Love for Quality, Comparative Advantage, and Trade*

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This Version: January 2014

First Version: March 2011

Abstract

We propose a Ricardian trade model with horizontal and vertical differentiation, where willingness to pay for quality rises with individuals' incomes, and productivity differentials across countries are stronger for high-quality varieties of goods. 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. This implies that comparative advantages strengthen gradually over the path of development as a by-product of the process of quality upgrading. The evolution of comparative advantages leads to specific trade patterns that change over the growth path, by linking richer importers to more specialised exporters. We provide empirical support for this prediction, showing that the share of imports originating from exporters exhibiting a comparative advantage in a specific 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 Andrea Carriero, Arnaud Costinot, Pablo Fajgelbaum, Giovanni Mastrobuoni, Ignacio Monzon, Alessio Moro, Juan Pablo Rud and Ina Simonovska for comments and suggestions, as well as seminar participants at Bologna University, Bristol University, Collegio Carlo Alberto, University of Namur, University of St. Gallen, University of Surrey, University of Cagliari, Queen Mary, the SED Meeting (Seoul), the RIEF Meeting (Bocconi), the Royal Economic Society Meeting (Cambridge), and the Midwest International Trade Meeting (Washington University).

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1 Introduction

Income is a key determinant of consumer choice. A crucial dimension through which purchasing power influences this choice is the quality of consumption. People with very different incomes tend to consume commodities within the same category of goods, such as clothes, cars, wines, etc. However, the actual quality of the consumed commodities differs substantially when comparing poorer to richer households. The same reasoning naturally extends to countries with different levels of income per capita. In this case, the quality dimension of consumption entails important implications on the evolution of trade flows.

Several recent studies have investigated the links between quality of consumption and international trade. One strand of literature has centred their attention on the demand side, finding a strong positive correlation between quality of imports and the importer's income per head [Hallak (2006), Fieler (2011a)].[1] Another set of papers has focused instead on whether exporters adjust the quality of their production to serve markets with different income levels. The evidence here also points towards the presence of nonhomothetic preferences along the quality dimension, showing that producers sell higher quality versions of their output to richer importers.[2]

These empirical findings have motivated a number of models that yield trade patterns where richer importers buy high-quality versions of goods, while exporters differentiate the quality of their output by income at destination [Hallak (2010), Fajgelbaum, Grossman and Helpman (2011), Jaimovich and Merella (2012)]. Yet, this literature has approached the determinants of countries' sectoral specialisation as a phenomenon that is independent of the process of quality upgrading resulting from higher consumer incomes. In this paper, we propose a theory where quality upgrading in consumption becomes the central driving force behind a general process of sectoral specialisation, comparative advantage intensification, and varying magnitude of bilateral trade links at different levels of income. The crucial novel feature of our theory is that quality upgrading by consumers leads to a strengthening in countries' specialisation in the sectors where they exhibit a relative cost advantage. Therefore, the quality of the goods consumed and exchanged in world markets

[1] See also related evidence in Choi, Hummels and Xiang (2009), Francois and Kaplan (1996) and Dalgin, Trindade and Mitra (2008).

[2] For example, Verhoogen (2008) and Iacovone and Javorcik (2008) provide evidence of Mexican manufacturing plants selling higher qualities in the US than in their local markets. Brooks (2006) establishes the same results for Colombian manufacturing plants, and Manova and Zhang (2012) show that Chinese firms ship higher qualities of their exports to richer importers. Analogous evidence is provided by Bastos and Silva (2010) for Portuguese firms, and by Crino and Epifani (2012) for Italian ones.

becomes a first-order determinant of the evolution of countries' sectoral specialisation, and of the intensity of the trade links that importers establish with different exporters.

Our theory is grounded on the hypothesis that productivity differentials are stronger for higher-quality goods, combined with the notion that willingness to pay for quality rises with income. Within this framework, we show that international specialisation and sectoral trade intensify over the growth path. The evolution of trade flows featured by our model presents novel specificities that stem from the interaction between nonhomothetic preferences and the deepening of sectoral productivity differentials at higher levels of quality. In particular, the process of quality upgrading with rising income sets in motion both demand-driven and supply-driven factors, which together lead to a simultaneous rise in specialisation by importers and exporters. Import and export specialisation arise as intertwined phenomena because, as countries become richer, consumers shift their spending towards high-quality goods, which are exactly those that tend to display greater scope for international trade.

We model a world economy with a continuum of horizontally differentiated goods, each of them available in a continuum of vertically ordered quality levels. Each country produces a particular variety of every good. The production technology differs both across countries and sectors. We assume that some countries are intrinsically better than others in producing certain types of goods. In addition, these intrinsic productivity differentials on the horizontal dimension tend to become increasingly pronounced along the vertical dimension. These assumptions lead to an intensifying process of Ricardian sectoral specialisation as production moves up on the quality ladders of each good. For example, a country may have a cost advantage in producing wine, while another country may have it in whisky. This 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 as production moves up towards higher quality versions of these goods. As a result, the scope for international trade turns out to be wider for high-quality wines and whiskies than for low-quality ones.

A key feature of our model is the embedded link between nonhomotheticicities in quality and international trade at the sectoral level. More precisely, as richer individuals upgrade the quality of their consumption baskets, sectoral productivity differentials across countries become stronger, leading to the intensification of some trading partnerships together with the weakening of others. In that respect, our model thus suggests that the study of the evolution of trade links may require considering a more flexible concept of comparative advantage than the one traditionally used in the literature, so as to encompass quality upgrading as an inherent part of it. In the literature of

Ricardian trade, the comparative advantage is univocally determined by exporters' technologies. This paper instead sustains that both the importers' incomes and the exporters' sectoral productivities must be taken into account in order to establish a rank of comparative advantage. This is because the degree of comparative advantage between any two countries is crucially affected by the quality of consumption of their citizens. As a consequence, richer and poorer importers may end up establishing trade links of substantially different intensity with the *same* set of exporters at the *sectoral* level, simply because the gaps between their willingness-to-pay for quality may translate into unequal degrees of comparative advantage across their trade partners.

The conditionality of comparative advantage on importers incomes entails novel testable predictions on the evolution of sectoral trade flows. In particular, our model predicts that the share of imports originating from exporters exhibiting a cost advantage in a given good must grow with the income per head of the importer. This is the result of richer importers buying high-quality versions of goods, which are the type of commodities for which cost differentials across countries are relatively more pronounced. Using bilateral trade data at the sectoral level, we provide evidence consistent with the prediction that richer economies are more likely to buy their imports from producers who display a comparative advantage in the imported goods.

Related Literature

Nonhomothetic preferences are by now a widespread 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: Fajgelbaum, Grossman and Helpman (2011) and Jaimovich and Merella (2012).

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 costs. Like ours, their paper leads to an endogenous emergence of comparative advantages,

[3] For some recent contributions with horizontal differentiation and nonhomothetic preferences see: Foellmi, Hepenstrick and Zweimuller (2010) and Tarasov (2012), where consumers are subject to a discrete consumption choice; Fieler (2011b) 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; Simonovska (2013) who fixes a bounded level of utility for each differentiated good; and Melitz and Ottaviano (2008), Zhelobodko *et al.* (2012) and Dhingra and Morrow (2012), who adopt non-homothetic specifications of preferences delivering linear demand systems.

which may have remained initially latent (in their case, this could be either due to trade costs being too high to induce trade, or countries' income distributions being too dissimilar to induce specialisation via a home-market effect). Our paper, instead, sticks to the Ricardian tradition where trade and specialisation stem from cross-country *differences* in sectoral technologies featuring constant returns to scale. In particular, in our model, comparative advantages and trade emerge gradually, not because trade costs may initially hinder the scope for exchange in the presence of increasing returns to scale, but because the demand for commodities displaying wider heterogeneity in cost of production (the high-quality goods) expands as incomes rise.[4]

Jaimovich and Merella (2012) also propose a nonhomothetic preference specification where budget reallocations take place both within and across horizontally differentiated goods. That paper, however, remained within a standard Ricardian framework where absolute and comparative advantages are determined from the outset, and purely by technological conditions. Hence, nonhomothetic preferences play no essential role there in determining export and import specialisation at different levels of development. By contrast, it is the interaction between rising differences in productivity at higher quality levels and nonhomotheticities in quality that generates our novel results in terms of co-evolution of export and import specialisation.

A key assumption in our theory is the widening in productivity differentials at higher levels of quality. To the best of our knowledge, Alcala (2012) is the only other paper that has explicitly introduced 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 actually crucial to our story and, in particular, to its main predictions regarding the evolution of trade flows and specialisation at different levels of income.

Finally, Fieler (2011b) also studies the interplay between nonhomothetic demand and Ricardian technological disparities. She shows that, when productivity differences are stronger for goods with high income elasticity, her model matches quite closely key features of North-North and North-South trade. While her model exhibits horizontal differentiation, it does not display vertical differentiation, which is a crucial dimension exploited by our model. Our mechanism differs from hers in that the effects of demand on trade flows stem from the (vertical) reallocation of consumer spending *within* categories of goods rather than (horizontally) *across* them. In particular, our

[4] In this regard, an important feature present in our model is that high-quality versions of goods are inherently more tradable than low-quality ones, while this is not necessarily the case in Fajgelbaum et al. (2011) unless they specifically assume quality-specific trade costs that are restricted to be relatively lower for high-quality varieties.

results hinge on richer consumers switching their good-specific expenditure shares from lower-quality to higher-quality versions of the goods. It is in fact this within-good substitution process –which is absent in Fieler (2011b)– that leads to our main predictions concerning income-dependent spending shares across different exporters.[5]

The rest of the paper is organised as follows. Section 2 studies a world economy with a continuum of countries where all economies have the same level of income per head in equilibrium. Section 3 generalises the main results to a world economy where some countries are richer than others. Section 4 presents some empirical results consistent with the main predictions of our model. Section 5 concludes. All relevant proofs can be found in the Appendices.

2 A world economy with equally rich countries

We study a world economy with a unit continuum of countries indexed by $v \in \mathbb{V}$.[6] In each country there is a continuum of individuals with unit mass. Each individual is endowed with one unit of labour time. We assume labour is immobile across countries. In addition, we assume all countries are open to international trade, and there are no trading costs of any sort.

Our model will display two main distinctive features: first, productivity differentials across countries will rise with the quality level of the commodities being produced; second, richer individuals will choose to consume higher-quality commodities than poorer ones. Subections 2.2 and 2.3 specify the functional forms of production technologies and consumer utility that we adopt to generate these two features. Before that, in subsection 2.1 we describe formally the set of consumption goods in our world economy.

[5] From this perspective, our paper relates also to Linder (1961) and Hallak (2010) views of quality as an important dimension in explaining trade flows between countries of similar income levels. We propose a new mechanism that links together quality of production, income per capita and trade at different stages of development.

[6] The continuum of countries somewhat departs from the standard assumption in trade models, which tend to work with a finite set of countries. Despite its lack of realism, and the heavier notation load that it entails, the continuum of countries still proves to be a useful analytical tool in our model, as it allows us to apply the law of large numbers to some of our equilibrium conditions, which would become quite difficult to solve algebraically otherwise. See Kaneda (1995), Yanagawa (1996), Matsuyama (1996), and Acemoglu and Ventura (2002) for other trade models working with a continuum of countries in their setup. See also Galí and Monacelli (2005) for a model with a continuum of countries in the literature of international monetary economics.

2.1 Commodity space

All countries share a common commodity space defined along three distinct dimensions: a *horizontal*, a *varietal*, and a *vertical* dimension.

Concerning the horizontal dimension, there exists a unit continuum of differentiated goods, indexed by z, where $z \in \mathbb{Z} = [0, 1]$. In terms of the varietal dimension, we assume that each country $v \in \mathbb{V} = [0, 1]$ produces a specific variety v of each good z. Finally, our vertical dimension refers to the intrinsic quality of the commodity: a continuum of different qualities q, where $q \in \mathbb{Q} = [1, \infty)$, are potentially available for every variety v of each good z. As a result, in our setup, each commodity is designated by a specific good-variety-quality index, $(z, v, q) \in \mathbb{Z} \times \mathbb{V} \times \mathbb{Q}$.

To fix ideas, the horizontal dimension refers to different types of goods, such as cars, wines, coffee beans, etc. The varietal dimension refers to the different varieties of any given type of good, originating from different countries, such as Spanish and French wines (differing, for instance, in specific traits like the types of grapes and regional vinification techniques). The vertical dimension refers to the intrinsic quality of each specific commodity (*e.g.*, the ageing and the grapes selection in the winemaking).

2.2 Production technologies

In each country v there exists a continuum of firms in every sector z that may transform local labour into a variety v of good z. Production technologies are idiosyncratic both to the sector z and to the country v. In order to produce one unit of commodity (z, v, q), a firm from country v in sector z needs to use $\Gamma_{z,v}(q)$ units of labour, where:

$$\Gamma_{z,v}(q) = e^{-\underline{\eta}(\overline{\eta}-1)/(\underline{\eta}-1)} \frac{q^{\eta_{z,v}}}{1+\kappa}. \tag{1}$$

Unit labour requirements contain two key technological parameters. The first is $\kappa > 0$, which applies identically to all sectors and countries, and we interpret it as the worldwide total factor productivity level. As such, in our model, increases in κ will capture the effects of aggregate growth and rising real incomes. The second is $\eta_{z,v}$, which may differ both across z and v, and governs the elasticity of the labour requirements with respect to quality upgrading. In what follows, we assume that each parameter $\eta_{z,v}$ is *independently* drawn from a probability density function with uniform distribution over the interval $\left[\underline{\eta}, \overline{\eta}\right]$. In addition, we assume that $\underline{\eta} > 1$. Hence, $\Gamma_{z,v}(q)$ are always strictly increasing and convex in q.

An important feature implicit in the functional form of (1) is that cross-country sectoral productivity differentials will rise with the level of quality of production. This feature will in turn imply that the cost advantage of countries with better sectoral productivity draws will widen up at higher levels of quality of production. To ease notation, we will henceforth denote $A \equiv e^{-\underline{\eta}(\overline{\eta}-1)/(\underline{\eta}-1)}$.[7]

Let w_v denote henceforth the wage per unit of labour time in country v. We assume that, in all countries and all sectors, firms face no entry costs. Since, as implied by (1), all firms in a given country share the same sector-specific technology, all commodities will then be priced exactly at their unit cost in equilibrium.[8] That is, in equilibrium:

$$p_{z,v,q} = A \frac{q^{\eta_{z,v}}}{1+\kappa} w_v, \quad \text{for all } (z, v, q) \in \mathbb{Z} \times \mathbb{V} \times \mathbb{Q}. \tag{2}$$

From (2) it follows that changes in κ leave all relative prices unaltered. In this regard, we may consider a rise in total factor productivity as an increase in real income, as it entails no substitution effect across the different commodities.

2.3 Utility function and budget constraint

To simplify the analysis, we introduce the following assumption concerning consumer choice:

Assumption 1 (Selection of quality) *Individuals consume a strictly positive amount of only one quality version of each good-variety pair* $(z, v) \in \mathbb{Z} \times \mathbb{V}$.

Assumption 1 is analogous to assuming an infinite elasticity of substitution across different quality versions of the good z sourced from country v. Henceforth, to ease notation, we denote the *selected* quality of variety v of good z simply by $q_{z,v}$. In addition, we denote by $c_{z,v}$ the consumed physical quantity of the selected quality $q_{z,v}$.

Utility is defined over the consumed physical quantities $\{c_{z,v}\}$ in the selected quality levels $\{q_{z,v}\}$; formally:

$$U = \left[\int_{\mathbb{Z}} \left(\int_{\mathbb{V}} \ln (c_{z,v})^{q_{z,v}} \, dv \right)^{\sigma} dz \right]^{\frac{1}{\sigma}}, \quad \text{where } \sigma < 0. \tag{3}$$

Individuals choose the physical quantity to consume for each of the selected qualities, subject to the budget constraint:

$$\int_{\mathbb{Z}} \left[\int_{\mathbb{V}} \left(\frac{A}{1+\kappa} (q_{z,v})^{\eta_{z,v}} w_v \right) c_{z,v} \, dv \right] dz \le w, \tag{4}$$

[7] Notice that the parameter A is simply a scale factor between labour input units and quality units. All our main results hold qualitatively true when the labour income requirement are given by $\Gamma_{z,v}(q) = q^{\eta_{z,v}}/(1+\kappa)$, only at the cost of more tedious algebra.

[8] Alternatively, one could assume that a (possibly finite) number of firms engage in Bertrand-type price competition, which would also drive, in equilibrium, the price of each commodity to its (costant) marginal cost.

where we have already substituted the price $p_{z,v}$ of each consumed commodity $q_{z,v}$ by its expression as a function of technological parameters and wages according to (2).

The utility function (3) displays a number of features that is worth discussing in further detail. Firstly, considering the quality dimension in isolation, the exponential terms $\{(c_{z,v})^{q_{z,v}}\}$ in (3) are instrumental to obtaining our desired non-homothetic behaviour along the quality space. The exponential functional form implies that, whenever $c_{z,v} > 1$, the magnifying effect of quality becomes increasingly important as $c_{z,v}$ rises. Such non-homothetic feature in turn leads to a solution of the consumer problem where higher incomes will translate into quality upgrading of consumption. Secondly, abstracting now from the quality dimension, (3) features two nested CES functions. On the one hand, for each good z, the (inner) logarithmic function implies a unit elasticity of substitution across varieties of the same good z. On the other hand, the parameter $\sigma < 0$ governs the elasticity of substitution across goods, which is equal to $1/(1-\sigma) < 1$. The specification in (3) thus intends to capture the notion that the elasticity of substitution across different goods is smaller than within goods (*i.e.*, across the different varieties of the same good).

