Can Nonhomothetic Preferences Explain the Post World War II Growth in Trade?[1]

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Abstract: Since 1950, trade has increased faster than product and has concentrated among developed countries and in manufactures. To explain these trade patterns, Markusen (1986) and Bergstrand (1990) have developed general equilibrium models where income per capita levels play a key role in the determination of trade. These models provide a theoretical formalization of Linder (1961). Little work, however, has tested this theory quantitatively.

This paper introduces a model that builds from the previous literature. The main goal is to measure how much of the increase in the volume and concentration of trade seen during the post World War II period can be accounted for by considering preferences as a \non-trivial" determinant of trade. This research represents the ¯rst attempt to quantify this feature using a calibrated general equilibrium model.

We ¯nd that the introduction of nonhomothetic preferences, although consistent with the directional changes in the data, cannot account for a signi¯cant part of the change in the level of trade.

How surprising is this? Not particularly, when we consider that the ratio of trade to product and the concentration among developed countries were greater 100 years ago than today. If nonhomothetic preferences were signi¯cantly driving the patterns of trade, trade should have been much lower and less concentrated in the past. So, why was trade so high and concentrated during the last century? And why has trade increased so fast since the 1950s? Many elements seem to be important for explaining these patterns. Among them, trade policy appears as especially signi¯cant. Low restrictions during the nineteenth century { and in particular by the 1860s { may have played an important role in the determination of the level of trade. Since the 1950s, the world has experienced a reduction in manufacturing restrictions, mainly among developed nations, and an increase in regional trade, emphasized by the creation of the European Community. Our concern should then be, how important has policy been for the evolution of trade levels? This question seems crucial and should receive more attention.

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Introduction

During the post World War II period, three main facts have characterized the evolution of international trade patterns. First, trade has increased faster than product; second, trade has concentrated among developed countries; and third, the share of manufactures to total trade has raised. (See Bergoeing 1996 and Deardor® 1984.) Some static facts become also apparent from the data. In particular, since the beginning of the Industrial Revolution, developed countries have tended to trade manufactures among themselves and to export them to the rest of the world from where they have imported primaries[2].

\Traditional theories" of trade, based on comparative advantage, explain trade as the result of di®erences in relative autarky prices, either because of endowments - the Heckscher-Ohlin model - or technologies - the Ricardian model. The more dissimilar these are, the larger the volume of trade. Therefore, to explain the pattern of trade between the United Kingdom and the rest of the world during the ¯rst half of the nineteenth century, or to predict the pattern of trade for the newly incorporated nations of Eastern Europe during the coming years, a Heckscher-Ohlin model may be appropriate. But, how do we explain the fact that, consistently, more than two thirds of world trade occurred among industrialized countries? World economic activity is mainly located in those countries and therefore is not surprising that a high volume of trade occurs there, but their trade is proportionally higher than their share in world production. How do we even explain the existence of this trade? It is clear from the data that comparative advantages are not able to fully account for the trade facts.

The \new theories"[3] of trade introduce imperfect competition and explain trade by assuming the existence of economies of scale and love for variety. A set of many varieties of di®erentiated products are available for potential production and countries tend to specialize in the production of some of these varieties by exploiting economies of scale[4] and engage in trade in order to make all varieties available in each place. In these models, the closer in terms of market size - as measured by GDP - two countries are, the more they trade. In fact, trade between two countries is maximized when they are identical. This model is typically used to explain the existence of trade in manufactures between developed countries.

Therefore, the previous theories complement each other and together explain the static structure of trade patterns; trade between developed and developing countries in primaries and manufactures would be explained by the former, and trade among developed countries in manufactures by the latter[5].

An integrated model of trade is, therefore, able to explain the static characteristics of trade, but what happens with its evolution over time? How well can we explain the

[2] Trade of manufactures for manufactures is typically referred as intra-industry trade and trade of manufactures for primaries as inter-industry trade. For these facts, see again Bergoeing (1996).

[3] See Helpman and Krugman (1985) for a description of these type of models.

[4] The concept of increasing e±ciency by using division of labor introduced by Adam Smith in 1776 is the base for this type of trade.

[5] A few models introduce the existence of exchange of commodities that belong to the same industry - typically referred as intra-industry trade - within the structure of a Heckscher-Ohlin economy. See for example Chipman (1992). Here, however, we will follow the more usual monopolistic competitive market assumption to talk about product di®erentiation.

dynamic facts observed since the end of World War II? As we will see next, there is no evidence of the ability of this model to account for either the concentration in directions - intra-developed countries trade - and composition - intra-industry trade - or for the increase of trade as a fraction of income.

To explain the rise in trade among developed countries, the Heckscher-Ohlin structure would require an increase in their relative endowment di®erences, which does not seem to have happened. (See Deardor® 1984.) The rise in two-way manufacturing trade is, obviously, not explained either. The monopolistic competition model would require that developed countries had became relatively more similar in terms of size, to explain the concentration of trade among them. Evidence in this respect is not clear. Finally, because of the more specialized nature of intra-industry trade, the concentration of trade among developed countries would lead to the relative increase in the share of world trade in manufactures, but as Leamer and Levinsohn (1995) say, the empirical studies that accompany this theory have not been able to provide strong support.

With respect to the evolution of the ratio of trade to income, again, both models have problems when accounting for the evidence. Their common assumption of identical homothetic preferences imposes independence between consumption patterns - and therefore trade patterns - and income per capita levels[6]. Increases in the level of income per capita shift proportionally the consumption of all goods and as a result neither directions nor composition are a®ected. The share of consumption to income is not a®ected as well. Furthermore, in the case of the Heckscher-Ohlin model, the assumption of constant returns to scale and homothetic preferences imposes constant ratios of trade to income. Therefore, two countries with di®erent sizes will trade identical fractions of their income[7]. Finally, in the monopolistically competitive model, a convergence in the size of developed countries would increase their share of world trade but, as we just said, with no response in the ratio of trade to income due to changes in the level of income per capita.

Since the end of World War II, per capita income levels, as reported by Parente and Prescott (1993), have increased as a result of the wealth distribution shifting up. Wealth disparity has not changed however. The distance between the richest and poorest countries has remained essentially the same. Changes in the level of incomes per capita may have had, therefore, important e®ects on trade that are not being captured in a homothetic environment.

As we will see next, by introducing preferences as an explanation for trade, the integrated model previously described becomes theoretically more consistent with the trade facts, especially, with respect to the evolution of trade since the 1950s.

Linder (1961) considered preferences as a determinant for trade. He observed that trade was being held mainly by industrialized countries and that it was concentrated in manufactures. Linder's conjecture was that manufactures trade is the result of a domestic market for that type of good. When production is established, producers will look for other markets where to put their products and they will ¯nd them in countries where preferences are similar. Then, he argued, since income per capita determines preferences, we would expect that this type of trade would be mainly held between countries with similar income

[6] By assuming identical homothetic tastes across countries, the consumption side of the model is neutralized. Trade, therefore, behaves similarly to production.

[7] This is another fact of trade that is at odds with this literature. See Arad and Hirsh (1981).

per capita.

This seems to have been the case of England in the nineteenth century, also the one of Japan where the invasion of textile markets was achieved with an industry that was supported by a growing domestic demand for low-grade cotton cloth.

Linder did not formalize his theory, however. Since then, many models that are, at least in part, consistent with Linder's conjecture have been created. Krugman (1979), Helpman and Krugman (1985), Markusen (1986) and Bergstrand (1990) are some examples[8]. The model in this paper is theoretically based on their work. It introduces preferences by assuming nonhomotheticity in an economy where both comparative costs and division for labor with taste for varieties explain trade. Such a model seems to move in the right direction when trying to account for the patterns of trade, especially for explaining the dynamic facts. Trade as a fraction of income will increase as the economy grows and specialization in high income elasticity goods - for example, manufactures - mainly traded by developed countries, occurs. Therefore, given comparative advantages, trade concentrates among rich economies, and its increase is mainly explained by the exchange of manufactures[9].

Little work, however, has been done in order to provide quantitative support for the importance of preferences in trade. In particular, these studies are typically characterized by the estimation of a set of equations that is consistent with Linder's ideas. These equations are derived from gravity type models[10]. But, as Deardor® (1984) notes, their lack of theoretical foundation weakens their conclusions.

This paper's main goal is to to quantify the e®ect of nonhomothetic preferences in trade. We want to know how much of the increase in volumes and change in directions and composition of trade can be accounted for by introducing preferences as a \non-trivial[11]" determinant of trade in an otherwise standard Heckscher-Ohlin-Chamberlainian type of model. We do so by calibrating a model to OECD trade data and then simulating the evolution of endowments across regions since 1965.

As noted above, the assumption of nonhomothetic preferences in an otherwise standard general equilibrium Heckscher-Ohlin-Chamberlainian model of trade seems to have some empirical support in accounting for the dynamic facts of trade in the post World War II period. Speci¯cally, the increase in the ratio of trade to income and the rising concentration of trade among developed countries and in manufactures seem consistent with a nonhomothetic model.

The justi¯cation for a nonhomothetic environment has a basis in microeconomic analysis as well. If preferences were homothetic, with individuals facing identical relative commodity prices, the fraction of income spent in a particular commodity should be the

[8]See Bergoeing (1997) for a survey on this literature.

[9]We will consider manufactures trade as the exchange of di®erentiated products. As we will see later, as intra-di®erentiated products trade increases relative to the trade with homogeneous goods, a larger fraction of production is traded.

[10]See, for example, Bergstrand (1985)

[11]Preferences could be trivially introduced by neutralizing di®erences in technologies and endowments and tautologically account for trade as a result of di®erences in tastes. Here, however, we will keep the assumption of identical preferences across countries but we will introduce nonhomotheticity.

same across consumers with di®erent income levels. Thus, if these fractions vary, the assumption of nonhomothetic preferences becomes an empirical regularity. [12]

The next table presents data on average annual expenditures for consumers in the United States across quintiles of income. These data have been constructed based on the consumer expenditure survey 1990-1991 published by the Bureau of Labor Statistics of the Department of Labor. Each column shows the fraction of total expenditures that consumers belonging to a particular quintile of income spend on di®erent items. As we just said, we use data from a single country to be clear that consumers face identical relative prices. Transport costs and tari®s, among others, break the equalization of relative prices across countries, which prevents us from using data for consumption shares in poor and rich nations as an empirical base for rejecting homotheticity.

