World Trade Patterns and Prices: The Role of Productivity and Quality Heterogeneity∗

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Abstract

This paper analyzes the role of productivity and quality in shaping the trade patterns and trade intensities within and across two groups of countries, developed and richer North and developing South. Taking prices as a proxy for quality, recent empirical literature identifies a positive relation between income per capita and both export and import prices, suggesting that rich countries trade goods of relatively higher quality. Instead of relying on specific demand side mechanisms such as preference non-homotheticity for explaining these findings, we focus on the supply side and North-South differences in technology as the key determinants of the trade specialization over quality. We employ a four countries North-South trade model with two dimensions of firm heterogeneity. Differences in firms’ product qualities and cost efficiencies result in a price distribution which, when the fixed cost of trade are applied, generate different consumption bundles and the predicted export and import prices across income levels. Furthermore, the resulting total expenditure allocation across quality shows that the North (South) spends a larger share of its income on high (low) quality even with the same homothetic preferences across regions.

JEL: F10, F12, F14, L11, L15

Keywords: International trade patterns, North-South trade, import and export prices, heterogeneous firms, product quality

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1 Introduction

World trade patterns and their relation to the technological development and income per capita levels of the trading partners have been studied extensively in the theoretical and empirical literature. Employing either the traditional trade models or the new trade theory incorporating the notion of heterogeneous firms, the studies have focused on the determinants of the direction and intensity of trade flows and the empirical validity of such models. We wish to analyze import and export prices and trade patterns within and across regions of the North and the South (developed, relatively richer countries and developing countries, respectively). We provide a theoretical framework for this analysis in the form of a four region North-South trade model with heterogeneous firms in two dimensions, quality and cost efficiency, and focus on intra-industry trade, particularly the manufacturing sector.

To the extent that the unit values of traded goods can represent quality, data on export and import prices might as well serve as evidence of regions’ trade specialization and demand schedules over quality. Fieler (2007) finds that export prices increase with income per capita of the origin country. Schott (2004) presents evidence on positive variation of US import prices depending on the exporter’s income per capita. Furthermore, it is found that import prices are positively related to income per capita, as well as that countries of different income per capita import goods of different prices from the same exporter. These evidence suggest that rich countries specialize in the production and export of relatively higher quality goods, but also that they devote larger share of income on high quality imports and possibly high quality total consumption.1 Most of the literature that proposes theoretical basis for this analysis starts from either non-homothetic preferences where different income levels generate different demand structures, or standard preferences with arbitrarily imposed different “love for quality” parameters in the North and the South. The supply side mechanisms result in a comparative advantage in the production of goods that are in high domestic demand. Non-homothetic preferences might be a natural candidate for explaining reported increase in traded goods prices with income per capita, but are certainly not the only one. Although the arbitrary parametrization of preferences might be regarded as a way around modeling the black box of demand heterogeneity across countries, non-homothetic preferences do have

1These findings, however, should not be taken as a straightforward support for the differences in expenditure distribution over quality in the North and the South, as traded goods might present only a minor share of total consumption.
some empirical support in the micro-level data. The purpose of this paper is not to contradict these findings, but to show that when the attention is shifted from modeling preferences to modeling technology more closely, standard preferences model with fixed operational and trade cost can yield the stated predictions as well.

We use homothetic preference structure and thus wish to give more weight to the supply side mechanisms and their role in shaping the demand structure. Namely, the focus is on the technology endowments of the North and the South which are the main determinants of the production and export specialization and the relative income per capita of the two regions. The North has a higher level of technological development, while the South is lagged behind the North and uses a lower level of technology. Firms in each region are heterogeneous in two technology dimensions: quality and cost efficiency (in further text, productivity) which together determine the firms’ domestic and foreign market profitability. Existing models of trade and heterogeneous firms that introduce only productivity dimension, such as Melitz (2003), predict negative relation between export prices and income per capita since higher technological development implies higher cost efficiency and thus lower prices. Empirical evidence on export prices call for the introduction of the quality dimension of heterogeneity in a way that it generates positive relation between quality and price. In that sense, Northern technology allows this region to produce relatively higher quality-higher price varieties, while the South specializes in the production of lower quality-lower price varieties.