2.4 Utility maximisation

Consider a representative individual (in a generic country) with income w. The consumer's problem requires choosing combinations of (non-negative) quantities on the good-variety-quality commodity space, subject to (4). However, it turns out that the optimisation problem may be simplified by letting $\beta_{z,v}$ denote the demand intensity for the variety v of good z.[9] Accordingly, we may note that $c_{z,v} = \beta_{z,v} w / p_{z,v}$ (where recall that $p_{z,v}$ is the market price of commodity $q_{z,v}$). Hence, using (2), we may write:

$$c_{z,v} = \frac{\beta_{z,v} w_i}{(q_{z,v})^{\eta_{z,v}} \, w_v A/(1+\kappa)}. \tag{5}$$

We may then restate the original consumer's optimisation problem into one defined only in terms of *optimal selected qualities* and *optimal budget allocations* across varieties of goods. In this reformulated problem, the consumer chooses the optimal quality $q_{z,v}$ and optimal budget allocation

[9] The demand intensity measures the fraction of income spent on each (atomless) commodity. More precisely, it is the continuous counterpart of the discrete-case expenditure share. The relationship between the two concepts is analogous to that between density and discrete probability. We borrow this nomenclature from Horvath (2000).

$\beta_{z,v}$ for each $(z,v) \in \mathbb{Z} \times \mathbb{V}$, so as to solve:[10]

$$\begin{aligned} \max_{\{q_{z,v},\beta_{z,v}\}_{(z,v)\in\mathbb{Z}\times\mathbb{V}}} \quad & U = \left\{ \int_{\mathbb{Z}} \left[\int_{\mathbb{V}} q_{z,v} \ln \left(\frac{1+\kappa}{A} \frac{\beta_{z,v}}{(q_{z,v})^{\eta_{z,v}}} \frac{w}{w_v} \right) dv \right]^{\sigma} dz \right\}^{\frac{1}{\sigma}} \\ \text{subject to:} \quad & \int_{\mathbb{Z}} \int_{\mathbb{V}} \beta_{z,v}\, dv\, dz = 1, \quad \text{and} \quad q_{z,v} \in \mathbb{Q}, \text{ for all } (z,v) \in \mathbb{Z} \times \mathbb{V}. \end{aligned} \tag{6}$$

We can observe that relative wages (w/w_v) may play a role in the optimisation problem (6). For the time being, we will shut down this channel, and characterise the solution of (6) only for the case in which wages are the same in all countries. (In any case, as it will be discussed next, in this specification of the model all wages will turn out to be equal in equilibrium.)

Lemma 1 *Let* $Q \equiv \int_{\mathbb{Z}} \int_{\mathbb{V}} q_{z,v}\, dv\, dz$ *denote the average quality of consumption. When* $w_v = w$ *for all* $v \in \mathbb{V}$*, problem (6) yields, for all* $(z,v) \in \mathbb{Z} \times \mathbb{V}$*:*

$$q_{z,v} = \left[\frac{(1+\kappa)/A}{e^{\eta_{z,v}} Q} \right]^{1/(\eta_{z,v}-1)}, \tag{7}$$

$$\beta_{z,v} = \left[\frac{(1+\kappa)/A}{(eQ)^{\eta_{z,v}}} \right]^{1/(\eta_{z,v}-1)}. \tag{8}$$

In addition, $\partial q_{z,v}/\partial\kappa > 0$ *and* $\partial^2 q_{z,v}/\left(\partial\kappa\, \partial\eta_{z,v}\right) < 0$.

Lemma 1 characterises the solution of the consumer's problem in terms of two sets of variables: (i) the expressions in (7), which stipulate the quality level in which each variety of every horizontally differentiated good is optimally consumed; (ii) the expressions in (8) describing the optimal expenditure shares allocated to those commodities.

The result $\partial q_{z,v}/\partial\kappa > 0$ summarises the key nonhomothetic behaviour present in our model: quality upgrading of consumption. That is, as real incomes grow with a rising κ, individuals substitute lower-quality versions of every variety v of each good z by better versions of them.[11] Moreover, the cross-derivative $\partial^2 q_{z,v}/\left(\partial\kappa\, \partial\eta_{z,v}\right) < 0$ implies that the quality rise is faster for commodities supplied by countries that received better sectoral productivity draws (*i.e.*, lower values of η). In our setup, this result will in turn lead to an increase in the quality differentials

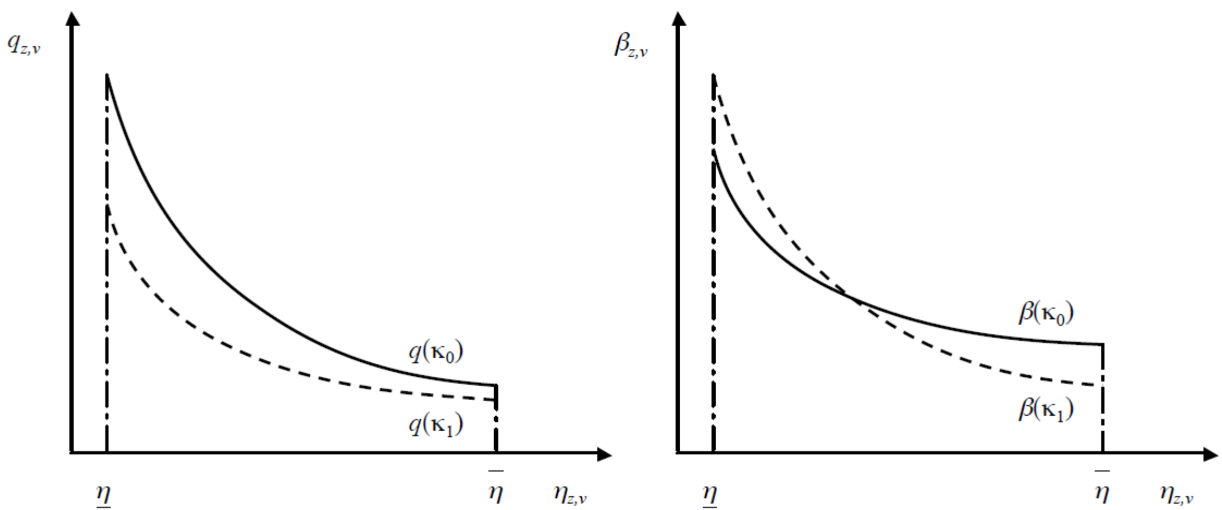
[10] A formal solution of problem (6) is provided in Appendix A.

[11] Note that variations in κ affect all prices in (2) in the same proportion, leaving *all* relative prices unchanged. In that regard, a rise in κ leads consumers to upgrade their quality of consumption via a pure *income-effect*, without any *substitution-effect* across quality versions of the same variety. In fact, a rise in κ entails the same effects as an exogenous increase of w in (6).

of output across countries over the growth path. (The left-hand panel of Figure 1 illustrates the adjustments on optimal qualities of a generic z for two levels of κ: $\kappa_0 < \kappa_1$.)

Another important implication of Lemma 1 is the implicit link between optimal budget shares and optimal qualities. In particular, plugging (7) into (8) yields $\beta_{z,v} = q_{z,v}/Q$. This result means that the distribution of consumer spending across varieties of each good z mirrors that of their optimal choice on the qualitative dimension. Such a link underlies the main source of interaction between supply and demand sides that we will exploit in our model: as κ grows, producers better able at providing quality upgrading in a particular sector will gradually attract larger world expenditure shares in that sector. (The right-hand panel of Figure 1 illustrates the adjustments on optimal demand intensities of a generic z for $\kappa_0 < \kappa_1$.)

Figure 1



The left-hand panel illustrates the optimal quality levels chosen by the consumer for the different varieties of a generic good z, for two different levels of total factor productivity such that $\kappa_0 < \kappa_1$. The right-hand panel illustrates the resulting demand intensities.

2.5 General equilibrium

In equilibrium, total world spending on commodities produced in country v must equal the total labour income in country v (which is itself equal to the total value of goods produced in v). Bearing in mind (6), we may then write down the market clearing conditions as follows:

$$\int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^i_{z,v} \, w_i \, di \, dz = w_v, \quad \text{for all } v \in \mathbb{V}, \tag{9}$$

where $i \in \mathbb{V}$ refers to the country of origin of a specific consumer.

More formally, an equilibrium in the world economy is given by a set of wages $\{w_v\}_{v \in \mathbb{V}}$ such that: i) prices of all traded commodities are determined by (2); ii) all consumers in the world choose their allocations $\left\{q_{z,v}, \beta_{z,v}\right\}_{(z,v)\in\mathbb{Z}\times\mathbb{V}}$ by solving (6); and *iii*) the market clearing conditions stipulated in (9) hold simultaneously for all countries.

In this world economy, the *ex-ante* symmetry across countries implies that, in equilibrium, all country wages w_v will always turn out to be equal to each other. Formally: $w_v = w$ for all $v \in \mathbb{V}$, for any level of $\kappa > 0$.[12] In other words, the relative wages across countries remain unchanged and equal to unity all along the growth path. The reason for this result is the following: as κ rises, and real incomes accordingly increase, aggregate demands and supplies grow together at identical speed in all countries. As a consequence, markets clearing conditions in (9) will constantly hold true without the need of any adjustment in relative wages across economies.

The fact that relative wages remain constant over the path of development conceals the fact that, as κ increases, economies actually experience significant changes in their consumption and production structures at the *sectoral* level. In other words, although aggregate demands and supplies change at the same speed in all countries, sectoral demands and supplies do not, which in turn leads to country-specific processes of labour reallocation across sectors. 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 higher quality versions of each commodity – as can be observed from (7). On the supply side, heterogeneities in sectoral labour productivities across countries become stronger as producers raise the quality of their output – as can be gleaned from (1). Hence, the interplay between income-dependent willingness to pay for quality and intensification of sectoral productivity differences at higher levels of quality leads to a process of increasing sectoral specialisation as κ rises. The following section describes in further detail this process of deepening sectoral specialisation across countries as world productivity κ rises along the growth path.

2.6 Sectoral specialisation

In what follows we study the effects of the above-mentioned sectoral reallocations of labour on the sectoral trade flows. In particular, we focus on the evolution of two variables as we let the worldwide total factor productivity parameter κ rise. With regards to the demand side of the economy, we examine the import penetration (IP) of commodity (z, v) in country i. For the supply side, we look at the revealed comparative advantage (RCA) of country v in sector z.

For every commodity (z, v), we thus compute the following ratios:

$$IP^i_{z,v} \equiv M^i_{z,v}/M^i_z, \tag{10}$$

[12] For a formal proof of this result, see Proposition 5 in Appendix B.1.

and

$$RCA_{z,v} \equiv \frac{X_{z,v}/X_v}{W_z/W}. \tag{11}$$

In (10), $M^i_{z,v} \equiv \beta^i_{z,v}$ is the value of imports of good z from country v by country i, and $M^i_z \equiv \int_{\mathbb{V}} \beta^i_{z,v}\, dv$ is the total value of imports of good z by country i. In (11), $X_{z,v} \equiv \int_{\mathbb{V}} \beta^i_{z,v}\, di$ (resp. $W_z \equiv \int_{\mathbb{V}} X_{z,v}\, dv$) is the total value of exports of good z by country v (resp. by the world), while $X_v \equiv \int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^i_{z,v}\, di\, dz$ (resp. $W \equiv \int_{\mathbb{Z}} W_z\, dz$) is the aggregate value of exports by country v (resp. by the world).[13]

Using (9) and the fact that all relative wages equal one, (10) and (11) simplify to:[14]

$$IP^i_{z,v} = \beta_{z,v}, \quad \text{for all } i \in \mathbb{V} \text{ and } (z,v) \in \mathbb{Z} \times \mathbb{V}; \tag{12}$$

and

$$RCA_{z,v} = \beta_{z,v}, \quad \text{for all } (z,v) \in \mathbb{Z} \times \mathbb{V}. \tag{13}$$

In other words, the revealed comparative advantage of country v in sector z is given by the total value of exports of good z by country v. In addition, in our symmetric world economy, the total value of exports equals the demand intensity for commodity (z, v), which turns out to be identical for all countries. This symmetry also implies that the demand intensity for commodity (z, v) equals the import penetration of source-country v in sector z for any destination-country i.

The following proposition characterises the main properties of each $\beta_{z,v}$ in this symmetric world economy. Subsequently, we provide some economic interpretation of the formal results in Proposition 1 in terms of both exports and imports specialisation.

Proposition 1 *In a symmetric world economy, $\beta_{z,v}$ equals both: (a) the import penetration of country v in sector z; and (b) the revealed comparative advantage of country v in sector z. For any pair of commodities (z', v') and (z'', v'') such that $\eta_{z',v'} < \eta_{z''v''}$, it holds that $\beta_{z',v'} > \beta_{z'',v''}$ and $\partial\beta_{z',v'}/\partial\kappa > \partial\beta_{z'',v''}/\partial\kappa$.*

[13] In defining the variables in (10) and (11), we have disregarded the effect of sales to local consumers, since in our model each country sells only a negligible share of its own production domestically.

[14] We can observe that Proposition 5 in Appendix B.2 implies $\beta^i_{z,v} = \beta_{z,v}$ for all $i \in \mathbb{V}$. Hence, bearing in mind that $\mathbb{V}$ has unit measure, $X_{z,v} = \beta_{z,v}$. Moreover, from Proposition 5 and (9), it follows that $\int_{\mathbb{V}} \beta_{z,v}\, dv = 1$ and $\int_{\mathbb{Z}} \beta_{z,v}\, dz = 1$. Therefore, $M^i_z = 1$ and $X_v = 1$. Notice also that, by the law of large numbers, when considering country-specific draws for every good $z \in \mathbb{Z}$, the sequence of sectoral productivity draws $\{\eta_{z,v}\}_{v\in\mathbb{V}}$ will turn out to be uniformly distributed over the interval $[\underline{\eta}, \overline{\eta}]$ along the countries space $\mathbb{V}$. As a consequence, the world spending on good z will be equal for all goods, in turn implying that $W_z = \int_{\mathbb{V}} \beta_{z,v}\, dv = 1$ for all $z \in \mathbb{Z}$. Furthermore, since $W \equiv \int_{\mathbb{Z}} W_z\, dz$, we also have that $W = 1$. Plugging all these results into (10) and (11) finally implies (12) and (13).

The results collected in Proposition 1 characterise the link between sectoral productivities and labour allocations across sectors: larger shares of resources are allocated to sectors that received better productivity draws (i.e., sectors carrying lower $\eta_{z,v}$). Moreover, the concentration of resources towards those sectors further intensifies as world incomes rise (i.e., as κ grows).

From a supply side perspective, Proposition 1 allows two types of interpretations. Firstly, by fixing $v'' = v'$, we can compare different sectors of a given exporter. As κ rises, countries increasingly export from those sectors where they enjoy higher labour productivity and a stronger RCA. Secondly, by fixing $z'' = z'$, we may compare a given sector across different exporters. In this case, recalling (13), we can observe that the evolution of RCA of exporter v in sector z as κ rises turns out to be monotonically linked to the productivity draw $\eta_{z,v}$: countries that receive better draws for sector z increasingly enjoy a stronger revealed comparative advantage in that sector.

From a demand side perspective, Proposition 1 may be interpreted as a result on increasing import specialisation along the growth path. In particular, fixing $z'' = z'$, our model predicts that as economies get richer, we observe a process of growing import penetration of the varieties of z produced by exporters who received better productivity draws in sector z.

The joint consideration of these two arguments suggests that, over the path of development, countries with a cost advantage in a given sector will increasingly specialise in that sector. At the same time, these countries will also attract a growing share of the world spending in that particular sector. Intuitively, as world consumers raise the quality of their consumption when κ grows, sectoral productivity differentials across countries widen, leading to an increase in countries' sectoral trade specialisation. Interestingly, this process takes place both at the importer and at the exporter level. In this regard, a central prediction of our model is the implicit secular tendency of sectoral trade flows to gravitate towards exporters with a rising cost advantage in the sector. This, in turn, means that while some bilateral sectoral trade links will intensify during the path of development, others will gradually fade.

The equilibrium characterised in this section has the particular feature that revealed comparative advantages coincide with the import penetrations. This is clearly a very specific result that hinges on the assumed symmetry in the distributions of sector-specific productivities across countries. The next section shows that this is no longer the case when we introduce some asymmetry across countries. As we will see, an asymmetric world leads to a richer characterisation of the links between export specialisation, import specialisation and income per capita.

3 A world economy with cross-country inequality

The previous section has dealt with a world economy where all countries exhibit the same real income, while we let the worldwide total factor productivity parameter κ increase. Such an analytical framework allowed us to portray the behaviour of sectoral trade flows (and sectoral specialisation patterns) within a world economy where countries shared a common economic growth path.

In this section, we slightly modify the previous setup to give room for cross-country inequality. To keep the focus as clean as possible (departing from Section 2) we now hold constant the parameter κ. More importantly, we no longer force sectoral productivity differentials to be drawn from the same probability distribution function, which was the ultimate reason leading to equal equilibrium wages. On the one hand, this alternative setup allows us to generalise the previous results concerning export specialisation to a case in which productivity differentials and cost differentials may *not* always coincide (as a result of equilibrium wages that differ across countries). On the other hand, introducing cross-country inequality leads to more powerful predictions concerning import penetration (of the different export sources) at different income levels, which we will later on contrast with cross-sectional data of bilateral trade flows in Section 4.

We keep the same commodity space and preference structure as those previously used in Section 2. However, we now assume that the world is composed by two subsets of countries. We will refer to the two subsets as *region* $\mathcal{H}$ and *region* $\mathcal{L}$ and, whenever it proves convenient, to a generic country belonging to either of them by $h \in \mathcal{H}$ and $l \in \mathcal{L}$, respectively. We let countries in $\mathcal{H}$ and $\mathcal{L}$ differ from each other in that they face *different* random generating processes for their sectoral productivity parameters $\left\{\eta_{z,v}\right\}_{z\in\mathbb{Z}}$. We assume that for any $h \in \mathcal{H}$ and every $z \in \mathbb{Z}$, each $\eta_{z,h}$ is independently drawn from a uniform density function with support $\left[\underline{\eta}, \overline{\eta}\right]$, where $\underline{\eta} > 1$, just like before. On the other hand, for any $l \in \mathcal{L}$ and every $z \in \mathbb{Z}$, we assume that each $\eta_{z,l} = \overline{\eta}$. (None of our results hinges upon countries in region $\mathcal{L}$ drawing their sectoral productivities from a degenerate distribution; in Section 3.4 we extend the results to multiple regions, where they all draw sectoral productivities from non-degenerate uniform distributions.)[15]

This setup still features the fact that sectoral productivity differentials become increasingly

[15] Another way to introduce absolute advantages would be by letting total factor productivity differ across $\mathcal{H}$ and $\mathcal{L}$, with $\kappa_H > \kappa_L$. This would in turn lead to $w_H > w_L$ in equilibrium. However, in our setup, if all countries received i.i.d. sectoral draws $\eta_{z,v}$ from the *same* uniform density function, then countries from $\mathcal{H}$ would not necessarily enjoy a comparative advantage in the higher-quality versions of the differentiated goods. This counter-empirical result, which we wish to avoid, is the consequence of the effect of $\kappa_H > \kappa_L$ becoming less important relative to differences in $\eta_{z,v}$ at higher levels of quality, while being partially undone by $w_H > w_L$.

pronounced at higher levels of quality. In addition, it allows for the presence of absolute advantages (at the aggregate level) across subsets of countries, which were absent in Section 2.

