(\kappa) \leq \eta(\underline{\kappa})$, where $\eta'(\kappa) > 0$ and $\eta(\underline{\kappa}) = \tau - 1$. Yet, goods for which $\eta_c \leq \tau - 1$ are never imported, as they may always be provided domestically at a lower price. Countries therefore remain in autarky until total factor productivity rises above $\underline{\kappa}$. Beyond that level, individuals start consuming high-quality varieties of goods that may be supplied more cheaply by foreign producers. Hence, as κ grows beyond $\underline{\kappa}$, and the fraction of goods consumed in their high-quality varieties keeps rising, international trade expands. As a result, when trade costs are introduced to the model, the imports/GDP ratio tend to rise, fast at first and then at a declining rate, as κ grows.[17]

[16] For details of the derivation of the threshold $\underline{\kappa}$, refer to Appendix A.

[17] At the highest levels of total factor productivity, the (common) growth rate of the import/GDP and ex-

This last prediction of our model is in line with vast empirical evidence. Measures of merchandise exports relative to GDP, compiled by several sources including the GATT International Trade and the World bank, has increased up to 2.5 times as fast as income in the postwar period (see, e.g., Krugman, 1995, Feenstra, 1998, and Bajona, 2004). Using a more comprehensive measure of manufacturing trade series (compiled by summing up the total value of imports and exports in the categories 5-8 of the SITC Rev. 2 classification system), together with data for manufacturing gross output, both acquired from OECD databases, Dalton (2010) shows that the trade share of gross output in manufacturing increased by a factor of 4.70. Furthermore, Ishii and Yi (1997) examine two-digit ISIC manufacturing export share data, collected from various sources, from 1970 to 1990, and find that almost all considered countries experienced export share increases over time in virtually every sector. Finally, Krugman (1995) and Feenstra (1998) also produces further evidence based on the trade shares in the U.K., the U.S, and Germany; the ratios of merchandise trade to merchandise value-added; the shares of U.S. exports and imports by end-use categories; and the ratio of imported to total intermediate inputs.

5 Empirical Analysis

5.1 Exporters Behaviour

Our theory is based on the fundamental assumption that countries' relative efficiency in production becomes more pronounced as they move up (vertically) along the quality ladders. In its purest sense, this assumption is really hard to test empirically. However, the assumed intensification of comparative advantage at higher qualities implies that the degree of specialization of countries in specific goods and the level of quality of their exports should display a positive correlation. In this subsection we aim to provide some suggestive evidence of this prediction.

Objective data on products quality is hardly available for a large set of goods. For that reason, we take unit values as a proxy for the quality of the commodity.[18] To measure the

port/GDP ratios eventually turns negative, without nevertheless fully reverting the outlined process of initial expansion.

[18] There is a large literature in trade using unit values as proxy for quality: e.g., Schott (2004), Hallak (2006), Fieler (2007). We acknowledge though the fact that unit values should are not a perfect proxy of quality, since other factors may also affect prices (for example, the degree of horizontal differentiation across industries, heterogeneous transport costs, trade tariffs). See Hallak and Schott (2011) for an innovative method to infer quality from prices taking into account both horizontal and vertical differentiation of products.

degree of specialization we use the revealed comparative advantage (RCA). That is, for each exporter x of product i, we compute the ratio:

$$RCA_{i,x} \equiv \frac{(\nu_{i,x}/V_x)}{(\nu_{i,world}/V_{world})};$$

where $\nu_{i,x}$ ($\nu_{i,world}$) is the total value of exports of product i by country x (by the world) and V_x (V_{world}) is the aggregate value of exports by country x (by the world).

We compute unit values of exports using the dataset compiled by Gaulier and Zignano (2010). This database reports monetary values and physical quantities of bilateral trade for years 1995 to 2009 for more than 5000 products categorised according to the 6-digit Harmonised System (HS-6).[19] Monetary values are measured FOB (free on board) in US dollars. To mitigate the effect possible reporting errors, we discard observations where quantity equals one or less than one, and we also discard observations where the value of exports is below 10 thousand US dollars. We use the same dataset to compute the RCA of each exporter in each particular HS-6 product. In what follows, for computational purposes, given the large number of observations in the panel, we use only data for year 1995 in our cross sectional regressions. However, we have run as well the same regressions separately for each year in the panel, and all estimates turn out to be very similar to those corresponding to 1995 (some of these results are shown in Appendix B and the rest are available from the authors upon request).

In our model, comparative advantages become stronger at higher levels of quality of production. Taking unit values as proxy for quality, this implies that the *maximum* unit values of exports by each country in each of the traded products should correlate positively with the RCA of the exporter in those products. To assess this implication, we run the following regression:[20]

$$\begin{aligned} \log\left(MaxP_{i,x}\right) &= \alpha + \beta \log\left(RCA_{i,x}\right) + \delta_i + \upsilon_{i,x}; \\ \text{where} &: MaxP_{i,x} \equiv \max_{\mathfrak{m} \in M} \left\{P_{i,x,\mathfrak{m}}\right\}. \end{aligned} \tag{25}$$

In (25), $MaxP_{i,x}$ denotes the maximum unit value at which exporter x sells product i, across the set of all importers M.[21] The regression also includes product dummies, denoted by δ_i

[19] Gaulier and Zignano (2009) dataset uses United Nations COMTRADE data as its source.

[20] The rationale to use maximum export prices dependent variable instead of, say, average export prices is that the former should more accurately reflect the higher levels of quality of exports by each exporter than the latter. Nevertheless, in Table 1.B we show that our results are robust to using average export prices as dependent variable.

[21] For example: US exports 'Automobiles, diesel engine of <1500 cc' (code 871331) to 68 different countries

Table 1.A

	Dependent Variable: log of maximum unit value by each exporter			
	(1)	(2)	(3)	(4)
Log RCA	0.162	0.214	0.208	0.200
	(0.014)***	(0.006)***	(0.006)***	(0.006)***
Distance expo-impo x 1000				0.008
				(0.002)***
Contiguity				-0.066
				(0.024)***
Common official language				-0.035
				(0.022)*
Common coloniser				0.022
				(0.029)
Common legal origin				-0.007
				(0.016)
Common currency				-0.049
				(0.032)*
Product dummies	YES	YES	YES	YES
Exporter dummies	NO	YES	YES	YES
Importer dummies	NO	NO	YES	YES
Observations	242148	242148	242148	233681
R squared	0.52	0.70	0.71	0.72

Robust absolute standard errors clustered at the exporter level in parentheses. All data is for year 1995. All regressions include a constant term. The total number of different products is 4898. * significant at 10%; ** significant at 5%; *** significant at 1%.

(product dummies will control, among other things, for different average unit values across goods in different categories of the HS-6 system). The results of regression (25) are shown in column (1) of Table 1.A. As implied by our model, the variables $\log(RCA_{i,x})$ and $\log(MaxP_{i,x})$ display a positive correlation, which is also highly significant. In the three subsequent columns we sequentially add some additional controls that may be expected to possibly affect $\log(MaxP_{i,x})$, for reasons other than comparative advantage.

