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International Trade and Real Wages*

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ABSTRACT

The facts indicate that real wage rates tend to be homogenous within the First World, but they exhibit significant differences between the First World and the Third World. The standard neoclassical trade model predicts real wage equalization across countries. This prediction is consistent with the first fact, but is refuted by the second. On the other hand, the standard Ricardian model does not predict real wage equalization, so in principle these facts do not refute the model; however, it is unable to explain the wages-profits distribution. This paper proposes a *generalized Ricardian trade model*, which solves this theoretical difficulty. The generalized model is able to explain both facts about real wages and international trade. On epistemological grounds, the Ricardian theory proves to be superior to the neoclassical theory.

Keywords: Factor price equalization, labor productivity differences, real wage rate differences, neoclassical trade model, Ricardian trade model.

JEL Codes: F11, F16

Comercio internacional y salarios reales

RESUMEN

Los datos indican que los salarios reales tienden a ser homogéneos dentro de los países del Primer Mundo pero muestran una diferencia significativa entre los países del Primer Mundo y los del Tercer Mundo. El modelo estándar de la teoría neoclásica del comercio internacional predice que los salarios reales tienden a igualarse entre países. Esta predicción es consistente con el primer hecho pero es refutada por el segundo. Por otro lado, el modelo estándar de la teoría ricardiana del comercio internacional no predice tal igualación de salarios reales y entonces, en principio, los hechos no lo refutan; sin embargo, no puede explicar la distribución entre salarios y ganancias. El presente artículo propone un modelo ricardiano generalizado que resuelve esta dificultad teórica. El modelo generalizado puede explicar ambos hechos sobre los salarios reales y el comercio internacional. Sobre fundamentos epistemológicos, la teoría ricardiana resulta siendo superior a la neoclásica.

Palabras clave: igualación de precios de factores, diferencias en productividad laboral, diferencias en tasas de salarios reales, modelo neoclásico de comercio, modelo ricardiano de comercio.

Códigos JEL: F11, F16

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1. INTRODUCTION

Differences in real wage rates between the First World and the Third World are a feature of the capitalist system. How significant are these differences? Data on real wage rates by countries are scarce. ILO (2010) has published a dataset that covers a large sample size of countries, but for minimum real wage rates only. Based on this source, Table 1 presents information for 90 capitalist countries around the world for 2009. We know that labor markets operate with scales of salaries and wages, whereby the bottom of the scale refers to minimum wage rates, which apply mostly to low-skill workers. Considering that relative real wage rates along the scale remain constant or do not change drastically, minimum wage rates can be taken as a good indicator of the differences in the level of real wage rates between countries.

As can be seen in Table 1, differences in the monthly minimum wages for comparable labor skill levels—unskilled workers in this case—are very significant *between* the First World and the Third World. The gap is around six times. Another feature of Table 1 is that minimum real wages *within* First World countries are more homogenous, with lower coefficient of variability (0.24), compared to that of Third World countries (0.75).

The US Bureau of Labor Statistics reports average hourly costs of labor (including all skill levels—that is, in wages and salaries) in the manufacturing sectors of several countries, measured in current US dollars. The 2010 Report includes data for 21 First World countries and only eight for the Third World. There is a wide dispersion: from 58 dollars in Norway, 35 dollars in the US, and 29 in the UK, down to 10 dollars in Brazil, 6 dollars in Mexico, and only 2 dollars in Philippines (BLS, 2011, Table 3). The fact is that average labor costs in the manufacturing sector are significantly higher in the First World compared to the Third World, which underlines the validity of using the data shown in Table 1 as an indicator of real wage-level differences across countries. Likewise, the calculations made by Trefler (1993, Table 1) for a sample of countries also showed significant differences in real wages between First World and Third World countries for 1983.

The gaps shown above refer to given years. The question that remains is whether they are widening or closing. Empirical studies seeking to answer this question are scarce. However, the magnitudes of the observed gaps are high enough—six to seven times for both minimum wages and industrial wages—to justify an explanation of the observed differences in real wages. Why does the gap in real wage rate *levels* persist between the First World and the Third World after so many years of trade and increasing globalization? Globalization, measured by world trade/GDP ratio, was 15% in 1985 and went up to 30% around 2005 (Docquier & Rapaport, 2012, Figure 1, p. 682).

To be sure, differentials in relative wage rates between the skilled and the unskilled is not the objective of the paper. Rather, it deals with the problem of explaining the observed real wage rate differentials for given skills across countries, and in particular between the First World and the Third World.

Table 1. Minimum Real Wage Rates in the Capitalist System, 2009

Regions	Number of countries	Minimum real wage rate (US dollars/month, PPP)		
		Mean	SD	SD/mean
First World	**15**	**1,284**	**304**	**0.24**
Third World	**75**	**229**	**171**	**0.75**
Africa	35	139	96	0.69
Asia	16	198	129	0.65
Latin America	24	377	186	0.48

Note: The source included 17 countries in the First World, but Israel and South Korea (middle-income countries according to the World Bank, 2010) have been excluded here; it also included 18 countries in Asia, but China and Vietnam (non-capitalist countries) have been excluded here. SD stands for standard deviation.
Source: ILO, 2010, Table SA2, pp. 116-119.

The answer to a "why" question requires a scientific theory. As we know, the standard trade literature presents two theories: Neoclassical and Ricardian. Both share the common view that international trade patterns are explained by comparative advantage, but they assume different sources of comparative advantage: factor-endowment differences in the former case, and differences in labor productivity in the latter.