The *ex-ante* symmetry across countries from the *same* region implies now that, in equilibrium, wages of countries in the same region must be equal. By contrast, wages in countries from region $\mathcal{H}$ must necessarily by higher than in region $\mathcal{L}$, for trade balances to be in equilibrium. More formally, in equilibrium: $w_h = w_H$ for any $h \in \mathcal{H}$ and $w_l = w_L$ for any $l \in \mathcal{H}$, where $w_H > w_L$.[16]

The intuition for this result is analogous to all Ricardian models of trade with absolute and comparative advantages. Essentially, region $\mathcal{H}$ (which displays an absolute advantage over region $\mathcal{L}$) will enjoy higher wages than region $\mathcal{L}$, since this is necessary to lower the production costs in $\mathcal{L}$, and thus allow countries in $\mathcal{L}$ to export enough to countries in $\mathcal{H}$ and keep the trade balance in equilibrium. Henceforth, without loss of generality, we take the wage in region $\mathcal{L}$ as the *numeraire* of the economy, and accordingly set $w_L = 1$.

Equal wages within regions implies that optimal choices will be identical for countries from the same region. We thus introduce the following notation, which will be recurrently used in the next subsections: we let $\beta^H_{z,v}$ denote the demand intensity for commodity (z, v) by a consumer from any country belonging to region $\mathcal{H}$; similarly, we let $\beta^L_{z,v}$ denote the demand intensity for (z, v) by a consumer from any country of region $\mathcal{L}$.

Recall also that our preferences imply that the willingness to pay for quality is increasing in the consumer's income. As a consequence, in the presence of cross-country income inequality, consumers from $\mathcal{H}$ purchase higher quality versions than consumers from $\mathcal{L}$. In addition, given the income level, consumers select a relatively higher quality of consumption for those commodities carrying a relatively lower $\eta_{z,v}$. The next proposition formally states these results.

Proposition 2 *Let $q^H_{z,v}$ and $q^L_{z,v}$ denote the quality of consumption of commodity $(z, v) \in \mathbb{Z} \times \mathbb{V}$ purchased by a consumer from region $\mathcal{H}$ and from region $\mathcal{L}$, respectively. Then, in equilibrium:*

(i) for all $(z, v) \in \mathbb{Z} \times \mathbb{V}$: $q^H_{z,v} \geq q^L_{z,v}$, with $q^H_{z,v} > q^L_{z,v}$ whenever $q^H_{z,v} > 1$.

(ii) for all $(z, h) \in \mathbb{Z} \times \mathcal{H}$: $\partial q^i_{z,h}/\partial \eta_{z,h} \leq 0$, with $\partial q^i_{z,h}/\partial \eta_{z,h} < 0$ whenever $q^i_{z,h} > 1$, for $i = H, L$. In addition, denoting by $q^i_{z,\overline{\eta}}$ (resp. $q^i_{z,\underline{\eta}}$) the value of $q^i_{z,h}$ corresponding to the commodity $(z, h) \in \mathbb{Z} \times \mathcal{H}$ such that $\eta_{z,h} = \overline{\eta}$ (resp. $\underline{\eta}$):

(iii) for all $(z, l) \in \mathbb{Z} \times \mathcal{L}$: $q^i_{z,l} = q^i_L$, with $q^i_{z,\overline{\eta}} < q^i_L < q^i_{z,\underline{\eta}}$ whenever $q^i_L > 1$, for $i = H, L$.

The first result stems from the rising willingness-to-pay for quality implied by (3): richer consumers substitute lower-quality versions of each good z by higher-quality versions of them.

[16] For a formal proof of this result, see Proposition 6 in Appendix B.1.

The second result states that, considering all commodities produced within region $\mathcal{H}$, the quality of consumption within a given country is a monotonically decreasing function of the labour requirement elasticities of quality upgrading $\eta_{z,h}$. In that regard, notice that since all countries in $\mathcal{H}$ have the same wage, a larger $\eta_{z,h}$ maps monotonically into a higher production cost, given the level of quality. Hence, consumers worldwide find it convenient to demand higher quality goods from countries with better sectoral productivity draws.

Finally, the third result shows that, for any given level of consumer income, the quality of the goods produced within region $\mathcal{L}$ is neither the highest nor the lowest. In particular, the highest quality of each good z purchased by *any* consumer is produced in the country of region $\mathcal{H}$ that received the best draw, $\eta_{z,h} = \underline{\eta}$. That is, in spite of $w_H > 1$, the highest qualities are still provided by the countries with the absolute advantage in the sector. Conversely, the lowest quality of each good z purchased by *any* consumer is produced in the country of region $\mathcal{H}$ that received the worst draw, $\eta_{z,h} = \overline{\eta}$. Despite the fact that all producers from $\mathcal{L}$ received draws equal to $\overline{\eta}$, the lower labour cost in $\mathcal{L}$ allows them to sell higher qualities than the least efficient producers from $\mathcal{H}$.

3.1 Export specialisation

We proceed now to study the patterns of exporters' specialisation in this world economy with cross-country inequality. Recall the definition of the RCA from (11). Notice first that the equality of total world demand across all differentiated sectors $z \in \mathbb{Z}$ found in Section 2 still holds true when countries differ in income.

Assume henceforth that a fraction $\lambda \in (0, 1)$ of all countries in the world belong to region $\mathcal{H}$. Denote by $RCA_{z,l}$ and $RCA_{z,h}$ the revealed comparative advantage of country $l \in \mathcal{L}$ and country $h \in \mathcal{H}$ in good $z \in \mathbb{Z}$, respectively. We have:[17]

$$RCA_{z,l} = 1, \quad \text{for all } (z, l) \in \mathbb{Z} \times \mathcal{L}. \tag{14}$$

Furthermore, let the common aggregate demand intensity for goods produced in region H by any country in region H and L be denoted by $\beta_H^H \equiv \int_{\mathbb{Z}} \beta_{z,h}^H \, dz$ and $\beta_H^L \equiv \int_{\mathbb{Z}} \beta_{z,h}^L \, dz$, respectively. Then,

[17] To compute (14) and (15), note that total exports by sector z from country v are $X_{z,v} = \lambda \beta_{z,v}^H w_H + (1 - \lambda) \beta_{z,v}^L$, hence aggregate exports by country v are $X_v = \lambda w_H \int_{\mathbb{Z}} \beta_{z,v}^H \, dz + (1 - \lambda) \int_{\mathbb{Z}} \beta_{z,v}^L \, dz$. Now, notice that since $\eta_{z,l} = \overline{\eta}$, we must have that $\beta_{z,l}^H = \beta_L^H$ and $\beta_{z,l}^L = \beta_L^L$, for all $(z, l) \in \mathbb{Z} \times \mathcal{L}$. Plugging these expressions into (11) then yields (14). Moreover, since all h obtain their draws of $\eta_{z,h}$ from independent $U\left[\underline{\eta}, \overline{\eta}\right]$ distributions, and since all $\beta_{z,h}^H$ are well-defined functions of $\eta_{z,h}$, by the law of large numbers it follows that $\int_{\mathbb{Z}} \beta_{z,h}^H \, dz$ and $\int_{\mathbb{Z}} \beta_{z,h}^L \, dz$ must both yield an identical value for every country $h \in \mathcal{H}$. Using these expressions, in conjuction with those for $X_{z,v}$ and X_v, and denoting $\beta_H^H \equiv \int_{\mathbb{Z}} \beta_{z,h}^H \, dz$ and $\beta_H^L \equiv \int_{\mathbb{Z}} \beta_{z,h}^L \, dz$, into (11) then leads to (15).

we also have:

$$RCA_{z,h} = \frac{\lambda\beta^{H}_{z,h}w_H + (1-\lambda)\beta^{L}_{z,h}}{\lambda\beta^{H}_{H}w_H + (1-\lambda)\beta^{L}_{H}}, \quad \text{for any } (z,h) \in \mathbb{Z}\times\mathcal{H}. \tag{15}$$

The result in (14) states that revealed comparative advantages are indentical for all goods, in every country in region $\mathcal{L}$. RCAs do vary though across countries in region $\mathcal{H}$. In particular, since $\beta^{H}_{z,h}$ and $\beta^{L}_{z,h}$ are decreasing functions of the sectoral productivity draws $\eta_{z,h}$, the result in (15) implies that the $RCA_{z,h}$ is also a decreasing function of $\eta_{z,h}$. Moreover, such monotonicity of the demand intensities also means that the revealed comparative advantage of the country in $\mathcal{H}$ with draw $\overline{\eta}$ will turn out to be lower than that of any country in $\mathcal{L}$. Similarly, the RCA of the country in $\mathcal{H}$ with draw $\underline{\eta}$ will be higher than that of any country in $\mathcal{L}$. These results are summarised in the following proposition.

Proposition 3 *Let $RCA_{z,\underline{\eta}}$ and $RCA_{z,\overline{\eta}}$ denote, respectively, the revealed comparative advantage in sector z of those countries from region $\mathcal{H}$ that received productivity draws $\eta_{z,h} = \underline{\eta}$ and $\eta_{z,h} = \overline{\eta}$. Then: $RCA_{z,\overline{\eta}} < RCA_{z,l} < RCA_{z,\underline{\eta}}$, for all $z \in \mathbb{Z}$; while the $RCA_{z,h}$ in (15) are decreasing functions of $\eta_{z,h}$.*

The most important result to draw from Proposition 3 is that producers from the country in $\mathcal{H}$ receiving the best possible draw in sector z will always display the highest revealed comparative advantage in that sector. These producers are also those supplying the highest quality varieties of good z, as shown in Proposition 2. Therefore, like in Section 2, countries offering the top quality varieties in a given sector also exhibit the strongest degree of export specialisation in that sector.

It is worth noting that Proposition 3 also implies that there exists a subset of countries in $\mathcal{H}$, with draws $\widetilde{\eta} < \eta_{z,h} < \overline{\eta}$, exhibiting a lower RCA in sector z than countries in $\mathcal{L}$. The reason is that the wage differential between regions $\mathcal{H}$ and $\mathcal{L}$ creates a wedge between the absolute and the comparative advantage, allowing countries in $\mathcal{L}$ to supply more competitively the relatively low-quality varieties of each good z.

3.2 Import specialisation

We turn now to study the implications of this version of the model in terms of import specialisation. Recall the definition of import penetration from (10): for any destination-country i, the import penetration of good z originating from the source-country v is given by $IP^{i}_{z,v} = \beta^{i}_{z,v} \,/\, \int_{\mathbb{V}} \beta^{i}_{z,v}\, dv$. Since the budget constraint implies $\int_{\mathbb{V}} \beta^{i}_{z,v}\, dv = 1$, we can once again represent the IP of commodity (z,v) in destination-country i simply by the demand intensity $\beta^{i}_{z,v}$.

Proposition 4 *Let $\beta^i_{z,\underline{\eta}}$ and $\beta^i_{z,\overline{\eta}}$ denote, respectively, the import penetration in any country of region $i = H, L$ by exporters from region $\mathcal{H}$ who received productivity draws $\eta_{z,h} = \underline{\eta}$ and $\eta_{z,h} = \overline{\eta}$. Then, for all $z \in \mathbb{Z}$:*
(i) $\beta^i_{z,\overline{\eta}} < \beta^i_{z,l} < \beta^i_{z,\underline{\eta}}$, while the import penetrations $\beta^i_{z,\eta}$ are decreasing functions of $\eta_{z,h}$.
(ii) $\beta^L_{z,\underline{\eta}} - \beta^L_{z,h} < \beta^H_{z,\underline{\eta}} - \beta^H_{z,h}$ for all $\eta_{z,h} > \underline{\eta}$, and $\beta^L_{z,\underline{\eta}} - \beta^L_{z,l} < \beta^H_{z,\underline{\eta}} - \beta^H_{z,l}$.

Part (i) of Proposition 4 can be seen as the demand-side counterpart of the supply-side result in Proposition 3: importers source a larger fraction of their demand for good z from exporters with a cost advantage in sector z. More interestingly, part (ii) of Proposition 4 states that import specialisation in those exporters is stronger for richer importers (that is, for countries in region $\mathcal{H}$).[18]

The intuition for this result rests on the specific nonhomothetic structure of our utility function. As shown in Proposition 2, richer importers tend to buy high-quality varieties, which are exactly those for which the cost advantage of countries receiving good sectoral draws becomes more pronounced. In addition, since the preference structure in (3) also implies that high-quality varieties attract growing consumer expenditure shares, richer importers tend to spend *proportionally* more in commodities originating from exporters that exhibit a stronger cost advantage in higher-quality varieties.

3.3 Discussion: Sectoral trade flows

The previous subsections have dealt separately with the behaviour of exporters facing importers with heterogeneous income, and with the behaviour of importers facing exporters with heterogeneous cost advantages. The joint consideration of these results yields an additional important prediction. To illustrate this prediction, we focus now on two intertwined demand-supply relationships implicit in our model: the link between the sectoral productivity draw $\eta_{z,v}$ and the RCA of exporter v in sector z; and the link between $\eta_{z,v}$ and the import penetration by exporter v in the total consumption of good z in a generic destination country i.

Firstly, note that Proposition 3 shows that exporters receiving the best possible productivity draw in sector z display the highest RCA in that sector. Moreover, according to Proposition 2, they also produce the highest quality-varieties of good z. Secondly, notice that part (i) of Proposition 4 adds to these results that these exporters also exhibit the largest import penetration in sector z

[18] The proof of Proposition 4 in Appendix A shows in fact a somewhat more general result than $\beta^L_{z,\underline{\eta}} - \beta^L_{z,h} < \beta^H_{z,\underline{\eta}} - \beta^H_{z,h}$ for all $\eta_{z,h} > \underline{\eta}$. More precisely, it shows that $\beta^L_{z,\eta'} - \beta^L_{z,\eta''} < \beta^H_{z,\eta'} - \beta^H_{z,\eta''}$ for any $\eta' < \eta''$. We chose, however, not to write the more general result in the main text to help the readability of the propositon.

in any destination country. Furthermore, part (ii) of Proposition 4 shows that their market share turns out to be greater when facing richer importers. Taken together, the above results imply that as we move from poorer to richer importers, exporters with a stronger cost advantage in a sector will attract increasing shares of demand in that particular sector.

The economic intuition behind this result is similar to the one discussed in Section 2 for the case of growing world incomes with a rising κ. However, with cross-country inequality this intuition becomes even more apparent because importers with heterogeneous incomes choose different quality levels of all varieties, which in turn implies different distributions of budget shares across the *same* set of exporters. More precisely, since richer consumers purchase higher-quality varieties of each good z, the most productive suppliers of each good z turn out to be better able to exploit their widening cost advantage when dealing with richer importers. Our model thus delivers a mechanism entailing a simultaneous rise in sectoral trade specialisation by importers and exporters at higher incomes: when measured at the sectoral level, richer importers tend to increasingly specialise their consumption in those varieties of goods supplied by the exporters most specialised in the sector.

In this respect, our model predicts that richer economies are more likely to buy their imports from producers who display a stronger revealed comparative advantage in the imported goods. To the best of our knowledge, this is a novel result in the trade literature, which has never been tested empirically. In Section 4, we provide evidence consistent with this prediction by using bilateral trade flows at the sectoral level.

3.4 Extension: Cross-country inequality in a multi-region world

We consider now an extension to the previous setup where the world is composed by $K > 2$ regions, indexed by $k = 1, ..., K$. We let $\mathcal{V}_k \subset \mathbb{V}$ denote the subset of countries from region k, where $\mathcal{V}_k$ has Lebesgue measure $\lambda_k > 0$. In addition, we let each country in region k be denoted by a particular $v_k \in \mathcal{V}_k$. (All the results discussed in this section are formalised in Appendix B.2.)

We assume that for any $v_k \in \mathcal{V}_k$ and every $z \in \mathbb{Z}$, each η_{z,v_k} is independently drawn from a uniform distribution with support over $[\eta_k, \overline{\eta}]$, where $\eta_k < \overline{\eta}$. To keep the consistency with the previous sections, let $\eta_k = \underline{\eta}$ when $k = 1$. In addition, let $\eta_{k'} < \eta_{k''}$ for any two regions $k' < k''$. In other words, we are indexing regions $k = 1, ..., K$ in terms of first-order stochastic dominance of their respective uniform distributions. All uniform distributions are assumed to share the same upper-bound $\overline{\eta}$, while they differ in their lower-bounds η_k.

In this extended setup, equilibrium wages will display an analogous structure as the one described in Proposition 6. Namely, in equilibrium, the wage for all $v_k \in \mathcal{V}_k$ will be w_k. In addition, equilibrium wages are such that $w_1 > ... > w_{k'} > ... > w_K$, where $1 < k' < K$.