Table 1

U.S. structure of consumption, 1990
(fraction of total expenditure, quintiles)

Item	1st	2nd	3rd	4th	5th
Food	17.40	16.97	15.09	14.38	12.21
- at home	12.82	12.19	9.86	8.68	6.73
- away from home	4.58	4.78	5.23	5.70	5.48
Housing	36.43	32.71	30.50	29.44	29.34
Transportation	14.07	16.92	18.44	18.92	16.34
Health care	7.73	7.26	6.04	4.62	3.73
Others¤	24.37	26.14	29.93	32.64	38.38

Source: Department of labor (1992).
(*): The category others includes items like reading, education, tobacco and alcoholic beverages.

The table shows that these fractions do vary across quintiles of income in the United States. For example, we can see that food represents a higher fraction of total expenditures in lower income segments of the population than in higher income ones. This fact is even more clear if we look at food expenditures at home. In this case, 12.82 per cent of the total expenditures by the consumers in the lowest quintile is allocated to this item but only 6.73 per cent at the highest quintile. Evidence with respect to nonhomothetic preferences is also provided by Ballance et al. (1985) and Crafts (1980).

The paper is organized as follows. The ¯rst section introduces the model. In section 2 we de¯ne an equilibrium and present the set of equations that characterize the solution in our economy. Section 3 establishes a connection between patterns of trade and nonhomothetic preferences. In section 4 the model is calibrated to OECD trade data, and a series

[12] When looking at dynamic data we observe that since the middle of the nineteenth century the evolution of the composition of trade has been strongly a®ected by the evolution of income per capita. Manufactures as a whole and especially certain types of manufactures in particular have increased systematically with income per capita as shown in Bergoeing (1996). These data, however, provide weak support for nonhomotheticity because of the changes in prices that may have occurred over time.

of numerical experiments is performed in order to quantify the effect of preferences in the evolution of trade patterns. Finally, in the last section, we present the conclusions of this paper and discuss some extensions for future research.

1. A Standard Model of Trade with Nonhomothetic Preferences

The model presented in this section is characterized by three main features: comparative advantages to explain inter-industry trade; economies of scale and taste for varieties to account for the existence of intra-industry trade; and nonhomothetic preferences to introduce income per capita levels as an explanation of trade. This model is based on the work by Krugman (1979), Dixit and Norman (1980), Helpman and Krugman (1985) and Markusen (1986). We will refer to it as a nonhomothetic Heckscher-Ohlin-Chamberlain model. We will use it to account for the facts previously mentioned.

We will solve a static economy problem with a single homogeneous commodity and a continuum of potential differentiated products as the only tradable commodities. We will have a non-tradable commodity that will become relevant for both the understanding of the effect of nonhomotheticity in trade patterns and the calibration exercise presented in section 4.

The environment for this economy is described by: n countries indexed by j; three types of commodities – differentiated-manufactures $y^j(i)$ for $i \in \Omega = [0; D]$, with the measure D finite in equilibrium but infinitely large potentially and endogenously determined; homogeneous-primaries x_0^j; and homogeneous-service products x_j. The primaries and differentiated products are tradable but services are not;[13] all consumers of a particular country share the same utility function; identical technologies and preferences across countries;[14] and two types of factors of production, labor (l) and capital (k). Each country is endowed with l^j units of labor and k^j units of capital. Labor is not equally productive across countries however. Let h^j be a productivity equivalent parameter such that l^j bodies are equal to $h^j l^j = \bar{l}^j$ effective units of labor in country j.

Next, we introduce the consumer's problem, firms' problems, and feasibility conditions that characterize the equilibrium.

1.1 Consumer's Problem

Each consumer in country j maximizes the nested Cobb-Douglas-CES-Klein-Rubin type utility function[15]

$$U(y^j; x_0^j; x_j) = \left(\left[\int_{i \in \Omega^w} y^j(i)^{\rho} di\right]^{\frac{\alpha}{\rho}}\right)(x_0^j - \sigma)^{\beta} x_j^{1-\alpha-\beta} \qquad (1)$$

[13] In what follows we will refer to x_0^j and x_j as the consumption of the homogeneous and non-tradable good, respectively.

[14] See Stigler and Becker (1977) who argue that "tastes neither change capriciously nor differ importantly between people".

[15] Klein and Rubin (1948) first introduced the linear expenditure system.

subject to the budget constraint

$$\int_{i \in \Omega^w} q^j(i) y^j(i)\, di + p_0 x_0^j + p_j x_j = r^j k^j + \bar{w}^j h^j . \tag{2}$$

x_0^j, x_j, and $y^j(i)$ are the consumption of each individual in country j for each type of commodity and for each i. Consumers' preferences for differentiated products extend over an infinite set of products which we index by $[0, \infty)$. Only a subset of these varieties is available for consumption, however. $\Omega^w = [0; D^w]$ represents the set of varieties available in the market. D^w is the measure of differentiated products produced. The constant σ is a requirement for minimum consumption and will represent the degree of nonhomotheticity. We will impose the restriction that the production of the homogeneous good be bigger than σl, i.e., that the homogeneous sector is productive enough to provide the subsistence level of the homogeneous good to all consumers.[16] It is also imposed that all consumers have enough income to purchase more than σ units of x_0^j. Notice that the assumption of nonhomothetic preferences, together with the existence of differences in labor productivity across countries, results in the equilibrium being dependent on both the endowment of effective units of labor and the size of the population. If the population is doubled but the productivity of labor is cut in half, the equilibrium changes. If preferences where homothetic, the equilibrium outcome would be unaffected.

The variables p_0, $q^j(i)$ and p_j are the prices of the homogeneous, differentiated and non-tradable commodities, respectively. The rental price of capital is r^j, and w^j is the rental price of labor services. Finally, because of the assumption of free trade, the prices of the tradable homogeneous commodities are equalized across countries. Each variety, as we will see later, will be produced in only one place, and when factor prices are equalized, they will be sold at the same price.

Each individual is assumed to be endowed with one unit of labor. Therefore, the individuals have h^j units of effective labor.

This utility function has a Cobb-Douglas structure at the inter-industry level, i.e., unit elasticity of substitution between differentiated products and the homogeneous commodity, and a constant elasticity of substitution (CES) structure at the intra-industry level, i.e., among different varieties of differentiated products. The elasticity of substitution between any two pairs of varieties is finite and represented by $\varepsilon = 1/(1 - \rho)$. We impose ρ to be between 0 and 1. $\rho < 1$ (ε finite and positive), guarantees that the product varieties are imperfect substitutes (this assumption is known in the literature as "love for variety".[17]) We also assume $\rho > 0$ ($\varepsilon > 1$), because with the Cobb-Douglas specification, the elasticity of substitution between x_0 and any $i \in \Omega$ is one. Thus, we impose that the differentiated

[16] With trade, σl^k can be larger than the production of the homogeneous good in country k but it is still restricted by the world production.

[17] This assumption captures the notion that each variety is value per se. For example, if a measure D of varieties is available to consumers and each variety has the same price q_i with the varieties not produced with an infinite price, consumers will consume all varieties in the same amount. Then, the sub-utility derived from their consumption is given by $D^{(1-\rho)/\rho} E(i)/q_i$ with $E(i)$ denoting the expenditure level allocated to differentiated products. Therefore, for a given level of spending and price for differentiated products, utility level increases as the "number" of varieties expands.

products be closer substitutes among themselves than with the homogeneous product. We also assume that $0 < \alpha + \beta < 1$, so that the utility function is concave.

We use a Klein-Rubin utility function to introduce nonhomothetic preferences. Thus, consumption patterns are dependent on income per capita.[18] If $\sigma = 0$, we have a standard homothetic utility. If $\sigma \neq 0$, the income elasticities of demand are not equal to one anymore. The homogeneous commodity has an elasticity lower than one and the other two types of commodities have elasticities greater than one. In this case, as incomes per capita differ across countries, so also do patterns of consumption. Richer countries will spend as higher fraction of their income in differentiated products and non-tradable and a lower fraction of their income in the homogeneous product than poorer countries.

The imposition of a minimum consumption requirement only on the homogeneous good has an empirical justification, since the consumption of differentiated products and the non-tradable good – interpreted as manufactures and services, respectively – increases more than proportionally with growth.

1.2 Firms' Problem

Firms solve the following problems:

1.2.1 Homogeneous Product (perfectly competitive)

A representative firm in the homogeneous product sector minimizes, given prices,

$$r^j k_0^j + \overline{w}^j \ell_0^j \tag{3}$$

subject to

$$Q_0^j \leq \theta k_0^{j\gamma} \ell_0^{j(1-\gamma)}. \tag{4}$$

1.2.2 Non-tradable product (perfectly competitive)

A representative firm in the non-tradable product sector minimizes, given prices,

$$r^j k_j + \overline{w}^j \ell_j \tag{5}$$

subject to

$$Q_j \leq \theta k_j^{\gamma} \ell_j^{1-\gamma}. \tag{6}$$

[18] Another way of introducing consumption patterns dependent on income per capita levels is to follow Lancaster (1979) where goods embody varying combinations of high-income and low-income characteristics, then one would expect countries to have preferences more weighted towards the goods with characteristics according with their income level.

Perfect competition and constant returns to scale technologies imply from Euler that both profits Π_0 and Π_j are equal to zero in equilibrium.

<u>1.2.3 Differentiated Products</u> (monopolistically competitive)

A typical firm in the differentiated product sector maximizes, for each variety,

$$\Pi^j(i) = q^j(i)y_w(i) - r^j k^j(i) - \bar{w}^j \bar{l}_t^j(i) \quad \text{with} \tag{7}$$

$$q^j(i) = \frac{\alpha y_w(i)^{-\frac{1}{\epsilon}}(M^w - \sigma I^w)}{\int_{k \in \Delta^w} y_w(k)^{\rho}\, dk}; \tag{8}$$

$$y_w(i) = \theta_d k^j(i)^{\psi}(\max\{\bar{l}_t^j(i) - \bar{l}_f; 0\})^{1-\psi}. \tag{9}$$

Furthermore, the sector is characterized by the existence of free entry.