The standard neoclassical model predicts real wages equalization across countries. There are few empirical studies that attempt to falsify this prediction. For a sample of only seven countries—all of them in the First World— for the period 1960-1991, the study of Doroodian and Jung (1995) found empirical consistency with this prediction. However, the neoclassical model is refuted by the magnitudes of the real wage gaps between the First World and the Third World shown above. In turn, the standard Ricardian model may not be refuted by the facts shown above, but it is unable to explain wage-profit distribution. Thus, new Ricardian trade model that resolves this theoretical difficulty is needed. This paper proposes such model.

The paper is organized as follows. Sections 1 and 2 summarize the standard static models of neoclassical and Ricardian trade theories to ensure that the paper is self-contained. A new generalized Ricardian model, capable of explaining income distribution and real wage differences under international trade, is developed in section 3. Section 4 discusses the long-run analysis. Section 5 compares the two trade theories. Section 6 concludes.

2. NEOCLASSICAL MODELS

The Standard Heckscher-Ohlin-Samuelson (HOS) Model

The neoclassical theory assumes that international trade is governed by the comparative advantage principle, which is rooted in the factor endowment differences of countries. It also assumes the same technology across countries and that goods are produced

with different factor intensities. Countries are similar in every respect, except in their endowments of factors of production, such as capital, labor, and land.

The standard trade model—also called the HOS model—is an extension of the standard neoclassical general equilibrium model (with Walrasian markets) applicable to the international trade of goods. The model seeks to explain inter-industry trade. The HOS model also assumes that market forces will lead to particular *pre-trade* relative prices. The relative price of labor-intensive goods (relative to the price of capital-intensive goods) in labor-abundant countries will be cheaper than it is in capital abundant countries. Therefore, countries will have incentives to trade, and will ship goods from cheaper sources to more expensive destinations. Thus, international competition will equalize relative prices across countries, which will lie somewhere between the pre-trade relative prices.

In short, the HOS model includes the following assumptions:

A. Technology is uniform everywhere and exhibits constant returns to scale;
B. Countries differ in their factor endowments;
C. Perfect competition reigns everywhere;
D. Full employment reigns everywhere, for labor markets are Walrasian;
E. All goods are tradable and are produced with different factor intensities.

Thus, using these assumptions, the model can generate the following empirical predictions:

(1) Relative prices of goods traded are uniform everywhere (net of transportation costs);
(2) Countries export goods that make more intensive use of the factor with which they are relatively more endowed;
(3) Relative factor prices are uniform everywhere; moreover, not only are relative factor prices equalized with trade, but real wage rates are also equalized across countries (which is called the "factor-price-equalization theorem" in the literature).

One property of the model is that in each country there is a relationship between relative product prices, relative factor prices, and factor intensities, and this relationship is similar across countries. Given that equilibrium under free trade implies equality in the relative prices of goods across countries, then it follows that there will be equalization in relative factor prices across countries and equalization in industry-specific factor intensities across countries.

Given the assumption of equality of technology in constant returns to scale everywhere, at uniform relative factor prices, countries will produce two goods, so specialization is only partial; moreover, each good will be produced with the same factor intensity across countries, which implies equality of average labor productivity in each industry across countries. Profit-maximizing firms will equalize the market real wage to the marginal productivity of labor, which is a fraction of average labor productivity;

thus, *the equality in real wage rates across countries follows from the equality of average labor productivity in each industry*.

This result can be readily proven as follows. Consider the standard trade model of two countries (H and F), two goods (B and C), and two production factors, capital (K) and labor (L). Then, for the output of good C (called Q_c) in country H, we can write the production function, which is homogeneous of degree one, as follows:

$$\lambda Q_c = \Phi (\lambda L_c, \lambda K_c) \tag{1}$$

From Euler's theorem, it follows that

$$Q_c = (\partial Q_c/\partial L_c)\, L_c + (\partial Q_c/\partial K_c)\, K_c \tag{2}$$

Dividing by L_c and rearranging terms, we get

$$Q_c/L_c = (\partial Q_c/\partial L_c) + (\partial Q_c/\partial L_c)\, [(\partial Q_c/\partial K_c)/\, (\partial Q_c/\partial L_c)]\, (K_c/L_c) \tag{3}$$

$$= (\partial Q_c/\partial L_c)\, [1 + (r/w)\, (K_c/L_c)] \tag{4}$$

Good C is also produced in country F and using the same technology, that is, the same production function Φ. Thus, a similar equation—with the notation $(Q_c/L_c)^*$—can be written for country F, denoted by asterisks.

Trade equilibrium implies equality in the relative prices of goods (set for convenience equal to 1), which implies equality in the relative factor prices $(r/w) = (r/w)^*$ across countries (relative factor price equalization), which in turn implies equality in factor intensity $(K_c/L_c) = (K_c/L_c)^*$ as well. The latter in turn implies equality in average labor productivity $(Q_c/L_c) = (Q_c/L_c)^*$; hence, from equation (4), it follows that $(\partial Q_c/\partial L_c) = (\partial Q_c/\partial L_c)^*$ and thus $w = w^*$.

According to the HOS model, therefore, the flow of goods between countries is a perfect substitute for the direct movement of factors between countries. This is why real wages are equalized between countries through trade: free trade of goods is equivalent to free migration of workers. Income distribution in each country is thus determined by the trade specialization.

When the predictions of the HOS model are confronted with facts, prediction (3) tends to be consistent within First World countries, but not between the First World and the Third World, as shown above. On epistemological grounds, this is sufficient reason to reject the HOS model.