In this framework, the export decision of any firm depends on its quality-productivity level which determines the profitability and thus the ability to cover the fixed cost of exporting. Consumers value higher quality more, but it also generates higher marginal cost of production. Baldwin and Harrigan (2007) develops a model of trade and heterogeneous firms in the quality dimension. They assume that quality rises faster than marginal cost and thus high quality-high cost varieties are the most profitable ones. Therefore, export profitability is increasing in quality (and price) monotonically. In that set-up, lower aggregate expenditure of the South implies that only the most profitable firms can cover the fixed cost of trade and export to the South, while the pool of exporters to the North is larger. At odds with the evidence, this results in the negative relationship between income per capita and import prices conditional on exporter. We introduce a separate measure of cost efficiency which affects the marginal cost independently of the quality. Each firm (variety) is characterized by a quality level which affects positively both utility and the cost of production, and by a productivity
level which raises the efficiency of production and thus decreases the marginal cost. Quality and productivity together determine the technology level of the firms, which are distributed across quality-productivity pairs, with the Southern joint distribution having a lower mean due to its technological lag behind the North. With the two dimensions of heterogeneity, less profitable firms that export only to the North also include those with highest quality but lower productivity and thus higher price. This contributes to the rise in the average import price with income per capita conditional on exporter. In that sense, Northern average import price is higher not because it consumes higher quality than the South, but due to the fact that it consumes also the high priced - high quality varieties. Given the right-skewed firms distribution in equilibrium, varieties of this type are relatively numerous which amplifies the effect on the average import price and insures that North imports higher price varieties on average.

In aggregate terms, higher income of the North compared to the South implies higher expenditure on any good, but higher in equal proportion across goods due to homothetic preferences. Since with fixed cost of export only a subset of varieties gets exported, the resulting expenditure shares on different quality are not equal across regions. North spends a lower share of income on low quality varieties originated from the South, while South spends a lower share on high quality produced in the North, both relative to the other region’s shares of expenditure on those varieties. If the income difference between the regions is sufficiently large, the statement above holds also in the absolute terms. South’s larger share of income is allocated to domestic varieties of low quality, while North spends more on the high quality produced domestically and imported from the other Northern region. Due to competition pressures from the South in the intermediate quality goods markets (lower quality portion of the production in the North), these varieties not produced only for the local market in the North, at a reduced scale. A part of these varieties are not exported by the South and thus not consumed by the North. More profitable varieties are exported by the South, but in a smaller share compared to the higher quality as they are in lower demand and are relatively few.

The analysis of trade intensities within and across regions refers to the Linder hypothesis. Linder (1961) argues that on the demand side, countries with high (low) income per capita spend a larger fraction of their income on high (low) quality goods. On the supply side, countries develop a comparative advantage in the goods that are in high domestic demand,
so high (low) income countries produce high (low) quality goods. Both these premises are predicted by our model, but Linder’s hypothesis goes further. The demand and supply premises are combined in order to argue that the overlap of production and consumption patterns between countries of similar income per capita should induce them to trade more intensively with one another. “Rich trade more with rich, while poor trade with poor.” Our model predicts the highest intensity and value of the North-North trade, while the ordering of the South-South and the North-South trade depends on the fixed and/or variable costs of trade, in particular on their asymmetries conditional on the origin and destination country. With symmetric costs, North-South trade is of higher value, but the result is reversed when stronger restrictions on Southern exports to the North are imposed. However, it should be noted that there is no robust empirical support of the Linder hypothesis. Namely, it is important to determine the level of aggregation at which the "Linder" mechanism might operate. Hallak (2008) shows that the trade intensities prediction is valid on both sides of income per capita distribution at the sectoral level (for some sectors), but is strongly rejected when data is aggregated over sectors.

The rest of the paper is organized as follows. Section 2 and Section 3 present the model and define the equilibrium, Section 4 discusses the results of the numerical exercise, while Section 5 concludes.

2 The Model

We propose a four countries (two symmetric North and two symmetric South) trade model with equal, homothetic preferences across countries, but different technology level across regions, North and South.

2.1 Consumers

Consumers have the same preferences in both regions, the North and the South. In every period, consumers choose consumption and supply labor inelastically at the wage rate \( w^N \) in the North and \( w^S \) in the South. Labor is not mobile across regions and the aggregate measure of population in each country in the North and the South regions is \( L^N \) and \( L^S \), respectively. Consumers allocate optimally the aggregate consumption \( X \) across
differentiated varieties produced by domestic firms and those imported from abroad. The measure of available goods in each country is hence given by domestic goods \(J_D\), imports from the other country of the same region \(J_J\) and from the two countries of the other region \(J_K\) with \(J = \{N, S\}, J \neq K\). Thus, \(I^N = I^N_D + I^N_N + 2I^N_S\) for the North and similarly for the South, \(I^S = I^S_D + I^S_S + I^N_S\). We use the same index to represent both the region and the country of a particular region, as we assume symmetry of the countries within a region in all environment and technology dimensions. However, the varieties they produce are perceived as different by the consumers and thus are all demanded, i.e. each country’s consumers demand varieties from the other country of the same region as well as the goods of both countries of the other region. The utility function for country \(J\) is given by a quality augmented Dixit-Stiglitz utility function,

\[
U^J = \left( \int_{i \in I^J} (q(i)x(i))^\alpha di \right)^{\frac{1}{\alpha}},
\]

where \(x(i)\) is the quantity and \(q(i)\) is the quality of a variety \(i \in I^J\). The standard CES utility index is augmented to account for the quality variation across products where quality acts as a utility shifter: a consumer prefers high quality over low quality products. The elasticity of substitution between any two goods is constant and equal to \(\sigma = 1/(1 - \alpha) > 1\), with \(\alpha \in (0, 1)\).