Equation (8) is the inverse demand function. $y_w(i)$ is the world demand for variety i faced by the producer. The parameter $\bar{l}_f$ represents a fixed cost to production that is expressed in effective units of labor. With this fixed cost, average cost is decreasing and firms face internal economies of scale. These economies of scale are small, so that the industry can accommodate many producers. We assume that firms can costlessly differentiate their products. The equilibrium in this sector is assumed to take the form of Chamberlainian monopolistic competition, where each firm has some monopoly power but due to the existence of free entry, monopoly profits are zero. [19] Because we assume that the potential range of varieties is a continuum, oligopolistic interaction is negligible. Because of the existence of a fixed cost and finite endowments, however, only a finite measure subset of the range will be produced in equilibrium. Thus, the measure of varieties produced is endogeneized by assuming free entry to the industry. Because new products can be created without cost, and producers can do better by doing so than by sharing the market with an existent producer, each variety is going to be produced in equilibrium by a single producer. Finally, since we assume that each variety is produced with the same technology, while consumers value them symmetrically and there is free movement of factors across sectors, in each country, each differentiated product is produced in the same amount and sold at the same price in equilibrium. Later, when the model is solved with factor price equalization, the previous result will be extended to all producers of differentiated products, independent of the country where they operate.

From (9) we see that a variety is produced only if there is enough labor to cover the fixed cost $\bar{l}_f$.

[19] As in Chamberlain (1933), every firm chooses a variety and its pricing as to maximize profits, taking as given the variety choice and pricing strategy of the other producers in the industry.

1.3 Feasibility

In what follows, we present the feasibility conditions for the homogeneous, non-tradable, and differentiated commodities, and for labor and capital. Capital letters represent aggregate consumption of each commodity at each country.

$$\sum_{j=1} X_0^j = \sum_{j=1} \theta_0 k_0^{j\gamma} \ell_0^{j(1-\gamma)}. \tag{10}$$

$$X_j = \theta k_j^{\gamma} \ell_j^{1-\gamma} \quad \text{at each } j. \tag{11}$$

$$\sum_{j=1} Y^j(i) = \sum_{j=1} \theta_d k^j(i)^{\psi} (\max\{\ell_t^j(i) - \ell_f, 0\})^{1-\psi} \quad \text{each } i \in \Omega^w. \tag{12}$$

$$\ell_0^j + \ell_j + \int_{i \in \Omega^j} \ell_t^j(i)di = \ell_0^j + \ell_j + \int_{i \in \Omega^j} (\ell^j(i) + \ell_f^j)di = \ell^j \quad \text{at each } j. \tag{13}$$

$$k_0^j + k_j + \int_{i \in \Omega^j} k^j(i)di = k^j \quad \text{at each } j. \tag{14}$$

Each differentiated product is produced by only one firm so that in (12) the total production of each i is strictly positive only for some j. Moreover, in (13) and (14) $\ell^j(i)$ and $k^j(i)$ are positive only for the products that are produced in the country.

Since, in each country, each variety is going to be produced in the same amount, $\int_{i \in \Omega^j} k^j(i)di = D^j k^j(i)$.

2. Equilibrium: Definition and Solution

In this section we define an equilibrium for this economy and present the set of equations used for solving numerically this equilibrium.

2.1 Definition of the Equilibrium

An equilibrium in this world is a set of allocations $[Y^j(i), X_0^j, X_j, \ell^j(i), \ell_0^j, \ell_j, k^j(i), k_0^j, k_j]$, a set of goods prices $[p_0, q^j(i), p_j]$, a set of rental factor prices $[\varpi^j, r^j]$ and a measure of differentiated products D^j, for all $i \in \Omega^w$ and for each j, such that, given goods prices and rental factor prices:

1. The consumer's problem is solved,

2. The firms' problem are solved, and

3. Feasibility conditions are satisfied.

2.2 Equilibrium Solution

We will present the unknowns and equations that characterize a free trade interior equilibrium in this economy.

The unknowns are (j and k index countries):

x_0^j demand function for the homogeneous good,
$y^j(i)$ demand function for variety i, $i \in \Delta^w$,
x_j demand function for the non-tradable good j,
r^j rental price of capital,
$\overline{w}^j$ price of the effective labor service,
p_0 price of the homogeneous good,
$q^j(i)$ price of variety i, $i \in \Delta^w$,
p_j price of the non-tradable good,
D^j varieties produced at j,
D^w varieties produced in the world.

k_0^j, $k^j(i)$, k_j: allocations of capital across secors,
$\bar{l}_0^j$, $\bar{l}^j(i)$, $\bar{l}_j$: allocations of efective labor across sectors, and

$Q_0^j; Q^j(i); Q_j$: production levels.

Since the demand functions are homogeneous of degree zero, we normalize prices so that a certain price index remains constant. Let, therefore, normalize prices according to the – based on consumption weights – price index $\beta p_0 + \alpha q_i^j + (1 - \alpha - \beta)p_j$ for some j. All prices, therefore, are expressed in terms of this index and wages, for example, are real wages. This index is country-independent when factor prices are equalized.

Because there is free trade and symmetry in preferences and technologies for differentiated products we have that $q^j(i) = q_i^j$; $k^j(i) = k_i^j$; $\bar{l}^j(i) = \bar{l}_i^j$; $Q^j(i) = Q_i^j$ and $y^j(i) = y_i^j$ at each j and for all i produced at j – in a two-region world (j=1,2) as the one we will use for the calibration, we would have 36 unknowns.

Next, we present the equations that characterized the equilibrium solution. We will keep the assumption that the world is divided into two regions.

In the consumer's problem the utility function is the composition of concave functions and therefore it is also concave. The constraint is linear, so that necessary first order conditions are also sufficient for a maximum. The continuity of the utility function together with the compactness of the constraint suffices for the existence of a maximum.
From the consumer's problem at each of the two regions, aggregate consumptions are:

$$x_0^j = \frac{\beta M^j}{p_0} + \sigma(1-\beta)l^j; \tag{15}$$

$$x_j = \frac{(1-\beta-\alpha)(M^j - \sigma l^j p_0)}{p_j}; \qquad \text{and} \tag{16}$$

$$y_i^j = \frac{\alpha(M^j - \sigma l^j p_0)}{q_i^{j\,\epsilon}\int_{n\in\Delta^w} q^j(n)^{(1-\epsilon)}dn}; \tag{17}$$

where $M^j \equiv r^j k^j + \overline{w}^j\overline{l}^j$. Furthermore, because there are no trade distortions, the price of the homogeneous tradable commodity is equalized after trade and as we will see later, when factor prices are equalized, the prices of all varieties are also equalized across countries with trade. Since individual demand functions are linear in income, we can aggregate them so that, for example, X_0^j is the aggregate demand function for the homogeneous commodity at country j.

This solution is obtained by using a two-stage method. Since preferences are linear, homogeneous, and weakly separable, the consumer's problem is solved by first maximizing utility given total spending so that the share of income spent for each type of good is obtained. Then, given the level of income left after consuming the homogeneous and non-tradable commodities, the consumer chooses the amount spent on varieties.

From the minimization of profits at the two competitive sectors in each country:

$$\overline{w}^j = p_0\theta_0(1-\gamma)k_0^{j\gamma}\overline{l}_0^{j(-\gamma)}; \tag{18}$$

$$r^j = p_0\theta_0\gamma k_0^{j(\gamma-1)}\overline{l}_0^{j(1-\gamma)}; \tag{19}$$

$$\overline{w}^j = p_j\theta(1-\gamma)k_j^{\gamma}\overline{l}_j^{-\gamma}; \qquad \text{and} \tag{20}$$

$$r^j = p_j\theta\gamma k_j^{\gamma-1}\overline{l}_j^{1-\gamma}. \tag{21}$$

Notice that $\overline{w}$ is the price per unit of effective labor $\overline{l}$, and w is the price per unit of bodies l; and since one unit of l provides h productivity equivalent units of service, $1/h$ units of l provide one productivity equivalent unit of service priced at $\overline{w} = w/h$.

In the differentiated products sector, we know that each variety is produced in the same amount and sold at the same price, within each country. The amount of labor and capital demanded by the single producer of variety i, after minimizing cost, are given by

$$k_i^j = \frac{Q_i^j(\bar{w}^j\psi)^{1-\psi}}{\theta_i(r^j(1-\psi))^{1-\psi}}; \qquad \text{and}$$

$$\bar{l}_i^j = \frac{Q_i^j(r^j(1-\psi))^{\psi}}{\theta_i(\bar{w}^j\psi)^{\psi}} \tag{22}$$

where, given the technology, only one (at each country) is independent.

Then, the cost function for an individual variety produced in the differentiated sector in country j is

$$C^j(Q_i^j; \bar{w}^j; r^j) = K\theta_d^{-1}Q_i^j\bar{w}^{j(1-\psi)}r^{j\psi} + \bar{w}^j\bar{l}_f; \qquad \text{with}$$

$$K = (1-\psi)^{\psi-1}\psi^{-\psi}.$$

This cost function is characterized by constant marginal cost and decreasing average cost.