Any other neoclassical model of trade will also fail. The reason is that any such model will have to maintain the assumptions of the neoclassical trade theory, namely that countries are equal in every respect except in the *quantities* of factor endowments; that is, partner countries are *qualitatively* homogenous societies. Therefore, any neoclassical model would arrive at the same prediction: real wage-rate equalization. Extended models are presented in Deardorff (1994). Thus, we can dismiss the neoclassical trade *theory* as well as the HOS *model*.

Intra-industry Trade: Increasing Returns Model

The increasing returns model seeks to explain intra-industry trade. It assumes that trade is explained by the existence of technology of increasing returns or economies of scale in the production of goods, where increasing returns refer to economies of scale that are internal or external to firms. This model modifies the aforementioned assumption A.

The existence of economies of scale internal to a firm in the production of a particular good implies the following relationship: The higher the level of the firm's output, the higher its productivity level and the lower the average cost of producing the good. Firms in different countries that can produce this good would seek international markets to achieve gains in productivity. Hence, the good could be produced in any country. The usual specialization hypothesis is that large countries will naturally produce the good for the domestic market and will then will conquer international markets. How, then, is trade possible for the same good? There will be monopolistic competition in the international market, which includes product-differentiation strategies by firms.

External economies of scale imply economies of scale external to a firm but internal to the industry, which will also generate higher productivity at firm levels when the industry is large. The firm's level of productivity and the average cost depends not only on the firm's level of output, but also upon the industry's level of output. The concentration of production of a good in some countries will reduce the average cost and thus these countries will seek to sell the good in international markets. Countries that were the first to start producing the good—due to some historical accident—will tend to export the good and will tend to continue doing so. Other countries cannot replicate this production history and will tend to remain as importers. Thus, there is path dependence in international trade—that is, history matters.

However, the model cannot explain specialization by countries. The sources of competition between countries are not identifiable (Krugman & Obstfeldt, 2009, p. 132). There are no exogenous variables, nor causality relations. Thus, this model is not empirically falsifiable; consequently, it must be abandoned. In addition, intra-industry trade constitutes a small fraction of world trade (around 25%), and is largely restricted to First World countries (Krugman & Obstfeldt, 2009, p. 132). Therefore, this supports the earlier conclusion that the neoclassical theory of trade should be rejected.

3. THE STANDARD RICARDIAN TRADE MODEL

According to Ricardian trade theory, comparative advantage between countries stems from differences in relative labor productivities. The theory assumes that countries have labor as the sole scarce factor of production; moreover, countries differ in their relative labor productivities, for technologies differ across countries.

The standard Ricardian trade model assumes average labor productivity that is constant and exogenously given for each good and each country. Market forces will

lead to differences in *pre-trade* relative prices, which reflect differences in relative labor productivity. In countries in which the ratio of labor productivity for good B to labor productivity for good C is higher than it is in the rest of countries, the pre-trade price ratio of good B to good C will be lower than it is in the other countries. Hence, the first group of countries has a comparative advantage in good B—that is, its relative labor productivity in good B is higher than for good C. Therefore, there are incentives to trading these goods between countries, and international competition will lead to relative prices equalization of goods, which will fall somewhere between the pre-trade relative prices.

The standard Ricardian model includes the following auxiliary assumptions:

a. Labor is the only production factor and technologies are different across countries, so average labor productivity is constant and exogenously determined in every industry and every country.
b. Full employment of labor reigns everywhere;
c. Perfect competition reigns everywhere;
d. All goods are tradable.

Thus, the model generates the following empirical predictions:

(i) Relative prices of goods traded are uniform across countries (net of transportation costs);
(ii) Countries export those goods in which the *relative* labor productivity is higher than it is in other countries;
(iii) Real wage rates are not equalized across countries.

These predictions can be proven easily using the model presented in Krugman and Obstfeld, (2009, Chapter 3). Thus, consider a world of two goods (B and C), two countries (H and F), and one type of labor (L). Let a_{Lj} represent the average labor productivity of good j in country H, whereas a^*_{Lj} (with asterisk) will refer to country F. Hence, by assumption:

$$(a_{Lc}/a_{Lb}) < (a^*_{Lc}/a^*_{Lb}) \text{ or } (a_{Lc}/a^*_{Lc}) < (a_{Lb}/a^*_{Lb}) \quad (5)$$

Thus, home country H has a comparative advantage in good C and foreign country F in good B. Before trade, relative prices (P_b/P_c) in each country reflect relative labor costs.

Thus,

$$(P_c/P_b) = (a_{Lc}/a_{Lb}) < (a^*_{Lc}/a^*_{Lb}) = (P^*_c/P^*_b) \quad (6)$$

Good C is thus relatively cheaper in H; hence, there are incentives to ship good C from the cheaper source H to the more expensive country F. Equilibrium relative price for both countries in the trade situation $(P_c/P_b)^0$ will then lie somewhere between pre-trade relative prices, as follows:

$$(P_c/P_b) < (P_c/P_b)^0 = (P^*_c/P^*_b)^0 < (P^*_c/P^*_b) \quad (7)$$

Consequently, country H specializes in producing good C, and country F specializes in producing good B. Trade equilibrium implies complete specialization.

Average labor productivity or output per worker must be equal to real wage rate because labor is the sole production factor. Given that good B is produced in country F and good C in country H, we have

$$w^*/w = (1/a^*_{Lb}) / (1/a_{Lc}) \tag{8}$$

Because average labor productivity is just the inverse of labor coefficients per unit of output, real wage rates (w^*/w) will be proportional to relative labor productivities in the two goods exchanged by the two countries.