Consumers derive the optimal demand for each good, both domestic and foreign, maximizing their utility subject to the individual budget constraint \(E^J = \int_{i \in I^J} p(i)x(i)di\), where \(E^J\) presents total expenditure in country \(J\) and \(p(i)\) is the price of variety \(i \in I^J\) at time \(t\). The demand for product \(x(i)\) is given by

\[
x(i) = \left( \frac{P^J q^\alpha(i)}{p(i)} \right)^{\frac{1}{\alpha}} X^J = \left( \frac{q^\alpha(i)}{p(i)} \right)^{\frac{1}{\alpha}} P^J \frac{1}{\alpha - 1} E^J
\]

with \(P^J\) as the price-quality index defined by

\[
P^J = \left( \int_{i \in I^J} \left( \frac{p(i)}{q(i)} \right)^{\frac{\alpha}{\alpha - 1}} di \right)^{\frac{\alpha - 1}{\alpha}} \text{ and } X_t = U_t.
\]

Although consumer preferences are the same in both regions, the bundles of varieties consumed are different. Due to fixed cost of export, subset of varieties in each region is not exported which results in different consumption composition and price schedules across regions. This yields different price indices as averages of the quality weighted prices of all varieties consumed by a region, domestically produced and imported.
2.2 Firms

Firms in each region differ in two dimensions of firm heterogeneity. The first source of heterogeneity is productivity, \( a(i) \in \mathbb{R}_{++} \), which increases the marginal productivity of labor, as in the seminal paper of Hopenhayn (1992). The second source is quality of a firm’s variety, \( q(i) \in \mathbb{R}_{++} \setminus (0,1) \), which decreases the marginal productivity of labor. In this respect, a higher quality variety implies a higher variable cost as in Verhoogen (2008), but contributes positively to consumers’ utility. The production technology has the following form

\[
x(i) = \frac{a(i)^{\chi}}{q(i)^{\eta}} n(i),
\]

(4)

where \( n(i) \) is the production labor employed by firm \( i \) and \( \chi, \eta \in (0,1) \). Firms in both regions distribute over productivity and quality and we assume that each firm produces only one variety so that the index \( i \) identifies both the firm and the corresponding variety it produces. Firms in the North lead in both dimensions while firms in the South are lagged behind the more advanced Northern technology.

In both regions firms enter and exit the market and the industry is characterized at the stationary equilibrium.

2.2.1 Production decision

Each firm is the monopolistic producer of its own variety. Firms pay a fixed operational cost, \( c_f \), expressed in terms of labor in order to produce, and incur an iceberg export cost \( \tau > 1 \) in the units of output\(^2\) and a fixed export cost \( c_{ex} \), expressed in terms of labor, in order to export. The fixed operational cost is necessary to trigger exit while the fixed export cost generates the partition between exporter and non exporter firms.

Solving the standard monopolistic problem, firms in each country \( J \) charge a price \( p^{JD} \) in the domestic market and a price \( p^{JX} \) in the foreign market which takes into account the iceberg cost. That is,

\[
p^{JD} = \frac{w^J q^n}{\alpha a^X}
\]

(5)

\(^2\)In the benchmark model we assume symmetric \( \tau \) across regions in order to abstract from this form of relative price distortion across regions and analyze only the effect of the fixed cost of export on the patterns of trade.
for the products sold in the domestic market and
\[ p^{JX} = \frac{\tau w^J q^n}{\alpha \chi} \]

for the products sold in the foreign markets. Substituting these expressions for prices in
the demand function it follows that \( x(i) \) is increasing in \( a \) and it is decreasing in \( q \) iff \( \eta > \alpha \). We restrict our attention to the specification when this condition holds.

Firms total profits are the sum of the profits obtained in the domestic market and the
profits from the foreign markets when it is profitable to export. Hence the optimal profits
with \( J, K = \{N, S\}, J \neq K \) are given by
\[
\begin{align*}
\pi^J(a, q) &= \pi^{JD}(a, q) + \max\{0, \pi^{JJ}(a, q)\} + 2 \max\{0, \pi^{JK}(a, q)\} \\
\pi^{JD}(a, q) &= \left(\frac{a^\chi q^{1-\eta} \omega^J}{w^J}\right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) P^{J \alpha E^J} - w^J c_f \\
\pi^{JJ}(a, q) &= \tau^{\alpha-1} \left(\frac{a^\chi q^{1-\eta} \omega^J}{w^J}\right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) P^{J \alpha E^J} - w^J c_{ex} \\
\pi^{JK}(a, q) &= \tau^{\alpha-1} \left(\frac{a^\chi q^{1-\eta} \omega^J}{w^J}\right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) P^{K \alpha E^K} - w^J c_{ex}
\end{align*}
\]

Since export profits depend on the aggregate variables of the foreign region, this is the
channel through which the aggregate economy of the foreign region affects the profitability
of the domestic firms.

