Comparative Advantages and Demand in the New Competitive Ricardian Model

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Abstract

What makes Ricardian a set of trade models in which comparative advantage does not rely on autarky prices and may not even be the main element? We review these new multicountry, multi-good economies trade models with exogenous technologies that focus either on cost or on demand linkages to trade. Cost-based models advance new forms of comparative advantages and have a demand side with a functional form that does not disturb cost-based prices. Conversely, demand-based models advance new demand-linkages to trade in product quality and have a supply specialization side that simply mirrors consumer demand for products. We further seek to identify these models vis-à-vis the Ricardo-Haberler-Deardorff tradition.

Key Words: Multicountry Economy, Ricardian Models, Trade Linkages, Comparative Advantages, Demand.

JEL: F10, 019, D5.

1 Introduction

The newest multicountry, multigood trade models have revived the competitive Ricardian trade models, whose novelties include features such as comparative advantages with no reliance on opportunity cost, nor with an autarky counterpart. At the other extreme, comparative advantages are closely immaterial. What defines them as Ricardian is certainly a vexing question.

As remarked by Caron et al. (2014), all trade models seek a mathematically treatable general equilibrium for prices, trade and allocations, which entails focusing on the supply side of that equilibrium.[1] When moving to bilateral trade in a multicountry, multigood economy, we find a new reason to retain this methodology in supply-side models further hinging on Ricardian exogenous technology. The latter, however, faces the challenge of overcoming the classical pairwise comparative advantages of Dornbusch et al. (1977, DFS hereinafter). The solution developed by Eaton and Kortum (2002, EK hereinafter), which is followed by all new cost-based Ricardian model, is a Cost Insurance Freight (CIF)-price-based comparative advantage, in which exporters' presence in the importing markets is ordered by a cumulative (Fréchet) probability distribution that is shaped by a *parameter of worldwide technology variability (tradability).*

To reintroduce industries, which were subsumed in EK's country-level model of bilateral trade, Costinot et al. (2011) advance a pure industry-level model of bilateral trade that yields a new index of *revealed comparative advantages*. Instead, Shikher (2012) expands EK by introducing industries through intermediate goods and the resulting new cost function, which account for the input-output linkages, enables screening the impact of trade upon the industries of each country.

How do these global models of trade succeed in achieving a treatable equilibrium in a multicountry trading economy with international technology differences? Here, they resort to a microeconomic trick introduced by DFS: a demand that is neutral as to the ordering of cost-based prices.

Another class of Ricardian model focuses instead on demand linkages to trade. In reality, an early first reference is the widely ignored three-sector model by Jones (1979)[2] – a reverse DFS model – whose two relative prices enable several variations with regard to how (international) demand can condition gains. When moving to a multicountry, multigood economy, demand elasticity is reduced to the income and the own-price elasticity of demand (Wilson, 1980), which paves the way for North-South trade in product quality with non-homothetic preferences. An initial Ricardian formulation (Flam & Helpman, 1987) sought to advance over models of horizontal differentiation (Helpman and Krugman, 1985), whereas later development sought to model multigood economies (Matsuyama, 2001; Jaimovich and Merella, 2012). Eventually, models for multicountry economies (Fieler, 2011a,b; Jaimovich and Merella, 2015) offer a more convincing view about differences in

[1] Neary (2003) offers another interesting characterization of general equilibrium in trade theory.

[2] That was not ignored in the seminal survey by Matsuyama (2008) who, however, improperly classifies Jones (1979) as a development of DFS.

international demand, which is connected with difference in the supply side.

Beyond the Ricardian technology, an extremely simple form of comparative-advantage underpins all these demand-based Ricardian models. Aside from the three-sector model, the supply-side industry's ordering just mirrors the demand ordering. In short, these models are the flip (microeconomic) side of the above cost-based models.

In this survey of the new Ricardian models, our first goal is to describe each model's specific contribution. The second goal is to highlight a common modeling of these trade models: a simplified general trading equilibrium for multigood, multicountry economies with exogenous technology in which a somewhat neutral demand (or supply) side matches the focused supply (or demand) linkages to trade. Our third goal is to simultaneously posit these new models with respect to the Ricardo-Harberler-Deardorff (RHD) tradition of comparative advantages. We focus on theory, and all of our goals compel us to pinpoint key mathematical terms used by some of the reviewed authors.

The remainder of this paper proceeds as follows. Section 2 emphasizes the role of demand in the textbook Ricardian 2-good model and introduces the RHD theorem. Section 3 addresses the new cost-based Ricardian models, while Section 4 addresses the new demand-based Ricardian models. Section 5 presents our concluding remarks.

2 The Ricardo-Harberler-Deardorff Tradition

Although Ricardo's (1817) analysis of international trade features three economic agents (capitalists, workers and landlords) and a corresponding political economy,[3] he considers only labor (workers) when formulating comparative advantages. His central development with regard to Smith (1776) lies in taking price as a relative value in anticipation of late general-equilibrium analyses (Pareto, 1909).