Let us consider the following numbers for the labor coefficients (also taken from Krugman and Obstfeldt, 2009, Chapter 3):

$$a_{Lb} = 2,\ a_{Lc} = 1,\ a^*_{Lb} = 3,\ a^*_{Lc} = 6 \tag{9}$$

Country H uses lower quantities of labor per unit of output in both industries than does country F; therefore, country H has absolute advantage in both goods. Because the difference is greater in good C, country H has a comparative advantage in good C. Using equation (6), we can see that the relative price of good C in terms of good B is ½ in country H and 2 in country F.

Let the *trade equilibrium relative price be equal to 1*, simply by choosing the appropriate units in which goods are measured. Now it can be shown that real wage rates are indeed proportional to average labor productivities, as shown in equation (8). The relation between real wages is not a pure number, but it holds true regardless of the units of measurement utilized, either measured in units of good B or in units of good C, by setting relative prices of goods equal to one. Thus, the relation can be explained as follows:

> In country H, output per worker is equal to one unit of good C, which in the market can be exchanged for one unit of good B; hence, a worker produces one unit of good B indirectly; therefore, the real wage rate (equal to output per worker) is one, measured in units of good C or B. In country F, output per worker is equal to 1/3 of a unit of good B, which in the market can be exchanged for 1/3 units of good C; hence, a worker produces 1/3 of good B indirectly; therefore, the real wage rate is 1/3, measured in units of good B or C.

Therefore, the real wage rate in country H is three times higher than it is in country F; and average labor productivity in country H is also three times higher than it is in country F.

As to empirical refutation of the standard Ricardian model, prediction (ii) is consistent with the results of empirical studies: indeed, countries export those goods that are subject to higher relative labor productivity than in the case of their partners,

as reported in two of the most popular textbooks: Krugman and Obstfeld (2009, Figure 3-6, p. 49), and Carbaugh (2011, Figure 2-9, p. 57). Prediction (iii) is not refuted by facts, as shown in Table 1 above. The limitation of the Ricardian standard model is that it leaves income distribution between wages and profits unexplained.

4. A GENERALIZED RICARDIAN TRADE MODEL

In this section, a new Ricardian model is constructed. Its purpose is to show that, under less restrictive assumptions, the basic predictions of the standard model will remain unchanged, but the new model will be able to explain income distribution.

Assumptions of the generalized model

The new model retains the assumptions of the standard one, except that assumption (a') will substitute (a). Instead, it assumes a production process in which labor productivity will reflect the effect of non-labor production factors as follows:

> (a') Production of goods requires labor and non-labor factors. Technologies are different across countries, so that the *levels* of average labor productivity by industries differ across countries.

The most common non-labor factors in the literature include physical capital, human capital, natural resources, and technological knowledge. Public goods in the form of infrastructure is also standard. Moreover, social order as a public good and as factor of production has been introduced in some theoretical models, and is used to refer to the quality of society. The lower the social order, the more interruptions there will be in the economic process, which must be repeated period after period. Social order depends upon the degree of income inequality, which in turn depends upon the initial inequality in the individual distribution of economic and political assets in society, known as initial inequality (Figueroa, 2015, Vol. 1).

Let us assume the following set of essential non-labor factors of production with which workers are equipped:

- Technology
- Physical capital
- Human capital
- Infrastructure capital
- Natural resources
- Social order or initial inequality

Hence, in the production process, workers are equipped with technology, factor endowments, and social order, the relevant exogenous factor of which is the initial inequality in the individual distribution of economic and political assets.

In the short run, in which the above set of non-labor factors remains constant, the number of workers employed will have an effect on labor productivity, which is positive and subject to generalized diminishing returns. This is due to the assumptions of both the variable factor proportions and the differences in the quality of natural resources, the Ricardian diminishing returns. At the industry level, under this set of assumptions, the same individual worker will contribute to the production of output to varying degrees, depending on both the quantity of non-labor factors with which the worker is equipped, and on the number of other workers with which he or she cooperates. In the economic process, labor productivity is not worker-specific; it is an economic and social category.

Therefore, average labor productivity in the short run can be represented as a curve that declines as more workers are employed. The position of this declining curve can be defined as the *level* of average labor productivity in the industry. The labor productivity level is determined by the given values of the non-labor factors. Therefore, exogenous changes in market prices and wage rates will lead the industry to change the number of workers employed, which implies changes in the coefficient of labor productivity along the *given* curve of the labor productivity level.

The standard assumption of profit maximization behavior by firms implies, in the short run, that firms will employ workers up to the number at which the real wage rate is equal to the marginal productivity of labor. In order to satisfy the second order conditions of this maximization problem, the model assumes generalized diminishing returns—due to variable factor proportions and Ricardian diminishing returns, as stated above—which implies that at equilibrium, marginal productivity of labor is smaller than average productivity.

In a competitive labor market, the demand for labor will be equal to the aggregate marginal productivity of labor, which together with the given quantity of labor supplied will determine the real wage rate, assuming (just for the sake of simplicity and to comply with the full employment assumption) that the labor market is Walrasian. Therefore, the market real wage rate is equal to the marginal productivity of labor, which is a fraction of the *average* productivity of labor—that is, profits originate from the gap between the real wage rate and average labor productivity.

The assumption of classical economics that labor is the essential factor of production must be taken not in a metaphysical sense, but analytically. This assumption implies that the efficiency of the production process is better reflected by output per worker, rather than by output per machine or output per hectare, or by total factor productivity. There is a hierarchy among production factors with labor as the primary factor. For one thing, non-labor factors contribute to production through the intelligence, talents, skills, creativity, and drives of human labor. The production process is, after all, a human activity. Thus, qualitatively, labor is the agent of non-labor factors, not the other way around. Labor is not only essential but also indispensable, so that zero labor input means zero total output, which may not be the case with the non-labor production factors.