The max operator in \( \pi^N \) and \( \pi^S \) indicates the choice of each firm to specialize only in
the domestic market or to open also to the foreign markets when the profits derived from
exporting exceed the fixed cost of export, \( c_{ex} \). This choice depends on both productivity
and quality of the variety produced by the firms. Profits are increasing in both dimensions of
firm’s technology and they are concave in both \( a \) and \( q \) if the following conditions hold
\[
\chi < \frac{1-\alpha}{\alpha} \quad \text{and} \quad 1 - \eta < \frac{1-\alpha}{\alpha}.
\]

As \( \eta > \alpha \) the condition on \( \eta \) holds. The specification of \( \chi \) affects not only the concavity
of profits in productivity dimension, but also the ratio of the profit elasticities with respect
to each dimension of technology. With \( \chi \) bigger (smaller) than \( 1 - \eta \) the profits increase
faster along the productivity (quality) dimension, which shapes the isoprofit curves in the 
$(a, q)$ space as presented in Figure 1.

Having in mind the distribution of prices (increasing in $q$ and decreasing in $a$), the shape of 
the isoprofit curves determines the quality and price composition of the domestic and import 
bundles of the two regions. In the following sections we show that the most profitable firms 
export both to the North and the South, while less profitable export only to the North. With 
$\chi > 1 - \eta$, bigger share of the relatively higher priced varieties (high $q$ and low $a$) are cut 
out from the Northern exports to the South and are shipped only to the North.\footnote{As opposed to the case with $\chi < 1 - \eta$ when relatively low priced varieties are excluded from exports to the South in a larger share than the high priced varieties.} Thus, the 
resulting average import price is higher for the North. Moreover, Northern imports are of 
higher average quality relative to the imports of the South as more high quality varieties are 
included in its import bundle. This effect is not present with only one dimension of firms 
heterogeneity as the profits are just a monotonic transformation of the price and the unique 
productivity measure.

The two sources of firm heterogeneity imply that the thresholds, characterizing the border 
between export and not export, is given by the infinite combinations of the $(a,q)$ couples. For 
this reason, it becomes convenient to express the reservation values in terms of productivity 
as a function of quality\footnote{It is equivalent to express product quality as a function of productivity, $q(a)$. Using a specific formulation for the cut-off function does not affect the implications of the model.}, $a(q)$, and to obtain a \textit{cutoff function} rather than cutoff values as in
one factor heterogeneous firm models. For a given \( q \in Q \) it is possible to define the following export cutoff functions for the North and the South, with \( J, K = \{ N, S \} \), \( J \neq K \),

\[
a_{ex}^{JJ}(q) = \left[ \left( \frac{w^J c_{ex}}{(1 - \alpha) P^J} \right)^{\frac{1-\alpha}{\alpha}} 1 \cdot \frac{w^J \tau}{\alpha q^{1-\eta}} \right]^\frac{1}{y} \tag{9}
\]

\[
a_{ex}^{JK}(q) = \left[ \left( \frac{w^J c_{ex}}{(1 - \alpha) P^K} \right)^{\frac{1-\alpha}{\alpha}} 1 \cdot \frac{w^J \tau}{\alpha q^{1-\eta}} \right]^\frac{1}{y} \tag{10}
\]

Given that the export decision depends on the aggregate variables of the foreign country, the export cutoff functions depend on the foreign aggregates as well. The cutoff functions are decreasing in quality implying that a firm characterized by a low level of productivity but a high quality may still find it optimal to export.

\[2.2.2 \text{ The exit decision}\]

Each firm faces an exogenous probability of a bad shock \( \delta \) which forces the firm to exit the market. Besides this exogenous exit, firms exit the market when their profits are not enough to cover the fixed operational cost, \( c_f \). This condition allows to define the exit cutoff functions for given \( q \in Q \) for both North and South, \( J = \{ N, S \} \),

\[
a_{ex}^J(q) = \left[ \left( \frac{w^J c_f}{(1 - \alpha) P^J} \right)^{\frac{1-\alpha}{\alpha}} 1 \cdot \frac{w^J \tau}{\alpha q^{1-\eta}} \right]^\frac{1}{y} \tag{11}
\]

The exit cutoff functions are decreasing in quality produced: high quality allows for an easier survival. However, the exit cutoffs depend only on the domestic aggregates. In other words, for a given quality firm partition in both North and South is such that for low level of productivity (\( a \)) firms exit the industry, for intermediate levels firms produce only for the domestic market, while for higher levels firms produce for both the domestic and the foreign markets, first for the market in the North and then for the foreign markets in both regions. The stated order of the firm partition is then assured by the conditions on the fixed costs of operation and export.\(^5\) The rest of the model is derived assuming that these conditions hold and hence only a part of the firms in both the North and the South survives and only a part of successful firms exports.