This means that in a two-good, two-country world economy the home country can have absolute advantages in both sectors, $a_i < a_i^*$ and $a_{i'} < a_{i'}^*$, but price (comparative) advantages in just one:

$$\frac{p_i}{p_{i'}} = \frac{a_i}{a_{i'}} \lessgtr \frac{a_i^*}{a_{i'}^*} = \frac{p_i^*}{p_{i'}^*}, \tag{1}$$

where a represents the labor-input coefficient and superscript * represents the foreign country. This basis of trade (1) – comparative advantages – is thus referred to an autarky (price) condition, $p^A \neq p^{*A}$. Insofar as international prices deviate from autarky prices, as perceived by Ricardo (1817), they differ from labor costs.[4]

Gottfried von Harberler (1930, as cited in Caves, 1967) casts (1) into opportunity cost, thus building a bridge to general equilibrium analyses. However, it is frequently overlooked that demand has no impact on relative prices in such a competitive one-factor economy without joint production

[3] As expressed in the so-called Ricardo-Viner model (see Findlay, 1984).

[4] This proposition is ignored by neo-Ricardians, including the otherwise noteworthy analysis by Pasinetti (1981, ch. 11).

– *i.e.,* the non-substitution theorem (Kurz and Salvadori, 1995). As shown in Figure (1), preferences can change the allocative position of the autarky equilibrium, x^A, but not the equilibrium price, which is that given by the production possibility frontier.

Nevertheless, preferences can affect price in an international economy. As shown in Figure 1, given convex preferences, aggregate excess of demand sets international prices $p \geqslant p^A$ that solve the trade-balance equilibrium, $px = p(x_c - x_p)$, with a corner equilibrium of full specialization at x_p, and the consumer's allocation at x_c. Thus, the international economy overcomes the non-substitution theorem and demand gains a role upon prices. Thus the textbook Ricardian model is established.

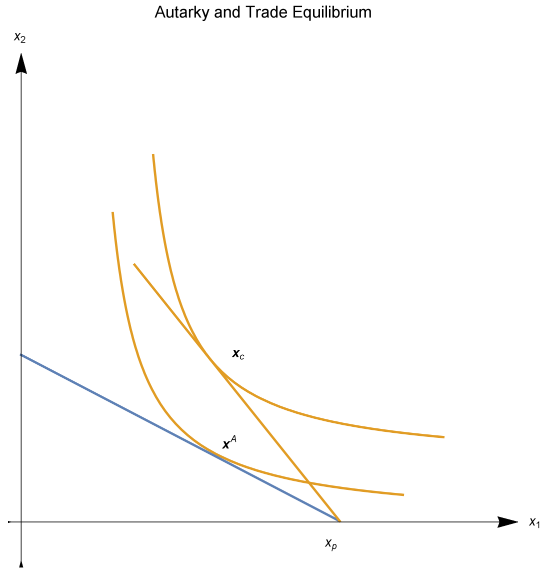

Figure 1: Autarky and Trade Equilibrium

Deardorff (1980) gives an ultimate step towards generalization of comparative advantages by starting the analysis from the efficiency of the international equilibrium

$$p^A x > px, \tag{2}$$

because px is less costly. Rearranging (2), one obtains

$$(p^A - p)x(p) > 0, \tag{3}$$

meaning that imported goods (positive excess of demand) are those whose autarky prices are above their trade prices, and exported goods are those whose autarky prices are lower than their trade price. (3) is called *the general law of comparative advantages* in that market prices are compatible with any technology, and the inner (vector) product of (3) predicts a trade pattern in goods in general, on average,[5] not in each specific good. For a N-good economy with trade barriers and intermediate goods, the trade linkages from comparative costs become weaker (Deardorff, 1979).

[5]Its empirically testable form is $corr(\rho, \varphi) < 0$, where $\rho = p^A/p$ and φ is the trade vector (Deardorff, 1980).

As shown below, the *general law* and the RHD tradition (Bernhofen, 2005) helps us understanding the novelties of the new Ricardian models.

3 Ricardian Models with Neutral Demand

Autarky price is an unappealing empirical aspect of comparative advantages.[6] In the Ricardian (1), p^A can be transformed into actual prices as $\frac{a_i^*}{a_i} > p = \frac{w}{w^*} > \frac{a_{i'}^*}{a_{i'}}$. With N-ordered industries:

$$\frac{a_1^*}{a_1} > \ldots > \frac{a_i^*}{a_i} > \omega = w/w^* > \frac{a_{i+1}^*}{a_{i+1}} > \ldots > \frac{a_n^*}{a_n}, \tag{4}$$

International specialization is thus determined by productivity and labor prices, with goods prices given by $p_i \leqslant w^c a_i^c$, with equality if good i is produced by country $c = j$. Noticing that this comparative cost advantages, (4), only apply to a competitive one-factor economy.

The strong linkage of comparative advantages implied in (4) is overcome in multicountry models, as well as in those following the RHD theorem.