On the other hand, labor is a primary factor in the sense that all other material inputs going into the production process are also produced with labor; hence, the total labor content of goods is the sum of the direct and the indirect labor quantities utilized in its production. Coefficients a_{Lj} and a^*_{Lj} shown in equation (5) above can now be understood in this manner. The consolidated, total labor content of goods is quantitatively more significant than the total content of any non-labor factors of production. It is in these analytical concepts that the Ricardian trade theory assumes that labor is the sole scarce factor of production. It is *as if* labor were the only factor of production.

We may call this the *generalized Ricardian trade model*, for it relaxes the assumption of the fixed and exogenously determined labor coefficient that is assumed in the standard Ricardian model. It is a short-run model. The curve showing the level of the average labor productivity is exogenously determined, whereas the labor coefficient is endogenously determined, along the given curve.

Figure 1 illustrates the generalized Ricardian model. For the sake of clarity, let us consider first the standard Ricardian model. Panel (a) shows the differences in the average labor productivity in good B between the two countries. Panel (b) does the same for good C. The labor productivity values represented in Figure 1 are those derived from the technological labor coefficients shown in equation (5) above, but are now interpreted as *total* (direct and indirect) labor coefficients. Thus, by assumption, the differences are such that country H is more productive in the case of both goods, but the difference is higher for good C. Hence, country H has an *absolute* advantage in both goods and a *relative* advantage in good C; thus, country H will specialize in producing good C and country F in good B. For the sake of simplicity, let both countries be endowed with the same quantities of labor, equal to L'. Thus, points F and H indicate the production equilibrium situations under international trade.

In order to represent the new Ricardian model in Figure 1, let us substitute the assumption of fixed average labor productivity for variable values, and let the average labor productivity curves go through points F and H. Thus, curve B^* represents the *level* of average labor productivity of good B in country F, and curve C that corresponding to good C in country H. These curves are given in the short run. The equilibrium situations are also at points F and H.

Figure 1 shows that country H has higher levels of average labor productivity in both goods compared to country F, and are given. However, these level differences in labor productivity assume that country H is more endowed with the non-labor factors listed above, which are exogenously determined, and are fixed in the short run, which in turn implies a given level of labor productivity. These country endowments of non-labor factors constitute a vector and will be called E for home country H; and E^* for foreign country F, such that $E>E^*$. The labor productivity curves shown in Figure 1 have these endowments as the parameters that fix the level of each curve.

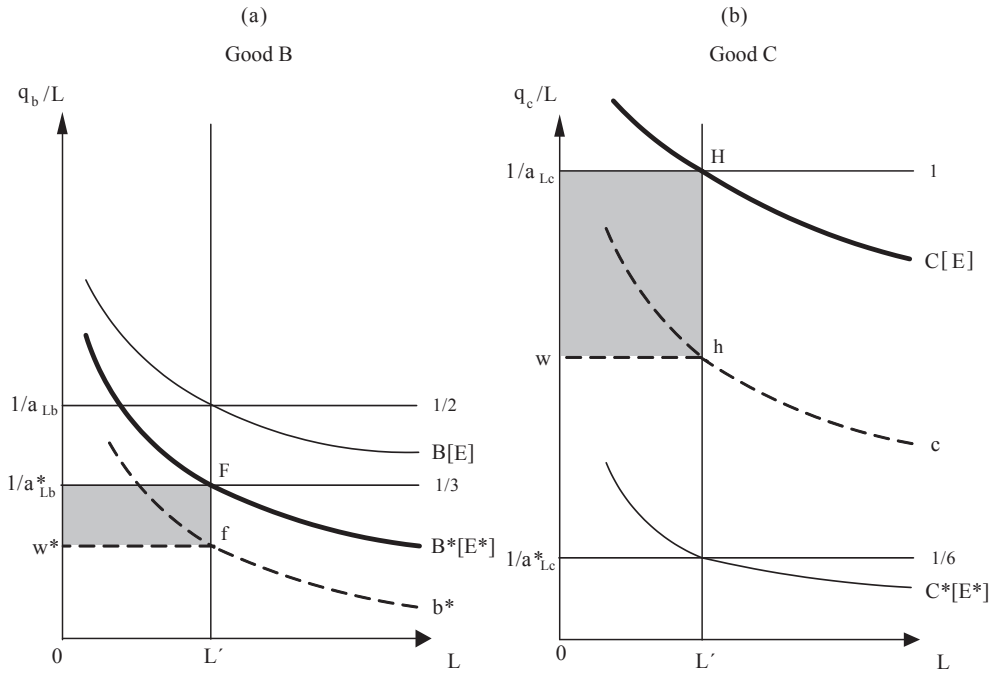
The country endowments include not only quantitative factors but also qualitative factors, such as natural environment and social environment (degree of social order in society).

Equilibrium conditions

Figure 1 depicts the trade equilibrium situation. Demand for labor in country F is given by curve b^* (equal to marginal productivity curve), which determines real wage rate w^*. Similarly, in country H, demand for labor is given by curve c, which determines real wage rate w. By introducing the assumption that equilibrium relative prices are equal to one in both countries, the real wage rates in both countries are comparable (as shown above); thus, the real wage rate in country H is higher than in country F (that is, $w>w^*$).