In column (2) we include exporter dummies (i.e., we run the regression: $\log(MaxP_{i,x}) = \alpha + \beta\log(RCA_{i,x}) + \delta_i + \varepsilon_x + \upsilon_{i,x}$). The positive and highly significant estimate of β remains in place. In fact, the magnitude of the coefficient linking $\log(RCA_{i,x})$ and $\log(MaxP_{i,x})$ rises by a fair amount compared to column (1). This result is actually expectable, as it would suggest that economies that are (overall) more specialised in selling their output abroad tend to charge relatively lower prices on their exports than those which are more specialised in selling their output in local markets (this could possibly be the effect that follows from a currency

(importers), after cleaning all the outliers. For each of those 68 importers, we calculate the average unit value of US exports of the product HS-871331, and then pick the highest of all. (It turns out that the importer paying the highest average price for 'Automobiles, diesel engine of <1500 cc' produced in the US is Netherlands.)

depreciation).[22]

In column (3) we add a set of dummies for the specific importer buying the product at the highest unit value sold by each exporter. More precisely, we run the following regression: $\log(MaxP_{i,x}) = \alpha + \beta \log(RCA_{i,x}) + \delta_i + \varepsilon_x + \mu_m + \upsilon_{i,x}$, where the term μ_m is the dummy variable associated to the importer $m \in M$ country that solves $MaxP_{i,x} \equiv \max_{\mathtt{m} \in M} \{P_{i,x,\mathtt{m}}\}$ in (25). These dummies would allow us to control for specific characteristics of certain importing countries (including their income per head) that may lead them to pay, overall, higher (or lower) prices for their imports. Again, we can observe that our correlation of interest between $\log(RCA_{i,x})$ and $\log(MaxP_{i,x})$ remains positive and highly significant.

Finally, in column (4) we add a set of gravity terms specific to the exporter-importer pair (x, m). In particular, we include the following six variables taken from Mayer and Zignano (2006): the weighted distance between the exporter and importer, and dummy variables for common language, common coloniser, common legal origin, common currency, and contiguity. The coefficient linking $\log(RCA_{i,x})$ and $\log(MaxP_{i,x})$ still remains positive and highly significant. In addition, it is interesting to note that the coefficient on distance is positive, while the one on contiguity is negative (both highly significant). These two results seem to suggest that when selling at distant markets exporters tend to ship higher qualities of specific products.[23]

One possible caveat with using the maximum unit values, as in Table 1.A, is that some countries may actually be selling a relatively small share of their exports at that particularly high level of quality (although this problem is partly mitigated by the fact that we restrict the sample to exports of at least 10 thousand US dollars). If this is the case, our estimates may be not capturing exactly the type of correlation that is predicted by our theory, but possibly *only* the fact that there is greater variance in productivity across producers located in countries displaying a comparative advantage in a particular industry (without also necessarily displaying greater average productivity in producing higher qualities). To deal with this issue, in Column (1) of Table 1.B we run the same regression as in Column (2) of Table 1.A, but in this case the dependent variable is the 'weighted mean unit value of exports', where the weights are given by export shares. As it can be readily observed, the correlation is again positive and highly significant (though, expectably, of smaller magnitude than that in column (2) of Table 1.A).

[22] Notice, too, that since we are using a cross section the exporter dummies are also controlling for the exporter's GDP per head.

[23] These results are also consistent with those found by Baldwin and Harrigan (2011) between US export unit values of HS-10 products and distance to export markets.

Table 1.B

	Dependent Variable		
	log mean u.v. (weighted)	log max to min u.v.	log coef. variation u.v.
Log RCA	0.064	0.329	0.05
	(0.006)***	(0.008)***	(0.006)***
Product dummies	YES	YES	YES
Exporter dummies	YES	YES	YES
Observations	242148	242148	173938
Number of HS-6 products	4898	4898	4893
R squared	0.68	0.55	0.23

Robust absolute standard erros clustered at the exporter level in parentheses. All data is for year 1995. All regressions include a constant.
Mean unit values in first column are weighted by their share of exports within that particular product for that particular exporter.

So far we have shown a series of correlations consistent with the notion that economies that exhibit a comparative advantage in the production of a certain good will export that a particular good in relatively higher quality levels. However, in addition to that, our model predicts that such economies will also display a larger dispersion in their quality of exports. In columns (2) and (3) of Table 1.B, we report the correlation between the log of the RCA and two different measures of dispersion of export unit values, namely: the log of the ratio of the maximum to the minimum unit value of exports and the log of the coefficient of variation of unit values of exports. In both cases, the correlation between the proxies for quality dispersion and the log of the RCA turns out to be positive and highly significant.

Exporters Behaviour across Time:

Our model is a static one. In particular, it assumes that production functions are given from the onset and once-and-for-all. It is not hard, however, to conjecture its main implications within a more dynamic version of it, where specialisation may possibly evolve over time. On the one hand, for example, it may well be the case that it takes time for economies to accumulate the required knowledge, human capital or infrastructure to produce and export certain goods; similarly, it may be that certain input sources are discovered or become available only at some particular point in time (after $t = 0$). On the other hand, even if technology is actually given once-and-for-all, in a context of secular growth in the world (as our analysis in Section 3.3 could actually be interpreted), our theory would still predict that the positive correlation between export specialisation and export prices should be captured by variation across time.

From this perspective, we could think of our previous correlations between export specialisation and export unit values within a time series, exploiting the across-time variation within countries. In that regard, our theory should predict that, as economies develop a comparative advantage in product i, they should concomitantly export product i at higher unit values than the rest. We show evidence of this relationship in Table 2, where we regress the difference between the $\log(MaxP_{i,x})$ recorded in 2009 and that recorded in 1995 against the difference between the $\log(RCA_{i,x})$ in those two years. More precisely, in column (1), we run:

$$\log(MaxP_{i,x,09}) - \log(MaxP_{i,x,95}) = a + b\left[\log(RCA_{i,x,09}) - \log(RCA_{i,x,95})\right] + \xi_{i,x}. \qquad (26)$$

Notice that (26) is just the difference between (25) in years 2009 and 1995, which removes both product and exporter fixed effects and generates $\xi_{i,x} = \upsilon_{i,x,2009} - \upsilon_{i,x,1995}$.[24] As we can see, the estimate of b is positive and highly significant; moreover, its magnitude is also surprisingly similar to that of the estimated β in columns (1) and (2) of Table 1.A, suggesting that the possible presence of product-exporter fixed effects tainting cross-sectional correlations in Table 1.A is not of much concern in this dataset.

In column (2) we add product and exporter dummies to (26). The former would control for the possibility that results may be influenced by the effect of heterogeneous income demand elasticities across different HS-6 products. The latter would control for the possibility that changes in export penetration and export prices may be simultaneously responding to some countries growing faster than others. Nevertheless, our estimate for the correlation between $\Delta\log(RCA_{i,x})_{09-95}$ and $\Delta\log(MaxP_{i,x})_{09-95}$ remains essentially intact both in magnitude and significance. Finally, in column (3) we include the differences in the gravity terms corresponding to the specific importer that purchased product i from exporter x at the maximum price sold by x in years 2009 and 1995. Again, we find a positive and highly significant value for our correlation of interest. In addition, as it can be observed from the table in Appendix B displaying the full set of results, the time-difference estimates for the gravity terms also turn out to be quite similar to those in column (4) of Table 1.A.

5.2 Importers Behaviour

Another key aspect of our theory is how imports respond to variations in incomes. The model predicts that changes in incomes will lead to: *i*) changes in the quality of consumption, and *ii*) changes in the distribution of total production across different economies. The former result

[24] In addition, if the presence of product-exporter fixed effects could have possibly contaminated our previous cross-sectional results, those fixed effects should also be removed by taking time differences as in regression (26).

Table 2

	Dep. Variable: Δ(log of max unit value by each exporter)$_{09\text{-}95}$		
	(1)	(2)	(3)
Δ(Log RCA)$_{09\text{-}95}$	0.183	0.191	0.185
	(0.005)***	(0.005)***	(0.005)***
Product dummies	NO	YES	YES
Exporter dummies	NO	YES	YES
Gravity Terms	NO	NO	YES
Observations	193084	193084	181197
R squared	0.05	0.16	0.17

Robust absolute standard errors clustered at the exporter level in parentheses. All regressions include a constant term.
Gravity terms include: weighted distance between exporter and importer, dummy for common language, contiguity, common coloniser, common legal origin, and common currency. Full Results are displayed in the Appendix.
The total number of different products is 4756.

stems from our nonhomothetic preferences, while the latter derives from the assumed increasing heterogeneity of production costs at higher levels of quality. In short, our model predicts the following:

1. Richer consumers will buy their imports of product i in higher quality levels than poorer consumers do. As a consequence, the average unit values of imports of product i should correlate positively with the importer's GDP per head.