\(^5\)See Appendix A. for discussion on exit and export cutoffs.
2.2.3 Firms entry

Each period, \( M^J \) firms enter the industry and pay a sunk entry cost, \( c_e \), expressed in terms of labor. After paying the entry cost they draw the productivity and product quality from a bivariate distribution \( G^J(a, q), J = \{N, S\} \), with corresponding density \( g^J(a, q) \). The density function in the North, \( g^N(a, q) \), is assumed to be log-normal and exogenous while \( g^S(a, q|\bar{p}^N) \) is log-normal but its mean, \( \bar{g}^S \), is determined as a fraction of the incumbents joint mean in the North, \( \bar{p}^N \), which we define in the next section.\(^6\)

As standard, we assume that the free entry condition holds. Firms in the North and the South enter the industry until the expected value of the firm, \( v^J \), is equal to the entry costs. With the value of the firm given as the discounted future flow of profits, and with no time discounting as in Melitz (2003), the free entry condition reads

\[
\bar{v}^J = \int_{a^J(q)}^{\bar{a}^J} \int_{q}^{Q} \frac{\pi^J(a, q)}{\delta} g^J(a, q) dq da = w^J c_e,
\]

2.3 Cross sectional distribution and aggregates

The density of firms conditional on successful entry is computed as

\[
\mu^N(a, q) = \begin{cases} \frac{g^N(a,q)}{1-G^N(a_x^N(q),q)} & \text{if } a(q) \geq a_x^N(q) \\ 0 & \text{otherwise} \end{cases}
\]

for the North firms and similarly for the South firms,

\[
\mu^S(a, q) = \begin{cases} \frac{g^S(a,q)}{1-G^S(a_x^S(q),q|\bar{p}^N)} & \text{if } a(q) \geq a_x^S(q) \\ 0 & \text{otherwise} \end{cases}
\]

where \( P_{in}^N = 1 - G^N(a_x^N(q), q) \) and \( P_{in}^S = 1 - G^S(a_x^S(q), q|\bar{p}^N) \) are the ex-ante probabilities of surviving for the firms in the North and the South, respectively. In a similar way we can define the ex-ante probability that a successful firm exports. That is, \( P_{ex}^{NN} = \frac{1-G(a_x^{NN}(q),q)}{1-G(a_x^N(q),q)} \), \( P_{ex}^{NS} = \frac{1-G(a_x^{NS}(q),q)}{1-G(a_x^S(q),q|\bar{p}^N)} \), \( P_{ex}^{SN} = \frac{1-G(a_x^{SN}(q),q)}{1-G(a_x^N(q),q|\bar{p}^N)} \), and \( P_{ex}^{SS} = \frac{1-G(a_x^{SS}(q),q)}{1-G(a_x^S(q),q|\bar{p}^N)} \) for North and South.

To compute the weighted mean of the Northern technology, necessary to generate the distribution of the firms in the South, we need to define the mass of incumbents in each country. Hence, \( I^{ND} \) and \( I^{SD} \) also represent the measure of varieties produced in each

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\(^6\)This specification is similar to the one used in Gabler and Licandro (2005).
country of the North and the South, so $I_{\text{ex}}^{NN} = \rho_{\text{ex}}^{NN} I_{\text{ex}}^{ND}$, $I_{\text{ex}}^{NS} = \rho_{\text{ex}}^{NS} I_{\text{ex}}^{ND}$, $I_{\text{ex}}^{SN} = \rho_{\text{ex}}^{SN} I_{\text{ex}}^{SD}$ and $I_{\text{ex}}^{SS} = \rho_{\text{ex}}^{SS} I_{\text{ex}}^{SD}$ are the masses of exporting firms and exported varieties in the North and the South, respectively. This means that the mass of available varieties in each country is given by the mass of varieties produced domestically plus the mass of varieties imported: $I_{\text{ex}}^{N} = I_{\text{ex}}^{ND} + I_{\text{ex}}^{NN} + 2I_{\text{ex}}^{SN}$ for the North, and $I_{\text{ex}}^{S} = I_{\text{ex}}^{SD} + I_{\text{ex}}^{SS} + 2I_{\text{ex}}^{NS}$ for the South.