Because firms face internal economies of scale, marginal cost pricing generates losses. In this structure, the equilibrium price for a single variety is given by $q_i^j(1+1/\eta) = MC^j$, where η is the price elasticity of demand faced by the firm that produces variety i and MC_i^j is the marginal cost given by

$$MC_i^j = \frac{K\bar{w}^{j\,1-\psi}r^{j\psi}}{\theta_d}.$$

From equation (17), the demand function for a single variety in country j, we can obtain the elasticity of demand η. Since we have a continuum of producers of differentiated products, each firm's pricing policy will have a negligible effect on the marginal utility of income. In other words, we assume that each firm in the differentiated product sector considers the expenditure level in the sector to be independent of its actions. In that case, the elasticity of demand facing each single producer of country j is given by

$$\eta = -\varepsilon - \frac{q_i^{j(1-\varepsilon)}}{\int_{n\in\Delta^w} q^j(n)^{(1-\varepsilon)}dn}(1-\varepsilon).$$

Thus, as long as Δ^w is of positive measure, the price elasticity of demand for variety $i \in \Delta^w$ is $-\varepsilon$. Therefore, $(1+1/\eta)$ is ρ, so that

$$q_i^j = \frac{(1-\sigma)^{\sigma-1}\sigma^{-\sigma}\bar{w}^{j(1-\sigma)} r^{j\sigma}}{\rho\theta_d}: \tag{23}$$

From the zero profit condition,

$$q_i^j = \frac{(1-\sigma)^{\sigma-1}\sigma^{-\sigma}\bar{w}^{j(1-\sigma)} r^{j\sigma}}{\theta_d} + \frac{\bar{w}^j \bar{l}_f}{Q_i^j}: \tag{24}$$

Furthermore, we know that the measure of varieties produced in the world must equal the sum of measures produced in each country, i.e.,

$$D^w = \sum_{j=1} D^j: \tag{25}$$

From feasibility,

$$\sum_{j=1} X_0^j = \sum_{j=1} Q_0^j: \tag{26}$$

$$\sum_{j=1} Y_i^j = Q_i^k; \qquad k = 1;2 \tag{27}$$

In each country,

$$X_j = Q_j \tag{28}$$

$$\bar{l}_0^j + \bar{l}_j + \int_{i \in \cdot j} \bar{l}_{ti}^j di = \bar{l}_0^j + \bar{l}_j + D^j \bar{l}_{ti}^j = \bar{l}_0^j + \bar{l}_j + D^j(\bar{l}_i^j + \bar{l}_f^j) = \bar{l}^j \tag{29}$$

$$k_0^j + k_j + \int_{i \in \cdot j} k_i^j di = k_0^j + k_j + D^j k_i^j = k^j: \tag{30}$$

From technologies,

$$Q_0^j = \theta_0 k_0^{j\gamma} \bar{l}_0^{j(1-\gamma)}; \tag{31}$$

$$Q_i^j = \theta_d k_i^{j\psi} \bar{l}_i^{j(1-\psi)}; \tag{32}$$

$$Q_j = \theta k_j^{\gamma} \bar{l}_j^{1-\gamma}. \tag{33}$$

Finally, from the price index,

$$\beta p_0 + \alpha q_i^j + (1 - \alpha - \beta) p_j = 1. \tag{34}$$

Equations (15) through (24) and (27) through (33) hold for each country j. Therefore, in a two region world, we have 34 equations; including equations (25), (26), and (34) we have a total of 37 equations.[20] After dropping one equation according to Walras's law, we finish with 36 equations and 36 unknowns.

We will calibrate a version of the model that is consistent with an equilibrium with factor price equalization, i.e., with $r^j = r$ and $\overline{w}^j = \overline{w}$ at each country j. In this equilibrium, $k_i^j = k_i; \bar{l}_i^j = \bar{l}_i; Q_i^j = Q_i; q_i^j = q_i$ and $y_i^j = y_i = \alpha(M^j - \sigma l^j p_0)/(D^w q_i)$, for all j.

Finally, notice that when factor prices are equalized, we can determine the measure of varieties produced in the world from the feasibility condition for the differentiated products. As we said before, since we are taking the product space to be continuous, we ignore the integer constraints on the number of goods.

Thus, we have

$$Q_i = \frac{\overline{w}\bar{l}_f \rho \theta_i}{(1-\psi)^{\psi-1}\psi^{-\psi} r^{\psi} \overline{w}^{1-\psi}(1-\rho)}, \qquad \text{and}$$

$$D^w = \frac{(1-\rho)\alpha(M^w - \sigma l^w p_0)}{\overline{w}\bar{l}_f}.$$

We can see that in this type of economy the production level of each variety is not affected by the size of the economy: only the number of varieties changes. In other words each variety is produced in a fixed amount. This result depends on the fact that the marginal cost is constant.

When factor prices are equalized, we also have that, because all varieties are sold at the same price, not only within each country but also across countries, the numerator of the aggregate demand function for varieties in any country is given by $q(n)^{\epsilon} \int_{n \in \Delta^w} q(n)^{1-\epsilon} dn = D^w q(n)$. Furthermore, in this case, the zero profit condition in the non-tradable sector

[20] One of the regions is the sum of identical countries, as we saw when looking at the total unknowns, and we can solve for its equilibrium by calculating typical allocations as if it were only one country.

implies that the prices of non-tradable goods are equalized across countries.[21]

Therefore, a solution to the interior free trade equilibrium follows from combining the demand functions found after solving the consumers' problem, the rental price of capital and labor from solving the firms' problem for each competitive sector; the demand functions for capital and labor from the solution to the producer's problem in the differentiated product sector; the equation for the number of varieties produced in the world; and the feasibility conditions in the commodity and factor markets.

The solution in this economy is characterized by both inter-industry and intra-industry trade. Differences in relative endowments are the source of comparative advantages and determine patterns of trade involving the exchange of the homogeneous good for varieties. Increasing returns to scale determine the efficient scale of production in the differentiated products sector; together with love for variety, this will induce countries to specialize and hence creates incentives for trade of different varieties.

Next, we describe the pattern of trade for thgis economy. Assuming that the world is divided in two regions, the OECD (OE) and the rest of the world (RW); the OECD is sub-divided in two identical sub-regions; the OECD has a comparative advantage in the production of varieties – with two factors and two tradable type of goods, this is sufficient for the RW to have a comparative advantage in the production of the homogeneous tradable good; and finally, imposing that varieties be produced everywhere, the apttern of trade for this economy is as follows: intra-industry trade, defined as the exchange of varieties that is identically matched in both directions, is given by

$$INTRA\; OE - RW = 2 q_i D^{rw} y_i^{oe}.$$

This is the case because intra-industry trade can be defined as two times the minimum between both countries' exports, and since we have imposed a structure that is consistent with the RW being a net importer of varieties, i.e.,

$$q_i D^{rw} y_i^{oe} < q_i D^{oe} y_i^{rw}.$$

In words, total exports of varieties from the RW to the OECD are smaller than the ones from the OECD to the RW.

Inter-industry trade is given by

$$INTER\; OE - RW = 2(Q_0^{rw} - X_0^{rw});$$

and total trade between them is given by

[21] From zero profits in the non-tradable sector, the ratio of labor to capital used is the same across countries if factor prices are equalized. Therefore, from the equilibrium condition for labor at any two countries, non-tradable commodity prices must be equalized.

$$TOT\ OE - RW = INTRA\ OE - RW + INTER\ OE - RW.$$

Finally, total world trade is the sum of TOT OE-RM and intra-industry trade between[22] the two OECD sub-regions given by,

$$INTRA\ OE - OE = \frac{D^{oe} y_i^{oe}}{2}.$$

We have described the pattern of trade for our economy when factor prices are equalized across countries. In what follows, we prove that factor price equalization holds.

2.3 Proof of Factor Price Equalization

We will calibrate the model for a free trade equilibrium with factor price equalization.[23] In what follows, therefore, we present a proof of factor price equalization for the set of allocations and prices consistent with no specialization.[24] This equalization of factor prices is in terms of productivity equivalent labor.

Factor Price Equalization: In the model economy previously introduced, assume no specialization at the industry level, then: $\overline{w}^j = \overline{w}$ and $r^j = r$ for all j.

Proof:

Step 1: $q^j(i) = q_i^j$ for all $i \in \Omega^j$, at each j.

We previously mentioned that since factors can move freely across sectors within each country, and there is symmetry in preferences and technologies, from $MR^j(i) = MC^j(i)$ we have that,

$$q^j(i) = \frac{MC^j(i)}{\rho} = \frac{MC_i^j}{\rho} = q_i^*(r^j; w^j).$$

Step 2: $q^j = q_i$ for all j.

If not, assume there exist two countries A and B such that $q_i^A > q_i^B$. Because we have assumed free entry, $\pi_i^j(w^j; r^j) = 0$ for all j. But, since we have free trade and varieties can be created at zero cost,

[22] Since the two sub-regions are identical, they only engage in trade of varieties with each other.

[23] The rental price of capital and the price of effective units of labor services will be equalized after trade.

[24] Dixit and Norman (1980) present a proof of factor price equalization for the general case of m commodities and n factors in a homothetic version of the model previously presented. Their proof follows the method of the integrated world economy. In general, the applicability of factor price equalization depends on the relative number of tradable commodities and factors, but where what is relevant is not the total number of distinguishable tradable commodities but the number of industries.

$$\pi_i^A(w^B, r^B) > \pi_i^A(w^A, r^A) = 0.$$

Step 3: Factor prices are completely determined by tradable commodity prices.

From the firm's optimization condition for both tradable sectors, we have that:

$$p_0 = p_0^*(r^j, w^j) \text{ and}$$

$$q_i = q_i^*(r^j, w^j) \text{ forall } j.$$

Therefore, $r^j = r^*(p_0, q_i)$ and $w^j = w^*(p_0, q_i)$ for all j. ■

3. Volumes of Trade and Nonhomothetic Preferences

Most of the models of trade assume that preferences are identical and homothetic across countries. This assumption implies that patterns of trade are completely determined by the production side of the model. In the data, however, budget shares are not identical across income levels. As we saw in Table 1, the poorer consumers are, the higher the fraction of income they spend on food.

The model we presented previously is characterized by nonhomothetic preferences. The consumption of either differentiated products or the non-tradable good, relative to the tradable homogeneous good, increases with the level of income. Thus, as countries get richer, their consumption of the high income elasticity goods as a fraction of income rises.

We are concerned with the effect of nonhomotheticity on trade, but as we will see later, the understanding of its effect on inter-industry trade – the exchange of varieties for the tradable homogeneous good – is sufficient for understanding the effects on intra-industry trade. Therefore, we will concentrate on the former, i.e., we will consider the differentiated products sector as a whole and look only at trade based on comparative advantages.

Next, we incorporate the analysis of preferences by Leamer (1984) with the existence of a non-tradable sector. Now, both production and demand affect the trade vector. The non-tradable sector will also have an effect on inter-industry trade if preferences are nonhomothetic. If preferences were homothetic, however, Leamer's finding (1984) of no effect in trade by a non-tradable sector holds.