3.1 The Dornbusch-Fischer-Samuelson Model

Exogenous technology is a useful assumption in some analyses, although rejected by the evidence (Davis et al., 1997).[7] However, in a general demand form, any change in costs (4) can lead to multiple prices.

The DFS model solves this N-good conundrum with a classical-like demand, defined by expenditure shares, $b_i(p_i) = p_i c_i(p_i)/Y$, and based on a Cobb-Douglas utility function. Thus, each b_i is constant. Goods become net complements, which warrants a definite and invariable relationship between the demand for goods and the demand for labor. Goods are also set into a continuum unit interval, $\tilde{x} = [0, 1]$, which not only enables first-order effects, but also nearly nullifies the b_i, which helps to attenuate the disputable economy in which all goods are net complements.

The point is that this neutral demand with respect to cost-based price ordering (4), warrants a simple and definite derived demand for labor. More to the point, a given equilibrium wage, $\bar{\omega}$, determines the set of home- and foreign-produced goods, $k = \int_0^{k(\tilde{x})} b(\tilde{x})d\tilde{x}$ and $1 - k = \int_{k(\tilde{x})}^1 b(\tilde{x})d\tilde{x}$, which, under trade balance, is the same as the share of these economies in the world's expenditure

[6] Bernhofen and Brown (2005) overcome this problem by examining a country whose total trade volume was only 2% of its GDP – Japan's Meiji revolution – but this exceptional case only reinforces the problem with this approach. However, Deardorff (1984) emphasizes that unobserved autarky prices can be substituted for country characteristics, such as factor endowments – see also Helpman and Krugman (1985, ch. 1).

[7] This empirical rejection undermines the opposite claim by neo-Ricardians (Kurz and Salvadori, 1995), based on technology re-switching. Adding that empirical tests of the Ricardian model for several OECD countries by Golub and Hsieh (2000) found a too low R^2. And, when testing the USA comparatively to an extremely different country, Brazil, Cinquetti (2008) found that comparative cost only achieves the expected negative sign with dummy variables for resource-based sectors, together with a latent variable for factor proportions.

$(wL + w^*L^*)$, where L and $L^*$are the labor forces of home and foreign, respectively. The relative derived demand for labor is then given by

$$\omega = \frac{k(\tilde{x})}{1 - k(\tilde{x})} \cdot \frac{1}{L/L^*} = B\left(\tilde{x}; \frac{L^*}{L}\right). \tag{5}$$

In a continuum of goods, (4) can be written as $\omega = A(\tilde{x}) = \frac{a^*(\tilde{x})}{a(\tilde{x})}$. The international (home-relative) supply function of $\tilde{x}$ is then:

$$\tilde{x} = A^{-1}(\omega), \tag{6}$$

depicting the labor-minimizing cost of supplying z worldwide. Notice that the supply schedule $A^{-1}(\omega)$ is downward sloping, whereas the demand schedule $B(\tilde{x}; \frac{L^*}{L})$ is upward sloping.

Most unusual, however, is the one-factor general equilibrium, in which $\bar{\omega}$ determines the specialization set at home and abroad and therefore which technology is active. The international economy, which overcomes the non-substitution theorem in the 2-goods economy, is fundamental here: it grants the market selection of the technologies.

In a graphical analysis, the DFS yields an elegant exposition of comparative advantages as a relationship between the good market and the factor markets, in which ω sets $k(\tilde{x})$ for given absolute advantages. Just as an illustration, a homogeneous technology change at home shifts $A^{-1}(\omega)$ upward, but the $\uparrow \omega$ along the $B(\tilde{x}; \frac{L^*}{L})$ schedule grants that $\Delta \uparrow \omega < \Delta A^{-1}(\omega)$, which also prevents an equal $\uparrow k$ expansion. Acemoglu and Ventura (2002) develop over this last result, emphasizing that economic growth with interdependence produces diminishing returns to scale even with constant return-to-scale technologies, since international demand for goods pushes down the exporting country's "factoral terms of trade," $\omega = \sum(p_i/p_i^*).(a_i^*/a_i)$. In fact, there were several developments of the DFS in the growth and trade literature.

3.2 Geography and Trade

Adding iceberg trade cost, $t > 1$, and thus non-traded goods gives more flavor to a trade model that hinges on net complements. With $I \geq 3$ countries, the *law of one price,* which underlies (4), falls apart even for traded goods, and trade volume is elevated to center stage.

Most importantly, the pairwise sequence, $A'(x) = \frac{A(x)}{t}$ over the N goods collapses within this new geographical setting. Wilson (1980) solves this problem by reducing the trade relationship to the fraction k of goods that each country d demands from any country o, as given by the pricing equation, $p_d(k) = \min\{p_{od}(k); \quad o = 1, \dots O\}$, a CIF-price model of comparative advantages.