The average weighted technology for the North is computed taking into account not only the output share of the domestic firms but also the additional export share of the better firms and the proportion $\tau$ of output lost during the export transit:

$$\overline{\mu}^{J} = \left( \frac{I_{\text{ex}}^{JD}}{(I_{\text{ex}}^{JD}+I_{\text{ex}}^{JJ}+2I_{\text{ex}}^{JK})} \overline{\mu}_{\text{ex}}^{JD} \right)^{\frac{\alpha}{1-\alpha}} + \left( \frac{I_{\text{ex}}^{JJ}}{(I_{\text{ex}}^{JD}+I_{\text{ex}}^{JJ}+2I_{\text{ex}}^{JK})} \left( \frac{\overline{\mu}_{\text{ex}}^{JJ}}{\tau} \right) \right)^{\frac{\alpha}{1-\alpha}} + \frac{2I_{\text{ex}}^{JK}}{(I_{\text{ex}}^{JD}+I_{\text{ex}}^{JJ}+2I_{\text{ex}}^{JK})} \left( \frac{\overline{\mu}_{\text{ex}}^{JK}}{\tau} \right)^{\frac{\alpha}{1-\alpha}} \right)$$

(15)

$$\overline{\mu}_{\text{ex}}^{JD} = \left( \int_{a_{\text{ex}}^{J}(q)} \int_{Q} (a^{J} q^{1-\eta})^{\frac{\alpha}{1-\alpha}} \mu^{J}(a, q) dq da \right)^{\frac{1-\alpha}{\alpha}}$$

(17)

$$\overline{\mu}_{\text{ex}}^{JJ} = \left( \int_{a_{\text{ex}}^{J}(q)} \int_{Q} (a^{J} q^{1-\eta})^{\frac{\alpha}{1-\alpha}} \overline{\mu}_{\text{ex}}^{JJ}(a, q) dq da \right)^{\frac{1-\alpha}{\alpha}}$$

$$\overline{\mu}_{\text{ex}}^{JK} = \left( \int_{a_{\text{ex}}^{J}(q)} \int_{Q} (a^{K} q^{1-\eta})^{\frac{\alpha}{1-\alpha}} \overline{\mu}_{\text{ex}}^{JK}(a, q) dq da \right)^{\frac{1-\alpha}{\alpha}}$$

Variables $\overline{\mu}_{\text{ex}}^{JJ}(a, q)$ and $\overline{\mu}_{\text{ex}}^{JK}(a, q)$ are the conditional distributions of firms exporting to the North and of firms exporting to both regions, respectively, given that the firm survives in the market.

### 2.4 Steady-state equilibrium

The steady state equilibrium is characterized with a sequences of prices $(p^{JD}, p^{JX})$, wages $(w^{J})$, exit and export cutoff functions $(a_{\text{ex}}^{J}(q), a_{\text{ex}}^{JJ}(q), a_{\text{ex}}^{JK}(q))$, firm distributions $(\mu^{J})$, number
of firms in each region \( (I^{JD}) \) and the aggregate expenditure and price indices \( (E^J, P^J) \) such that

- consumers choose consumption optimally and firms choose prices to maximize their profits
- exit and export cutoff functions satisfy the conditions given in section 2.2.1 and 2.2.2
- entry and exit are such that the aggregate stability condition \( (\delta I^{JD} = P^J_{in} M^J) \) and free entry conditions are satisfied
- distribution of firms in the North and the South are given by equations in section 2.3
- number of operating firms is such that the labor markets clear, i.e. total labor is used for domestic and export production and also for the fixed cost of entry, operation and export,

\[
L^J = \int_{a^J_1(q)}^{a^J_2(q)} \int_Q n(a, q) \mu^J(a, q) I^{JD} dq da + \int_{a^J_1(q)}^{a^J_2(q)} \int_Q n(a, q) \mu^J(a, q) I^{JD} dq da
\]

\[
+ \int_{q_{ex}^1(q)}^{q_{ex}^2(q)} \int_Q n(a, q) \mu^J(a, q) I^{JD} dq da + c_e M^J + c_{ex}(P^{JJ}_{ex} + P^{JK}_{ex}) I^{JD} + c_f I^{JD}
\]

- the trade balance condition is satisfied, implying that the total value of exports from the North to the South is equal to the total value of Southern exports to the North.\(^7\)

We solve the model numerically using the value of parameters which are calibrated to match the recent data on the aggregate trade values (shares of North-North, North-South and South-South exports in the total world exports, relative wage of the South compared to the North) and the firm-level variables\(^8\).

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\(^7\)Due to symmetry between the countries of the same region, trade balance depends only on the values of export flows between countries of different regions.

\(^8\)For details on calibration and data see Appendix B.
3 Results

This section presents the numerical results of the North-South trade model with four regions, two symmetric Norths and two symmetric Souths. Given the technological lag of the entrants in the South behind the incumbents in the North, the selection of the firms in the equilibrium results in the distribution of operating firms over productivity-quality levels in the North and the South as presented in Figure 2. The equilibrium technological lag of the South results in the positive North-South wage differential in equilibrium.