We now use the superindex $j = 1, 2, ..., K$ to denote the region of origin of the consumer. (Notice that, since all individuals from the same region earn the same wages, they choose identical consumption profiles.) We then let β^j_{z,v_k} denote the demand intensity by a consumer from region $\mathcal{V}_j$ for good $(z, v_k) \in \mathbb{Z} \times \mathcal{V}_k$. Once again, this immediately implies that $IP^j_{z,v} = \beta^j_{z,v}$. Furthermore, it follows that, for a country v_k:

$$X_{z,v_k} = \sum_{j=1}^{K} \lambda_j w_j \beta^j_{z,v_k}.$$

In equilibrium, it must be the case that $X_{v_k} = w_k$ for all $v_k \in \mathcal{V}_k$. In addition, W_z equal for all $z \in \mathbb{Z}$ is still true in this extended setup. As a result, the RCA of country v_k in good z is given by:

$$RCA_{z,v_k} = \frac{\sum_{j=1}^{K} \lambda_j w_j \beta^j_{z,v_k}}{w_k}. \tag{16}$$

Since wages differ across regions, once again, we cannot find a monotonic relationship between RCA_{z,v_k} in (16) and the productivity draws η_{z,v_k} when all countries in the world are pooled together. However, we can still find a result analogous to Proposition 3. In particular, it is still true that the highest value of RCA_{z,v_k} corresponds to the country in region $\mathcal{V}_1$ receiving the best possible draw in sector z. That is, RCA_{z,v_k} is the highest for some country v_1 with $\eta_{z,v_1} = \underline{\eta}$.

Lastly, concerning import penetration, this extension also yields a result that is analogous to that in Proposition 4. Following the notation in Proposition 4, we can show that $\beta^1_{z,\underline{\eta}} > ... > \beta^{k'}_{z,\underline{\eta}} > ... > \beta^K_{z,\underline{\eta}}$, where $1 < k' < K$. Again, this result stems from our nonhomothetic structure along the quality dimension, which implies that richer consumers allocate a larger share of their spending in good z to the producers who can most efficiently offer higher qualities versions of z.

4 Empirical analysis

Our theory rests crucially on two fundamental assumptions: one related to cross-country heterogeneities in sectoral production functions; the other one related to nonhomotheticities in the consumers' preference structure. In terms of technologies, we have assumed that cross-country sectoral productivity differentials widen at higher levels of quality of production. Concerning preferences, we postulated a utility function where richer individuals choose a consumption basket comprising higher-quality varieties of all available goods. Taken independently, each of these two assumptions lead to clear testable predictions in terms of trade flows, which in fact our theory shares with several other papers in the trade literature. More specifically, the first implies that the degree of specialisation of countries in particular goods and the level of quality of their exports of those goods should display a positive correlation.[19] The second implies that richer consumers buy their imports in higher quality levels than poorer consumers do.[20]

The most interesting and novel testable prediction of our model stems from the interaction between the above-mentioned assumptions. When consumers' taste for quality rises with their income and sectoral cost advantages deepen at higher levels of quality, richer countries will purchase a larger share of their imports of every good from economies displaying a stronger revealed comparative advantage in the sector producing the good. In other words, our model yields novel predictions regarding import specialisation at *different* income levels, which link richer importers more *intensely* to highly specialised exporters in each of the sectors.

4.1 Baseline regressions

In what follows we aim at providing evidence of the relationship between importer's income per head and the intensity of sectoral trade flows by origin of imports. We measure the degree of import specialisation using the definition of import penetration. That is, for each importer m and exporter x of good z, we compute the ratio:

$$IP_{z,m,x} = \left(\frac{impo_{z,m,x}}{\sum_{x \in X} impo_{z,m,x}} \right),$$

where $impo_{z,m,x}$ denotes the value of imports of good z by importer m originating from exporter x, and X denotes the set of exporters in the sample. To measure export specialisation we follow

[19] Several papers provide evidence consistent with this prediction. For example, Alcala (2012) shows that import prices by the US in the apparel industry tend to be higher for imports sourced from exporter displaying a higher revealed comparative advantage in that industry. In a previous working paper version, Jaimovich and Merella (2013), we show that a similar correlation is found considering all 5000 products categorised according to the 6-digit Harmonised System (HS-6), and all pairs of bilateral sectoral trade flows in the world. Furthermore, empirical results consistent with this assumption can also be found in articles using firm-level data. For example, Kugler and Verhoogen (2012) find a positive correlation between output prices in narrowly derfined products and plant size for Colombian manufacturing firms, while Manova and Zhang (2012) report a positive correlation between unit values and total export sales by Chinese firms. Similarly, Crino and Epifani (2012) find that Italians manufacturing firms exhibiting higher TFP tend to concentrate their production in high-quality varieties and export relatively more to richer destinations.

[20] There is also vast evidence supporting this prediction: *e.g.*, Hallak (2006, 2010), Choi et al. (2009), Fieler (2011a), Feenstra and Romalis (2012). In particular, Fieler (2011a) shows that import prices correlate positively with the level of income per head of the importer, even when looking at products originating from the same exporter and HS-6 category. The use of unit values as proxy for quality dates back to Schott (2004). See Khandelwal (2010) and Hallak and Schott (2011) for some innovative methods to infer quality from prices, taking into account both horizontal and vertical differentiation of products

the definition of revealed comparative advantage (RCA). That is, for each exporter x of good z , we compute the ratio:

$$RCA_{z,x} \equiv \frac{(V_{z,x}/V_x)}{(W_z/W)},$$

where $V_{z,x}$ (resp. W_z) is the total value of exports of good z by country x (resp. by the world), and V_x (resp. W) is the aggregate value of exports by country x (resp. by the world).[21]

In Table 1.A, we regress the import penetration of exporter x in country m trading good z on the revealed comparative advantage of x in z interacted with the importer's income per head Y_m.[22] More precisely, we conduct the following regression:

$$\begin{aligned} \log\left(IP_{z,m,x}\right) = \rho \log\left(RCA_{z,x}\right) + \theta \left[\log\left(Y_m\right) \times \log\left(RCA_{z,x}\right)\right] \\ + \mathbf{G}_{m,x} + \delta_z + \mu_m + \varepsilon_x + \nu_{z,x,m}. \end{aligned} \tag{17}$$

Regression (17) includes product dummies (δ_z), importer dummies (μ_m), exporter dummies (ε_x), and a set of bilateral gravity terms ($\mathbf{G}_{m,x}$) taken from Mayer and Zignano (2006). Our model predicts a positive value for θ. This would suggest that richer importers tend to buy a larger share of the imports of good z from exporters exhibiting a comparative advantage in z.

Before strictly running regression (17), we firstly regress the dependent variable against *only* the RCA of exporter x in good z (together with product, importer and exporter dummies). Column (1) of Table 1.A expectably shows that those two variables are positively correlated. Secondly, in column (2), we report the results of the regression that includes the interaction term. We can see that the estimated θ is positive and highly significant, consistent with our theory. Finally, in column (3), we add the six traditional gravity terms, 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.

Notice that regression (17) includes exporter fixed effects (ε_x). This implies that our regressions are actually comparing different degrees of export specialisation across products for a *given*

[21] Both the $IP_{z,m,x}$ and $RCA_{z,x}$ are computed 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). Monetary values are measured FOB (free on board) in US dollars.

[22] For computational purposes, given the large number of observations, our regression uses only data from 2009, which is the last year available in the panel. As robustness checks, we have also run the regressions reported in Table 1.A separately for all the years in the sample. All the results for years 1995-2008 are qualitatively identical, and very similar in magnitude, to those of year 2009. These additional results are available upon request.

Table 1.A

	Dependent Variable: log import shares of product *i* from exporter *x*				
	Full Sample			Restricted Sample	
	(1)	(2)	(3)	(4)	(5) - 2SLS
Log RCA exporter	0.456***	-0.676***	-0.469***	-0.422***	-0.594***
	-0.026	(0.138)	(0.106)	(0.092)	(0.129)
Interaction term		0.119***	0.104***	0.088***	0.125***
		(0.015)	(0.012)	(0.010)	(0.014)
Distance expo-impo (× 1000)			-0.121***	-0.116***	-0.121***
			(0.009)	(0.010)	(0.010)
Contiguity			1.098***	1.116***	1.162***
			(0.101)	(0.131)	(0.132)
Common official language			0.362***	0.413***	0.436***
			(0.099)	(0.133)	(0.133)
Common coloniser			0.255*	0.164	0.219
			(0.152)	(0.178)	(0.179)
Common legal origin			0.204***	0.204**	0.222**
			(0.082)	(0.096)	(0.096)
Common currency			0.351**	0.415**	0.408**
			(0.149)	(0.174)	(0.174)
Observations	5,773,873	5,773,873	5,571,567	2,709,459	2,709,459
Number of importers	184	184	184	92	92
R squared	0.47	0.47	0.53	0.51	0.51

Robust absolute standard errors clustered at the importer and exporter level reported in parentheses. All data corresponds to the year 2009.

All regressions include product dummies, importer dummies and exporter dummies. The total number of HS 6-digit products is 5017.

Column (4) uses importers in *subset A* to compute the exporters' RCA and importers in *subset B* to compute the dependent variable. Column (5) uses the RCA computed with importers in *subset A* to instrument the exporters' RCA. * significant 10%; ** significant 5%; *** significant 1%.

exporter, and the different degrees of import penetration of the exporter across its exports destinations. As such, exporter dummies would control for the fact that a country with higher total factor productivity may be commanding larger market shares and may be specialising in higher qualities varieties of goods, which are exactly the varieties mostly purchased by richer importers.[23]

4.2 Simultaneity of RCA and import penetration

One possible concern with regression (17) is the fact that $RCA_{z,x}$ is computed with the *same* data that is used to construct $IP_{z,m,x}$. In terms of our estimation of θ, this could represent an issue if a very large economy turns out to be also very rich (for example, the case of the US). In that case, since the imports of good z by such sizable and rich economy will be strongly influencing the independent variable $RCA_{z,x}$, we may be somehow generating by construction a positive correlation between the dependent variable and the interaction term.

In order to deal with this concern, in column (4) we split the set of 184 importers in two separate subsets of 92 importers each (subset A and subset B). When splitting the original set of 184 importers, we do so in such a way the two subsets display similar GDP per capita distributions. (See Appendix C for details and descriptive statistics of the two sub-samples.) We next use the subset A to compute the revealed comparative advantage of each exporter in each product ($RCA_{z,x}$), while we use the subset B for $IP_{z,m,x}$. By construction, there is therefore no link between $IP_{z,m,x}$ and $RCA_{z,x}$, since those two variable are computed with data from different subsets of importers.

As we may readily observe, the results in column (4) of Table 1.A confirm our previous results in column (3) – the estimate for θ is positive and highly significant, and of very similar magnitude as in column (3). Lastly, in column (5) we use the RCA computed with the subset A of importers to instrument the RCA used in column (3); again the obtained results confirm our previous findings.

4.3 Further robustness checks and Linder term

Table 1.B presents some additional regressions intended as robustness checks. First, in column (1) we show the results of a regression analogous to column (3) in Table 1.A, but where we control for product-importer fixed effects, instead of product (δ_z) and importer (μ_m) fixed effects separately.

[23] Notice too that, since we are using only data from year 2009, the exporter dummies are also capturing the effect of the exporter GDP per head in 2009. For this reason the results in Table 1.A are implicitly taking into account the fact that the level of average prices and wages in a country tend to correlate with the exporter GDP per head, which is in fact a result that is present in our model in Section 3.

After including the set of product-importer dummies, the estimated coefficient for the interaction term remains essentially intact, as well as its significance level.

Next, in columns (2) and (3) we exclude from the sample of importers the OECD countries and the high-income countries as classified by the World Bank, respectively. The idea behind these restricted-sample regressions is to see whether our previous results are driven only by the behaviour of the richest importers. As we can observe, in both cases our correlation of interest remains still positive and highly significant.[24]

Our paper emphasises the interplay between nonhomothetic preferences with respect to quality and increasing sectoral specialisation at higher qualities of production (owing to wider cross-country sectoral productivity differentials at higher layers of quality). The interaction term in (17) intends to reflect the impact of such interplay on the intensity of bilateral trade links (at the sectoral level) at different levels of income per head of the importer. Some recent articles in the trade literature with nonhomothetic preferences have argued that richer countries exhibit a comparative advantage in higher-quality varieties of goods – see Hallak (2010) and Fajgelbaum *et al.* (2011).[25] If that is actually the case in reality and, moreover, if the share of imports to GDP grows with the importer's income per capita (as it has been widely documented in the trade literature), then our interaction term in (17) may end up capturing (at least partially) a different type of effect: the fact that richer importers, who tend to source a larger fraction of their final demand from abroad, establish stronger trade links with richer countries, since these tend to specialise in higher-quality varieties which are in turn those demanded by richer importers. In order to deal with this concern, the regression in column (4) adds a Linder term among the regressors. In particular, we include as independent variable the absolute difference between the log income per head of the importer and exporter: $|\ln y_{impo} - \ln y_{expo}|$.[26] This regressor should absorb the above-mentioned concern.[27] The results in column (4) indeed show that the Linder term carries a negative and highly significant

[24] The estimate associated to 'common currency' falls essentially to zero in columns (2) and (3). This is because when we remove the Euro-area countries from the sample of importers, we lose practically all the source of variation exploited in column (1).

[25] In fact, this result is also present in our model when we extend our basic setup in Section 3 to allow for cross-country income inequality.

[26] We have also run the regression using the $(\ln y_{impo} - \ln y_{expo})^2$ as the Linder term, and results remain qualitatively intact as those displayed in column (4).

[27] Notice that the inclusion of exporter fixed effects will, by themselves, already greatly mitigate this confounding effect. In the end, the concern with a Linder-type of effect is one of a similar nature to the one previously discussed at the end of Section 4.1.

coefficient, which is consistent with the evidence of the Linder hypothesis holding at the sectoral level previously found in Hallak (2010). Nevertheless, the estimate of the coefficient associated to the interaction term remains positive and highly significant. This last result suggests that our mechanism explaining the intensity of sectoral trade links by export source at different levels of income of importers is playing a role alongside the traditional Linder-type effect.[28]

4.4 Sectoral and product level regressions

The regressions in Table 1.A pool together approximately 5000 different 6-digit products, implicitly assuming the same coefficients for all of them. This might actually be a strong assumption to make. In Table 2.A we split the set of HS 6-digit products according to fourteen separate subgroups at the 2-digit level.[29] In the sake of brevity, we report only the estimates for ρ and θ in (17). As we can observe, the estimates for each subgroup follow a similar pattern as those in Table 1.A: the estimate for the interaction term is always positive and highly significant for each subgroup.

Lastly, as further robustness check, in Table 2.B we report the percentage of positive and negative estimates obtained for θ when we run a separate regression for each of the products in the HS 6-digit categorisation. These results again tend to confirm those obtained before Table 1.A.

[28] In practical terms, one additional concern may be raised. Suppose high-quality varieties of goods are subject to more intense trade than lower-quality varieties as a result of trade frictions affecting the former less intensely than the latter. If that is the case, then our interaction term in (17) may also be capturing a different type of effect: the fact that richer economies tend to consume higher-quality varieties, and that those varieties are traded more intensely as a result of trade frictions affecting them less strongly. Since we cannot observe unit trade costs at different layers of quality, and our regressions exploit within-product variation of import shares by source, we cannot envisage a practical way to directly identify which of the two types of heterogeneities (i.e., rising sectoral productivity differentials at higher levels of quality vs. trade costs that affect lower-qualities relatively more) is the more important factor tilting trade flows in the way reflected by the interaction term in (17). Notice, however, that if this issue related to trade-friction differentials along the quality dimension were quantitatively really serious, we should expect to find very different estimate for 'distance' and 'contiguity' in column (1) and column (3), since the latter excludes richer importers. Indeed, the fact that both regressions yield similar estimates suggests that, once we control for all the importer and exporter characteristics, we do not observe huge differences in the effects of sector-specific trade frictions across richer and poorer importers.

[29] The subgroups are formed by merging together subgroups at 2-digit aggregation level, according to http://www.foreign-trade.com/reference/hscode.htm. We excluded all products within the subgroups 'Miscellaneous' and 'Service'.

Table 1.B

	Dependent Variable: log import shares of product *i* from exporter *x*			
	full sample	excl. OECD	excl. high income	full sample
	(1)	(2)	(3)	(4)
Log RCA exporter	-0.293***	-0.066	-0.184	-0.250**
	(0.107)	(0.104)	(0.132)	(0.103)
Interaction term	0.091***	0.064***	0.078***	0.086***
	(0.012)	(0.012)	(0.016)	(0.012)
Linder Term: $\| \ln y_{impo} - \ln y_{expo} \|$				-0.117***
				(0.038)
Distance expo-impo (× 1000)	-0.124***	-0.115***	-0.118***	-0.122***
	(0.009)	(0.010)	(0.011)	(0.008)
Contiguity	1.119***	0.963***	0.953***	1.053***
	(0.107)	(0.116)	(0.117)	(0.110)
Common official language	0.345***	0.397***	0.451***	0.319***
	(0.098)	(0.113)	(0.129)	(0.095)
Common coloniser	0.284*	0.167	0.295*	0.239
	(0.165)	(0.161)	(0.174)	(0.160)
Common legal origin	0.214**	0.118	0.071	0.205**
	(0.086)	(0.093)	(0.099)	(0.084)
Common currency	0.396**	0.069	-0.053	0.227
	(0.167)	(0.245)	(0.303)	(0.149)
Exporter dummies	Yes	Yes	Yes	Yes
Importer-Product dummies	Yes	Yes	Yes	Yes
Number of importers	184	163	147	184
Observations	5,773,873	3,921,408	3,397,049	5,242,134
R squared	0.57	0.52	0.52	0.57

Robust absolute standard errors clustered at the importer and exporter level reported in parentheses. All data corresponds to the year 2009.

* significant 10%;** significant 5%; *** significant 1%.