Figure 1 also shows profits per unit of worker, which are measured by the vertical segment Ff in country F; and by Hh in country H. Total profits in country F will therefore be equal to the area that results from multiplying the vertical segment Ff by the horizontal segment OL', which is the shaded area located above the area representing the total wage bill (w multiplied by OL'). In the case of country H, total profits will be equal to the shaded area that results from multiplying the vertical segment Hh by the horizontal segment O'L, which lies on top of the area that represents the total wage bill. Income distribution is thus determined in each country, and depends upon the specialization in the production of goods.

Figure 1. Differences in levels of labor productivity between Countries H (no asterisk) and F (with asterisk) for goods B and C.



In the generalized Ricardian model, international trade leads to price equalization of goods but not to equalization of real wage rates. However, unlike the standard Ricardian model, real wage rates are no longer equal to the corresponding average labor productivity, but to a fraction of it—the marginal labor productivity—since the other fraction goes to profits; therefore, relative real wage rates (w^*/w) are not strictly proportional to relative labor productivities, but are *related* to them. This can be shown easily.

From equation (8), relative real wages can now be written as:

$$w^*/w = [1/a^*_{Lb}\,(1+\beta)] \,/\, [1/a_{Lc}\,(1+\gamma)],\ \beta>0,\ \gamma>0 \qquad (10)$$

Coefficients β and γ denote the mark up on unitary wage cost that firms are able to impose in order to obtain gross profits. This mechanism is used to generate the share of profits in average productivity (the Ff and Hh segments in Figure 1). Given that perfect competition reigns everywhere, the mark-up is endogenously determined. Thus, the relative real wage is not proportional to the labor productivity ratio, but it is related to it—that is, *the ratio of real wage rates is not independent of the labor productivity ratio*. It therefore follows that higher average labor productivity still implies a higher real wage rate. Certainly, if $\beta=\gamma=0$, then these ratios are strictly proportional, as in equation (8).

Labor market equilibrium in each country is another feature of Figure 1. For the sake of initial convenience in the construction of Figure 1, we assumed equality in the labor supply across countries and full employment equilibrium. In the case of the first assumption, there is no loss of generality across the results. In fact, what the graph assumes is that workers of country H are more equipped with non-labor factors than those of country F. As long as this assumption is maintained, the difference in labor productivity levels will prevail and the results will follow. As regards the assumption of full employment equilibrium, it is time to replace it with another that likewise will not change the results.

The modern labor market theory assumes efficiency wages rather than Walrasian wages, where the former is set above the latter; therefore, equilibrium is with excess labor supply, which is a social device to extract effort from workers. Figueroa (2015, Vol. 1) has utilized this theory to explain the differences in the functioning of labor markets between the First World and the Third World. In the First World, the applicable device is unemployment. In the Third World, which are overpopulated due to the limited non-labor factors with which workers are equipped, the device is a gap between the market wages and marginal income of those workers who are self-employed in the subsistence sector, which means that excess labor supply takes the form of both unemployment and underemployment. Therefore, under capitalism, labor market equilibrium implies not full employment, but *effective full employment*—that is, the maximum wage-employment—subject to the required excess labor supply.

Figure 1 can now be read under the efficiency wage theory; let country C represent the First World, and country F the Third World. The labor market equilibrium in each

case is with effective full employment (equal to L'), which implies the existence of excess labor supply (not shown). Therefore, the generalized Ricardian model abandons the assumption of Walrasian labor markets—assumption (b) above—and it is replaced by assumption (b') as follows:

> (b') Labor markets operate not with full employment, but with effective full employment, which implies excess labor supply.

In sum, the generalized Ricardian model predicts *complete* specialization of countries, as opposed to *partial* specialization (as predicted by neoclassical model). Relative labor-productivity levels determine the patterns of international trade.

Therefore, in the aggregate, the generalized Ricardian model can also be represented by the following set of equations. For the export industry in which the country specializes, let us start with the following identity, where Q is total output, L is total labor, and q is output per worker or average labor productivity:

$$Q \equiv L\, q \tag{11}$$

The value of q depends upon the aforementioned set of non-labor factors which we will call set E. So,

$$Q = F\,(L; E), \text{ where } F_1 > 0 \text{ and } F_{11} < 0 \tag{12}$$

Given the set of non-labor factors E, equation (12) shows that total output and output per worker would depend upon the quantity of labor employed, subject to diminishing returns. In the static and short-run model, exogenous changes in the non-labor factors E will shift the level of both total output and output per worker. The generalized Ricardian model predicts that the persistence of real wage differences between the First World and the Third World is caused by the persistence of differences in the non-labor factors (E) with which workers are equipped and socially endowed, which implies persistent differences in average labor productivity levels.

Do the facts refute this prediction? Considering that each country produces one single good, as in the model, the average labor productivity in the industry also represents output per worker (or per capita income) for the society as a whole. Therefore, if real wages were independent of output per worker (or per capita income of countries), then the model would be refuted by the facts. However, this is not the case. On the contrary, it can be observed that real wage rates are relatively higher in the First World, which reflects their well-known relative differences in output per worker or per capita income. Hence, the generalized Ricardian model can be accepted as a good approximation of the real world.

Furthermore, differences in relative labor productivities may be associated with the fact that some goods cannot be produced everywhere because particular natural resources are needed, with which only some countries are endowed. Thus, tropical goods can only be produced in tropical climates, so tropical countries will export tropical goods.