![Figure 2: Incumbents distribution over productivity and quality](image)

When North and South are open to trade, each region specializes in the production of varieties in which it has a comparative advantage. With the lower cost of production, the South specializes in the production of low quality varieties that are demanded mostly domestically but also by the North whose international competitiveness in this portion of the distribution is weakened due to South opening to trade. On the other hand, Northern production is more spread out on the whole remaining area of the technology space, higher productivity and higher quality. Few firms in the South reach these technology levels and thus North mostly specializes in the production and export of higher \((a, q)\) varieties.

In Figure 3, we present the partitioning of the firms across the \((a, q)\) space into exiting
firms, domestic producers and exporters of two types, those that export only to the North and those that export both to the North and the South. Analyzing the partition over the productivity dimension, the lowest \( a \) firms exit the industry in both regions, but the exit cutoff in the North is higher than in the South due to higher absolute value of the fixed operational cost. Therefore, there are low productivity varieties consumed exclusively by the South as the North exits this market and the South does not export as the profitability is low. The North-South head-on competition occurs in the next higher productivity area. Southern varieties are more competitive and are exported to the North, while the North produces them only for the domestic consumption at a reduced scale compared to the autarky. At even higher levels of productivity, the number of Southern firms (varieties) is decreasing as the technology is getting more advanced. That is the market of Northern exporters who employ large share of the total labor force in the North. Details on labor (size) distribution of firms and the values of average productivities across different areas of the \((a, q)\) space in the North and the South are presented in Appendix C.

![Figure 3: Firms partition](image)

Having in mind the price schedule over the \((a, q)\) space, the partitioning graph provides graphical explanation of the reasons for positive relationship between the average export and import prices on one side and income per capita on the other. North abandons the export of low price varieties due to competition from the South which results in higher export prices of the North. On the other hand, it imports goods of higher average price not simply because
it consumes higher quality than the South but due to the fact that it consumes the high
priced high quality varieties. The analogue reasoning applies to the imports from the South.
Average prices of export and import are presented in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports</td>
<td>4.0739</td>
<td>0.9495</td>
</tr>
<tr>
<td>Imports</td>
<td>1.0072</td>
<td>0.9101</td>
</tr>
<tr>
<td>Imports from North</td>
<td>4.2514</td>
<td>3.9861</td>
</tr>
<tr>
<td>Imports from South</td>
<td>1.0008</td>
<td>0.9054</td>
</tr>
</tbody>
</table>

Table 1: Average Import Prices

The following graph (Figure 4.) presents the expenditure shares distribution of the two
regions across different levels of quality for given productivity of the firm. Northern demand
is relatively higher for the varieties produced by the high quality firms and the South is
demanding relatively more of the goods in the lower quality portion of the distribution, which
is the effect of the fixed cost of trade. With no fixed costs, the homothetic preferences would
result in lower demand of the South but exactly proportional to the one of the North. Once
the fixed cost of export is introduced in both North and South, this results in subsets of firms
with only domestic sales which necessarily distorts the proportionality of the consumption
shares of the two regions across varieties.

![Expenditure share per variety over quality](image1)

Figure 4: Expenditure shares distribution over quality
Figure 5. shows the total trade values within and across two groups of countries with no asymmetries in the costs of trade. The model implies that larger shares of Northern export revenue is coming from the North (both due to higher profitability requirements for the export to the South and low absolute expenditure of the South). This also implies higher import between countries of the same region. As a result, the North-North trade is the largest compared to other trade flows, North-South and South-South. In this set-up North-South trade is of higher value than the South-South trade, but the ranking reverses when the asymmetric variable cost of trade are introduced, with the highest cost imposed on Southern exports to the North. Some empirical evidence points to such asymmetries in the form of higher export barriers imposed on the exporters from the South (iceberg trade cost, quality requirements, tariffs). In sectors with such asymmetries, our model’s results might support the final conjecture of the Linder hypothesis, besides predicting the demand and supply premises.

Figure 5: Total trade values within and across regions
4 Conclusion

This paper analyzes the role of productivity and quality in shaping the trade patterns and trade intensities within and across two groups of countries, developed and richer North and developing South. We employ a four countries North-South trade model with two dimensions of firm heterogeneity. Matching the empirical values of within and across region export shares in the total world exports, we show that the equilibrium results support the ranking of the average prices of tradables within and across regions as found in the data. This result was not found in the literature since using only one technology dimension does not simultaneously allow for increasing relation between export prices, import prices and import prices conditional on exporter on one side and income per capita on the other.