Table 2.A

	animal & anim. prod.	vegetable products	foodstuff	mineral products	chem. & allied ind.	plastic & rubbers	skin, leath. & furs
log RCA	-0.322***	-0.298***	-0.344***	-0.269**	-0.500***	-0.548***	-0.622***
	(0.106)	(0.104)	(0.096)	(0.145)	(0.138)	(0.138)	(0.155)
interaction term	0.073***	0.079***	0.089***	0.075***	0.107***	0.118***	0.120***
	(0.012)	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)	(0.016)
Observations	105,332	210,866	215,975	72,839	602,592	317,328	66,347
Adj. R squared	0.44	0.49	0.50	0.46	0.49	0.52	0.60

	wood & wood prod.	textiles	footwear	stone & glass	metals	machinery & electrical	transport.
log RCA	-0.444***	-0.411***	-0.644***	-0.527***	-0.541***	-0.711***	-0.554***
	(0.105)	(0.166)	(0.155)	(0.131)	(0.130)	(0.131)	(0.112)
interaction term	0.101***	0.090***	0.119***	0.107***	0.111***	0.134***	0.114***
	(0.012)	(0.019)	(0.016)	(0.015)	(0.015)	(0.014)	(0.013)
Observations	252,135	795,926	75,522	209,397	630,910	1,296,090	176,916
Adj. R squared	0.53	0.55	0.61	0.53	0.50	0.55	0.53

Robust absolute standard errors clustered at the importer-exporter level in parentheses. All data corresponds to year 2009. All regression include product, exporter and importer dummies, and the set of gravity terms used before in Table 1.A taken from Mayer & Zignano (2006). *** significant 1%.

Table 2.B

Coefficients of Log(Yn) x Log(RCA): independent regressions for each HS 6-digit product

% positive coefficients			% negative coefficients			median coefficient
insignificant	significant 10%	significant 1%	insignificant	significant 10%	significant 1%	
29.8%	15.7%	38.0%	14.3%	1.6%	0.5%	0.076
	83.5%			16.4%		

Total number of different products was 4904 (98 products were lost due to insufficient observations). Data corresponds to year 2009 Regressions include importer dummies and the set of gravity terms used in Table 1.A taken from Mayer & Zignano (2006).

4.5 Discussion: A comparison with the existing literature

Two recent related articles, Fieler (2011) and Fajgelbaum, Grossman and Helpman (2011) –FGH, henceforth– have also incorporated nonhomothetic preferences into general equilibrium trade models, and study the ensuing patterns of trade flows. In the Introduction, we summarised mostly the main theoretical differences between our framework and theirs. We now discuss briefly how some of our empirical predictions differ from theirs, and how these differences may be discerned in the data.

Fieler (2011) focuses on the bilateral trade flows of horizontally differentiated goods displaying heterogeneous income demand elasticities.[30] She finds that including intersectoral nonhomotheticities into a model à la Eaton and Kortum (2002), coupled with productivity dispersions across countries that correlate positively with income demand elasticities, can substantially improve its quantitative predictions regarding aggregate trade flows across countries. Her empirical predictions then encompass cross-country variation of aggregate trade flows at different income levels as a result of *intersectoral* changes in trade, while her paper is silent about *intrasectoral* variations in trade flows. This last source of adjustment is exactly what regression (17) is aiming at capturing. More precisely, our regressions are exploiting *within-product* variation of export sources by importer, abstracting from intersectoral changes in trade flows. The main novel empirical finding is that, looking at each particular product category in isolation, we can observe that richer importers source a larger share of their imports from those exporters that display a stronger degree of specialisation in the sector producing that product.

As we highlighted in the Introduction, FGH shares with our framework the introduction of nonhomothetic preferences in a context with vertical and horizontal differentiation. Both papers deliver a general equilibrium mechanism that leads to a rise in international productive specialisation as incomes increase. The underlying driving forces however differ. In FGH, the main driving force is the exploitation of a home-market effect, in the spirit of Linder (1961).[31] In our paper, instead, the leading aspect is the deepening of heterogeneities in the cost of production across countries at higher levels of quality. More importantly, our mechanism leads to some testable predictions that cannot be straightforwardly rationalised by FGH, where heterogeneities in sec-

[30] See also Hunter (1991) and Francois and Kaplan (1996) for partial equilibrium frameworks assessing the relevance of intersectoral differences in income demand elasticities in explaining trade patterns.

[31] Hallak (2010) provides a partial equilibrium model with a home-market effect that also builds on the original hypothesis in Linder (1961). In his model, countries of similar incomes trade more with each other, when considering sectoral level trade flows. He also provides empirical evidence for this prediction using bilateral trade flows at the sectoral level.

toral productivities across countries are absent. In particular, FGH leads to patterns of productive specialisation that take place *only* along the quality dimension: richer countries are net exporters of high-quality varieties, while poorer countries are net exporter of low-quality ones. Yet, those patterns of specialisation in quality cannot be ascribed to any specific sector. By contrast, in our model, the interplay between nonhomothetic preferences and wider sectoral productivity differentials at higher quality levels implies that, for each particular sector, richer importers will end up establishing stronger trade links with those exporters more intensely specialised in each of the sectors. From a strict empirical viewpoint, the mechanism suggested by FGH is then reflected in the Linder term included in column (4) of Table 2.A. However, this last regression seems to suggest that, even when we take into account that richer importers trade more with richer exporters, this factor does not *fully* explain the fact that richer economies source a larger fraction of their imports of each product from exporters exhibiting a comparative advantage in those products. In that regard, our paper proposes a novel mechanism that seems to play an important role in the determination of sectoral trade links, alongside those suggested by previous theories exploiting the more traditional Linder home-market effect.

5 Conclusion

We presented a Ricardian model of trade with the distinctive feature that comparative advantages reveal themselves gradually over the course of development. The key factors behind this process are the individuals' 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 sectoral 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 richer consumers buying a larger share of their consumption of specific goods from countries exhibiting a comparative advantage in the sectors producing those goods.

As a last remark, our model has assumed away any sort of trade frictions. In a sense, this was a deliberate choice, so as to illustrate our proposed mechanism as cleanly as possible. Yet, incorporating trade costs could actually represent a promising extension to the core model. We do so in Appendix B.3. There we show that, owing to the widening of productivity differentials at higher quality of production, a natural implication of the model is that trade costs generate milder distortions on trade flows as the quality of production rises. This implication could help rationalising some empirical observations found in the trade literature, such as the positive relationship between the imports/GDP ratio and the importer's GDP per head.

Appendices

A Omitted proofs

Solution of Problem (6). Let the subscript $i \in \mathbb{V}$ denote country of origin of the consumer. We will denote by v^i the Lagrange multiplier associated to the budget constraint, and by $\delta^i_{z,v}$ the Lagrange multipliers associated to each constraint $q^i_{z,v} \geq 1$. Then, the FOC are given by:

$$\ln \beta^i_{z,v} - \eta_{z,v} \ln q^i_{z,v} + \ln(1+\kappa) - \ln A + \ln\left(\frac{w_i}{w_v}\right) - \eta_{z,v} + \delta^i_{z,v} = 0, \ \forall (z,v) \in \mathbb{Z} \times \mathbb{V} \quad (18)$$

$$\frac{1}{\Omega \cdot \Lambda_z} \frac{q^i_{z,v}}{\beta^i_{z,v}} - v^i = 0, \quad \forall (z,v) \in \mathbb{Z} \times \mathbb{V} \quad (19)$$

$$q^i_{z,v} - 1 \geq 0, \quad \delta^i_{z,v} \geq 0, \quad \text{and} \quad \left(q^i_{z,v} - 1\right) \delta^i_{z,v} = 0, \quad \forall (z,v) \in \mathbb{Z} \times \mathbb{V} \quad (20)$$

$$\int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^i_{z,v} \, dv \, dz = 1 \quad (21)$$

where:

$$\Omega \equiv \left\{ \int_{\mathbb{Z}} \left[\int_{\mathbb{V}} q^i_{z,v} \ln\left(\frac{1+\kappa}{A} \frac{\beta^i_{z,v}}{\left(q^i_{z,v}\right)^{\eta_{z,v}}} \frac{w_i}{w_v} \right) dv \right]^{\sigma} dz \right\}^{\frac{\sigma-1}{\sigma}}$$

$$\Lambda_z \equiv \left[\int_{\mathbb{V}} q^i_{z,v} \ln\left(\frac{1+\kappa}{A} \frac{\beta^i_{z,v}}{\left(q^i_{z,v}\right)^{\eta_{z,v}}} \frac{w_i}{w_v} \right) dv \right]^{1-\sigma}$$

Note that, although Λ_z in (19) are indexed by z, in the optimum all Λ_z will turn out to be equal.[32] Hence, we may use that, in the optimum, $\Lambda_z = \Lambda$ for all z, and define:

$$\mu^i \equiv (\Omega \cdot \Lambda) \, v^i,$$

which in turn allows us to re-write (19) as $q^i_{z,v} = \mu^i \beta^i_{z,v}$. Hence, integrating both sides of the equation over $\mathbb{Z}$ and $\mathbb{V}$, and making use of (21), we may obtain:

$$\int_{\mathbb{Z}} \int_{\mathbb{V}} q^i_{z,v} \, dv \, dz = \mu^i; \quad (22)$$

which in turn implies that:

$$\beta^i_{z,v} = \frac{q^i_{z,v}}{\mu^i}. \quad (23)$$

[32] The result $\Lambda_z = \Lambda$ for all z stems from the assumed iid draws of $\eta_{z,v}$ with a continuum of countries and goods. The combination of these assumptions implies that all goods z will display (*ex post*) an identical distribution of $\eta_{z,v}$ over the space of countries v. Such *ex post* symmetry in the distribution of $\eta_{z,v}$ across goods, in turn, leads consumers to optimally set $\Lambda_z = \Lambda$ for all z.

Notice also that $\mu^i \geq 1$, since $q^i_{z,v} \geq 1$ and both $\mathbb{Z}$ and $\mathbb{V}$ have unit mass. ■

Proof of Lemma 1. Let's first show that when $w_v = w$ for all $v \in \mathbb{V}$ and unit labour requirements are given by (1), then none of the constraints $q_{z,v} \geq 1$ of (6) binds in the optimum. For this, note that given the expressions in (18) and (23), whenever $w_v = w$ for all $v \in \mathbb{V}$, it must be the case that $q^i_{z',v'} \geq q^i_{z'',v''} \Leftrightarrow \eta_{z',v'} \leq \eta_{z'',v''}$. Thus, if in the optimum $q^i_{z'',v''} > 1$ holds for a $(z'', v'') \in \mathbb{Z}\times\mathbb{V}$ with $\eta_{z'',v''} = \overline{\eta}$, then $q^i_{z,v} > 1$ must be true for all $(z, v) \in \mathbb{Z} \times \mathbb{V}$. Then, in order to prove that $q^i_{z,v} > 1$ holds for all $(z, v) \in \mathbb{Z} \times \mathbb{V}$, it suffices to prove the following: even when all $\eta_{z,v} = \underline{\eta}$, except for a *single (zero-mass)* good-variety (z'', v'') for which $\eta_{z'',v''} = \overline{\eta}$, the optimisation problem (6) yields $q^i_{z'',v''} > 1$. If this is the case, then $q^i_{z'',v''} > 1$ will actually hold true for *any* distribution of the productivity draws $\eta_{z,v}$ with support in the interval $\left[\underline{\eta}, \overline{\eta}\right]$, which includes the uniform distribution as one special case.

When all $\eta_{z,v} = \underline{\eta}$, except for a *single (zero-mass)* (z'', v'') with $\eta_{z'',v''} = \overline{\eta}$, it follows that when $q_{z'',v''} = 1$:

$$q^i_{z,v} = e^{-\frac{\underline{\eta}}{\underline{\eta}-1}} \left(\frac{1+\kappa}{A\mu^i}\right)^{\frac{1}{\underline{\eta}-1}}, \quad \text{for all } (z, v) \in \mathbb{Z} \times \mathbb{V} \text{ other than } \left(z'', v''\right). \tag{24}$$

Since the set $\mathbb{Z} \times \mathbb{V}$ has unit mass, integrating (24) across the space $\mathbb{Z}$ and $\mathbb{V}$, we obtain $\mu^i = e^{-\underline{\eta}/(\underline{\eta}-1)} \left[(1+\kappa) / \left(A\mu^i\right)\right]^{1/(\underline{\eta}-1)}$, which in turn yields:

$$\mu^i = \frac{1}{e}\left(\frac{1+\kappa}{A}\right)^{\frac{1}{\underline{\eta}}}. \tag{25}$$

Now, plugging (25) into (18) and (23), computed for (z'', v''), while using the fact that $\beta^i_{z'',v''} = 1/\mu^i$ when $q^i_{z'',v''} = 1$, we get:

$$\ln(1+\kappa) - \ln A - \left[\ln(1+\kappa) - \ln A\right]/\underline{\eta} + \ln e - \overline{\eta} + \delta^i_{z'',v''} = 0. \tag{26}$$

Hence, considering the definition of $A \equiv e^{-\underline{\eta}(\overline{\eta}-1)/(\underline{\eta}-1)}$, (26) reduces to

$$\ln(1+\kappa) + \delta^i_{z'',v''}\frac{\underline{\eta}}{\underline{\eta}-1} = 0. \tag{27}$$

However, (27) cannot be true for any $\kappa > 0$. As a consequence, it must be true that $q_{z'',v''} > 1$ for all $\kappa > 0$, implying in turn that $q_{z,v} > 1$ must hold $(z, v) \in \mathbb{Z} \times \mathbb{V}$ under any distribution of $\eta_{z,v}$ with support within the interval $\left[\underline{\eta}, \overline{\eta}\right]$ when $w_v = w$ for all $v \in \mathbb{V}$.

Now, taking into account the above result, we can use (22), (23) and (18), setting $\delta^i_{z,v} = 0$ for all $(z, v) \in \mathbb{Z} \times \mathbb{V}$, to obtain (7) and (8).

Finally, note that, when $w_v = w$ for all $v \in \mathbb{V}$, using again (18) leads to $\ln(1+\kappa) - \ln A - \ln \mu^i = \eta_{z,v} + \left(\eta_{z,v} - 1\right) \ln q^i_{z,v}$ for all $(z,v) \in \mathbb{Z} \times \mathbb{V}$. Defining now $\Upsilon^i(\kappa) \equiv \ln(1+\kappa) - \ln A - \ln \mu^i$, we can observe that:

$$\frac{\partial \Upsilon^i}{\partial \kappa} = \frac{\left(\eta_{z,v} - 1\right)}{q^i_{z,v}} \frac{\partial q^i_{z,v}}{\partial \kappa}. \tag{28}$$

But, given that $\left(\eta_{z,v} - 1\right) > 0$, then all $\partial q^i_{z,v}/\partial \kappa$ must necessarily carry the same sign. Suppose then that $\partial q^i_{z,v}/\partial \kappa \leq 0$, for all $(z,v) \in \mathbb{Z} \times \mathbb{V}$. Recalling (22), it follows that $\partial \mu^i/\partial \kappa \leq 0$ as well. But, since $\partial \Upsilon^i/\partial \kappa = (1+\kappa)^{-1} - \left(\mu^i\right)^{-1} \partial \mu^i/\partial \kappa$, the fact that $\partial \mu^i/\partial \kappa \leq 0$ implies that $\partial \Upsilon^i/\partial \kappa > 0$, which in turn contradicts the fact that $\partial q^i_{z,v}/\partial \kappa \leq 0$ for all $(z,v) \in \mathbb{Z} \times \mathbb{V}$. As a result, it must be the case that $\partial q^i_{z,v}/\partial \kappa > 0$ for all $(z,v) \in \mathbb{Z} \times \mathbb{V}$. Finally, the result $\partial^2 q^i_{z,v}/\left(\partial \kappa \, \partial \eta_{z,v}\right) < 0$ follows immediately from the expression in (28), after noting that $\partial \left(\partial \Upsilon^i/\partial \kappa\right)/\partial \eta_{z,v} = 0$. ■

Proof of Proposition 1. Preliminarily, notice that (22) together with (23) yields:

$$\beta_{z',v'} = \frac{q_{z',v'}}{\int_{\mathbb{Z}} \int_{\mathbb{V}} q_{z'',v''} \, dv'' \, dz''}. \tag{29}$$

From (18), together with Lemma 1 and Proposition 5, we have:

$$\left(\eta_{z,v} - 1\right) \ln q_{z,v} + \eta_{z,v} = \ln(1+\kappa) - \ln A - \ln \mu; \tag{30}$$

thus, computing (30) for any pair of commodities $(z',v'), (z'',v'') \in \mathbb{Z} \times \mathbb{V}$ yields:

$$\left(\eta_{z',v'} - 1\right) \ln q_{z',v'} + \eta_{z',v'} = \left(\eta_{z'',v''} - 1\right) \ln q_{z'',v''} + \eta_{z'',v''}. \tag{31}$$

Hence, (31) implies that $q_{z',v'} > q_{z'',v''} \Longleftrightarrow \eta_{z',v'} < \eta_{z''v''}$. By considering this result in conjunction with (29), our claim immediately follows.

Furthermore, differentiating (31) with respect to κ yields:

$$\frac{dq_{z',v'}}{d\kappa} = \frac{\eta_{z'',v''} - 1}{\eta_{z',v'} - 1} \frac{q_{z',v'}}{q_{z'',v''}} \frac{dq_{z'',v''}}{d\kappa}. \tag{32}$$

Using (22), (30) and (32):

$$\frac{dq_{z',v'}}{d\kappa} = \frac{A}{1+\kappa} \left[\frac{\eta_{z',v'} - 1}{q_{z',v'}} - \frac{1}{\mu} \left(\int_{\mathbb{Z}} \int_{\mathbb{V}} \frac{\eta_{z',v'} - 1}{\eta_{z'',v''} - 1} \frac{q_{z'',v''}}{q_{z',v'}} \, dv'' \, dz'' \right) \right]^{-1} > 0 \tag{33}$$

Moreover, from (29), and considering (32) and (33):

$$\frac{d\beta_{z',v'}}{d\kappa} = \frac{1}{\mu^2} \frac{dq_{z',v'}}{d\kappa} \left(\int_{\mathbb{Z}} \int_{\mathbb{V}} \left(\frac{\eta_{z'',v''} - \eta_{z',v'}}{\eta_{z'',v''} - 1} \right) q_{z'',v''} \, dv'' \, dz'' \right) \tag{34}$$

It is then easy to observe that (32) implies that $dq_{z',v'}/d\kappa > dq_{z'',v''}/d\kappa$ when $\eta_{z',v'} < \eta_{z''v''}$. By considering this result in conjunction with (34) our claim immediately follows. ■

Proof of Proposition 2.