EK develop it into a country-level model of bilateral-trade. The CIF prices on d is then

$$p_{od}(k) = \frac{c_o}{z_o(k)} t_{od}, \tag{7}$$

where c_o is the input cost in country o, t_{od} is a vector of physical and cultural barriers, and $z_o(k)$ is the randomly drawn technology efficiency of o in the world economy. As explained below, $z_o(k)$ fixes k : the extensive margin of o into d.

The country unit cost function is given by

$$c_o = w_o^{\beta} \rho_o^{1-\beta}, \tag{8}$$

where ρ_o is the price of intermediate goods, which is proxied by the price index in country o. Intermediate goods enrich the Ricardian description of the worldwide technology differences.

Comparative advantages, in this CIF-price model, are defined by d's domestic prices distribution across the $p_{od}(k)$, which is featured by the extensive margin of each o into d, $\pi_{\{od\}}(k)$. The latter, given the huge bilateral-trade set, $I(I-1)$, are a random realization of a cumulative probability distribution on $z_o(k)$: $F_o(z) = Pr[Z_o \leq z]$, as given by

$$F_o(z) = \exp^{-T_o z_o^{-\theta}} = \exp^{-\left[T_o (c_o t_{od})^{-\theta}\right] \rho^{\theta}}. \tag{9}$$

In this Fréchet distribution of extreme, T_i represents o's technology (absolute) advantage, and θ represents a worldwide index of global technology variation. Recalling that, similarly, N increases trade volume in the DFS. The non-observed z_o is substituted from (7) in the second equality, with t, gives the global-like comparative advantages, $(c_o t_{od})^{-\theta}$: cost-prices sets the price-efficiency of o on $F_o(z)$, and so the extensive margin for a given θ.

The lower the $F_o(z)$, the higher o's contribution to d´s cumulative price distribution (i.e., price index), $G_{od}(p) = 1 - F_o(z)$. Given its equivalence to the share of o in d's expenditure, it then follows that

$$\pi_{od} = \frac{G_{od}(p)}{G_d(p)} = \frac{T_{od}(c_o t_{od})^{-\theta}}{\sum_{o=1}^{O} T_o (c_o d_{od})^{-\theta}} = \frac{X_{od}}{X_d}, \tag{10}$$

where X_d represents the country's total expenditures and X_{od} is the fraction spent on goods from i. T_o and θ are pro-trade forces, whereas t_{od} is the anti-trade force. Simulations yield the θ for which bilateral trades (10) best fit actual world data.

Import shares (10) have unit-price elasticity, given consumer demand from a CES utility and firm demand from (8). Thus, cost differences alone dictate price differences, although goods are not net complements as in the DFS model.

EK is a supply-side structural gravity model, in which trade volume stems from *technology differences*, *input cost* and *trade barriers*. From another perspective, it is a model of countries' bilateral trade with a Ricardian specialization term. Inasmuch as this model is not concerned with trade patterns, its comparative advantages, $(c_o t_{od})^{-\theta}$, are not grounded on opportunity cost, as are the previously defined Ricardian models.[8]

Costinot et al. (2011) reintroduce industries by taking goods k as differentiated, and demand for varieties v coming from CES preferences. From this *love of varieties,* intra-industry trade follows,

[8]In which comparative advantages might even reduce bilateral trade (Oladi and Beladi, 2010).

with CIF prices conditioning expenditures according to $p_d^k(v) = \min_{1\leq o\leq O}\{c_{od}^k(v) = t_{od}^k.w_o/z_o^k(v)\}$; changed to $c_{od}^k = t_{od}^k w_o/z_o^k$ for simplicity. The predicted trade flows are equally determined by a Fréchet distribution:

$$F_o^k(z) = \exp[-(z/z_o^k)^{-\theta}], \tag{11}$$

where $z_o^k > 0$ is fundamental productivity, defining the world's efficiency frontier in industry k. The z/z_o^k in (11) is meant to express $z_{o'}^k/z_o^k$, as explained below, whereas θ indicates technology heterogeneity at industry k, which is assumed to be the same for all industries.

From (11), together with consumer demand, a new revealed comparative advantages (NRCA) index is derived from d's imports from any pair of exporters, o and o': $NRCA_{oo'}^d(k) = \frac{\tilde{x}_{od}^k \tilde{x}_{o'd}^{k'}}{\tilde{x}_{od}^{k'} \tilde{x}_{o'd}^k}$, where $\tilde{x}_{od}(k)$ represents exports from o to d. It is worth stressing that Balassa's (1965) $RCA_w^o(k) = \frac{X_k^o/X^o}{X_k^w/X^w}$, based on the pairwise advantages (4), compares o with one o' with respect to the world economy, w, but not with respect to any o' in any importing country d, as does the $NRCAR_{oo'}^d(k)$. The latter, moreover, compares k to another k', which renders a country's ordering for each industry k, unlike the N-good sequence of comparative advantages of the $RCA_w^o(k)$.