2. Richer consumers will buy a larger share of their consumption of product i from countries exhibiting a comparative advantage in product i than poorer consumers do. As a consequence, the share of imports originating from exporters exhibiting a comparative advantage in product i should correlate positively with GDP per head of the importer.

In columns (1) and (2) of Table 3.A we report the correlation between the (weighted) mean unit values of imports and GDP per head.[25] In the first column we only include product dummies. As robustness check, in the second column, we add a set of geographical controls (area, population, density, distance to equator, latitude, longitude, landlocked dummy and island dummy) and a set of dummy variables for continents.[26] In both cases the variable of interest exhibits a positive and highly significant correlation.[27]

[25] The mean unit values of imports of product i by importer m are computed by weighting the unit values of product i sold by each exporter x to m by their respective share over the total value of imports of i by m.

[26] Full results are reported in Appendix B..

[27] See Fieler (2007) for a more thorough analysis of this particular correlation. More precisely, using the entire panel in Gaulier and Zignano (2009), she finds that unit prices of imports correlate positively with the level

Table 3.A

	Dependent Variable: log (weighted) mean unit value of imports					
	All goods		Short ladder	Long ladder	Short ladder	Long ladder
	(1)	(2)	(bottom 10%)	(top 10%)	(bottom 5%)	(top 5%)
Log GDP per head	0.177	0.205	0.118	0.215	0.127	0.220
	(0.017)***	(0.024)***	(0.014)***	(0.03)***	(0.022)***	(0.032)***
Product dummies	YES	YES	YES	YES	YES	YES
Importer geog. controls	NO	YES	YES	YES	YES	YES
Continental dummies	NO	YES	YES	YES	YES	YES
Observations	420623	415343	23258	51377	9785	25339
Number of HS-6 products	4898	4898	490	490	245	245
R squared	0.67	0.68	0.70	0.69	0.71	0.68

Robust absolute standard errors clustered at the importer level in parentheses. Importer geographical controls include: area, population, density, distance to equator, latitude, longitude, landlocked dummy, and island dummy. Continental dummies include: Africa, America, Asia, Europe and Oceania. All data is for year 1995. All regressions include a constant term

Not all types of goods display the same scope of quality upgrading. Our preference specification implies that the positive association between income per head and unit values should be more pronounced for goods that exhibit longer quality ladders. We proxy the length of the quality ladder of each of the HS-6 products by computing the ratio of maximum-to-minimum export unit values for each of them. Next, in the following four columns of Table 3.A, we re-run the regression displayed in column (2), but using only the bottom and top decile (in the third and fourth columns), and the bottom and top 5 percentile (in the fifth and sixth columns), of the distribution of the (proxied) length of quality ladders. As it can be readily observed, the point estimate of the correlation between income and import prices is larger for long-ladder goods than for short-ladder goods, and the differences are significant at 10% level.

The previous correlations are consistent with the idea that richer individuals purchase goods in higher quality levels. However, they remain silent in terms of where those imports actually come from. Our second prediction stated above relates to this issue. More precisely, if it is true that taste for quality rises with income and that countries' comparative advantage in production become more pronounced at higher levels of quality, then richer countries should purchase a larger share of their imports of given products from economies displaying a comparative advantage in those products. In Tables 3.B and 3.C we aim at providing evidence of such relationship between income per head and origin of imports.

We first construct a measure of the 'revealed comparative advantage of imports' as a weighted average of the RCA of the exporters where the imports of product i by importer m originate

of income per head of the importer, even when looking at goods originating from the same exporter and HS-6 category..

Table 3.B

	Dependent Variable			
	log RCA of imports		Δ(Log RCA of imports)$_{09\text{-}95}$	
	(1)	(2)	(3)	(4)
Log GDP per head	0.167	0.173		
	(0.02)***	(0.04)***		
Δ(Log GDP per head)$_{09\text{-}95}$			0.206	0.213
			(0.069)***	(0.068)***
Product dummies	YES	YES	NO	YES
Importer geogr. controls	NO	YES	-	-
Continental dummies	NO	YES	-	-
Observations	587557	579950	511960	511960
Number of HS-6 products	5017	5017	4894	4894
R squared	0.10	0.12	0.002	0.07

Robust absolute standard errors clustered at the importer level in parentheses. Importer geogr. controls include: area, population, density, dist. to equator, latitude, longitude, landlocked dummy, and island dummy. Continental dummies: Africa, America, Asia, Europe and Oceania. All data in columns (1) and (2) is for year 1995. All regressions include a constant term

from. More specifically, we compute:

$$\log\left(RCA\ \ of\ imports_{i,m}\right) = \sum_{x\in X} \frac{impo_{i,m,x}}{\sum_{x\in X} impo_{i,m,x}} \log\left(RCA_{i,x}\right); \tag{27}$$

where $impo_{i,m,x}$ denotes the value of imports of product i by importer m originating from exporter x. In column (1) we regress the dependent variable (27) against the log of GDP per head and product dummies. In column (2) we add geographical controls and continental dummies. In both cases, the estimate of the coefficient linking log of RCA of imports and log of GDP per head is positive and highly significant, in line with our model. As further robustness check, in columns (3) and (4) we conduct the same kind of regressions but this time exploiting time differences within countries over the period between years 1995 and 2009. This would allow us to control, for example, for the presence of importers fixed effects (beyond those captured by geographical controls and continental dummies). As we can observe, the results using variation across time are in concordance with those of the cross-sectional analysis in columns (1) and (2).

A similar type of exercise is presented in Table 3.C, where we regress the share of imports of product i by importer m originating from exporter x on the RCA of x in i interacted with the importer's income per head. More precisely, we conduct the following regression, where Y_m denotes the importer's income per head:

$$\begin{aligned}\log\left(\frac{impo_{i,m,x}}{\sum_{x\in X} impo_{i,m,x}}\right) &= \varsigma + \rho \log\left(RCA_{i,x}\right) \\ &\quad + \theta\left[\log\left(Y_m\right) \times \log\left(RCA_{i,x}\right)\right] + \delta_i + \mu_m + \varepsilon_x + \nu_{i,x,m};\end{aligned} \tag{28}$$

Table 3.C

	Dependent Variable: log impo shares of product i from exporter x		
	(1)	(2)	(3)
Log RCA exporter	0.438	-0.897	-0.734
	(0.029)***	(0.161)***	(0.136)***
Inter. term (log Y_m × log RCA exporter)		0.142	0.132
		(0.018)***	(0.016)***
Distance expo-impo x 1000			-0.109
			(0.010)***
Contiguity			0.989
			(0.102)***
Common official language			0.307
			(0.091)***
Common coloniser			0.229
			(0.142)*
Common legal origin			0.235
			(0.068)***
Common currency			0.312
			(0.144)**
Importer dummies	YES	YES	YES
Product dummies	YES	YES	YES
Exporter dummies	YES	YES	YES
Observations	4545789	4282269	4137695
R squared	0.48	0.48	0.53

Robust absolute standard errors clustered at the importer-exporter level in parentheses. All data is for year 1995. All regressions include a constant. The number of different products is 5017. * significant at 10%; ** significant at 5%; *** significant at 1%.

where we expect to find a positive value for θ. This would, again, suggest that richer importers tend to buy a larger share of the imports of product i from exporters exhibiting a comparative advantage in i.

Firstly, in column (1), we regress the dependent variable of (28) against *only* the log of the RCA of exporter x in product i (together with product, importer and exporter dummies), which shows as we would expect that those two variables are positively correlated. Secondly, in column (2), we report the results of regression (28), where we can see that the estimated θ is positive and highly significant, consistent with our theory. Finally, in column (3), we add to (28) the six gravity terms from Mayer and Zignano (2006), and we can observe the previous results remain essentially intact. We can also observe that the estimates for each of the gravity terms are significant, and they all carry the expected sign.