Part (i). From the FOC (18)-(21) we may obtain that for a consumer in any country in region $\mathcal{L}$ the following conditions must hold:

$$-(\overline{\eta}-1)\ln q_L^L - \ln\mu^L + \ln(1+\kappa) - \ln A - \overline{\eta} + \delta_L^L = 0, \text{ for all } (z,l)\in\mathbb{Z}\times\mathcal{L}; \quad (35)$$

$$-\left(\eta_{z,h}-1\right)\ln q_{z,h}^L - \ln\mu^L + \ln(1+\kappa) - \ln A - \ln w_H - \eta_{z,h} + \delta_{z,h}^L = 0, \text{ for all } (z,h)\in\mathbb{Z}\times\mathcal{H}. \quad (36)$$

Similarly, for a consumer in any country in region $\mathcal{H}$, it must be true that:

$$-(\overline{\eta}-1)\ln q_L^H - \ln\mu^H + \ln(1+\kappa) - \ln A + \ln w_H - \overline{\eta} + \delta_L^H = 0, \text{ for all } (z,l)\in\mathbb{Z}\times\mathcal{L}; \quad (37)$$

$$-\left(\eta_{z,h}-1\right)\ln q_{z,h}^H - \ln\mu^H + \ln(1+\kappa) - \ln A - \eta_{z,h} + \delta_{z,h}^H = 0, \text{ for all } (z,h)\in\mathbb{Z}\times\mathcal{H}. \quad (38)$$

Suppose now there exists some $(z',v')\in\mathbb{Z}\times\mathbb{V}$ for which $q_{z',v'}^L > q_{z',v'}^H$. Then, combining either the pair of equations (35) and (37), or the pair of equations (36) and (38), in both cases we would obtain that:

$$\ln\left(\frac{\mu^H}{\mu^L w_H}\right) = \left(\eta_{z',v'}-1\right)\ln\left(\frac{q_{z',v'}^L}{q_{z',v'}^H}\right) + \delta_{z',v'}^H > 0. \quad (39)$$

Expression (39) implies, in turn, that $1<\mu^L<w_H\mu^L<\mu^H$. From (22), it follows that there must exist some $(z'',v'')\in\mathbb{Z}\times\mathbb{V}$ for which $q_{z'',v''}^L < q_{z'',v''}^H$. Using the same line of reasoning, we now obtain:

$$\ln\left(\mu^L w_H/\mu^H\right) = \left(\eta_{z'',v''}-1\right)\ln\left(q_{z'',v''}^H/q_{z'',v''}^L\right) + \delta_{z'',v''}^L > 0,$$

which contradicts (39). As a consequence, it must be the case that $q_{z,v}^H \geq q_{z,v}^L$ for all $(z,v)\in\mathbb{Z}\times\mathbb{V}$. Now, suppose $q_{z',v'}^H = q_{z',v'}^L > 1$ for some $(z',v')\in\mathbb{Z}\times\mathbb{V}$. Again, combining either the pair of equations (35) and (37), or the pair of equations (36) and (38), we obtain:

$$\ln\left(\mu^H/\mu^L w_H\right) = 0. \quad (40)$$

Expression (40) implies, in turn, that $1<\mu^L<w_H\mu^L=\mu^H$. Hence, there must exist again some $(z'',v'')\in\mathbb{Z}\times\mathbb{V}$ for which $q_{z'',v''}^L < q_{z'',v''}^H$. Using the same line of reasoning, we now obtain:

$$\ln\left(\mu^L w_H/\mu^H\right) = \left(\eta_{z'',v''}-1\right)\ln\left(q_{z'',v''}^H/q_{z'',v''}^L\right) > 0,$$

which contradicts (40). Therefore, it must be true that $q_{z,v}^H > q_{z,v}^L$ for all $(z,v)\in\mathbb{Z}\times\mathbb{V}$, whenever $q_{z,v}^H > 1$.

Part (ii). The claim straightforwardly follows by differentiation of conditions (36) and (38). This yields $\partial q_{z,h}^i/\partial\eta_{z,h} = -q_{z,h}^i\left(1+\ln q_{z,h}^i\right)/\left(\eta_{z,h}-1\right) < 0$ whenever $q_{z,h}^i > 1$, while $\partial q_{z,h}^i/\partial\eta_{z,h} = 0$

whenever $q^i_{z,h} = 1$.

Part (iii). The proof that $q^i_{z,l} = q^i_L$ for all $(z,l) \in \mathbb{Z} \times \mathcal{L}$ follows straightforwardly from (35) and (37). For the second argument, let $i = L$, and consider the commodity $(z', h') \in \mathbb{Z} \times \mathcal{H}$ such that $q^L_{z',h'} = q^L_L > 1$. Using (35) and (36) we obtain, respectively:

$$-\left(\overline{\eta} - 1\right) \ln q^L_L - \ln \mu^L + \ln\left(1+\kappa\right) - \ln A - \overline{\eta} = 0,$$

and:

$$-\left(\eta_{z',h'} - 1\right) \ln q^L_L - \ln \mu^L + \ln\left(1+\kappa\right) - \ln A - \ln w_H - \eta_{z',h'} = 0.$$

This, in turn, leads to:

$$\left(\overline{\eta} - 1\right) \ln q^L_L + \overline{\eta} = \left(\eta_{z',h'} - 1\right) \ln q^L_L + \ln w_H + \eta_{z',h'}. \tag{41}$$

Isolating now $\eta_{z',h'}$ from (41) we then have $\eta_{z',h'} = \overline{\eta} - \ln w_H / \left(1 + \ln q^L_L\right) \equiv \widehat{\eta} < \overline{\eta}$. Suppose now that $\widehat{\eta} \leq \underline{\eta}$. Since $\partial q^L_{z,h} / \partial \eta_{z,h} \leq 0$, from the definition of $\widehat{\eta}$ it follows that $q^L_{z,h} \leq q^L_L$ for all $(z,h) \in \mathbb{Z} \times \mathcal{H}$. Next, from the definition of μ^L, we obtain that $\mu^L \leq q^L_L$. In addition, from the market clearing condition for a country in $\mathcal{L}$, we have $\lambda q^H_L w_H / \mu^H + (1-\lambda) q^L_L / \mu^L = 1$, where λ is the measure of countries in region $\mathcal{H}$. This leads to $1 - \lambda q^H_L w_H / \mu^H = (1-\lambda) q^L_L / \mu^L > 1 - \lambda$, which in turn implies that $q^H_L w_H / \mu^H < 1$. Now, using the fact that $w_H \mu^L > \mu^H$ and the result $\mu^L \leq q^L_L$, the last inequality finally yields $q^H_L < \mu^L \leq q^L_L$, leading to a contradiction. Hence, it must necessarily be that $\widehat{\eta} > \underline{\eta}$. Thus, given the fact that $\partial q^L_{z,h} / \partial \eta_{z,h} < 0$ whenever $q^L_{z,h} > 1$, the result $q^L_{z,\overline{\eta}} < q^L_L < q^L_{z,\underline{\eta}}$ immediately follows. An analogous reasoning, letting $i = H$, may be followed to prove that $q^H_{z,\overline{\eta}} < q^H_L < q^H_{z,\underline{\eta}}$. ■

Proof of Proposition 3. The proof follows straightforwardly from noting that: (a) both $\beta^H_{z,h}$ and $\beta^L_{z,h}$ in (15) are functions of $\eta_{z,h}$; (b) part (ii) of Proposition 2 implies that $\partial \beta^H_{z,h} / \partial \eta_{z,h} < 0$ and $\partial \beta^L_{z,h} / \partial \eta_{z,h} < 0$; (c) β^H_H and β^L_H represent average demand intensities, hence $\beta^H_{z,\overline{\eta}} < \beta^H_H < \beta^H_{z,\underline{\eta}}$ and $\beta^L_{z,\overline{\eta}} < \beta^L_H < \beta^L_{z,\underline{\eta}}$; and (d) from (14), it follows that $RCA_{z,h} = RCA_{z,l}$ only if $\beta^H_{z,h} = \beta^H_H$ and $\beta^L_{z,h} = \beta^L_H$. ■

Proof of Proposition 4. Part (i). Our claim immediately follows from part (iii) of Proposition 2 in conjunction with (23), since the distribution of demand intensities across goods and varieties mirrors that of the levels of the optimally selected qualities.

Part (ii). Using (37) and (38), together with (23), for a consumer from $\mathcal{H}$ we get:

$$\begin{aligned} \ln\left(1+\kappa\right) - \ln A &= \left(\eta_{z,h} - 1\right) \ln \beta^H_{z,h} + \eta_{z,h} \ln \mu^H + \eta_{z,h}, \quad \text{for all } (z,h) \in \mathbb{Z} \times \mathcal{H}. \\ &= \left(\overline{\eta} - 1\right) \ln \beta^H_{z,l} + \overline{\eta} \ln \mu^H - \ln w + \overline{\eta}, \quad \text{for all } (z,l) \in \mathbb{Z} \times \mathcal{L}. \end{aligned}$$

Similarly, considering (35) and (36) together with (23), in the case of a consumer from $\mathcal{L}$ we obtain:

$$\begin{aligned}\ln(1+\kappa)-\ln A &= \left(\eta_{z,h}-1\right)\ln\beta^{L}_{z,h}+\eta_{z,h}\ln\mu^{L}+\ln w+\eta_{z,h}-\delta^{L}_{z,h}, \quad \text{for all } (z,h)\in\mathbb{Z}\times\mathcal{H}.\\ &= (\overline{\eta}-1)\ln\beta^{L}_{z,l}+\overline{\eta}\ln\mu^{L}+\overline{\eta}-\delta^{L}_{L}, \quad \text{for all } (z,l)\in\mathbb{Z}\times\mathcal{L}.\end{aligned}$$

On the one hand, equating the first expression of the each case, simplifying and rearranging, we get:

$$\ln\beta^{H}_{z,h}-\ln\beta^{L}_{z,h}=\frac{\eta_{z,h}\left(\ln\mu^{L}-\ln\mu^{H}\right)+\ln w-\delta^{L}_{z,h}}{\left(\eta_{z,h}-1\right)}\equiv k_{z,h}.$$

Getting rid of the logs, we then obtain $\beta^{H}_{z,h}=e^{k_{z,h}}\beta^{L}_{z,h}$, and hence:

$$\beta^{H}_{z,h}-\beta^{L}_{z,h}=\left(e^{k_{z,h}}-1\right)\beta^{L}_{z,h}.$$

Consider now two producers $h',h''\in\mathcal{H}$ such that $\eta_{z,h'}<\eta_{z,h''}$. Since $\beta^{L}_{z,h'}-\beta^{L}_{z,h''}<\beta^{H}_{z,h'}-\beta^{H}_{z,h''}$ requires $\beta^{H}_{z,h''}-\beta^{L}_{z,h''}<\beta^{H}_{z,h'}-\beta^{L}_{z,h'}$, and from part (i) of this proof it follows that $\beta^{L}_{z,h''}<\beta^{L}_{z,h'}$, we are left to prove that $k_{z,h''}\leq k_{z,h'}$. Suppose $k_{z,h''}>k_{z,h'}$. Since by assumption $\eta_{z,h'}<\eta_{z,h''}$, and part (ii) of Proposition 2 implies $\delta^{L}_{z,h'}\leq\delta^{L}_{z,h''}$, a necessary condition for this to hold is $\left(\eta_{z,h''}-\eta_{z,h'}\right)\left(\ln\mu^{L}-\ln\mu^{H}\right)>0$. But this is impossible, since $\ln\mu^{H}>\ln\mu^{L}$. So it must be that $k_{z,h''}\leq k_{z,h'}$, hence $\beta^{L}_{z,h'}-\beta^{L}_{z,h''}<\beta^{H}_{z,h'}-\beta^{H}_{z,h''}$.

On the other hand, equating the second expression of each case, simplifying and rearranging, we get:

$$\ln\beta^{H}_{z,l}-\ln\beta^{L}_{z,l}=\frac{\overline{\eta}\left(\ln\mu^{L}-\ln\mu^{H}\right)+\ln w-\delta^{L}_{L}}{\overline{\eta}-1}\equiv k_{z,l}.$$

We can thus write $\beta^{H}_{z,l}-\beta^{L}_{z,l}=\left(e^{k_{z,l}}-1\right)\beta^{L}_{z,l}$ and, following an analogous reasoning, it is straightforward to obtain $\beta^{L}_{z,\underline{\eta}}-\beta^{L}_{z,l}<\beta^{H}_{z,\underline{\eta}}-\beta^{H}_{z,l}$ (and $\beta^{L}_{z,l}-\beta^{L}_{z,\overline{\eta}}<\beta^{H}_{z,l}-\beta^{H}_{z,\overline{\eta}}$). ■

B Additional theoretical results

B.1 Existence and uniqueness of equilibrium

Proposition 5 *Suppose that, for each commodity* $(z, v) \in \mathbb{Z} \times \mathbb{V}$, $\eta_{z,v}$ *is independently drawn from a uniform density function with support* $\left[\underline{\eta}, \overline{\eta}\right]$. *Then, for any* $\kappa > 0$, *in equilibrium:* $w_v = w$ *for all* $v \in \mathbb{V}$.

Proof. *Existence of equilibrium:* As a first step, we prove that $w_v = w$ for all $v \in \mathbb{V}$ is an equilibrium of the model. Firstly, notice that when $w_i = w$ for all $i \in \mathbb{V}$, the Lagrange multipliers will be identical for all countries, and in particular we may write $\mu^i = \mu$ for all $i \in \mathbb{V}$. Secondly, using Lemma 1, when $w_v = w$ for all $v \in \mathbb{V}$, conditions in (18) together with (23) and $\mu^i = \mu$ for all $i \in \mathbb{V}$, lead to:

$$q^i_{z,v} = q_{z,v} = \left(\frac{1+\kappa}{Ae^{\eta_{z,v}}\mu}\right)^{1/\left(\eta_{z,v}-1\right)}, \quad (42)$$

$$\beta^i_{z,v} = \beta_{z,v} = \left(\frac{1+\kappa}{A\left(e\mu\right)^{\eta_{z,v}}}\right)^{1/\left(\eta_{z,v}-1\right)}. \quad (43)$$

Now, recall that each $\eta_{z,v}$ is drawn from from an independent uniform probability distribution with support $\left[\underline{\eta}, \overline{\eta}\right]$. Hence, by the law of large numbers, for each country $v \in \mathbb{V}$, the (infinite) sequence of draws $\left\{\eta_{z,v}\right\}_{z \in \mathbb{Z}}$ will also be uniformly distributed over $\left[\underline{\eta}, \overline{\eta}\right]$ along the goods space. This implies that, integrating over $\mathbb{Z}$ and bearing in mind (43), $\int_{\mathbb{Z}} \beta^i_{z,v}\, dz = \int_{\mathbb{Z}} \beta_{z,v}\, dz = \beta_v = \beta > 0$, for each good $v \in \mathbb{V}$. Next, replacing $\int_{\mathbb{Z}} \beta^i_{z,v}\, dz = \beta$ into (21), and swapping the order of integration, we obtain $\int_{\mathbb{V}} \beta\, dv = 1$, which in turn implies that $\beta = 1$ since $\mathbb{V}$ has unit mass. Then, it is easy to check that all conditions (9) hold simultaneously when $w_v = w$ for all $v \in \mathbb{V}$.

Equilibrium uniqueness: We now proceed to prove the above equilibrium is unique. Normalise $w = 1$, and suppose for a subset $\mathcal{J} \subset \mathbb{V}$ of countries with measure $\lambda_j > 0$ we have $w_j > 1$, while for a (disjoint) subset $\mathcal{K} \subset \mathbb{V}$ of countries with measure $\lambda_k > 0$ we have $w_k < 1$. Denote finally by $\mathcal{I} \subset \mathbb{V}$ the (complementary) subset of countries with $w_i = 1$. Consider some $k \in \mathcal{K}$, $i \in \mathcal{I}$, and $j \in \mathcal{J}$, and take $(z_k, k), (z_i, i), (z_j, j)$ such that: $\eta_{z_k,k} = \eta_{z_i,i} = \eta_{z_j,j} = \eta$. Notice that, due to the law of large numbers, for any $\eta \in \left[\underline{\eta}, \overline{\eta}\right]$ the measure of good-variety couples for which the last condition is satisfied is the same in k, i and j.

As a first step, take country $i \in \mathcal{I}$. (18) and (19) imply that, for (z_k, k), (z_i, i) and (z_j, j), we must have, respectively:

$$\begin{aligned}
\ln(1+\kappa) - \ln A &= \eta \ln\left(\mu^i\right) + \ln(w_k) + (\eta-1)\ln(\beta^i_{z_k,k}) + \eta - \delta^i_{z_k,k} \\
&= \eta \ln\left(\mu^i\right) + (\eta-1)\ln(\beta^i_{z_i,i}) + \eta - \delta^i_{z_i,i} \\
&= \eta \ln\left(\mu^i\right) + \ln(w_j) + (\eta-1)\ln(\beta^i_{z_j,j}) + \eta - \delta^i_{z_j,j}.
\end{aligned}$$

Notice also from (20) and (23) that if $\delta^i_{z,v} > 0$, then $\ln \beta^i_{z,v} = -\ln \mu^i$, whereas if $\delta^i_{z,v} = 0$, then $\ln \beta^i_{z,v} \geq -\ln \mu^i$. Then, $\beta^i_{z_k,k} \geq \beta^i_{z_i,i} \geq \beta^i_{z_j,j}$.

As a second step, take country $k \in \mathcal{K}$. (18) and (19) imply that, for (z_k,k), (z_i,i) and (z_j,j), we must have, respectively:

$$\begin{aligned}
\ln(1+\kappa) - \ln A &= \eta \ln(\mu^k) + (\eta-1)\ln(\beta^k_{z_k,k}) + \eta - \delta^k_{z_k,k} \\
&= \eta \ln(\mu^k) + \ln\left(\frac{1}{w_k}\right) + (\eta-1)\ln(\beta^k_{z_i,i}) + \eta - \delta^k_{z_i,i} \\
&= \eta \ln(\mu^k) + \ln\left(\frac{w_j}{w_k}\right) + (\eta-1)\ln(\beta^k_{z_j,j}) + \eta - \delta^k_{z_j,j}.
\end{aligned}$$

Following an analogous reasoning as before, it follows that $\beta^k_{z_k,k} \geq \beta^k_{z_i,i} \geq \beta^k_{z_j,j}$.