Similarly, countries endowed with mineral resources will export minerals, and countries endowed with petroleum resources will export oil. Certainly, this is not to descend to "such fatuities as: the tropics produce tropical fruits…," as Samuelson described these propositions in his seminal paper on factor price equalization (1948, p. 182). The tropics produce tropical fruits because labor productivity differences dictate so. Therefore, these facts are also consistent with the predictions of the generalized Ricardian model.

5. THE ECONOMIC GROWTH PROCESS AND CHANGES IN LABOR PRODUCTIVITY LEVELS

In the long run, in the economic growth process, endogenous changes in output and output per worker, and in the accumulation of some non-labor factors, will take place. From the list of non-labor factors showed above, we can assume that technological progress increases exogenously at a given rate. Moreover, we can combine the three forms of capital into one single good. And for the sake of simplicity, we can also assume that natural resources are redundant factors and that environment degradation problems associated with economic growth are ignored, and that the initial inequality remains constant and so too does the degree of social order.

With these simplifying assumptions, we can arrive at the standard aggregate production function used in neoclassical growth models, where the set of non-labor factors E is now reduced to only K as capital stock and A as level of technology, which takes the following form:

$$Q = F(K, AL) = K\alpha\,(AL)^{1-\alpha}\,,\ 0 < \alpha < 1 \tag{13}$$

The term AL is labor measured in efficiency units. The assumption implies that double value of A would mean that in order to produce the same quantity of Q, either only half of the labor is required (technological innovations are labor saving) or the quantity of labor in efficiency units is equivalent to double the quantity of workers. This formulation of the production function is consistent with the assumption of labor as the essential production factor.

The derived concepts of average labor productivity (output per worker) and marginal labor productivity are then equal to

$$Q/L \equiv q = A^{1-\alpha}\,(K/L)\alpha \tag{14}$$

$$\partial Q/\partial L = (1-\alpha)\,A^{1-\alpha}\,(K/L)\alpha = (1-\alpha)\,q \tag{15}$$

Under labor market equilibrium, the real wage rate must be equal to the marginal productivity of labor. Thus, it follows that the real wage rate is a fixed proportion of average labor productivity—that is, real wage rates cannot be independent of average labor productivity. Indeed, real wage rates depend upon average labor productivity,

which in turn depend upon the quantity of capital and the level of technology with which labor is equipped.

These relationships can be applied to industries engaging in international trade. Let us consider two separate equations of the form shown in equation (13), one for each of the two goods being traded between two countries (as in Figure 1). Equilibrium in international trade implies that countries will exchange goods at the same relative prices, which we may assume take the value of 1. Therefore, trade equilibrium implies average labor productivity differences and thus real wage rate differences too, as implied in equations (14) and (15).

Equations (13)-(15) can also apply to the aggregate output by countries. They predict that rich countries, with relatively higher output per worker, will have relatively higher real wage rates than poor countries. Moreover, they predict that as long as differences in output per worker persist over time, so too will real wage rate differences.

In the growth process, dynamic equilibrium will imply a steady-state situation. This will determine a growth frontier for each country. Output per worker will increase endogenously along the transition dynamics moving toward its corresponding growth frontier.

Empirical studies about differences in output per worker (or output per person) between the First World and the Third World conclude that these gaps tend to be persistent over time (e.g., Barro & Sala-i-Martin, 2004; Figueroa, 2015, Vol. 2, Chapter 6). Therefore, the real wage differences shown in Table 1 reflect these differences in aggregate output per worker as well. Countries with relatively high labor productivity levels also exhibit relatively higher real wage rates. Again, this fact is consistent with the prediction of the generalized Ricardian model.

It is a fact that First World countries with high wage rates compete in international markets against Third World countries with low wage rates, even if this does seem paradoxical. How to explain it?

The generalized Ricardian model explains this paradox as follows. High-wage countries are able to compete against low wages countries because they also have higher labor productivity levels. As shown in Figure 1, country H has a comparative advantage in good C—that is, country H's relative productivity in good C is higher than it is in good B. Country H has a cost advantage in good C, despite its higher wage rate, because the higher wage rate is more than offset by its higher labor productivity. Similarly, because of its lower wage rate, country F has a cost advantage in good B, even though it has lower labor productivity.

Therefore, the generalized Ricardian model can explain trade between the First World and the Third World. It predicts that differences in real wages are related to the differences in average labor productivity across countries, such that lower real wage countries correspond to those where the average labor productivity is lower, as is the case of Third World countries. Indeed, facts are consistent with the prediction.

The generalized Ricardian model can also explain trade between First World countries. Real wages in this group of countries are more homogeneous because average labor productivities (or output per worker or per capita income) are also more homogeneous. The generalized Ricardian model predicts that equalization of real wage rates across countries requires equalization of labor productivities and that international trade is not the mechanism conducive to this.

Why is it that differences in the levels of labor productivity between the First World and the Third World do not tend to equalize with economic growth? What are the ultimate factors determining these differences? Why do high-labor-productivity countries and lower-labor-productivity countries coexist in an increasingly globalized capitalist system? These are the questions that economic growth theory seeks to answer. However, it seems that a scientific answer is still pending, as no canonical theory has yet been established.

According to the generalized Ricardian model, we could say that the process of economic growth observed in the capitalist system over the last five to six decades has not contributed to real wage equalization across countries because it has not led to equalization in the levels of labor productivity or output per worker. To be sure, the failure does not lie with international trade. In the economic process, trade plays the role of a mechanism—the market mechanism—not that of an exogenous variable; thus, it cannot be a causal factor. Tariff or any measure of degree of free trade could be an exogenous variable and thus a causal factor.