From the above specified relationships, the $NRCAR_{oo'}^d(k)$ is given by

$$ln\left(\frac{\tilde{x}_{od}^k \tilde{x}_{o'd}^{k'}}{\tilde{x}_{od}^{k'} \tilde{x}_{o'd}^k}\right) = \theta ln\left(\frac{\tilde{z}_o^k \tilde{z}_{o'}^{k'}}{\tilde{z}_o^{k'} \tilde{z}_{o'}^k}\right) - ln\left(\frac{d_{od}^k d_{o'd}^{k'}}{d_{od}^{k'} d_{o'd}^k}\right), \tag{12}$$

where $\tilde{z}$ is the observed productivity, $\frac{\tilde{z_o}^k/\tilde{z_{o'}}^k}{\tilde{z_o}^{k'}/\tilde{z_{o'}}^{k'}}$ is the comparative (opportunity) cost, and $\frac{d_{od}^k/d_{od}^k}{d_{od}^{k'}/d_{o'd}^{k'}}$ is the comparative trade cost. International trade drives a wedge between observed and fundamental productivity, $\tilde{z}$ and z respectively, thus conveying a notion of *trade linkages* other than Deardorff (1979). The fundamental point here, which is common to all these Ricardian gravity models, is a comparative advantage model that has no autarky counterpart.[9]

Conversely, Shikher (2012) introduces industries into the EK's model through intermediate goods. That is, rather than (8), unit cost of industry k in o is given by $c_o(k)$=$w_o^\beta \rho_{ok}^{1-\beta}$, with input prices given by a Cobb-Douglas function, $\rho_o(k) = \Pi_{k=1}^K p_o^{\eta_{km}}(m)$, in which η_{km}, the share of industry m in the output of k, is taken from input-output tables. This limits Shikher's (2012) empirical analysis to eight industries and nineteen countries.

Consumers in each importing d follow "the winner (the exporter with the best price) takes all," as in EK, and the CIF price is given by

$$p_d(k) = \gamma\left[\sum_{o=1}^{O} T_o(k)(d_{od}(k)c_o(k))^\theta\right], \tag{13}$$

where parameter γ follows from the CES preferences as in EK, and T_o^k is an estimated measure of

[9]Finicelli et al.'s (2013) analysis of Ricardian selection is a concrete example of how trade affects productivity – i.e., average productivity – in a way that is irrespective of autarky's comparative advantages.

industry k's productivity in country o. Although θ conditions the impact of $(d_{od}(k)c_o(k))$ on trade, the latter does not define comparative advantages as shown below.

However, an inter-industry trade occurs because each industry m supplies several intermediate goods l to industry k. In this sense, the intensive margin defines trade flows both here and in Costinot et al. (2011). That is, productivity $z_o(l_k)$ and the corresponding prices, $p_{od}(l_k) = c_o(k)d_{od}(k)/z_o(l_k)$, determine the share of each $X_{od}(k)$ in each $X_d(k)$. More to the point

$$\pi_{od}(k) = \frac{X_{od}(k)}{X_d(k)} = T_o(k)\left(\frac{\gamma(d_{od}(k)c_o(k))}{p_d(k)}\right)^{-\theta}, \tag{14}$$

which indicates the industry's bilateral trade between o and d. As suggested in (13), country o has comparative advantages if $T_o(k)/T_o(k') > T_{o'}(k)/T_{o'}(k')$, similar to Costinot et al. (2011).

The endogenous ρ and its effect on industry cost, $c_o(k)$, is the way through which trade barriers in one industry spreads throughout all industries, via their backward and forward linkages. Simulations from the computable general equilibrium render an accurate picture of impacts from trade cost on industrial employment and total welfare.

The ultimate way to handle the chain of comparative-advantages in a multicountry economy is to focus on a country's trade pattern with the world, as proposed by Romalis (2004). Trade barriers matter here only for engendering unequal factor prices and thus technology differences, whereas the Dixit & Stiglitz's (1977) monopolistic competition warrants not only a constant ratio of price to marginal cost, but also intra-industry trade.[10] Additionally assuming homothetic technology, this renders a unique ordering of sectors' factor intensities. Unfolding the North-South economy into $2M$-countries, one obtains a multicountry comparative cost grounded on the number of firms per sector and on factor prices (two factor proportions with respect to a third one), upon which the comparative chain is built. It is called a quasi-HO prediction for its reliance on the monopolistic competition and for not predicting trade in each factor's service.

Morrow (2010) expands this model with TFP differences, and takes each country's opportunity costs with respect to the mean world economy. The result is Ricardo-HO comparative advantages. Given that both firm's scale and the market power under monopolistic competition – so similar to perfect competition[11] – the RHO can be seen as a global-market extension of the RHD tradition. The Ricardian technology based on a multifactor TFP (total factor productivity) is similar to Costinot et al. (2011), but the RHO is not Ricardian, given that one of two technology differences is endogenous.

[10]In each country i cost is given by $C(\omega, \tilde{x}) = [f + q_{M_i}]s_i^{\tilde{x}}w_i^{1-\tilde{x}}$, where q_M is the marginal cost, s and w are the prices of skilled and unskilled labor, respectively, and $\tilde{x}$ ranks industries according to their skilled-labor intensity.