To conclude, taken jointly, our results seem to yield support to the following ideas: (i) as getting richer, countries tend to raise the quality of the goods they consume (positive correlation between import prices and income per head of importer); (ii) this, in turn, leads them to raise their import shares originating from exporters displaying a comparative advantage in those products (positive correlation between the expression in (27) and income per head of importer, and positive interaction term in equation (28)); (*iii*) this alteration in the origin of imports would reflect the fact that these are the exporters relatively more efficient at providing higher quality varieties of those products (positive correlation between export prices and RCA of exporter).

6 Conclusion

We presented a Ricardian trade model with the distinctive feature that comparative advantages reveal themselves gradually over the course of development. The key factors behind this process are the individuals' continuing upgrading in quality of consumption combined with productivity differentials that widen up as countries seek to increase the quality of their production. As incomes grow and wealthier consumers raise the quality of their consumption baskets, cost differentials between countries become more pronounced. The emergence of such heterogeneities, in turn, alters trade flows, as each economy gradually specialises in producing the subset of goods for which they enjoy a rising comparative advantage.

Our model yielded a number of implications that find empirical support. In this respect, using bilateral trade data at the product level, we showed that the share of imports originating from exporters more intensely specialised in a given product correlates positively with GDP per head of the importer. This is consistent with the model's prediction that richer consumers tend to buy a larger share of their consumption of specific products from countries exhibiting a comparative advantage in those products. We also provided some evidence supporting the central assumption of our model, namely the intensification of comparative advantage at higher quality levels. In particular, we found that the degree of export specialisation of countries in specific goods and the level of quality of their exports (proxied by the average unit values of their exports) display a positive correlation, both in the cross-section and over time. This fact is consistent with the idea that Ricardian specialisation tends to become more intense at the upper levels of quality of production of specific goods.

Finally, we also investigated some extensions of the benchmark model. In that regard, the role of trade is of particular interest. An important implication of this extension is that trade costs generate a positive relationship between the imports/GDP ratio and the level GDP per head. This is because trade costs impose milder frictions on higher-quality varieties, which tend to be consumed in higher proportion by richer individuals.

Appendix A: Omitted Proofs

Proof of Lemma 1. Preliminarily, notice that: a) from (10) it follows that, for a given $c \in \{H, F\}$, $d\widehat{\eta}_F^c/d\kappa \lesseqgtr 0 \Leftrightarrow d\widehat{\eta}_H^c/d\kappa \lesseqgtr 0$ and $d\widehat{\eta}_F^c/dw_F \lesseqgtr 0 \Leftrightarrow d\widehat{\eta}_H^c/dw_F \lesseqgtr 0$; b) from (6) it follows that $\partial\alpha_z/\partial\kappa = 0$ and $\partial\alpha_z/\partial w_F \geq 0$.

In what follows, we let $c = H$. The proof for $c = F$ follows an analogous reasoning, and is available upon request. Following the definitions given in Section 3, the budget constraint of an individual from H is given by:

$$\begin{aligned} &\int_0^{\widehat{\eta}_H^H} (1+\eta_H)\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H + \alpha\left(1 - \widehat{\eta}_F^H\right)\left(1 - \widehat{\eta}_H^H\right) + \\ &w_F\left[\int_0^{\widehat{\eta}_F^H} (1+\eta_F)\left[1 - G\left((1+\eta_F)w_F - 1\right)\right] d\eta_F + (1-\alpha)\left(1 - \widehat{\eta}_H^H\right)\left(1 - \widehat{\eta}_F^H\right)\right] = \kappa; \end{aligned} \tag{29}$$

Part i) Compute total differentiation of (29) with respect to $\widehat{\eta}_H^H$ and κ:

$$\begin{aligned} &\left(1+\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right)d\widehat{\eta}_H^H - \alpha\left(1-\widehat{\eta}_F^H\right)d\widehat{\eta}_H^H - \alpha w_F^{-1}\left(1-\widehat{\eta}_H^H\right)d\widehat{\eta}_H^H \\ &\quad + \left(1+\widehat{\eta}_F^H\right)\left(1-\widehat{\eta}_H^H\right)d\widehat{\eta}_H^H - (1-\alpha)w_F\left(1-\widehat{\eta}_F^H\right)d\widehat{\eta}_H^H - (1-\alpha)\left(1-\widehat{\eta}_H^H\right)d\widehat{\eta}_H^H = d\kappa. \end{aligned}$$

Rearranging terms and simplifying:

$$d\kappa = \left\{\left[1+\widehat{\eta}_H^H - \alpha - (1-\alpha)w_F\right]\left(1-\widehat{\eta}_F^H\right) + \left[1+\widehat{\eta}_F^H - (\alpha/w_F + 1 - \alpha)\right]\left(1-\widehat{\eta}_H^H\right)\right\} d\widehat{\eta}_H^H.$$

Denote the RHS of this last expression by $\Phi d\widehat{\eta}_H^H$. Using (6), it follows that $\alpha + (1-\alpha)w_F \leq 1$ and $\alpha/w_F + 1 - \alpha \leq 1$, hence:

$$\begin{aligned} \Phi = &\left[1+\widehat{\eta}_H^H - \alpha - (1-\alpha)w_F\right]\left(1-\widehat{\eta}_F^H\right) + \left[1+\widehat{\eta}_F^H - \alpha/w_F - (1-\alpha)\right]\left(1-\widehat{\eta}_H^H\right) \\ &\geq \widehat{\eta}_H^H\left(1-\widehat{\eta}_F^H\right) + \widehat{\eta}_F^H\left(1-\widehat{\eta}_H^H\right) > 0. \end{aligned}$$

Hence, $d\widehat{\eta}_H^H/d\kappa > 0$. Our first preliminary statement then implies that $d\widehat{\eta}_F^H/d\kappa > 0$ also holds.

Part ii) Compute total differentiation of (29) with respect to $\widehat{\eta}_H^H$ and w_F:

$$\begin{aligned} &\left[\int_0^{\widehat{\eta}_H^H}\left(\frac{1+\eta_H}{w_F}\right)^2 g\left(\frac{1+\eta_H}{w_F} - 1\right) d\eta_H + \mathcal{I}_\alpha\left(1-\widehat{\eta}_F^H\right)\left(1-\widehat{\eta}_H^H\right)\right. \\ &\qquad + \int_0^{\widehat{\eta}_F^H}(1+\eta_F)\left[1 - G\left((1+\eta_F)w_F - 1\right)\right] d\eta_F + (1-\alpha)\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right) \\ &\left. - w_F\int_0^{\widehat{\eta}_F^H}(1+\eta_F)^2 g\left((1+\eta_F)w_F - 1\right) d\eta_F - \mathcal{I}_\alpha w_F\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right)\right] dw_F = -\Phi d\widehat{\eta}_H^H; \end{aligned}$$

where $\mathcal{I}_\alpha \in [0,1]$ takes a non-zero value only when the relative wage is in the vicinity of $w_F = 1$. Note that the integral in the fifth term can be rewritten on η_H by considering the following relationship:[28]

$$\eta_F = \phi(\eta_H) \equiv \frac{1+\eta_H}{w_F} - 1, \text{ with } d\eta_F = \frac{1}{w_F} d\eta_H; \tag{30}$$

hence, the fifth term becomes:

$$w_F \int_0^{\widehat{\eta}_F^H} (1+\eta_F)^2 g\left((1+\eta_F) w_F - 1\right) d\eta_F = \int_0^{\widehat{\eta}_H^H} \left(\frac{1+\eta_H}{w_F}\right)^2 g\left(\frac{1+\eta_H}{w_F} - 1\right) d\eta_H;$$

which then cancels out with the first term. Notice that the second and sixth terms also cancel out, as they have non-zero value only when in the vicinity of $w_F = 1$, exactly the case when the difference in their magnitudes is infinitesimal and therefore negligible. Thus, simplifying and rearranging, we obtain:

$$\frac{d\widehat{\eta}_H^H}{dw_F} = -\frac{\int_0^{\widehat{\eta}_F^H} (1+\eta_F)\left[1 - G\left((1+\eta_F) w_F - 1\right)\right] d\eta_F + (1-\alpha)(1-\widehat{\eta}_H^H)(1-\widehat{\eta}_F^H)}{\Phi} < 0;$$

where the the negative sign of the derivative follows from $\Phi > 0$. Finally, once again, our first preliminary statement then implies that $d\widehat{\eta}_F^H / dw_F < 0$ also holds. ■