In order to have income dependent consumption, we can represent the aggregate consumption vector of a particular country by

$$X = Bl + CM,$$

where l is the endowment of labor (bodies) or population, M is aggregate income expenditure and B and C are constants. The solution to our model gives us aggregate demand functions of this form.[25]

From equations (15), (16) and (17), when factor prices are equalized, we have the following aggregate demand functions in a country j:

$$X_0^j = \frac{\beta M^j}{p_0} + \sigma(1 - \beta)l^j;$$

$$Y_I^j = \frac{\alpha(M^j - \sigma l^j p_0)}{q_i}; \qquad \text{and}$$

$$X_j = \frac{(1 - \alpha - \beta)(M^j - \sigma l^j p_0)}{p_j};$$

where $Y_I^j = D^w Y_i^j$ is the aggregate level of consumption at the differentiated products sector.

In what follows, since we will focus on a single country, we omit the supra-index j.

The feasibility conditions for factors of production are:

$$a_{k0}(\bar{w}; r)Q_0 + D^w A_{ki}(\bar{w}; r; Q_i) + a_{kj}(\bar{w}; r)Q_j = k;$$

$$a_{\bar{l}0}(\bar{w}; r)Q_0 + D^w A_{\bar{l}i}(\bar{w}; r; Q_i) + a_{\bar{l}j}(\bar{w}; r)Q_j = \bar{l};$$

with $a_{vt}(\bar{w}; r) = \partial c_t(\bar{w}; r)/\partial v$ for $v = \bar{l}; k$ and $t = 0; j$ being the demand for factor v per unit of output in industry t and where $c_t(\bar{w}; r) = C_t(\bar{w}; r; Q_t)/Q_t$ is the unit cost function for commodity t, and with $A_{vt}(\bar{w}; r; Q_i) = \partial C_i(\bar{w}; r; Q_i)/\partial v$ for $v = \bar{l}; k$ being the demand for factor v by a representative producer in the manufacturing sector.
Then, let $a_{vt}(\bar{w}; r; Q_i) \equiv A_{vt}(\bar{w}; r; Q_i)/Q_i$ and $Q_i = Q_I/D$, where Q_I is the level of output of the manufacturing sector.

The feasibility conditions can be expressed as:

$$a_{k0}(\bar{w}; r)Q_0 + a_{ki}(\bar{w}; r; Q_i)Q_I = k - a_{kj}(\bar{w}; r)Q_j; \qquad \text{and}$$

$$a_{\bar{l}0}(\bar{w}; r)Q_0 + a_{\bar{l}i}(\bar{w}; r; Q_i)Q_I = \bar{l} - a_{\bar{l}j}(\bar{w}; r)Q_j.$$

In matrix form, we have

[25] This is referred in the literature as a linear expenditure system.

$$V - A_j Q_j = AQ;$$

where A and A_j are the 2x2 and 2x1 matrices of unit factor requirements for the production of the tradable commodities and the non-tradable good, respectively, Q is the 2x1 vector of production, Q_j is the production level for the non-tradable good, and V is the 2x1 vector of endowments.

The trade vector is given by:

$$T = Q - X = A^{-1}V - A^{-1}A_j Q_j - BI - CM:$$

From $X = BI + CQ$ we can get:

$$X_w = BI_w + CQ_w = Q_w = A^{-1}(V_w - A_j Q_{jw})$$

with the subscript w denoting aggregation over the world. From this,

$$C = \frac{A^{-1}(V_w - A_j Q_{jw}) - BI_w}{M_w}; \qquad \text{andthen}$$

$$T = A^{-1}(V - sV_w) - B(I - sI_w) - A^{-1}A_j B_j (I - sI_w); \qquad \text{where}$$

$$s = \frac{M}{M_w};$$

$$B_j = -\frac{(1 - \alpha - \beta)\sigma p_0}{p_j}; \text{ and}$$

$$T = \begin{bmatrix} T_0 \\ T_l \end{bmatrix}, \quad A = \begin{bmatrix} a_{k0} & a_{ki} \\ a_{\bar{l}0} & a_{\bar{l}i} \end{bmatrix}, \quad V = \begin{bmatrix} k \\ \bar{l} \end{bmatrix}, \quad B = \begin{bmatrix} \sigma(1-\beta) \\ -\frac{\alpha\sigma p_0}{q_i} \end{bmatrix} \quad \text{and,}$$

$$A_j = \begin{bmatrix} a_{kj} \\ a_{\bar{l}j} \end{bmatrix}.$$

Then,

$$T = \frac{1}{a_{k0}a_{\ell i} - a_{\ell 0}a_{ki}} \begin{bmatrix} a_{\ell i} & -a_{ki} \\ -a_{\ell 0} & a_{k0} \end{bmatrix} \begin{bmatrix} k - sk_w \\ \ell - s\ell_w \end{bmatrix} + \begin{bmatrix} \sigma(1-\beta) \\ -\frac{\alpha\sigma p_0}{q_i} \end{bmatrix} (l - sl_w) -$$

$$\begin{bmatrix} \frac{a_{\ell i}a_{kj} - a_{ki}a_{\ell j}}{a_{k0}a_{\ell j} - a_{\ell 0}a_{kj}} \end{bmatrix} * \frac{(1-\alpha-\beta)\sigma p_0}{p_j} (l - sl_w) \frac{1}{a_{k0}a_{\ell i} - a_{\ell 0}a_{ki}}.$$

Therefore, if a low income per capita country is relatively scarce in e®ective labor and Q_l is produced with a technology intensive in e®ective labor, the signs of the trade vector are:

$$T = \begin{bmatrix} + \\ - \end{bmatrix} + \begin{bmatrix} - \\ + \end{bmatrix} - \begin{bmatrix} \frac{a_{\ell i}a_{kj} - a_{ki}a_{\ell j}}{a_{k0}a_{\ell j} - a_{\ell 0}a_{kj}} \end{bmatrix}.$$

This ¯nal expression for the trade vectors tells us that the pattern of trade for each country is driven by three forces. First, we have the familiar Heckscher-Ohlin result that a country tends to export the commodity that is intensively produced with its relatively abundant factor. Second, countries that are relatively abundant in numbers of people tend to import the low income elasticity good.[26] Therefore, if the OECD has a comparative advantage in the production of di®erentiated products and these products have a high income elasticity of demand, the model predicts that they will tend to export this type of good from the production side of the model and to import them from the demand side, since the OECD countries have a higher income per capita than the RW.[27] Therefore, the usual Heckscher-Ohlin patterns of trade are moderated, and for strong enough nonhomotheticity, could even be reverted. In other words, under our assumptions, nonhomotheticity reduces the level of inter-industry trade relative to the standard homothetic model. Third, depending on the technology for producing the non-tradable commodity, heckscher-Ohlin trade may either be bolstered or reduced.

Looking at the non-tradable sector in more detail, we see that the non-tradable sector can have three di®erent e®ects on trade patterns, depending on the relative factor intensity of its technology relative to the other sectors of the economy. First, if it is intensively produced with the abundant factor, relative to the exported good, the Heckscher-Ohlin pattern is reinforced. Second, if it is intensively produced with the scarce factor, relative to the imported good the preference pattern is reinforced.[28] Finally, if it is intensively produced with the scarce factor relative to the export sector { but not relative to the import substitution sector { the tendency is to export both goods.

Notice that these results depend on the assumption that preferences are nonhomothetic. If they were homothetic, the second and third terms in the trade vector would drop

[26] Notice that a country can be abundant in productivity equivalent labor but still be scarce in numbers of people if workers are su±ciently productive.

[27] Bergoeing (1996) provides evidence that supports the assumption of OECD countries having a comparative advantage in the production of di®erentiated products. Furthermore, Hufbauer (1970) found that developed countries tend to export products that are di®erentiated.

[28] As before, if the non-tradable good is intensively produced with the scarce factor relative to the import substitution sector, it must also be with respect to the export good, since this sector is intensively produced with the abundant factor.

out, and neither relative income per capita nor the existence of non-tradable commodities would have any effect on the prediction for inter-industry trade.

Total exports in this model are determined by two main features. First, as reported by Dixit and Norman (1980), the Heckscher-Ohlin part of the model that generates inter-industry trade implies that total exports depend on the difference in relative endowments across countries. Relative country size does not have any effect on the amount of exports. The monopolistic competitive sector generates intra-industry trade, and the total amount of exports associated with it is sensitive to reallocation of resources that bring more equality in relative country sizes. As two countries become closer in terms of size, the value of trade between them, measured as total exports, increases. Furthermore, if resources are reallocated so that the production of differentiated products increases, keeping total product constant, total exports increase again, since a world with differentiated products is more specialized than one with constant returns to scale, and therefore, it is characterized by a larger fraction of product being traded among countries. Nonhomotheticity affects intra-industry trade analogously to inter-industry trade, i.e., by changing the consumption patterns. Since the poor country reduces its consumption share of differentiated products, it reduces its tendency to import them, and since the rich country increases its consumption share, it reduces its tendency to export them. Therefore, since intra-industry trade is defined as identically matched trade, it must decrease. This result, obviously, would be reversed if we had assumed that the rich country has a comparative advantage in the production of the low income elasticity good.

If we study the evolution of trade as a fraction of income in a homothetic economy, income per capita levels do not play any role. When nonhomothetic preferences are introduced, a positive association arises between the level of the distribution of income per capita and total trade. Not only is the direction of trade affected by nonhomothetic preferences, but so also is the magnitude of the changes that relative endowments and sizes cause in the share of trade in product.

We have seen that nonhomotheticity can improve the ability of a standard homothetic trade model in explaining the previously reported trade facts. Specifically, the reduction (increase) in the tendency of poor (rich) countries to import differentiated products is consistent with the concentration of manufacturing trade among developed countries and the reduction in the share of primary products in total trade observed during the last four decades. Furthermore, the increase in the share of developed countries' trade over product results from the fact that intra-industry trade is more specialized than comparative advantage based trade, and therefore, with the increase in the former, larger fractions of product are traded. But how important are nonhomothetic preferences quantitatively? The main goal of the next section is to provide an answer to this question by calibrating our model and measuring the effect of preferences on trade patterns during the last 30 years.