As a third step, take country $j \in \mathcal{J}$, and notice $w_j > 1$. (18) and (19) imply that, for (z_k,k), (z_i,i) and (z_j,j), we must have, respectively:

$$\begin{aligned}
\ln(1+\kappa) - \ln A &= \eta \ln\left(\mu^j\right) + \ln\left(\frac{w_k}{w_j}\right) + (\eta-1)\ln(\beta^j_{z_k,k}) + \eta - \delta^j_{z_k,k} \\
&= \eta \ln\left(\mu^j\right) + \ln\left(\frac{1}{w_j}\right) + (\eta-1)\ln(\beta^j_{z_i,i}) + \eta - \delta^j_{z_i,k} \\
&= \eta \ln\left(\mu^j\right) + (\eta-1)\ln(\beta^j_{z_j,j}) + \eta - \delta^j_{z_j,j}.
\end{aligned}$$

Again, an analogous reasoning as in the previous cases leads to $\beta^j_{z_k,k} \geq \beta^j_{z_i,i} \geq \beta^j_{z_j,j}$.

Finally, integrate among the good space $\mathbb{Z}$ and country space $\mathbb{V}$. The above results lead to:

$$\begin{aligned}
&\lambda^j w_j \int_{\mathbb{Z}} \beta^j_{z,k} dz + \lambda^k w_k \int_{\mathbb{Z}} \beta^k_{z,k} dz + \left(1-\lambda^j-\lambda^k\right) \int_{\mathbb{Z}} \beta^i_{z,k} dz \geq \\
&\lambda^j w_j \int_{\mathbb{Z}} \beta^j_{z,i} dz + \lambda^k w_k \int_{\mathbb{Z}} \beta^k_{z,i} dz + \left(1-\lambda^j-\lambda^k\right) \int_{\mathbb{Z}} \beta^i_{z,i} dz \geq \\
&\lambda^j w_j \int_{\mathbb{Z}} \beta^j_{z,j} dz + \lambda^k w_k \int_{\mathbb{Z}} \beta^k_{z,j} dz + \left(1-\lambda^j-\lambda^k\right) \int_{\mathbb{Z}} \beta^i_{z,j} dz.
\end{aligned} \tag{44}$$

Note that the first line in (44) equals the world spending on commodities produced in k, the second equals the world spending on commodities produced in i, and the third equals the world spending on commodities produced in j. However, when $w_k < 1 < w_j$, those inequalities are inconsistent with market clearing conditions (9). As a result, there cannot exist an equilibrium with measure $\lambda_j > 0$ of countries with $w_j > 1$ and/or a measure $\lambda_k > 0$ of countries with $w_k < 1$. ■

Proposition 6 *Suppose that the set $\mathbb{V}$ is composed by two disjoint subsets with positive measure: $\mathcal{H}$ and $\mathcal{L}$. Assume that: a) for any $(z,h) \in \mathbb{Z} \times \mathcal{H}$, $\eta_{z,h}$ is independently drawn uniform density function with support $[\underline{\eta}, \overline{\eta}]$; b) for any $(z,l) \in \mathbb{Z} \times \mathcal{L}$, $\eta_{z,l} = \overline{\eta}$. Then: (i) for any $h \in \mathcal{H}$, $w_h = w_H$; (ii) for any $l \in \mathcal{L}$, $w_l = w_L$; (iii) $w_H > w_L$.*

Proof. We prove the proposition in different steps. We first prove that, if an equilibrium exists, then for all $h \in \mathcal{H}$ and all $l \in \mathcal{L}$, it must necessarily be the case that: 1) $w_h \neq w_l$; 2) $w_h = w_H$, $w_l = w_L$; 3) $w_H/w_L > 1$; 4) $w_H/w_L < \infty$. Lastly, we prove that a unique equilibrium exists, with: 5) $1 < w_H/w_L < \infty$.

Preliminarily, consider a generic country $i \in \mathbb{V}$, and compute the aggregate demand by i for goods produced in country $v \in \mathbb{V}$. From the first-order conditions, it follows that:

$$\beta^i_{z,v} = \max\left\{ \left[\frac{(1+\kappa)(w_i/w_v)}{A(e\mu^i)^{\eta_{z,v}}} \right]^{\frac{1}{\eta_{z,v}-1}}, \frac{1}{\mu^i} \right\}. \tag{45}$$

Hence, total demand by i for goods produced in $h \in \mathcal{H}$ and in $l \in \mathcal{L}$ are given, respectively by:

$$\int_{\mathbb{Z}} \beta^i_{z,h}\, w_i\, dz = w_i \int_{\underline{\eta}}^{\overline{\eta}} \max\left\{ \left(\frac{1+\kappa}{A(e\mu^i)^{\eta}} \frac{w_i}{w_h} \right)^{1/(\eta-1)}, \frac{1}{\mu^i} \right\} \frac{1}{\overline{\eta}-\underline{\eta}} d\eta, \quad \text{for any } h \in \mathcal{H}, \tag{46}$$

and

$$\int_{\mathbb{Z}} \beta^i_{z,l}\, w_i\, dz = w_i \max\left\{ \left(\frac{1+\kappa}{A(e\mu^i)^{\overline{\eta}}} \frac{w_i}{w_l} \right)^{1/(\overline{\eta}-1)}, \frac{1}{\mu^i} \right\}, \quad \text{for any } l \in \mathcal{L}. \tag{47}$$

Step 1. Suppose now that, in equilibrium, $w_i = w$ for all $i \in \mathbb{V}$. Recalling the proof of Lemma 1, we can observe that the constraints $q^i_{z,v} \geq 1$ will not bind in this case. Demand intensities in (45) are then given by $\beta^i_{z,v} = \beta_{z,v} = (e \cdot \mu)^{-\eta_{z,v}/(\eta_{z,v}-1)} [(1+\kappa)/A]^{1/(\eta_{z,v}-1)}$ for all $i \in \mathbb{V}$. As a result, the value in (46) must be strictly larger than the value in (47), since the term $[(1+\kappa)/A]^{1/(\eta-1)} / \mu^{\eta/(\eta-1)}$ is strictly decreasing in η. As a consequence, given that i represents a generic country in $\mathbb{V}$, integrating over the set $\mathbb{V}$, it follows that the world demand for goods produced in a country from $\mathcal{H}$ will be strictly larger than the world demand for goods produced in a country from $\mathcal{L}$. But this is inconsistent with the market clearing conditions, which require that world demand is equal for all $v \in \mathbb{V}$. Hence, $w_v = w$ for all $v \in \mathbb{V}$ cannot hold in equilibrium.

Step 2. Suppose that, in equilibrium, $w_{h'} > w_{h''}$ for some $h', h'' \in \mathcal{H}$. Computing (46) respectively for h' and h'' yields:

$$w_i \int_{\underline{\eta}}^{\overline{\eta}} \max\left\{ \left(\frac{1+\kappa}{A(e\mu^i)^{\eta}} \frac{w_i}{w_{h'}} \right)^{\frac{1}{\eta-1}}, \frac{1}{\mu^i} \right\} \frac{1}{\overline{\eta}-\underline{\eta}} d\eta \leq w_i \int_{\underline{\eta}}^{\overline{\eta}} \max\left\{ \left(\frac{1+\kappa}{A(e\mu^i)^{\eta}} \frac{w_i}{w_{h''}} \right)^{\frac{1}{\eta-1}}, \frac{1}{\mu^i} \right\} \frac{1}{\overline{\eta}-\underline{\eta}} d\eta$$

Now, since i represents a generic country in $\mathbb{V}$, integrating over the set $\mathbb{V}$, it follows that the world demand for goods produced in country h' will be no larger than the world demand for goods produced in country h''. But this is inconsistent with the market clearing conditions, which require that world demand for goods produced in country h' must be strictly larger than world demand for goods produced in country h''. Furthermore, an analogous reasoning rules out $w_{h'} < w_{h''}$. As a consequence, it must be the case that, if an equilibrium exists, it must be characterised by $w_{h'} = w_{h''}$ for any $h', h'' \in \mathcal{H}$. (Similarly, it can be proved that, if an equilibrium exists, it must be characterised by $w_{l'} = w_{l''}$ for any $l', l'' \in \mathcal{L}$.)

Step 3. Bearing in mind the result in the previous step, denote by w_L the wage of a country belonging to $\mathcal{L}$ and by w_H the wage of a country belonging to $\mathcal{H}$. In addition, without any loss of generality, let $w_L = 1$ (i.e., take w_L as the *numeraire* of the world economy). Suppose now that $w_H < 1$. Since $\left\{\left[(1+\kappa)/A\right](w_i/w_v)/\left(\mu^i\right)^\eta\right\}^{1/(\eta-1)}$ is strictly decreasing in η, it follows that the value in (47) is no larger than the value in (46). Moreover, since i represents a generic country in $\mathbb{V}$, integrating over the set $\mathbb{V}$, we obtain that the world demand for goods produced in a country from region $\mathcal{L}$ is no larger than world demand for goods produced in a country from region $\mathcal{H}$. But this is inconsistent with the market clearing conditions when $w_H < 1$, which require that world demand for goods produced in a country from region $\mathcal{L}$ must be strictly larger than world demand for goods produced in a country from region $\mathcal{H}$.

Step 4. As a result of steps 1, 2 and 3, our only remaining candidate for an equilibrium is then $w_H > w_L = 1$. From (46), it follows that the aggregate demand by any $h' \in \mathcal{H}$ for goods produced in region $\mathcal{H}$ coincides with its aggregate supply to the same region. Hence, there must be no net surplus within region $\mathcal{H}$. Analogously, from (47) it follows that there must be no net surplus within region $\mathcal{L}$. As a result, a necessary condition for market clearing is that the aggregate demand by region $\mathcal{L}$ for goods produced in region $\mathcal{H}$ must equal the aggregate demand by region $\mathcal{H}$ for goods produced in region $\mathcal{L}$. Formally:

$$\int_{\mathcal{L}}\int_{\mathcal{H}}\int_{\mathbb{Z}}\beta_{z,h}^{l'}\, w_{l'}\, dz\, dh\, dl' = \int_{\mathcal{H}}\int_{\mathcal{L}}\int_{\mathbb{Z}}\beta_{z,l}^{h'}\, w_{h'}\, dz\, dl\, dh' \tag{48}$$

Suppose now that $w_H \to \infty$. Then, on the one hand, from (46) we obtain the aggregate demand by $l' \in \mathcal{L}$ for goods produced in region $\mathcal{H}$ would be equal to a finite (non-negative) number. Since this would hold true for every $l' \in \mathcal{L}$, then the aggregate demand by region $\mathcal{L}$ for goods produced in region $\mathcal{H}$ —left-hand side of (48)— would be equal to a finite (non-negative) number. On the other hand, from (46) it follows that when $w_H \to \infty$ the aggregate demand by $h' \in \mathcal{H}$ for goods produced in any $l \in \mathcal{L}$ would tend to infinity. Since this would hold true for every $h' \in \mathcal{H}$ and

$l \in \mathcal{L}$, then the aggregate demand by region $\mathcal{H}$ for goods produced in region $\mathcal{L}$ —right-hand side of (48)— would also tend to infinity. But this then is inconsistent with the equality required by condition (48). Hence, if an equilibrium exists, it must be then characterised by $w_L < w_H < \infty$.

Step 5. Finally, we prove now that there exists an equilibrium $1 < w_H < \infty$, and this equilibrium is unique. Recall that, by setting $w_L = 1$, w_H represents the relative wage between region $\mathcal{H}$ and region $\mathcal{L}$. Step 1 shows that, should the relative wage equal one, then the world demand for goods produced in a country from $\mathcal{H}$ would be strictly larger than the world demand for goods produced in a country from $\mathcal{L}$. Step 4 shows instead that, should $w_H \to \infty$, then the world demand for goods produced in a country from $\mathcal{H}$ would be strictly smaller than the world demand for goods produced in a country from $\mathcal{L}$. Consider now (45) for any $v = h \in \mathcal{H}$, implying that $w_h = w_H$, and notice that the demand intensities $\beta^i_{z,h}$ are all non-increasing in w_H. In addition, consider (45) for any $v = l \in \mathcal{L}$, implying that $w_l = 1$, and notice that in this case the $\beta^i_{z,l}$ are all non-decreasing in w_H, while they are strictly increasing in w_H for at least some $z \in \mathbb{Z}$ when $i \in \mathcal{H}$. Therefore, taking all this into account, together with the expressions in (46) and (47), it follows that the world demand for goods produced in a country from $\mathcal{L}$ may increase with w_H, while world demand for goods produced in a country from $\mathcal{H}$ will decrease with w_H. Hence, by continuity, there must necessarily exist some $1 < w_H < \infty$ consistent with all market clearing conditions holding simultaneously. In addition, this equilibrium must then also be unique. ∎

B.2 Formalisation of results discussed in Section 3.4

Proposition 7 *Suppose that the set $\mathbb{V}$ is composed by K disjoint subsets, indexed by $k = 1, ..., K$, each denoted by $\mathcal{V}_k \subset \mathbb{V}$ and with Lebesgue measure $\lambda_k > 0$. Assume that for any country $v_k \in \mathcal{V}_k$ each η_{z,v_k} is independently drawn from a uniform distribution with support $[\eta_k, \overline{\eta}]$, with $\eta_{k'} < \eta_{k''}$ for $k' < k''$.Then: $w_1 > ... > w_{k'} > ... > w_K$, where $1 < k' < K$.*

Proof. Combining (18) and (19), yields:

$$\beta^i_{z,v} = \max\left\{\left[\left(\frac{1+\kappa}{A}\right)\left(\frac{w_i}{w_v}\right)\left(e\cdot\mu^i\right)^{-\eta_{z,v}}\right]^{1/\left(\eta_{z,v}-1\right)}, \frac{1}{\mu^i}\right\} \equiv \beta^i\left(\eta_{z,v}, w_v\right). \tag{49}$$

Notice from (49) that $\partial\beta^i\left(\eta_{z,v}, w_v\right)/\partial\eta_{z,v} \leq 0$ and $\partial\beta^i\left(\eta_{z,v}, w_v\right)/\partial w_v \leq 0$.

Consider now two generic regions $k' < k''$, and suppose that $w_{k'} \leq w_{k''}$. Since the distribution of $\eta_{z,k'}$ FOSD the distribution of $\eta_{z,k''}$, then it follows that $\int_{\mathbb{Z}} \beta^i_{z,k'} dz \geq \int_{\mathbb{Z}} \beta^i_{z,k''} dz$. Moreover, recalling the proof of Lemma 1 it follows that the $\beta^i_{z,v}$ in (49) must be *strictly* decreasing in $\eta_{z,v}$

and in w_v at least in one of all the regions in the world.[33] As a result, there will exist a positive measure of countries for which $\int_{\mathbb{Z}} \beta^i_{z,k'} dz > \int_{\mathbb{Z}} \beta^i_{z,k''} dz$ when $w_{k'} \leq w_{k''}$. Therefore, integrating over the set $\mathbb{V}$, we obtain that $\int_{\mathbb{V}} \int_{\mathbb{Z}} \beta^i_{z,k'} dz > \int_{\mathbb{V}} \int_{\mathbb{Z}} \beta^i_{z,k''} dz$. That is, the world demand for goods produced in a country from region k' is strictly larger than world demand for goods produced in a country from region k''. But this is inconsistent with the market clearing conditions when $w_{k'} \leq w_{k''}$, which require that world demand for goods produced in a country from region k' must be no larger than world demand for goods produced in a country from region k''. As a consequence, it must be that $w_{k'} > w_{k''}$. ■

Proposition 8 *For country $v_1 \in \mathcal{V}_1$ such that $\eta_{z,v_1} = \underline{\eta}$ and any country $v_k \in \mathcal{V}_k$ such that $\eta_{z,v_k} = \eta_k$ and $k \neq 1$: $RCA_{z,v_1} > RCA_{z,v_k}$, for any $z \in \mathbb{Z}$.*

Proof. Countries with identical incomes have identical budget shares. Let $\beta^j_{z,v}$ denote the common budget share for (z, v) in j. Then, from the definition of total production of good z by country v, we have that $X_{z,v} = \sum_{j=1}^K \lambda_j \beta^j \left(\eta_{z,v}, w_v\right) w_j$. Notice also that $X_v = w_v$ and $W_z/W = 1$. Hence, (11) yields:

$$RCA_{z,v} = \frac{\sum_{j=1}^K \lambda_j \beta^j \left(\eta_{z,v}, w_v\right) w_j}{w_v}. \tag{50}$$

Consider a generic good $z \in \mathbb{Z}$ and, without loss of generality, select countries: $v_1 \in \mathcal{V}_1$ such that $\eta_{z,v_1} = \underline{\eta}$; and $v_k \in \mathcal{V}_k$ from any region $k \in (1, K]$ such that $\eta_{z,v_k} = \eta_k$. From (50) we obtain that $RCA_{z,v_1} > RCA_{z,v_k}$ requires:

$$\frac{\sum_{j=1}^K \lambda_j \beta^j \left(\underline{\eta}, w_1\right) w_j}{w_1} > \frac{\sum_{j=1}^K \lambda_j \beta^j \left(\eta_k, w_k\right) w_j}{w_k}. \tag{51}$$

Notice too that market clearing conditions imply:

$$\int_{\mathbb{Z}} \left[\sum_{j=1}^K \lambda_j \beta^j \left(\eta_{z,1}, w_1\right) w_j \right] dz = w_1 \quad \text{and} \quad \int_{\mathbb{Z}} \left[\sum_{j=1}^K \lambda_j \beta^j \left(\eta_{z,k}, w_k\right) w_j \right] dz = w_k.$$

Therefore, it follows that $\int_{\mathbb{Z}} RCA_{z,v_1} dz = \int_{\mathbb{Z}} RCA_{z,v_k} dz = 1$. We can transform the integrals over z in integrals over η, to obtain:

$$\frac{1}{\overline{\eta} - \underline{\eta}} \int_{\underline{\eta}}^{\overline{\eta}} \left[RCA_{\eta,v_1}\right] d\eta \quad = \quad 1, \tag{52}$$

$$\frac{1}{\overline{\eta} - \eta_k} \int_{\eta_k}^{\overline{\eta}} \left[RCA_{\eta,v_k}\right] d\eta \quad = \quad 1 \tag{53}$$

[33] More precisely, it must be that the $\beta^i_{z,v}$ in (49) are strictly decreasing in $\eta_{z,v}$ and w_v *at least* in region k^*, such that $w_{k^*} \in \max\{w_1, ..., w_K\}$. That is, the region (or regions) exhibiting with the highest wage.