Proof of Lemma 2. Notice first that, when $w_F = 1$: (i) (10) yields $\widehat{\eta}_F^H = \widehat{\eta}_H^H = \widehat{\eta}^H$ and $\widehat{\eta}_F^F = \widehat{\eta}_H^F = \widehat{\eta}^F$; (ii) the probability distribution is such that $g(\eta) = 1$ always and, as a consequence, $G(\eta) = \eta$. The budget constraints for individuals from H and F may be written, respectively, as follows:

$$1 + \left(\widehat{\eta}^H\right)^2 - \tfrac{2}{3}\left(\widehat{\eta}^H\right)^3 = \kappa \qquad \text{and} \qquad 1 + \left(\widehat{\eta}^F\right)^2 - \tfrac{2}{3}\left(\widehat{\eta}^F\right)^3 = \kappa. \tag{31}$$

Hence, the two equations above imply $\widehat{\eta}^H = \widehat{\eta}^F = \widehat{\eta}$.

Differentiating either equations in (31), we get that:

$$\frac{d\widehat{\eta}}{d\kappa} = \frac{1}{2}\frac{1}{\widehat{\eta} - \widehat{\eta}^2};$$

which is strictly positive whenever $0 < \widehat{\eta} < 1$. Finally, by setting $\widehat{\eta} = 1$ into (31), we obtain the threshold $\kappa = 4/3$. ■

[28] The underlying function relates η_F and η_H on the threshold dividing the set of high-quality goods purchased abroad, for which inequality (8) holds, from those purchased domestically, for which inequality (9) holds instead.

Proof of Proposition 1. Firstly, notice from Lemma 2 that, when $w_F = 1$, we have $\widehat{\eta}_H^H = \widehat{\eta}_F^H = \widehat{\eta}_H^F = \widehat{\eta}_F^F = \widehat{\eta}(\kappa)$. As a result, when $w_F = 1$, the first terms of both sides of (14) turn out to be equivalent, namely:

$$\int_0^{\widehat{\eta}(\kappa)} (1+\eta_H)(1-\eta_H)\, d\eta_H = \int_0^{\widehat{\eta}(\kappa)} (1+\eta_F)(1-\eta_F)\, d\eta_F.$$

Therefore, as long as $\alpha = 1/2$, $w_F = 1$ is an equilibrium for any $\kappa \geq 1$.

Secondly, suppose in equilibrium $w_F > 1$. Then, from (6) we have $\alpha = 1$. As a consequence, the equilibrium in the labour markets of H and F would read, respectively, as follows:

$$\begin{aligned}\int_0^{\widehat{\eta}_H^H} \frac{1+\eta_H}{\kappa}\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H + \frac{1}{\kappa}\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right) \\ + \int_0^{\widehat{\eta}_H^F} \frac{1+\eta_H}{\kappa}\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H + \frac{1}{\kappa}\left(1-\widehat{\eta}_H^F\right)\left(1-\widehat{\eta}_F^F\right) = 1;\end{aligned} \tag{32}$$

and:

$$\begin{aligned}\int_0^{\widehat{\eta}_F^H} \frac{1+\eta_F}{\kappa}\left[1 - G\left((1+\eta_H)\, w_F - 1\right)\right] d\eta_F \\ + \int_0^{\widehat{\eta}_F^F} \frac{1+\eta_F}{\kappa}\left[1 - G\left((1+\eta_H)\, w_F - 1\right)\right] d\eta_F = 1;\end{aligned} \tag{33}$$

Notice now that condition (10) implies $\widehat{\eta}_H^H > \widehat{\eta}_F^H$ and $\widehat{\eta}_H^F > \widehat{\eta}_F^F$ when $w_F > 1$. Hence, from (32) and (33) it must be the case that:

$$\begin{aligned}\int_0^{\widehat{\eta}_F^H} (1+\eta)\left[1 - G\left(\frac{1+\eta}{w_F} - 1\right)\right] d\eta + \int_0^{\widehat{\eta}_F^F} (1+\eta)\left[1 - G\left(\frac{1+\eta}{w_F} - 1\right)\right] d\eta \\ < \int_0^{\widehat{\eta}_F^H} (1+\eta)\left[1 - G\left((1+\eta)\, w_F - 1\right)\right] d\eta + \int_0^{\widehat{\eta}_F^F} (1+\eta)\left[1 - G\left((1+\eta)\, w_F - 1\right)\right] d\eta.\end{aligned}$$

However this is impossible when $w_F > 1$, since in that case $G\left((1+\eta)/w_F - 1\right) < G\left((1+\eta)\, w_F - 1\right)$.

Lastly, suppose in equilibrium $w_F < 1$. Then, from (6) we have $\alpha = 0$, and the equilibrium in the labour markets of H and F would be given, respectively, by:

$$\begin{aligned}\int_0^{\widehat{\eta}_H^H} \frac{1+\eta_H}{\kappa}\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H \\ + \int_0^{\widehat{\eta}_H^F} \frac{1+\eta_H}{\kappa}\left[1 - G\left(\frac{1+\eta_H}{w_F} - 1\right)\right] d\eta_H = 1;\end{aligned} \tag{34}$$

and:

$$\begin{aligned}\int_0^{\widehat{\eta}_F^H} \frac{1+\eta_F}{\kappa}\left[1 - G\left((1+\eta_H)\, w_F - 1\right)\right] d\eta_F + \frac{1}{\kappa}\left(1-\widehat{\eta}_H^H\right)\left(1-\widehat{\eta}_F^H\right) \\ + \int_0^{\widehat{\eta}_F^F} \frac{1+\eta_F}{\kappa}\left[1 - G\left((1+\eta_H)\, w_F - 1\right)\right] d\eta_F + \frac{1}{\kappa}\left(1-\widehat{\eta}_H^F\right)\left(1-\widehat{\eta}_F^F\right) = 1.\end{aligned} \tag{35}$$

Notice now that condition (10) implies $\widehat{\eta}_H^H < \widehat{\eta}_F^H$ and $\widehat{\eta}_H^F < \widehat{\eta}_F^F$ when $w_F < 1$. Hence, from (34) and (35) it must be the case that:

$$\int_0^{\widehat{\eta}_F^H} (1+\eta)\left[1-G\left(\frac{1+\eta}{w_F}-1\right)\right] d\eta + \int_0^{\widehat{\eta}_F^F} (1+\eta)\left[1-G\left(\frac{1+\eta}{w_F}-1\right)\right] d\eta$$
$$> \int_0^{\widehat{\eta}_F^H} (1+\eta)\left[1-G\left((1+\eta)\, w_F-1\right)\right] d\eta + \int_0^{\widehat{\eta}_F^F} (1+\eta)\left[1-G\left((1+\eta)\, w_F-1\right)\right] d\eta.$$

But, this is impossible, since $w_F > 1$ implies $G\left((1+\eta)/w_F - 1\right) > G\left((1+\eta)\, w_F - 1\right)$. ■