4. Calibration and Simulations

In this section we calibrate and simulate our economy by changing endowments to be consistent with income per capita growth during the last thirty years. Our main goal is to quantify the effect of preferences on trade patterns.

4.1 Calibration

We will calibrate to the OECD for 1982.[29] We will have two regions: the OECD and the rest of the world (RW). We use the OECD, National Accounts, Detailed Tables, volume II. The data are available per country and in local currency. From the data on GDP in U.S. dollars and local currency, we obtain exchange rates that are used to express all data in U.S. dollars. Then, we generate the OECD data base by aggregating the country-specific data for all members but Yugoslavia. Data on trade between OECD countries and the rest of the world is obtained from the OECD, Foreign Trade by Commodities, volumes I and II.

The goal of the exercise is to match the trade facts for the OECD in 1982. In particular, we look at total trade between OECD and the RW (t oe-rw); inter-industry and intra-industry trade between the OECD and the RW (inter oe-rw and intra oe-rw);[30] and total trade among the OECD countries (t oe-oe.)[31]

Parameters: In what follows we present a list of the parameters and endowments we must calibrate:

from preferences: $\alpha; \beta; \sigma; \rho$

from technologies: $\gamma; \psi; \nu; \bar{l}_f; \theta_0; \theta_i; \theta$

labor productivities: $h^{oe}; h^{rw}$

endowments: $\bar{l}^{oecd}; k^{oecd}; \bar{l}^{rw}\ k^{rw};$

Calibration: To calibrate, we choose one unit of a good to be worth one million 1982 U.S. dollars. This choice of units is implicit in the data we are using. We can then calibrate by setting all prices equal to 1 in the benchmark equilibrium.

The parameter h^{row} is obtained from the United States Labor Statistics Bureau, 1989, by looking at the ratio of average hourly compensation between the United States and Mexico for 1982. We found that $h^{row} = .3; h^{oecd}$ is taken to be 1.

Endowments are calculated from factor compensation and operating surpluses. Since we have factor prices equal to one, the endowment of labor can be obtained from the share of GDP that is allocated to labor. We calculated that share to be the compensation to employees plus one half of net indirect taxes plus profits from unincorporated enterprises. The category profits from unincorporated enterprises is added to compensation for employees in order to capture the fact that, especially in poor countries, the operating surplus of these enterprises primarily includes labor income. The capital endowment is computed as total GDP minus the labor endowment. As we will see later, we get the allocation of workers and capital across sectors analogously.

The data will show that OECD countries are labor abundant and that the homogeneous sector is capital intensive. Labor must be interpreted as productivity equivalent

[29] The benchmark year was chosen based on data availability.

[30] The value of exports of manufactures between the OECD and the RW that is exactly matched in both directions will be referred as intra-industry trade between them. This definition, however, considers total manufactures, i.e., SITC classification at the one digit level and is intended for references purposes only.

[31] This trade is only of the intra-industry type since the two sub-regions are identical.

labor. This is consistent with Leontief's claim that the United States was abundant in productivity equivalent labor with respect to the rest of the world in the 1950s.[32]

Next we classify production, sectoral factor allocation, and consumption.

Production classification:

Q_0 is agriculture, hunting, forestry and fishing, mining and quarrying
Q_i is manufacturing
Q_j is others (electricity, construction, transport and services, among others)

Notice that from the data we get total production of manufactures, which in our model is equal to the production of a typical variety times the number of varieties produced, but we do not see either the number of varieties produced nor the production of an individual variety.

Factor allocation:

As with endowments, we get the allocation of labor across sectors from sectoral labor compensation adjusted by net taxes and profits of unincorporated enterprises, and the allocation of capital as the residual from the sector's production level. Again, for the differentiated products sector, we only see the total factor allocation, i.e., both the number of varieties produced and the amount of factors used for the production of a single variety are not observable. Furthermore, we do not know the fraction of total labor that corresponds to either variable labor or the fixed cost.

Consumption classification:

We classified production according to the classification of GDP by kind of economic activity. For consumption, we will calibrate its value so that production and consumption are consistent with the trade data we want to match. Therefore, we will have that:

$$X_0^{oe} = Q_0^{oe} + \frac{\text{inter } oe - rw}{2};$$

$$Y_I^{oe} = Q_I^{oe} - \frac{t\ oe - rw}{2} + \frac{\text{intra } oe - rw}{2}; \qquad \text{and}$$

$$X_j = Q_j \qquad \text{for } j = oe \text{ and } rw:$$

By doing this, consumption and production satisfy the budget constraints and the feasibility conditions and are consistent with the trade facts.

[32] See Leontief (1953). Trefler (1993) also provides evidence of the abundance of the United States in productivity equivalent labor in the 1980s.

Next, we can calibrate the parameters of our model.

To get the constant shares and σ from the Cobb-Douglas utility function, we use the demand functions (equations 15, 16 and 17). But only two of them are independent. We obtain β from Selvanathan (1984), leaving σ and α as:

$$\sigma = \frac{X_0^* - \beta M^*}{(1-\beta)I^*} \qquad \text{and}$$

$$\alpha = \frac{D^w Y_i^*}{M^* - \sigma I^*}.$$

To get the shares of factors in the production of the homogeneous and non-tradable goods, we use equations (18), (19), (20) and (21), so that,

$$\gamma = \frac{k_0^*}{k_0^* + \ell_0^*}; \qquad \text{and}$$

$$\nu = \frac{k_*}{k_* + \ell_*}.$$

Then by looking at production and factor allocations we get the technological parameters, θ_0 and θ_j, from equations (31) and (33).

$$\theta_0 = \frac{Q_0^*}{k_0^{*\gamma}\ell_0^{*(1-\gamma)}}; \qquad \text{and}$$

$$\theta = \frac{Q_*}{k_*^{\nu}\ell_*^{1-\nu}}.$$

We have left $\psi; \ell_f; \theta_d$ (from the differentiated products' sector) and ρ (from preferences).

From Morrison (1990), we get an estimate for the markup ratio, defined as the price of a typical variety over its marginal cost. From equation (23) we see that the markup ratio is equal to the inverse of ρ.

Next, we solve for the total fixed cost ($D^*\ell_f$) so that the zero profit function is satisfied – equation (24). Therefore,

$$D^*\ell_f = D^*Q_i(1-\rho).$$

Since we have expressed the ¯xed cost in terms of labor, we know that the OECD's total allocation of labor in the manufacturing sector is given by $D^{oe}\bar{l}_{ti} = D^{oe}(\bar{l}_i + \bar{l}_f)$. Since the number of varieties produced is not observable, we do not know the ¯xed cost of a speci¯c variety. We set, therefore, $\bar{l}_f$ such that $\bar{l}_{ti}$ is normalized to 1. Then, the number of varieties produced contains all the relevant information. We ¯nd this by imposing that

$$\bar{l}_f = \frac{D^{oe}\bar{l}_f}{D^{oe}\bar{l}_{ti}}:$$

Then, we get Ã from the demand functions for labor and capital by a single producer of variety i from equation (22), as follows:

$$\frac{D^{oe}\bar{l}_i}{D^{oe}k_i} = \frac{D^{oe}(\bar{l}^{oe}_{ti} ¡ \bar{l}_f)}{D^{oe}k_i} = \frac{1 ¡ Ã}{Ã};$$

and $µ_i$ from equation (32) by setting

$$µ_i = \frac{D^{oe}Q_i}{D^{oe}(k_i^{Ã}\bar{l}_i^{1 ¡ Ã})}:$$

Finally, we need to match the RW factor allocations with the trade facts. By looking at total, intra-industry and inter-industry trade, and since we have normalized total e®ective labor to be 1, we know the number of varieties for the OECD and the RW, the production of a typical individual variety, and its consumption in each region. Speci¯cally, from total e®ective labor ($\bar{l}_{ti}$) in the di®erentiated sector we have D^{oe}. Then, we obtain the consumption of a typical variety in the OECD from

$$Y_i^{oe} = \frac{2toe ¡ oe}{D^{oe}};$$

and with D^{oe} known, we can get the measure of varieties produced in the world, D^w, the consumption of a typical variety in the RW, Y_i^{rw}, and the production of a typical variety, Q_i from:

$$D^w = \frac{D^w Y_i^{oe}}{Y_i^{oe}};$$

$$Y_i^{rw} = \frac{toe ¡ rw}{2D^{oe}}; \qquad \text{and}$$

$$Q_i = \frac{D^{oe} Q_i}{D^{oe}}:$$

The measure of varieties produced in the RW, D^{rw}, is the residual of the measure for the world minus the measure for the OECD.

Finally, we calibrate the endowments for the RW so that they are consistent with the measures of varieties for the world and each region. Endowments in millions of dollars across regions from the data and calibration are as follows: k^{oecd} is 1,994,453 and $\bar{l}^{oecd}$ is 5,798,614 when both ¾ 6= 0 and ¾ = 0; and k^{rw} is 676,814 and 586,620 and $\bar{l}^{rw}$ is 1,417,072 and 1,340,026, when ¾ 6= 0 and ¾ = 0 respectively. We see from these endowments that the OECD is relatively abundant in e®ective labor relative to the RW.

Thus, we have calibrated the parameters, OECD consumption and endowments for the RW so that the benchmark equilibrium is reproduced and the trade facts are matched.

The calibrated parameters for both the nonhomothetic and homothetic versions of the model are presented in Table 2.

Table 2

benchmark parameters	¾ 6= 0	¾ = 0
®	.22	.21
¯	.08	.11
¾	.05	0
½	.83	.83
°	.54	.54
Ã	.33	.33
º	.22	.22
$\bar{l}_f$	.23	.23
μ_0	1.99	1.99
μ_d	2.27	2.27
μ	1.68	1.68
h^{rw}	.3	.3
h^{oe}	1	1

We have calibrated our economy in order to achieve two main goals: ¯rst, to use the model to simulate trade patterns during the last 30 years in order to know how much of the increase in trade between developed countries as a fraction of their income can be accounted for by nonhomothetic preferences; and more generally, to understand better the e®ect of nonhomothetic preferences on trade. By having a calibrated general equilibrium model, we can experiment with di®erent exercises that can provide insight with respect to the effect of preferences on the model.