Recall that $\partial \beta^j(\cdot)/\partial \eta < 0$, implying that $\partial(RCA_{\eta,v})/\partial \eta < 0$. Moreover, since $w_k < w_1$, notice that it must be the case that $RCA_{\eta,v_k} > RCA_{\eta,v_1}$ for any $\eta \in [\eta_k, \overline{\eta}]$. Now, suppose that $RCA_{\eta_k,v_k} \geq RCA_{\underline{\eta},v_1}$, then bearing in mind that $\partial^2 \beta^j(\cdot)/(\partial \eta)^2 > 0$ and $\partial^2 \beta^j(\cdot)/(\partial \eta \partial w_v) < 0$ (proved in Lemma 2 below), we can observe that when (53) holds true then

$$\frac{1}{\overline{\eta} - \underline{\eta}} \int_{\underline{\eta}}^{\overline{\eta}} [RCA_{\eta,v_1}]\, d\eta < 1,$$

which contradicts (52). Therefore, it must be the case that $RCA_{\eta_k,v_k} < RCA_{\underline{\eta},v_1}$. ■

Lemma 2 *For any country $i \in \mathbb{V}$: (i) $\partial^2 \beta^i(\cdot)/(\partial \eta)^2 \geq 0$; and (ii) $\partial^2 \beta^i(\cdot)/(\partial \eta \partial w_v) \leq 0$; both with strict inequality if $\beta^j(\cdot) > 1/\mu^j$.*

Proof. Recall the definition of $\beta^i_{z,v}$ given by (45). It is straightforward to notice that, whenever $\beta^i_{z,v} = 1/\mu^i$, $\partial^2 \beta^i(\cdot)/(\partial \eta)^2 = \partial^2 \beta^i(\cdot)/(\partial \eta \partial w_v) = 0$. Otherwise, taking the logs in both sides of the equation, and differentiating with respect to $\eta_{z,v}$ yields: $\partial \ln \beta^i_{z,v}/\partial \eta_{z,v} = -\left(1 + \ln q^i_{z,v}\right)/\left(\eta_{z,v} - 1\right) < 0$. Now, differentiating with respect to $\eta_{z,v}$, result (i) obtains:

$$\frac{\partial^2 \ln \beta^i_{z,v}}{\left(\partial \eta_{z,v}\right)^2} = -\frac{\partial \beta^i_{z,v}}{\partial \eta_{z,v}} \frac{1}{\eta_{z,v} - 1} \frac{1 + \beta^i_{z,v}}{\beta^i_{z,v}} > 0.$$

With regard to result (ii), differentiating with respect to $\eta_{z,v}$ and w_v, we have:

$$\frac{\partial^2 \ln \beta^i_{z,v}}{\partial \eta_{z,v} \partial w_v} = -\frac{1}{\eta_{z,v} - 1} \left(\frac{\partial \ln \beta^i_{z,v}}{\partial w_v} + \frac{\partial \ln \mu^i}{\partial w_v} \right).$$

Note that the term in brackets can be rewritten as $-\left(1/w_v + \partial \ln \mu^i/\partial w_v\right)/\left(\eta_{z,v} - 1\right)$. From the definition of $q^i_{z,v}$:

$$\frac{\partial \ln q^i_{z,v}}{\partial w_v} = -\frac{1}{\eta_{z,v} - 1} \left(\frac{1}{w_v} + \frac{\partial \ln \mu^i}{\partial w_v} \right) \leq 0.$$

hence, it must hold $1/w_v + \partial \ln \mu^i/\partial w_v > 0$, which in turn implies:

$$\frac{\partial \ln \beta^i_{z,v}}{\partial w_v} + \frac{\partial \ln \mu^i}{\partial w_v} < 0.$$

Then it straightforwardly follows that $\partial^2 \ln \beta^i_{z,v}/\left(\partial \eta_{z,v} \partial w_v\right) > 0$ as claimed. ■

Proposition 9 *Let $\beta^j_{z,\underline{\eta}}$ denote the demand intensity by a consumer from country $j \in \mathcal{V}_j$ for the variety of good z produced in country v_1 such that $\eta_{z,v_1} = \underline{\eta}$. Then: $\beta^1_{z,\underline{\eta}} > ... > \beta^{j'}_{z,\underline{\eta}} > ... > \beta^K_{z,\underline{\eta}}$, where $1 < j' < K$.*

Proof. Consider a pair of generic consumers from regions j' and j'', where $j' < j''$. In addition, consider a pair of generic exporters from countries $v_{k'}$ and $v_{k''}$, where $k' \leq k''$. Following an analogous procedure as in the proof of Proposition 4, combining (18) and (19) of consumers j' and j'' for the varieties of good z produced in $v_{k'}$ and $v_{k''}$, we may obtain:

$$\begin{aligned}\left(\eta_{z,v_{k''}} - \eta_{z,v_{k'}}\right) \ln\left(\mu^{j'}/\mu^{j''}\right) + \left(\delta^{j''}_{z,v_{k'}} - \delta^{j'}_{z,v_{k'}}\right) + \left(\delta^{j''}_{z,v_{k''}} - \delta^{j'}_{z,v_{k''}}\right) = \\ \left(\eta_{z,v_{k'}} - 1\right) \ln\left(\beta^{j'}_{z,v_{k'}}/\beta^{j''}_{z,v_{k'}}\right) + \left(\eta_{z,v_{k''}} - 1\right) \ln\left(\beta^{j''}_{z,v_{k''}}/\beta^{j'}_{z,v_{k''}}\right).\end{aligned} \tag{54}$$

Since $\ln\left(\mu^{j'}/\mu^{j''}\right) > 0$ and $\delta^{j''}_{z,v_k} \geq \delta^{j'}_{z,v_k}$, from (54) it follows that $\beta^{j'}_{z,v_{k'}}/\beta^{j''}_{z,v_{k'}} > \beta^{j'}_{z,v_{k''}}/\beta^{j''}_{z,v_{k''}}$ when $\eta_{z,v_{k'}} < \eta_{z,v_{k''}}$. Now, let $k' = 1$ and pick z such that $\eta_{z,v_1} = \underline{\eta}$. Next, suppose $\beta^{j'}_{z,\underline{\eta}} \leq \beta^{j''}_{z,\underline{\eta}}$. Then, we must have that $\beta^{j'}_{z,v} \leq \beta^{j''}_{z,v}$ for all $(z,v) \in \mathbb{Z} \times \mathbb{V}$, with strict inequality for all (z,v) such that $\eta_{z,v_k} > \underline{\eta}$. However, since the budget constraints of consumer j' and j'' require that $\int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^{j'}_{z,v}\, dv\, dz = \int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^{j''}_{z,v}\, dv\, dz$, then $\beta^{j'}_{z,\underline{\eta}} \leq \beta^{j''}_{z,\underline{\eta}}$ cannot possibly be true. ■

B.3 A world economy with symmetric countries and iceberg trade costs

We briefly discuss here the effects brought about by the introduction of iceberg trade costs into the model presented in Section 2. Since we have a continuum of countries, trade costs will entail a meaningful effect only if they are not identical across all possible trade partnerships. In that respect, we will assume each country v faces an iceberg trade cost $\tau > 0$ with a fraction of countries equal to $\gamma \in (0,1)$. For the remainder fraction $(1-\gamma)$ trade costs are zero. In order to keep the symmetry across countries, we further assume that the proportion γ is the result of random i.i.d. draws for each possible trade partnership.[34]

The optimisation problem will yield conditions that will be slightly different, depending on whether a specific trade partnership is subject to the trade cost $\tau > 0$ or not. To simplify the exposition, we let $I(i,v)$ denote an *index function* which is equal to 1 when exchanging commodities between countries i and v is subject to the iceberg trade cost $\tau > 0$, while $I(i,v) = 0$ otherwise.[35] In addition, in the sake of brevity, we assume that the value of κ is always large enough to ensure that the baseline quality constraint, $q_{z,v} \geq 1$, never binds in the optimum for any commodity (z,v).

Note, firstly, that this setup keeps intact the (*ex-ante*) symmetry across countries; hence, in equilibrium, $w_v = w$ for all $v \in \mathbb{V}$ will still hold true. Secondly, note that the price of commodity (z,v) in quality q sold to country i is now given by: $p^i_{z,v}(q) = [1 + I(i,v)\,\tau]\, A\, q^{\eta_{z,v}} w_v / (1+\kappa)$. As

[34] That is, each trade partnership is subject to a draw for its trade cost: with a probability γ it equals $\tau > 0$ and with probability $1-\gamma$ it equals zero.

[35] Note that $I(i,v) = 1$ for a fraction γ of all possible trading partnerships. Note also that $I(i,v) = I(v,i)$.

a consequence, the FOC for a consumer in country i are now given by:

$$\begin{aligned}
\ln \beta^i_{z,v} - \eta_{z,v} \ln q^i_{z,v} + \ln(1+\kappa) - \ln A - \ln[1 + I(i,v)\tau] - \eta_{z,v} &= 0, \quad \forall (z,v) \in \mathbb{Z} \times \mathbb{V} \quad (55) \\
\frac{1}{\Omega \cdot \Lambda} \frac{q^i_{z,v}}{\beta^i_{z,v}} - v^i &= 0, \quad \forall (z,v) \in \mathbb{Z} \times \mathbb{V} \quad (56) \\
\int_{\mathbb{Z}} \int_{\mathbb{V}} \beta^i_{z,v}\, dv\, dz &= 1. \quad (57)
\end{aligned}$$

Comparing (56) and (57) to their counterparts in (19) and (21), we can observe that they are unaffected by the index function $I(i,v)$. This implies that in the optimum the condition (23) will still hold in this setup. The differences arise between (55) and (18), after removing the terms $\ln(w_i/w_v)$ and $\delta^i_{z,v}$ from (18), since the former includes the term $\ln[1 + I(i,v)\tau]$.

Using (55) and (23), together with the notation $Q \equiv \int_{\mathbb{Z}} \int_{\mathbb{V}} q_{z,v}\, dv\, dz$, we may obtain the optimal levels of $q^i_{z,v}$ and $\beta^i_{z,v}$ for a consumer from country i :

$$q^i_{z,v} = \left[\frac{(1+\kappa)}{[1 + I(i,v)\tau] A} \frac{1}{e^{\eta_{z,v}} Q} \right]^{1/\left(\eta_{z,v}-1\right)}, \quad (58)$$

$$\beta^i_{z,v} = \left[\frac{(1+\kappa)}{[1 + I(i,v)\tau] A} \frac{1}{(eQ)^{\eta_{z,v}}} \right]^{1/\left(\eta_{z,v}-1\right)}. \quad (59)$$

Since the term $[1 + I(i,v)\tau]$ enters multiplicatively into both (58) and (59), it is straightforward to extend to proofs of Lemma 1 and Proposition 1 to show that all the following results still hold true under this setup:

- For any commodity (z,v), the optimal quality is increasing in real income: $\partial q^i_{z,v}/\partial\kappa > 0$.
- The increase in quality with a rising income is decreasing in $\eta_{z,v}$: $\partial^2 q^i_{z,v}/\left(\partial\kappa\, \partial\eta_{z,v}\right) < 0$.
- For any pair of commodities (z',v') and (z'',v'') such that $\eta_{z',v'} < \eta_{z''v''}$, when the real income grows, the expenditure share in (z',v') grows faster than in (z'',v''): $\partial\beta^i_{z',v'}/\partial\kappa > \partial\beta^i_{z'',v''}/\partial\kappa$.

The above three results show that the presence of iceberg trade costs does not have any effect on the nonhomotheticities present in our model. There is however one important result, regarding expenditure share levels, that is no longer true for *all* levels of κ, but only for sufficiently large values of κ; namely:

- For any pair of commodities (z',v') and (z'',v'') such that $\eta_{z',v'} < \eta_{z''v''}$, for κ sufficiently large: $\beta^i_{z',v'} > \beta^i_{z'',v''}$.

Unlike the result in Proposition 1, we have now that $\beta^i_{z',v'} > \beta^i_{z'',v''}$ only holds as a general result for κ sufficiently large. In particular, suppose that exchanges between i and v' are subject to frictions, but trade costs do not affect exchanges between i and v''. Then, for values of κ that are not too high, it may happen that country i sources a larger value of their imports of good z from v'' than from v' in spite of $\eta_{z',v'} < \eta_{z''v''}$. Nevertheless, the effect of the trade fictions tend to dissipate as κ grows and consumers raise their quality of consumption, as the quality-upgrading cost-differential effect generated by $\eta_{z',v'} < \eta_{z''v''}$ eventually defeats the trade-friction effect caused by $I(i, v')\,\tau > I(i, v'')\,\tau$. More formally, we can show that:

- For any pair of commodities (z', v') and (z'', v'') such that $I(i, v') = 1$, $I(i, v'') = 0$ and $\eta_{z''v''} - \eta_{z',v'} < \ln(1+\tau)$, there is a threshold $\widetilde{\kappa}$ such that: $\beta^i_{z',v'} > \beta^i_{z'',v''}$ if and only if $\kappa > \widetilde{\kappa}$.

The above result is interesting in its own right, and it suggests that trade frictions tend to become relatively less important as incomes rise. In that regard, this result points towards interesting avenues for extensions to our benchmark model that may be studied in future research: how the interaction between nonhomothetic preferences along the quality dimension and iceberg trade costs may lead to *aggregate* increases in trade among economies as their incomes rise.

C Additional empirical results

Subset *A*				Subset *B*			
country	**GDP pc**	**country**	**GDP pc**	**country**	**GDP pc**	**country**	**GDP pc**
Un. Arab Emirates	52855	Albania	6641	Luxembourg	84572	Turkmenistan	6936
Macau	51111	Samoa	6547	Bermuda	52091	Dominica	6580
Singapore	47313	Ukraine	6415	Norway	49974	Vanuatu	6531
Brunei	46206	Tunisia	6300	Kuwait	46747	El salvador	6341
USA	41147	Ecuador	6171	Australia	41288	Guatemala	6288
Switzerland	39632	Armenia	5376	Netherlands	40574	Algeria	6074
Iceland	37212	Egypt	4957	Austria	37413	Georgia	5063
Canada	36234	Namibia	4737	Sweden	35246	Angola	4756
Belgium	34625	Jordan	4646	Denmark	33929	Iraq	4709
United kingdom	33410	Maldives	4461	Ireland	33406	Bhutan	4566
Finland	32186	Fiji	4284	Japan	31980	Guyana	4336
Trinidad and Tobago	31057	Indonesia	4074	France	30837	Kiribati	4092
New Zealand	27878	Syrian Arab Rep.	3995	Bahamas	28382	Sri lanka	4034
Spain	27647	Cape verde	3770	Italy	27709	Bolivia	3792
Israel	25559	Honduras	3608	Greece	27305	Paraguay	3702
Slovenia	24956	Micronesia	3329	Korea, Rep.	25048	Swaziland	3444
Puerto rico	23664	India	3238	Seychelles	23864	Morocco	3292
Czech republic	23059	Viet nam	2871	Bahrain	23538	Mongolia	3170
Equatorial guinea	22008	Papua new guinea	2753	Barbados	22928	Philippines	2839
Saudi arabia	21542	Moldova	2496	Malta	21668	Lao	2636
Slovakia	19986	Uzbekistan	2384	Oman	20541	Yemen	2401
Libya	19233	Kyrgyzstan	2300	Portugal	19904	Pakistan	2353
Hungary	16521	Nicaragua	2190	Cyprus	18998	Congo	2223
Estonia	16294	Djibouti	2061	Poland	16376	Sudan	2188
Antigua-Barbuda	15047	Solomon islands	2004	Croatia	15084	Nigeria	2034
Russian federation	14645	Cameroon	1807	Palau	14988	Tajikistan	1873
Saint lucia	13079	Zambia	1765	Lithuania	14189	Cambodia	1768
Belarus	12782	Mauritania	1578	Lebanon	12907	Sao Tome-Princ.	1681
Saint Kitts-Nevis	12755	Gambia	1464	Latvia	12777	Senegal	1492
Chile	12007	Bangladesh	1397	Grenada	12024	Haiti	1444
Kazakhstan	11733	Lesotho	1309	Argentina	11960	Cote d'ivoire	1344
Cuba	11518	Ghana	1241	Mexico	11634	Chad	1276
Costa rica	11227	Kenya	1205	Malaysia	11309	Nepal	1209
Bulgaria	10923	Afghanistan	1171	Uruguay	11067	Tanzania,	1189
Iran	10620	Benin	1116	Suriname	10644	Uganda	1152
Panama	10187	Mali	999	Gabon	10276	Rwanda	1030
Dominican republic	9919	Burkina faso	900	Turkey	9920	Comoros	915
Azerbaijan	9619	Guinea	823	Romania	9742	Sierra leone	871
Brazil	9356	Mozambique	759	Mauritius	9487	Guinea-bissau	818
Botswana	8868	Togo	733	Venezuela	9123	Madagascar	753
Belize	8444	Malawi	652	Jamaica	8801	Ethiopia	684
Thailand	7799	Eritrea	593	Tonga	7862	Central Afr. Rep.	647
Saint Vincent-Gren.	7378	Somalia	461	Macedonia	7682	Niger	534
Bosnia-Herz.	7117	Burundi	368	Colombia	7528	Liberia	397
China	7008	Zimbabwe	143	Peru	7279	Congo, Dem. Rep.	231

GDP pc	**Subset *A***	**Subset *B***
Mean	12302	12931
Median	7063	7185
Max	52855	84572
Min	143	231
Std. Dev.	13315	14954

Note: we dropped Qatar from the sample whose GDP per head in 2009 was 159,144.

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