Proof of Proposition 2. Differentiating (16) with respect to κ yields:

$$\begin{aligned} \frac{\partial E\left[\eta^c \middle| \text{demanded}\right]}{\partial \kappa} &= \widehat{\eta}(\kappa)\left[1-\widehat{\eta}(\kappa)\right]\frac{\partial \widehat{\eta}}{\partial \kappa} - \frac{\left[1-\widehat{\eta}(\kappa)\right]\left[1+\widehat{\eta}(\kappa)\right]}{2}\frac{\partial \widehat{\eta}}{\partial \kappa} \\ &= \frac{\left[\widehat{\eta}(\kappa)-1\right]\left[1-\widehat{\eta}(\kappa)\right]}{2}\frac{\partial \widehat{\eta}}{\partial \kappa}. \end{aligned}$$

As a result, whenever $\partial\widehat{\eta}/\partial\kappa > 0$, it must be the case that $\partial E\left[\eta^c \middle| \text{dem.}\right]/\partial\kappa < 0$. The other two parts of the proof follow immediately from replacing, respectively, $\widehat{\eta}(1) = 0$ and $\widehat{\eta}(\kappa) = 1$ for all $\kappa > 4/3$, into (16). ■

Proof of Proposition 3. Firstly, it should be noted that $\int_0^{\widehat{\eta}^c} \eta_{c'}\left(1-\eta_{c'}\right) d\eta_{c'} < \widehat{\eta}^c \int_0^{\widehat{\eta}^c} \left(1-\eta_{c'}\right) d\eta_{c'} = \widehat{\eta}^c\left[\widehat{\eta}^c - \left(\widehat{\eta}^c\right)^2/2\right]$; and also that $\int_{\widehat{\eta}^c}^1 \eta_{c'}\, d\eta_{c'} > \widehat{\eta}^c \int_{\widehat{\eta}^c}^1 d\eta_{c'} = \widehat{\eta}^c\left(1-\widehat{\eta}^c\right)$; then, it immediately follows that $E\left[\eta_{c'}^{\text{expo}} \middle| q=1\right] < \widehat{\eta}^c < E\left[\eta_{c'}^{\text{expo}} \middle| q=0\right]$. ■

Proof of Proposition 4.

First, suppose $w_F \le 1$ in equilibrium. Then, (21) implies:

$$\int_0^{\widehat{\eta}_H^F} \left(1+\eta_H\right)\left[1-G\left(\frac{\left(1+\eta_H\right)\kappa}{w_F}-1\right)\right] d\eta_H$$
$$\ge \frac{w_F}{\kappa}\int_0^{\widehat{\eta}_F^H} \left(1+\eta_F\right)\left[1-G\left(\frac{\left(1+\eta_F\right)w_F}{\kappa}-1\right)\right] d\eta_F.$$

Using the following change of variables

$$\eta_F = \varphi\left(\eta_H\right) \equiv \left(1+\eta_H\right)\frac{\kappa}{w_F} - 1, \text{ with } d\eta_F = \frac{\kappa}{w_F} d\eta_H; \tag{36}$$

we may write:

$$\begin{aligned} \int_0^{\widehat{\eta}_H^F} \left(1+\eta_H\right)\left[1-G\left(\varphi\left(\eta_H\right)\right)\right] d\eta_H &\ge \int_0^{\widehat{\eta}_F^H} \frac{w_F}{\kappa}\left(1+\eta_F\right)\left[1-G\left(\varphi^{-1}\left(\eta_F\right)\right)\right] d\eta_F \\ &= \int_0^{\widehat{\eta}_H^H} \left(1+\varphi\left(\eta_H\right)\right)\left[1-G\left(\eta_H\right)\right] g\left(\varphi\left(\eta_H\right)\right) d\eta_H. \end{aligned}$$

Also notice that, when $w_F \leq 1$, we have $\widehat{\eta}_H^F \leq \widehat{\eta}_H^H$; hence:

$$\int_0^{\widehat{\eta}_H^H} (1+\eta_H)\left[1-G(\varphi(\eta_H))\right] d\eta_H \geq \int_0^{\widehat{\eta}_H^H} (1+\varphi(\eta_H))\left[1-G(\eta_H)\right] g(\varphi(\eta_H))\, d\eta_H.$$

But, given that $w_F < \kappa$ implies $\varphi(\eta_H) > \eta_H$, the above condition cannot hold since: (i) whenever $g(\varphi(\eta_H)) = 0$, then $[1-G(\varphi(\eta_H))] = 0$, (ii) whenever $g(\varphi(\eta_H)) = 1$, the fact that $\varphi(\eta_H) > \eta_H$ entails $(1+\eta_H)[1-G(\varphi(\eta_H))] < (1+\varphi(\eta_H))[1-G(\eta_H)]$.

Now, suppose $w_F > \kappa$ in equilibrium. Then, (21) implies:

$$\int_0^{\widehat{\eta}_H^F} (1+\eta_H)\left[1-G\left(\frac{(1+\eta_H)\kappa}{w_F}-1\right)\right] d\eta_H$$
$$\leq \frac{w_F}{\kappa}\int_0^{\widehat{\eta}_F^H} (1+\eta_F)\left[1-G\left(\frac{(1+\eta_F)w_F}{\kappa}-1\right)\right] d\eta_F;$$

which using (36) leads to:

$$\int_0^{\widehat{\eta}_H^F} (1+\eta_H)\left[1-G(\varphi(\eta_H))\right] d\eta_H \leq \int_0^{\widehat{\eta}_H^H} (1+\varphi(\eta_H))\left[1-G(\eta_H)\right] g(\varphi(\eta_H))\, d\eta_H.$$

Finally, noting that when $w_F > \kappa \geq 1$, we have $\widehat{\eta}_H^F \geq \widehat{\eta}_H^H$; the above expression implies:

$$\int_0^{\widehat{\eta}_H^H} (1+\eta_H)\left[1-G(\varphi(\eta_H))\right] d\eta_H \leq \int_0^{\widehat{\eta}_H^H} (1+\varphi(\eta_H))\left[1-G(\eta_H)\right] g(\varphi(\eta_H))\, d\eta_H.$$

But, since given that $w_F > \kappa$ means that $\varphi(\eta_H) < \eta_H$, the above condition cannot hold.[29] ■

Proof of Proposition 5. Let us first look at the case when $w_F < \kappa$. In this case $\alpha = 0$, and:

$$E[\eta^c|\,\text{demanded}] = \int_0^{\widehat{\eta}_H^c} \eta_H \left[1-G\left(\frac{(1+\eta_H)\kappa}{w_F}-1\right)\right] d\eta_H + \int_0^{\widehat{\eta}_F^c} \eta_F \left[1-G\left(\frac{(1+\eta_F)w_F}{\kappa}-1\right)\right] d\eta_F + (1-\widehat{\eta}_H^c)\int_{\widehat{\eta}_F^c}^1 \eta_F\, d\eta_F. \tag{37}$$

Differentiating (37) with respect to $\widehat{\eta}_F^c$, bearing in mind that $d\widehat{\eta}_H^c = (w_F/\kappa)d\widehat{\eta}_F^c$, we obtain:

$$\frac{\partial E[\eta_F^c|\,\text{demanded}]}{\partial \widehat{\eta}_F^c} = \widehat{\eta}_H^c(1-\widehat{\eta}_F^c)\frac{w_F}{\kappa} - \frac{w_F}{\kappa}\int_{\widehat{\eta}_F^c}^1 \eta_F\, d\eta_F = \frac{w_F}{\kappa}(1-\widehat{\eta}_F^c)\frac{\widehat{\eta}_H^c-1}{2} < 0.$$

Now, let us look at the case in which $w_F = \kappa$. In this case, $\widehat{\eta}_H^c = \widehat{\eta}_F^c$ with $0 \leq \alpha \leq 1$. We may then write:

$$E[\eta^c|\,\text{demanded}] = \int_0^{\widehat{\eta}_H^c} \eta_H \left[1-G\left(\frac{(1+\eta_H)\kappa}{w_F}-1\right)\right] d\eta_H + \int_0^{\widehat{\eta}_F^c} \eta_F \left[1-G\left(\frac{(1+\eta_F)w_F}{\kappa}-1\right)\right] d\eta_F + (1-\widehat{\eta}_F^c)\int_{\widehat{\eta}_H^c}^\infty \eta_H\, d\eta_H. \tag{38}$$

[29] Bear in mind that within the relevant interval $\left[0, \widehat{\eta}_H^H\right]$ the density $g(\varphi(\eta_H))$ is either zero (when $\varphi(\eta_H) < 0$) or one ($\varphi(\eta_H) \geq 0$). Hence, for any $\eta_H \in \left[0, \widehat{\eta}_H^H\right]$, $(1+\eta_H)[1-G(\varphi(\eta_H))] > (1+\varphi(\eta_H))[1-G(\eta_H)]\, g(\varphi(\eta_H))$, when $w_F > \kappa$.