By quantifying the increase in trade predicted by our model when incomes per capita grow, we do not expect to account for all trade changes during the period under study. Our model only considers differences in relative endowments, economies of scale and nonhomothetic preferences. Clearly other factors – such as seasonal trade, trade restrictions, border trade, cultural differences and policy, among others – can have a significant effect on trade. This latter category of trade determinants will not be addressed directly in this research, but by quantifying the effects of endowments, scale economies, and nonhomotheticity, we can see whether other issues are quantitatively important.

4.2 Quantification of the Trade Facts and Other Results

In this section we will simulate the calibrated economy. The numerical solution to each simulation is obtained by using a globally convergent root finding method based on Newtwon.

We will measure the effect of preferences in trade. First, we will simulate the growth of income per capita that both the OECD and the RW experienced since 1965 and we will examine the evolution of the ratio of trade to income, directions and composition of trade;[33] then, we will adjust the endowments in both regions according to the data minimum growth rate of capital and effective labor, i.e., since capital per capita grew in 1990 3.8 per cent and 2.1 per cent in the OECD and RW, respectively, we will increase the capital endowment of both regions by 2.1 per cent. The endowment of effective labor will be adjusted analogously. In this way, we will look at the effect of nonhomotheticity for giving comparative advantages.

As we just said, we will first adjust the yearly endowment of capital and effective labor to match the change in income per capita that both the OECD and the RW experienced from 1965 to 1990. We use data on non-residential capital stock per worker – that we express in per capita terms – and on income per capita growth from Summers, Heston, Aten and Nuxoll (1995).[34] The growth rate of capital per capita is used to adjust each region's yearly capital endowment. In order to match the growth of incomes per capita, we assume that all technological progress adopts the form of increases in labor productivity, i.e., in h^{oe} and h^{rw}, and therefore, we adjust effective labor per capita per region accordingly. Thus, we change each region's yearly per capita endowment of capital and effective labor and then we look at the model's predictions with respect to trade. The effect of nonhomothetic preferences is captured by simulating both, the calibrated model with $\sigma \neq 0$ (nonhomothetic preferences) and $\sigma = 0$ (homothetic preferences).

As relative endowments change, Heckscher-Ohlin trade patterns alter; when the OECD increases its abundance of effective labor relative to the RW, inter-industry trade increases. As relative GDP changes, the exchange of varieties also changes, which can be thought of as Chamberlainian trade. Thus, the more equal in size two countries are, the more they trade varieties; As the RW's size increases relative to the OECD's size, intra-industry trade between the OECD and the RW increases. Finally, as incomes per capita

[33] 1965 is the first year of capital data that we have.

[34] The numbers have been converted to U.S. dollars adjusting by purchasing power parity rather than by using current exchange rates, as described by Summers and Heston (1991).

grow, by increasing the fraction of income spent on varieties as countries get richer, nonhomothetic trade grows.

Table 3 shows the result of our simulations for a measure of trade to income and of concentration of trade. We report, for di®erent years, the simulated ratios of intra-OECD trade to product and intra-OECD trade to OECD-RW trade.[35] The ¯rst and second columns show the ¯ndings for the nonhomothetic version of the model and the third and fourth for the homothetic version. Finally, the last two columns show the actual data values.

Table 3

Year	$\sigma \neq 0$ F1(%)	F2	$\sigma = 0$ F1(%)	F2	Data F1(%)	F2
1965	9.86	1.16	10.53	1.08	5.13	1.01
1970	10.11	1.18	10.36	1.10	7.66	1.51
1975	9.53	1.05	9.58	1.01	9.21	1.05
1982	9.98	1.01	9.98	1.01	9.98	1.01
1990	10.16	1.15	9.91	1.13	11.29	1.59

Note: F1 is the ratio of OECD-OECD trade to income; F2 is the ratio of OECD-OECD to OECD-RW trade.

As we noted above, 1982 represents the benchmark year. Therefore, for that year, both the homothetic and nonhomothetic model are calibrated to match the actual data. During the whole period under study F1 increased 120 per cent (from 5.12 per cent to 11.29 per cent) and F2 rose 57.4 per cent (from 1.01 to 1.59). The nonhomothetic version of the model predicts a change in F1 of only 3 per cent and a reduction in F2, while the homothetic simulated equilibrium results in a reduction in F1 and an increase of 4 per cent in F2. The evolution of F1 in the model is the result of changes in the relative endowment of each region and the variations in the level of incomes per capita. In fact,

$$F1 = \frac{t^{oe-oe}}{Gdp^{oe}} = \frac{q_i D^{oe} Y_i^{oe}}{2M^{oe}} = \frac{D^{oe}\alpha(M^{oe} - \sigma I^{oe})}{2D^w M^{oe}}.$$

Therefore, if the model is homothetic,

$$F1 = \frac{\alpha D^{oe}}{2D^w}.$$

When both regions become more similar in terms of relative endowments, the share of varieties produced in the OECD decreases. During the periods 1965-70, 1970-75 and 1982-90 this is what happened. Inter-region di®erences in the ratio of capital to e®ective

[35] As we said before, we divide the OECD into two identical subregions in order to generate intra-OECD trade.

labor were reduced. As a result, F1 when $\sigma = 0$ moved accordingly. When $\sigma \neq 0$, however, there is a second effect due to the change in the level of income per capita. As it rises, the share of income spent on varieties increases. Since income per capita increased during each of the subperiods, F1 tended to increase too. During 1965-70 and 1982-90, the latter effect compensated for the former, resulting in an increase in F1. During the 1970-75 period, however, the OECD experienced its lowest increase in income per capita of the whole period and the relative endowment effect dominated.

In summary, the nonhomothetic and homothetic versions of the model predict different patterns for the ratio of OECD trade to income. Overall, the model with $\sigma \neq 0$ does a better job predicting the directional changes of F1 than the homogeneous demand one. Neither one can account for the change in the data, however.

When looking at the concentration of trade among OECD countries, as measured by F2, we find that both versions predict the same directional changes, but again, the nonhomothetic model does a better job accounting for the level change in the data. The change predicted, however, is substantially smaller than the actual one.

$$F2 = \frac{t_{oe-oe}}{t_{oe-rw}} = \frac{q_i D^{oe} Y_i^{oe}}{4 q_i D^{oe} Y_i^{rw}} = \frac{M^{oe} - \sigma l^{oe}}{4(M^{rw} - \sigma l^{rw})}.$$

If $\sigma = 0$,

$$F2 = \frac{M^{oe}}{4M^{rw}}.$$

Therefore, when relative income per capita increases for the OECD, which is what happened during the 1965-70 and 1982-90 periods, F2 will increase. For the other periods the opposite happened. When $\sigma \neq 0$, the model's predictions are amplified. A nonhomothetic economy predicts larger fluctuations in the ratio of intra-OECD to OECD-RW trade than a homothetic one. In the actual data, F2 moved in the same direction, but as before, with much more amplitude than the nonhomothetic prediction.

These results are robust in the sense that for reasonable changes in the value of the free parameters, namely β, ρ and h^{oe}, h^{rw} – the only parameters that are not endogenously determined from the model, the predictions of the model are not significantly affected, as shown by Table 4.

Table 4

Year	$\beta = .5$		$\rho = .95$		$\rho = .66$		$h^{rw} = .1$		$h^{rw} = .5$	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
1965	9.38	1.27	9.92	1.17	9.93	1.17	8.63	1.69	10.14	1.11
1970	9.94	1.29	10.27	1.21	10.24	1.2	9.42	1.49	10.31	1.16
1975	9.50	1.09	9.67	1.07	9.52	1.05	9.08	1.13	9.61	1.04
1982	9.98	1.01	9.98	1.01	9.98	1.01	9.98	1.01	9.98	1.01
1990	10.35	1.17	10.16	1.15	10.16	1.15	10.28	1.12	10.01	1.17

$\beta = .5$ is consistent with a higher level of nonhomotheticity, i.e., with a higher σ; when ρ is .95 and .66, the markup is 5 per cent and 50 per cent respectively; finally, when h^{rw} is .1 and .5, a unit of labor in the RW is one tenth and one half as productive as a unit of labor in the OECD. These values for the free parameters do not cause the predictions of the model to change significantly, as we just said.

In addition, we can look at the model's predictions with respect to the ratio of OECD-RW trade to OECD income (F3), OECD-RW inter-industry trade to OECD income (F4), and OECD-OECD to OECD-RW intra-industry trade (F5). Table 5 reports these measures.

Table 5

Year	$\sigma \neq 0$			$\sigma = 0$			Data		
	F3(%)	F4(%)	F5	F3(%)	F4(%)	F5	F3(%)	F4(%)	F5
1965	8.51	6.77	5.66	9.75	9.48	38.2	5.08	4.13	5.42
1970	8.56	7.27	7.87	9.39	8.41	10.5	5.09	3.83	6.09
1975	9.08	5.08	2.38	9.45	5.34	2.33	8.76	7.07	5.44
1982	9.87	7.38	4.01	9.87	7.38	4.01	9.87	7.38	4.01
1990	8.82	6.71	4.78	8.75	5.98	3.58	7.13	3.35	2.99

Note: F3 is the ratio of OECD-RW trade to OECD income; F4 is the ratio of OECD-RW inter-industry trade to OECD income; and F5 is the ratio of OECD-OECD to OECD-RW intra-industry trade.

To understand the effect of changes in endowments on relative intra-industry trade we can look at the ratio of intra-industry trade between the OECD and the RW to the total trade between them. This measure is known as the Gruebel and Lloyd index IIT.[36] In this model, the IIT index is given by

$$IIT_{oe-rw} = \frac{D^{rm}Y_i^{oe}}{D^{oe}Y_i^{rw}}.$$

Therefore, if the measure of varieties produced in the RW (OECD) increases, ceteris paribus, the index increases (decreases). This happens because the RW produces fewer varieties than the OECD and intra-industry trade is defined as the minimum between $D^{oe}Y_i^{rw}$ and $D^{rw}Y_i^{oe}$. Furthermore, it can be shown that if $\sigma = 0$, proportional changes in capital and effective labor in both regions do not affect this index. If $\sigma \neq 0$, however, population must also change proportionally to get the same result. Finally, since trade must be balanced, changes that increase the number of varieties produced in the OECD and reduce inter-industry trade – like an increase in the endowment of capital in the effective labor abundant OECD – will create an increase in the level of intra-industry trade between the OECD and the RW. Since countries are relatively more similar in terms of endowments, Heckscher-Ohlin trade decreases, but since varieties are consumed everywhere, exports from

[36] See Gruebel and Lloyd (1975).

the OECD to the RW increase, and the exports of varieties from the RW to the OECD must do so too.