[11]As held by Neary (e.g., 2010). Colacicco's (2015) survey on the general oligopolistic equilibrium is a good reference for the whole discussion here.

4 Ricardian Models with Non-neutral Demand

In the above models, some demand-neutral forms warrant trade based on cost differences (or changes) alone. However, in a 3-good economy, demand in a general form can condition price change and thus the gains from trade in evolving ways. With $I \geq 3$ countries, international trade can be based on differences from a standard form of demand. This section addresses these linkages between demand and trade.

4.1 Trade Gains from Technical Progress: The Three-good Model

Jones'(1979) reversal DFS model[12] is certainly the first formalization of the complex manner in which demand can condition trade gains. His three-good model resembles that of Lewis' (1954), but departs from both Lewis's model and Ricardo (1817) model in that it has a demand function.

To briefly review it, let good 2 be a non-tradable price *numeraire* and $\hat{a}_1 < 0$ be the technical progress in the home export sector. The foreign gain is then:

$$dy^* = -D_1^* dp_1, \tag{15}$$

which is conditioned to demand share, D_1^*, a feature that is absent in both the DFS and EK models.

With x once again indexing goods, the home gain is then

$$dy = (x_1 - D_1)dp_1 + \{p_1 dx_1 + dx_2\} \tag{16}$$

Given full employment, the expression in brackets above can be transformed into $a_1 dx_1 + a_2 dx_2 = -x_1 da_1$, which can be transformed to $-x_1 dp_1$, so (16) is reduced to

$$dy = -D_1 dp_1. \tag{17}$$

Therefore, contradicting Lewis (1954), technical progress in the export sector cannot result in immiserizing growth. However, the home gain is higher the lower its export share, confirming the bleak prospects for commodity-exporting economies.

The outcome shifts altogether when x_2 becomes a traded good in which the home country has comparative advantages. Given that wages are no longer constant in a_2, p_1 is no longer proportional to $\hat{a}_1$, whereas p_3, which is no longer tied to *numeraire* p_2, can either rise or fall according to international market clearings. More precisely, given $D_3 = D_3(p_1, p_3, y)$, $\hat{D}_3 = E_3^1 \hat{p}_1 + E_3^3 \hat{p}_3 + \frac{m_3}{p_3 D_3} dy$, showing that $\hat{D}_3$ is conditioned by not only cross- and own-price elasticity, but also by m_3, the marginal propensity to consume (import) these goods. A decrease in p_1 causes a substitution away from x_3 if x_1 and x_3 are gross substitutes, pushing p_3 downward. The result reminds us of the well-known case of the North's synthetic goods harming the South's exports of natural goods, and

[12] Jones was the referee of the DFS and advised Wilson (1underpins and 980), and Caves, Frankel & Jones' (1999) textbook is also unique in highlighting that the Ricardian model overcomes the role of demand upon prices in a competitive one-factor economy.

it cannot be deduced in known exporter's immiserizing growth models (Bhagwati, 1958; Brecher & Díaz-Alejandro , 1977).

To evaluate the paradox that technical progress in the imported good makes the foreign country worse off, consider its income change:

$$dy^* = -p_1 D_1^* \hat{p}_1 + p_3 D_3 \hat{p}_3. \tag{18}$$

Thus, $dy^* < 0$ depends on both $dp_1 < dp_3$ and on the weights D_1^* and D_3, where $D_3 = (x_3^* - D_3^*)$. As demonstrated by Jones (1979), the income gain from the initial decline in p_1 prevents p_3 from decreasing as much as p_1, when all goods are net substitutes and when the substitution effects are high. The latter condition is easily met by the fact that $-E_3^3 = E_1^3 + E_2^3$, such that the own-price elasticity is greater than the cross-price elasticity, E_1^3. However, when goods 2 and 3 are net complements, then the cross-price elasticity, E_1^3, will exceed the own-price elasticity effect, E_3^3, leading to $dp_3 < dp_1 < 0$. Finally, regarding the income effect, foreign imports both goods 1 and 2, so its import share, D_1^*, is smaller than its export share, D_3, and we thus fall back into the above-mentioned paradox.

In sum, the full-fledged demand relationship in Jones's (1979) demand-based Ricardian model shows that immiserizing growth is conditioned not only by the exported goods' price elasticity of demand, as in Bhagwati (1958), but also by the entire range of goods' demand elasticities.

4.2 The Multicountry, Multigood Model

Should we extend this model to a multigood economy, the equilibrium prices would become inextricably complex. However, as Wilson (see 1980) notices, in such an economy the income impact of any good's price becomes negligible, so only the own-price and the income elasticity of demand matter. That creates ample room for models of trade in quality with non-homothetic demand.

One initial development is Flam & Helpman (1987), whose two-good economy – one of each is differentiated – avoid the above price problem. Instead, Matsuyama (2001) expands the DFS model with quality, and his modeling of non-homothetic preferences is more referential for the latter multigood, multicountry Ricardian models of trade in quality. In both of these North-South trade models the income elasticity of demand conditions the international price of quality attached to goods.