Differentiating (38) with respect to $\widehat{\eta}_F^c$, bearing in mind that $d\widehat{\eta}_H^c = (w_F/\kappa)d\widehat{\eta}_F^c$, we get:

$$\frac{\partial E\left[\eta^c\right|\text{demanded}]}{\partial\widehat{\eta}_F^c} = \widehat{\eta}_F^c\left(1-\widehat{\eta}_H^c\right) - \int_{\widehat{\eta}_H^c}^{\infty}\eta_H\, d\eta_H = \left(1-\widehat{\eta}_H^c\right)\frac{\widehat{\eta}_F^c - 1}{2} < 0.$$

Lastly, since when $w_F > 1$, then $\widehat{\eta}_F^F > \widehat{\eta}_H^F$, we can then conclude that $E\left[\eta^F\right|\text{demanded}\right] < E\left[\eta^H\right|\text{demanded}\right]$. ■

Derivation of $\underline{\kappa}$. Preliminarily, consider that, using the definition of α^H, for $w_F = 1$ the budget constraint for an individual from H simplifies to:

$$\left(1-\widehat{\eta}\right)\left(2-\frac{1+\widehat{\eta}}{\tau}\right) + \int_0^{\widehat{\eta}}\left(1+\eta\right)\left[1-G\left(\frac{1+\eta}{\tau}-1\right)\right]d\eta$$
$$+\,\tau\int_0^{(1+\widehat{\eta})/\tau-1}\left(1+\eta\right)\left[2-\left(1+\eta\right)\tau\right]d\eta = \kappa;$$

Compute total differentiation of this last expression with respect to $\widehat{\eta}$ and κ:

$$\left[-\left(2-\frac{1+\widehat{\eta}}{\tau}\right)-\frac{1-\widehat{\eta}}{\tau}+\left(1+\widehat{\eta}\right)\left(2-\frac{1+\widehat{\eta}}{\tau}\right)+\left(1+\widehat{\eta}\right)\left(1-\widehat{\eta}\right)\right]d\widehat{\eta} = d\kappa.$$

Rearranging and simplifying yields:

$$\left[\widehat{\eta}\left(1-\frac{\widehat{\eta}}{\tau}\right)+\widehat{\eta}\left(1-\widehat{\eta}\right)+\frac{\tau-1}{\tau}\right]d\widehat{\eta} = d\kappa.$$

from which we immediately infer that $d\widehat{\eta}/d\kappa > 0$, since the quantity in square brackets is positive.

From conditions (22) and (23), it is straightforward to notice that, if $\widehat{\eta} \leq \tau - 1$, then international trade does not take place. In this case, the last expression further simplifies to:

$$\left(1-\widehat{\eta}\right)\left(2-\frac{1+\widehat{\eta}}{\tau}\right) + \int_0^{\widehat{\eta}}\left(1+\eta\right)\left[1-G\left(\frac{1+\eta}{\tau}-1\right)\right]d\eta = \kappa.$$

Since $d\widehat{\eta}/d\kappa > 0$, this situation occurs for any $\kappa \leq \underline{\kappa}$. To pinpoint the threshold $\underline{\kappa}$, we solve the last equation for κ letting $\widehat{\eta} = \tau - 1$:

$$2-\tau+\tau\int_0^{\tau-1}d\eta = 2-2\tau+\tau^2 = \underline{\kappa},$$

where we have used the fact that:

$$G\left(\tfrac{1+\eta}{\tau}-1\right) = \begin{cases} 0 & \text{if } \eta \leq \tau - 1, \\ \dfrac{1+\eta}{\tau}-1 & \text{otherwise.} \end{cases}$$

Thus, it straightforwardly follows that $\underline{\kappa} = \left(\tau-1\right)^2 + 1 > 1$. ■

Appendix B: Additional Empirical Results

Table 1.A and 1.B (all years)

Year 1996

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.161	0.218	0.068	0.340
	(0.013)***	(0.007)***	(0.007)***	(0.008)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	257296	257296	257296	257296
R squared	0.05	0.4	0.16	0.51

Year 1997

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.161	0.220	0.068	0.345
	(0.013)***	(0.007)***	(0.006)***	(0.008)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	258409	258409	258409	258409
R squared	0.04	0.4	0.15	0.51

Year 1998

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.165	0.227	0.070	0.354
	(0.012)***	(0.007)***	(0.006)***	(0.009)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	260569	260569	260569	260569
R squared	0.05	0.4	0.15	0.51

Year 1999

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.174	0.238	0.075	0.371
	(0.013)***	(0.007)***	(0.007)***	(0.009)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	259090	259090	259090	259090
R squared	0.05	0.4	0.14	0.51

Year 2000

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.181	0.240	0.077	0.370
	(0.013)***	(0.007)***	(0.006)***	(0.008)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	267008	267008	267008	267008
R squared	0.06	0.4	0.14	0.52

Year 2001

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.179	0.240	0.075	0.379
	(0.013)***	(0.006)***	(0.005)***	(0.009)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	269238	269238	269238	269238
R squared	0.05	0.4	0.13	0.52

Year 2002

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.184	0.240	0.074	0.378
	(0.013)***	(0.007)***	(0.006)***	(0.009)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	271384	271384	271384	271384
R squared	0.06	0.4	0.13	0.53

Year 2003

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.187	0.235	0.072	0.375
	(0.013)***	(0.006)***	(0.006)***	(0.008)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	278231	278231	278231	278231
R squared	0.06	0.41	0.15	0.52

Year 2004

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.187	0.225	0.070	0.364
	(0.012)***	(0.006)***	(0.005)***	(0.008)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	285329	285329	285329	285329
R squared	0.06	0.41	0.15	0.51

Year 2005

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.161	0.188	0.054	0.303
	(0.011)***	(0.005)***	(0.005)***	(0.006)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	305239	305239	305239	305239
R squared	0.06	0.42	0.16	0.53

Year 2006

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.161	0.185	0.053	0.299
	(0.011)***	(0.005)***	(0.004)***	(0.006)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	303236	303236	303236	303236
R squared	0.07	0.41	0.16	0.52

Year 2007

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.173	0.195	0.061	0.305
	(0.011)***	(0.005)***	(0.004)***	(0.006)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	307183	307183	307183	307183
R squared	0.07	0.42	0.15	0.52

Year 2008

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.175	0.192	0.060	0.300
	(0.011)***	(0.005)***	(0.004)***	(0.006)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	308570	308570	308570	308570
R squared	0.08	0.41	0.15	0.52

Year 2009

	Dependent Variable: all in logarithms			
	maximum unit value		weighted mean u.v	max to min u.v.
Log RCA	0.157	0.191	0.061	0.294
	(0.011)***	(0.005)***	(0.005)***	(0.006)***
Product FE	YES	YES	YES	YES
Exporter FE	NO	YES	YES	YES
Observations	286338	286338	286338	286338
R squared	0.06	0.4	0.14	0.51

Robust absolute standard errors clustered at the exporter level in parentheses. All regressions include a constant term. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2 (full results)