Table 6 shows the simulated values for the previous trade measures when factors were adjusted, holding comparative advantages unchanged.

Table 6

Year	F1(%)	F2	F3(%)	F4(%)	F5
1965	9.40	1.08	8.72	5.11	2.61
1970	9.65	1.05	9.19	6.07	3.08
1975	9.83	1.03	9.57	6.80	3.55
1982	9.98	1.01	9.87	7.38	4.01
1990	10.04	1.00	10.0	7.63	4.24

When preferences are homothetic, since neither relative income per capita across regions nor the relative abundance of endowments has changed, all measures stay constant. For ¾ 6= 0, since incomes per capita increase consistently over time, all measures change monotonically during the period under study. Every year represents a higher level of income per capita than the previous one and is associated, therefore, with higher trade to income for OECD countries, smaller trade within the OECD relative to OECD-RW and higher trade OECD-RW and intra-OECD intra-industry trade relative to OECD-RW. In this case, the proportional change in endowments does change the relative size of countries, however. This a®ects the ratio of intra-industry trade, as we noted above.

The model's predictions with respect to the income distribution e®ects of trade liberalization are consistent with the conclusions that would be inferred from a pure monopolistically competitive economy. Since inter-industry trade is reduced relative to the case with homotheticity, and since each region tends to import the good that it produces with a comparative advantage, the real change in factor returns predicted by a Heckscher-Ohlin economy is not so signi¯cant. This is consistent with evidence from the European Community creation and the North American auto pact. It is important to mention, however, that the assumption of constant marginal cost, together with the CES structure in the subutility for varieties results in an economy that is characterized by no competitive gains when engaging in trade; i.e., any bene¯t due to trade is in the form of an increase in varieties available for consumption. Trade does not increase the scale of production of any variety, even though it is scale economies that are responsible for the gains from trade.

Finally, it can be noted that the nonhomothetic model's prediction with respect to terms of trade is consistent with the evolution observed in the data. The price of the homogeneous tradable good, p_0, decreases consistently during the period under study, denoting the deterioration in terms of trade experienced by less developed countries since the 1930s.[37]

In summary, the model's prediction with respect to the evolution of trade relative to product and the concentration of trade improves, in terms of the directional change,

[37] See Borensztein et al. (1994)

when nonhomothetic preferences are assumed. How much of the data changes can be accounted for by these feature? Not much, however. The data show changes in the previous two measures of trade that are larger than the ones predicted by the model by a factor of 10 and 5 respectively. Shocks like the increase in the price of oil and the regionalization of the world economy { especially as a result of the European Economic Community creation { may have had an e®ect in the pattern of trade that fundamentals in general { and nonhomothetic preferences in particular { cannot account for.

5. Conclusions

Our main goal has been to measure how much of the increase in the volume and concentration of trade seen during the post World War II period can be accounted for by considering preferences as a \non-trivial" determinant of trade. In order to do so, we introduced a model where trade is explained by di®erences in relative autarky prices { due to country speci¯c relative endowments, economies of scale and love for variety, and nonhomothetic preferences.

The world is separated into two regions: the OECD and the RW. The OECD has a comparative advantage in the production of manufactures and the RW in the production of a primary product. In addition, there is a non-tradable homogeneous commodity that is associated with non-tradables and services in the data. Manufactures take the form of varieties in a monopolistically competitive sector and are characterized by a high income elasticity of demand; the primary product is represented by a homogeneous good competitively produced and is characterized by a low income elasticity of demand. Therefore, as the level of income per capita grows, the consumption of manufactures as a fraction of income increases. Since production of varieties is highly specialized, trade of manufactures as a fraction of total trade increases. Furthermore, if income per capita for the OECD increases relative to the RW, trade concentrates there. In fact, during the 1965-90 period incomes per capita increased 87.7 per cent and 71.9 per cent in the OECD and the RW, respectively. If the model were homothetic, the increase in income per capita levels would have no e®ect on the ratio of trade to product, as long as relative endowments and size stay unchanged across regions. Since consumption patterns are a®ected by income, however, a homothetic model will omit this e®ect on trade patterns. Finally, when a rich country has a comparative advantage in the production of the high income elasticity good, each country tends to import its Heckscher-Ohlin exported good. With nonhomotheticity, therefore, inter-industry trade is reduced relative to the case with homogeneous demands. This seems consistent with the directional changes of the post World War II trade patterns. But how important is it quantitatively?

We simulate this economy by adjusting capital and e®ective labor in per capita terms in both regions to match changes in income per capita, and then look at the predictions of the model with respect to di®erent measures of trade. The calibrated model, however, is not able to account for a substantial part of the change in trade. Neither the increase in trade as a fraction of income nor the concentration of trade among developed countries can be signi¯cantly accounted for by this model. In fact, while the ratio of intra-OECD trade to OECD income increased from 5.1 per cent to 11.29 per cent during the 1965-90 period, the nonhomothetic version of the model predicts a change from 9.86 per cent to 10.16 per cent. The model's predictions are more accurate during the 1975-90 period but still only account for 6.6 per cent of the 22 per cent change observed in the data. With respect to the concentration of trade among OECD countries, while the data shows an increase in the ratio of intra-OECD trade to OECD-RW trade from 1.009 to 1.51 and 1.01 to 1.59 during the 1965-70 and 1982-90 periods, respectively, the nonhomothetic model predicts changes from 1.16 to 1.18 and 1.01 to 1.15. This model, therefore, is not able to account for the growth in trade observed during the last 30 years.

How surprising is this? Not particularly, when we consider that the ratio of trade to product at the end of the nineteenth century was higher than it is today. In fact, the levels of trade and concentration among developed countries that characterized the world during the last century have not been achieved again, even after 40 years of continuous growth in trade. If nonhomothetic preferences were significantly driving the patterns of trade, trade should have been much lower and less concentrated 100 years ago than it is today. So why was trade so high and concentrated during the last century? And why has trade increased so fast since the 1950s? Many elements seem to be important for explaining these patterns. As we mentioned in Bergoeing (1996), for example, the Industrial Revolution and the changes in the production and consumption structure that followed did play a key role. In addition, the evolution of trade policy seems to have been crucial. Low restrictions during the nineteenth century – and in particular by the 1860s – may have been fundamental for the determination of the level of trade. Since the 1950s, the reduction in manufacturing restrictions, mainly among developed nations, and the increase in regional trade, emphasized by the creation of the European Community, may have played a crucial role. In fact, during the 1953-90 period, over 40 per cent of the total increase in world exports is the result of the rise in intra-European trade alone.

Our results, however, can be affected by some theoretical and empirical limitations. The model is static. It might be interesting to introduce a dynamic setting and study the nonhomothetic transition toward a balanced growth path, allowing for capital accumulation. Moreover, this model not only omits trade policy but also other important elements, such as seasonal trade, border trade and cultural differences. Finally, the specific functional forms chosen, although simplifying the model's solution, impose restrictions on different areas: The Klein-Rubin type of function is characterized by linear consumption expansion paths. Empirical research, however, suggests that Engel curves show curvature;[38] the income elasticity of the inferior good increases with income per capita introducing more sensitivity to income per capita levels in poor countries than in rich ones. This may explain the fact that in the model the RW tends to increase its trade of differentiated products more than the OECD does; Economies of scale result from the fixed cost in the differentiated products sector; this cost is expressed in terms of labor. By considering a fixed capital cost, as well, the importance of intra-industry trade could increase. We have assumed the existence of only two factors of production, capital and labor. By having a third factor – land for example – that could be sector specific, decreasing returns would be emphasized. Gains from trade take the form of increasing variety exclusively, the level of production does not change. Finally, with respect to the assumption of the monopolistically competitive sector,

[38] See Yen and Roe (1989).

few industries in the world are well described by this model. The model assumes that a ¯rm behaves as if it were a true monopoly. Instead, the most common market structure is one of small-group oligopoly. In this setting ¯rms may engage in collusive and strategic behavior.

With respect to the empirical analysis, problems arise as a result of the interpretation of the data for the calibration. One of the most controversial features in the data has to do with the fact that less developed countries seems to be abundant in capital and developed countries in labor. As we saw before, however, we interpret labor as e®ective units and as in Leontief (1953) and Tre°er (1993), we say that the OECD is abundant in e®ective units of labor, even though the RW is abundant in people, for example.

As we just said, however, the model provides a plausible theoretical explanation of trade patterns. In particular, this model give us some insight to understand the e®ect of fundamentals in trade patterns. Trade of manufactures as a share of total trade has consistently increased since the beginning of the Industrial Revolution. Speci¯cally, as income per capita rises, the demand for manufactured consumer goods, capital goods, and services increases while the demand for food and clothing decreases. These changes in consumption patterns in°uence the structure of both domestic consumption and production and a®ect the volume, direction and composition of international trade. Moreover, trade seems to move faster than production during episodes of stable economic environment. These facts are consistent with the introduction of nonhomotheticity in a model of the kind presented in this paper.

Furthermore, there is evidence that trade liberalization is less disruptive than predicted by comparative advantage based models, as we have seen with the European experience and the North American auto pact. Models of monopolistic competition are consistent with this feature, and the introduction of nonhomotheticity moves in the same direction since inter-industry trade { which causes factor returns to change { is reduced. It would be interesting to quantify this e®ect; i.e., does this model improve the prediction with respect to the income distribution e®ects of trade liberalization relative to a homothetic model with a Heckscher-Ohlin and monopolistically competitive structure?

Summarizing, even though the theoretical implications of the model may help us to understand the evolution in trade patterns, the model is unable to explain a substantial part of the change in the post World War II level of trade. Restrictions and trade agreements may be crucial to account for these patterns. Our concern should then be, how important has policy been for the evolution of trade levels? This question seems crucial and should receive more attention.

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