Furthermore, we find differences in the consumption bundles across regions even though the preferences are of standard, homothetic form. Namely, the resulting total expenditure allocation across quality shows that the North spends a larger share of its income on high quality while the South allocates more of its expenditure on low quality varieties. Therefore, we wish to remind that the trade patterns in this model are not determined by the non-homotheticity of preferences and thus do not originate exclusively from the demand structures. The results mainly come from the supply side through the productivity-quality distribution of incumbents and it’s effect on the prices. This in turn allows the fixed cost of exporting to act in a way that the empirically predicted trading pattern is replicated. In other words, it is not that the consumers alone have different preferences over qualities based on their income but differences in production technology and income (coming endogenously from the technology level) play the main role.

The future research agenda calls for the development of an endogenous R&D mechanism which will determine technology level of the North and the South in equilibrium. In such set-up, firm would choose the level of their investment in technology and affect initial technology draw through the innovation in the North and technology adoption in the South. R&D incentives would come partly from the domestic demand structure but also as a response to foreign demand, which would together shape the comparative advantage of each region over quality segments. This opens room for the analysis of several issues such as trade liberalization, income inequality and R&D subsidies to promote welfare. It should also be noted that the set-up is easily extendable to include $n$ countries which allows for more empirically testable predictions.
References


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Appendix

A. Conditions on fixed costs and technological lag

The setup of the model requires that the exit cutoff in any region, $a^J_x(q)$, is lower than the export cutoff, $a^{JK}_x(q)$, in order to rule out the possibility of firms not operating in the domestic and producing only for the export market. To insure this we impose conditions on the fixed costs of production and export, and on the level of the technological lag of the South behind the North. With fixed export cost $c_{ex}$ higher than the fixed operational cost $c_f$, the cutoff for exporting to the other country of the same region (North-North and South-South trade) will be higher than the exit cutoff. However, to insure higher cutoff for exporting to the other region (North-South trade) than the exit cutoff, the following condition is required

$$\left( \frac{w^S c_f}{w^N c_{ex}} \right)^{\frac{1-\alpha}{\alpha}} < \frac{P^N}{P^S} < \left( \frac{w^S c_{ex}}{w^N c_f} \right)^{\frac{1-\alpha}{\alpha}}$$

As the equilibrium wage and price indices are functions of the technological lag $\theta$, it follows that the three parameters together determine whether the condition above holds. In a numerical exercise, we find that under wide range of $c_f$, $c_{ex}$ and $\theta$ that satisfy the stated condition, the resulting ordering of the cutoffs is such that the exit cutoff is lower in the North than in the South. Moreover, the exporters of relatively lower productivity export only to the North while the highest productivity firms export also to the South. More formally, numerical exercise show that parameters that satisfy the condition on exit and export cutoffs also satisfy the condition that results in the stated ordering,

$$\left( \frac{w^S}{w^N} \right)^{\frac{1-\alpha}{\alpha}} < \frac{P^N}{P^S} < \left( \frac{w^S}{w^N} \right)^{-1}.$$
B. Calibration

The parameters of the model are calibrated to match the 2006 data on the within and across region export shares in the total world exports, exit and entry rates in the manufacturing industry and the South-North relative wage.

The data on export shares are taken from The OECD Policy Brief "South-South Trade: Vital for Development", August 2006, available at: www.oecd.org/publications/Policybriefs and Goksel (2008). The reported export shares are 52.69% for the North-North trade, 40.86% for the North-South and 6.45% for the South-South exports.

Average firms exit rate in the data for the North is around 10%, while it is slightly higher in the South, 20% (Bartelsman et al. (2004)).

The relative South-North wage in the manufacturing sector is on average 0.4 (World Bank, International Comparison Program database, online edition, 2009).

We calibrate the following parameters: the parameter on technological gap between the North and the South ($\theta$), the fixed cost of entry ($c_e$), the fixed operational cost ($c_f$), the fixed cost of export ($c_{ex}$) and the entrants distribution variance for the North and the South (assuming equal variance over productivity and quality dimensions).

The remaining parameters (the preference parameter $\alpha$, exponents on productivity and quality in the production function, $\chi$ and $\eta$, exogenous exit probability, $\delta$, the variable trade cost, $\tau$, and the mean of the entrants in the North, $\overline{g}^N$) are fixed.
C. Size distribution and average productivities

Figure 6: Conditional Labor Distribution over Technology

<table>
<thead>
<tr>
<th>Weighted Average Technology</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>16.76</td>
<td>8.38</td>
</tr>
<tr>
<td>Domestic</td>
<td>15.01</td>
<td>8.05</td>
</tr>
<tr>
<td>Export to North</td>
<td>17.23</td>
<td>13.29</td>
</tr>
<tr>
<td>Export to N and S</td>
<td>19.79</td>
<td>16.18</td>
</tr>
</tbody>
</table>

Table 2: Weighted Average Technology Across Firm Partition