	Dependent Variable: Δ(log of max unit value by each exporter)$_{09\text{-}95}$		
	(1)	(2)	(4)
Δ(Log RCA)$_{09\text{-}95}$	0.183	0.191	0.185
	(0.005)***	(0.005)***	(0.005)***
Δ(Dist. expo-impo)$_{09\text{-}95}$ x 1000			0.011
			(0.001)***
Δ(Contiguity)$_{06\text{-}95}$			-0.060
			(0.021)***
Δ(Common off. language)$_{09\text{-}95}$			-0.017
			(0.017)
Δ(Common coloniser)$_{09\text{-}95}$			0.013
			(0.019)
Δ(Common legal origin)$_{09\text{-}95}$			-0.032
			(0.015)**
Δ(Common currency)$_{09\text{-}95}$			0.012
			(0.023)
Product fixed effects	NO	YES	YES
Exporter fixed effects	NO	YES	YES
Observations	193084	193084	181197
R squared	0.05	0.09	0.09

Robust absolute standard errors clustered at the exporter level in parentheses. All regressions include a constant term.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.B (full results)

	Dependent Variable: log RCA of imports	
	(1)	(3)
Log GDP per head	0.167	0.173
	(0.02)***	(0.04)***
Landlocked dummy		-0.136
		(.064)**
Island dummy		-0.173
		(0.07)***
Area		2.29E-08
		(1.46E-08)*
Population		2.23E-10
		(2.7e-10)
Density x 1000		-0.024
		(0.0183)
Latitude x 100		-.028
		(0.168)
Dist. to equator x 100		0.148
		(0.306)
Longitude x 100		0.036
		(0.093)
Product fixed effects	NO	YES
Continent fixed effects	NO	YES
Observations	587557	579950
R squared	0.02	0.04

Robust absolute standard errors clustered at the importer level in parentheses.
All regressions include a constant term. * significant at 10%; ** significant at 5%; *** significant at 1%.

References

[1] Alcala, F. (2009). 'Comparative Advantage across Goods and Product Quality', DT02/09, BBVA.

[2] Artopoulos, A., Friel, D. and Hallak, J. C. (2011). 'Lifting the Domestic Veil: The Challenges of Exporting Differentiated Goods Across the Development Divide' NBER Working Papers 16947.

[3] Bajona, C. (2004). 'Specific Factors, Learning, and the Dynamics of Trade', *International Economic Review*, vol. 45(2), pp. 499-521.

[4] Baldwin, R. and Harrigan, J. (2011). 'Zeros, Quality and Space: Trade Theory and Trade Evidence', *American Economic Journal: Microeconomics*, vol. 3, pp. 60-88.

[5] Bastos, P. and Silva, J. (2010). 'The Quality of a Firm's Exports: Where you export to matters', *Journal of International Economics*, vol. 82, pp. 99-111.

[6] Bergstrand, J. (1990). 'The Heckscher-Ohlin-Samuelson Model, The Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade', *Economic Journal*, vol. 100, pp. 1216-1229.

[7] Brooks, E. (2006). 'Why don't firms export more? Product quality and Colombian plants', *Journal of Development Economics*, vol. 80, pp. 160-178.

[8] Choi, Y. C., Hummels, D. and Xiang, C. (2009). 'Explaining Import Quality: The Role of the Income Distribution', *Journal of International Economics*, vol. 77, pp. 265-275.

[9] Dalgin, M., Trindade, V. and Mitra, D. (2008). 'Inequality, Nonhomothetic Preferences, and Trade: A Gravity Approach', *Southern Economic Journal*, vol. 74, pp. 747-774.

[10] Dalton, J. (2010). 'Explaining the Growth in Manufacturing Trade', Mimeo, Wake Forest University.

[11] Dornbusch, R., Fischer, S. and Samuelson, P. (1977). 'Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods', *American Economic Review*, vol. 67, pp. 823-839.

[12] Fajgelbaum, P., Grossman, G. and Helpman, E. (2011). 'Income Distribution, Product Quality, and International Trade', *Journal of Political Economy*, forthcoming.

[13] Feenstra, R. (1998). 'Integration of Trade and Disintegration of Production in the Global Economy', *Journal of Economic Perspectives*, vol. 12, pp. 31-50.

[14] Flam, H. and Helpman, E. (1987). 'Vertical Product Differentiation and North-South Trade', *American Economic Review*, vol. 77, pp. 810-822.

[15] Fieler, A. C. (2007). 'Quality Differentiation in International Trade: Evidence from the Demand and Supply Sides', Mimeo, NYU.

[16] Fieler, A. C. (2011). 'Nonhomotheticity and Bilateral Trade: Evidence and a Quantitative Explanation', *Econometrica*, vol. 79, pp. 1069-1101.

[17] Foellmi, R., Hepenstrick, C. and Zweimuller, J. (2010). 'Income Effects in the Theory of Monopolistic Competition and International Trade', Mimeo, University of Zurich.

[18] Francois, J. and Kaplan, S. (1996). 'Aggregate Demand Shifts, Income Distribution, and the Linder Hypothesis', *Review of Economics and Statistics*, vol. 78, pp. 244-250.

[19] Gaulier, G. and Zignago, S. (2010). 'BACI: International Trade Database at the Product-level. The 1994-2007 Version', CEPII Working Paper 2010-23.

[20] Hallak, J. C. (2006). 'Product Quality and the Direction of Trade', *Journal of International Economics*, vol. 68, pp. 238-265.

[21] Hallak, J. C. (2010). 'A Product-Quality View of the Linder Hypothesis', *Review of Economics and Statistics*, vol. 92, pp. 453-466.

[22] Hallak, J. C., and Schott, P. (2011). 'Estimating Cross-Country Differences in Product Quality', *Quarterly Journal of Economics*, vol. 126, pp. 417-474.

[23] Iacovone, L. and Javorcik, B. (2008). 'Shipping Good Tequila out: Investment, Domestic Unit Values and Entry of Multi-Product Plants into Export Markets', Mimeo, Oxford University.

[24] Ishii J. and YI, K-M. (1997). 'The Growth of World Trade', Manuscript, Federal Reserve Bank of New York.

[25] Jaimovich, E. and Merella, V. (2010). 'Quality Ladders in a Ricardian Model of Trade with Nonhomothetic Preferences', *Journal of the European Economic Association*, forthcoming.

[26] Krugman P. (1995). 'Growing World Trade: Causes and Consequences', *Brookings Papers on Economic Activity*, vol. 1, pp. 325-377.

[27] Linder, S. (1961). *An Essay on Trade and Transformation*, Uppsala: Almqvist & Wiksell.

[28] Manova, K. and Zhang, Z. (2011). 'Export Prices across Firms and Destinations', *Quarterly Journal of Economics*, forthcoming.

[29] Matsuyama, K. (2000). 'A Ricardian Model with a Continuum of Goods under Nonhomothetic Preferences: Demand Complementarities, Income Distribution, and North-South Trade', *Journal of Political Economy*, vol. 108, pp. 1093-1120.

[30] Markusen, J. (1986). 'Explaining the Volume of Trade: an Eclectic Approach,' *American Economics Review*, vol. 76, pp. 1002-1011.

[31] Mayer, T. and Zignago, S. (2006). 'GeoDist: the CEPII's Distances and Geographical Database', MPRA Paper 31243.

[32] Murphy, K. and Shleifer, A. (1997). 'Quality and Trade,' *Journal of Development Economics*, vol. 53, pp. 1-15.

[33] Schott, P. (2004). 'Across-Product versus within-Product Specialization in International Trade', *Quarterly Journal of Economics*, vol. 119, pp.647-678.

[34] Stokey, N. (1991). 'The Volume and Composition of Trade between Rich and Poor Countries', *Review of Economic Studies*, vol. 58, pp. 63-80.

[35] Verhoogen, E. (2008). 'Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector', *Quarterly Journal of Economics*, vol. 123, pp 489-530.