The Ricardian trade theory, even its generalized model, is unable to explain what factors explain changes in labor productivity in the long run. In the short-run analysis, labor productivity levels can be taken as exogenously given; in the long run, however, labor productivity is endogenous, as it needs an explanation. A good long-run trade theory will therefore come from a good economic growth theory.

6. COMPARING RICARDIAN AND NEOCLASSICAL TRADE THEORIES

The Ricardian trade theory assumes that comparative advantage is rooted in labor-productivity differences. The standard Ricardian model assumes that labor productivity is a fixed coefficient. This assumption can be relaxed to introduce labor productivity as variable and endogenously determined in a generalized Ricardian model, with which one can then analyze the distribution between wages and profits in the context of international trade, as shown above. The generalized model predicts that real wage rates are dependent on average labor productivity levels: When trade partners are homogeneous countries, labor productivity levels will be homogenous, which will be conducive to homogenous age rates as well; when trade partners are non-homogeneous countries, labor productivity levels will not be homogeneous, and nor will real wages.

The facts are consistent with the predictions of this model. Thus, trade between First World countries tend to exhibit homogeneous labor productivity levels and homogeneous wage rates as well. Trade between the First World and the Third World show higher relative levels of labor productivity in the First World and higher relative real wage rates as well. Hence, the generalized Ricardian model is able to explain trade in the capitalist system, for its empirical predictions are consistent with facts. Differences in levels of labor productivities explain the patterns of international trade.

On the other hand, the neoclassical trade theory assumes that comparative advantage is rooted in factor-endowment differences. The standard HOS model predicts equalization of wage rates across countries. The model explains trade between First World countries, as real wages in these countries tend to be homogeneous. However, the model fails to explain trade between the First World and the Third World, for its prediction is refuted by the facts: relative real wages are significantly higher in the First World.

The HOS model assumes trade partners are homogenous in every respect, except in factor endowments, which, together with the assumption of constant returns to scale, implies similar labor productivity levels, which in turn implies real wages equalization. This was shown above, in equations (1)-(4). In other words, no matter how different the factor endowments of countries are (such as capital, labor or land), free trade will be conducive to equality in real wage rates. This seems to contradict the principle of scarcity: relative labor abundant countries should exhibit lower relative real wages. This apparent paradox has an explanation. According to the HOS model, free trade of goods is equivalent to free factor movements; hence, free trade leads to factor price equalization. The empirical refutation of its predictions indicate that the assumptions of the model are wrong in explaining trade between the First World and the Third World.

So, within First World countries, what would be the factor endowment differences? The required data set is unavailable. However, it seems that the differences are hardly significant in terms of physical and human capital endowments, nor in infrastructure and social order. The most notable difference seems to rest upon natural resources endowments, particularly arable land. World Bank data on arable land per capita shows that the average for the First World is 0.41 hectares, but with great variations by countries; thus, the US has 0.67, but the UK only 0.10; whereas the range goes from Australia 2.75 and Canada 1.53 to France 0.31 and Germany 0.14, and to Japan 0.03 (World Bank, 2010, Table 8).

The HOS model assumes homogeneous technology and differences in factor endowments. Could we also extend the neoclassical HOS model to construct a generalized model in which technology could be heterogeneous? Indeed, this has already been done in the literature (Trefler, 1993). However, the introduction of this *auxiliary* assumption in the new model contradicts the *primary* assumptions of the neoclassical trade theory. On epistemological grounds, this procedure is unacceptable, for it is a violation of the rules of scientific theory construction: an economic theory must be

a family of models with a common core of primary assumption, or else it will be difficult to falsify the theory (Figueroa, 2016).

7. CONCLUSIONS

The standard trade literature presents two theories: Neoclassical and Ricardian. They share the common view that international trade patterns are explained by comparative advantage, but they assume different sources of comparative advantage: factor-endowment differences in neoclassical theory and differences in labor productivity in Ricardian theory.

The standard neoclassical trade model (HOS) predicts that equilibrium trade implies wage rate equalization across countries. This prediction tends to be empirically consistent with the case of trade between First World countries, where wage rates do indeed tend to be homogeneous. However, it fails to explain trade between First World and Third World countries, for relative wage rates are significantly higher in the First World. Any other model of the neoclassical theory will arrive at the same conclusions.

The standard Ricardian model assumes fixed coefficients of labor productivities, which leads to the theoretical problem of explaining distribution between wages and profits. In this paper a generalized Ricardian model was developed in order to resolve this theoretical problem. Non-labor factors have been introduced so as to make labor productivity levels exogenous and labor productivity coefficients endogenous in the short run. The relevant prediction of the generalized model is that real wages are dependent on labor productivity levels. The generalized model can explain trade between First World countries, for observed labor productivity levels tend to be homogenous and so do wage rates across countries. The generalized model can also explain trade between the First World and the Third World, for observed labor productivity levels are relatively higher in the First World and so are relative real wages.

The generalized Ricardian model, unlike the neoclassical trade models, can explain trade in the entire capitalist system. Therefore, on epistemological grounds, we may say that the Ricardian trade theory is superior to the neoclassical trade theory. For a given variety of real phenomena—real wage differences across countries—Ricardian theory can explain a wider range. It can explain phenomena that neoclassical theory can also explain, but it also explains phenomena that neoclassical theory cannot.

The generalized Ricardian trade model is a short-run model in which the levels of labor productivity are assumed to be exogenously determined. Thus, these levels are the causal factors in the model. In the long run, however, labor productivity levels need to be explained. Economic growth theory seeks to explain changes in labor productivity levels or output per worker over time. Therefore, a good trade theory for the long run will come from a good economic growth theory.

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