An insightful development over this two-country approach by Matsuyama (2001) is Jaimovich and Merella (2012), who introduce a structural shift in preference for goods associated with a quality q_k level. As the DFS, consumer demands all k product, but only one q of each, and their preferences over a quality-adjusted consumption index, C_k, are given by

$$U = \int_k lnC(k)dk, \qquad \text{with} \quad C_k = \begin{cases} x(k) & \text{if} \quad x(k) < 1 \\ x(k)^{q_k} & \text{if} \quad x(k) \geq 1 \end{cases}, \tag{19}$$

The $x_k < 1$ are basic goods, whereas the $x_k \geq 1$ are non-basic goods whose utility increases with $q(k)$.

In sum, (19) features a utility-adjusted quantity.

Jaimovich and Merella (2012) further assume that high-quality goods have lower quality upgrading cost, $c_{kq} = a(k)q^{\eta(k)}/\kappa$, where $\eta(k)$ is the cost elasticity of quality upgrading and κ is an index for the *global technology frontier*. An increase in either κ or population size, leads to a larger increase in world demand for high-quality goods, given the non-homothetic preferences (19), and so to higher gains to the H economy if it had an initial comparative advantage in non-basic goods. Alongside a tradition in development theory (e.g., Prebisch, 1950), goods' intrinsic characteristics dictate which country gains the most, *i.e.,* the one that by chance first specialized in the most dynamic and highly priced goods.[13]

A multicountry model helps to make countries' characteristics the fundamental element of gains from trade, given goods' characteristics. In Fieler's (2011b) multicountry Ricardian model, demand $x(k)$ is either 0 or 1 and for only on good k with quality $q(k)$. Accordingly, in each country n, consumers with endowment e and income w_n choose $\{x(k)q(k)\}$ from the problem:

$$\max \int_{\{k\in K\}} q(k)x(k)dk, \qquad \text{subject} \quad \text{to} \int_{\{k\in K\}} p_n(q(k),k)x(k)dk \leq ew_n, \tag{20}$$

The resulting demand over these vertically differentiated goods is non-homothetic: wealthier consumers buy the most expensive and high $q(k)$ goods.

Firms in countries with higher (lower) e – and thus higher (lower) w – maximize profits by producing high (low)-quality products, which is similar to the above-quoted 2-country models. The outcome is then a trade pattern in which developed (developing) countries both export and import the most (least) costly varieties. Therefore, unlike Jaimovich and Merella (2012), this trade pattern stems from each country's endowment of human capital.

The international one-factor economy here enables that demand borrowed from oligopoly models of quality competition (Boccard, 2010) work for these competitive models (Jaimovich and Merella, 2012; Fieler, 2011b). That is, in each domestic labor market, labor cost captures all marginal revenue.[14] This oligopoly genealogy also means that demand for quality in these Ricardian models are not grounded on quality-adjusted preferences for horizontally differentiated goods (Cinquetti, 2015), as in most recent analyses of trade in quality (e.g., Hallak and Schott, 2011; Kluger and Verhoogen, 2011; Hummels and Klenow, 2005; Bernard et al., 2011; Baldwin and Harrigan, 2011).

Yet, these new Ricardian models of trade in quality fail to address both horizontally and vertically differentiated goods. Jaimovich and Merella (2015) address in which preferences for products follow a CES specification, so that importers will demand for each exporter in the world, whereas

[13]Thus **?** attribute the growth trajectory of colonial Jamaica and Argentina to their original specializations in sugar-cane and cattle, respectively, with no reference to the implied share of slave labor in both activities, and its impact on both labor incentives and reallocation.

[14]Otherwise, in a two-country economy with two factors of production, trade in quality can explain why trade can promote income re-distribution favoring skilled labor in the Southern-country (e.g., Kluger and Verhoogen, 2011).

the subutility in quality follows closely the non-homothetic form of Jaimovich and Merella (2015), so that a higher share of wealthier importer is direct to high-quality product. Cost function is elastic to q, following Jaimovich and Merella (2012), and also conditioned to country's development level, so that the most developed countries can supply high-q goods. In a sense country's characteristics set the international supply specialization, as in Fieler (2011a). Yet, as argued by Baldwin and Harrigan (2011) quality competition among exporters entails a FOB-price competition, that is, exporters that set prices, as shown by a model on product-level price-premium by Cinquetti and Faria (2016). Jaimovich and Merella (2015) overcome it by regressing importer's value on exporters' GDP and RCA.

Fieler (2011a) instead extends EK with a non-homothetic demand that is not grounded on goods´quality. More to the point, preferences of the international consumer is given by

$$\sum_{k=1}\left\{(\alpha_k)^{1/\sigma_k}\left(\frac{\sigma_k}{\sigma_k-1}\right)\int_0^1\left[x(v_k)^{(\sigma_k-1)/\sigma_k}\right]\right\}, \qquad \sigma_k>1,\alpha_k>0, \tag{21}$$

where the weights $\sum_k(\alpha_k)^{1/\sigma_k}=1$. (21) is not a traditional CES, especially because σ_k rather stands for a constant income elasticity, as shown by the relative demand for two goods:

$$\frac{x_k}{x_{k'}}=\lambda^{\sigma_2-\sigma_1}\left(\frac{\alpha_1 P_1^{1-\alpha_1}}{\alpha_2 P_2^{1-\alpha_2}}\right), \tag{22}$$

where λ are the Lagrangian multiplier associated with the inverse of consumer budget constraint, whereas P are the price indexes. If $\sigma_k>\sigma_{k'}$ then the ratio $x_k/x_{k'}$ increases with income. This will lead to a North-South trade if one further assumes difference in the EK's parameter's $\theta_k\neq\theta_{k'}$. In the case $\theta_k<\theta_{k'}$, meaning that goods k are more bound to be traded than k', we would have both, as well explained by Caron et al. (2014): (i) wealthier countries trade more among themselves, and (ii) trade less with respect to their GDP. This EK model with a heterogeneous demand structure fits the data better than EK (see Fieler, 2011a). It is, from another standpoint, a gravity model with demand- and supply-side structure.

Overall, when it deals of a multigood economy, the new demand-based Ricardian are but a flip side of the new Ricardian models of comparative advantages, in that the labor-input's ordering mirrors the quality demand's ordering. In the case of Fieler (2011a) this is patent in the assumed differences in the supply and demand parameters respectively, that is, $\sigma_k>\sigma_{k'}\Leftrightarrow\theta_k<\theta_{k'}$. Caron et al. (2014) extends Fieler (2011a) in two important ways: with a more detailed inter-industry modeling, which makes more room for the role of trade cost, and fitting (21) for industry's bilateral trade by following Costinot et al. (2011). They also develop it to a HO's model of bilateral trade yields and obtain that skilled intensive goods are more income elastic. Off course, making use of the hypothesis that the demand parameters σ_ks order the trade (or supply) parameter θ_ks.

One alternative multicountry framework is Hidalgo et al.'s (2007) network approach to economic complexity. The theoretical simplification here is a theoretical agnosticism, or a purely empiricallystructured model that takes full advantage of computer-based resources for handing big data. Its empirical reliance on goods' characteristics – the conditional probability of the RCA among pairs of products – reminds Jaimovich and Merella (2012) and Fieler (2011a), and it can address both horizontal and vertical product differentiation (see Ferrarini and Scaramozzino, 2015), as well as the production chain.

5 Conclusions

The new Ricardian models solve several new issues raised in trade theories of multicountry, multigood economies. The models that focus on the link between cost and trade hinge on random bilateral trade from a cumulative (Fréchet) probability distribution built on a supplier's comparative advantages in an importing market. In EK's original formulation, a worldwide parameter of technological heterogeneity conditions the impact of marginal costs (encompassing geographic variables) on trade flow that is meant to represent the extensive margin of a country's bilateral trade. Developments in industries' bilateral trade reintroduce opportunity cost, and trade flow is referred to the intensive margin. A pure model of intra-industry bilateral trade renders a new and insightful index of RCA, whereas another focus on inter-industry trade via intermediate goods (input-output table), which offers an ampler inter-sector view of the welfare impacts of international trade. Less noticed, though no less important: this class of model hinge on neutral forms of demand with respect to cost-based prices.

As the DFS model is a reference for the above models, so is Jones' (1979) three-sector model for the new Ricardian models that focus on the link between demand and trade. His full consideration of cross- and own-price elasticities of demand provides a new assessment of how international demand can condition gains from technological changes. Multigood models rules out cross-price elasticity, which thus enables a definite analysis of trade in product quality hinging on several forms of non-homothetic preferences. Expanding this framework to a multicountry economy allows characterizing the heterogeneous import and export structure across countries, from the country's characteristics. Another direction is expanding the simple cost side of EK and differentiate goods according to their tradability, that is, with a between product differentiation rather than a within product differentiation. This form of non-homothetic preferences allows an ultimate development carrying horizontal and vertical product differentiation. This class of multicountry model of international specialization from country's income levels can definitely be deemed a Ricardian revenge against the RHD tradition. They flip side of these is having a technology ordering that just mirrors the demand ordering.

In sum, the new Ricardian models must be viewed as a comprehensive framework for multigood, multicountry trade models that focus either on cost or demand linkages to trade and that always adopt some well-devised simplification – beyond the exogenous technology – for the other side of this equilibrium. This economic setting, which compels comparative advantages with no reliance on autarky prices, is another fundamental difference from the RHD tradition, which focuses on trade pattern.

Acknowledgments

Early comments and suggestions by R. Jones, D. Bernohofen, D. Levcovitz, J. Moenius, J. H. Faro, and R. N. Faria are gratefully acknowledged. This work was initially advanced during my sabbatical at the University of Colorado, which was supported by Sao Paulo State University, CAPES under Grant [BEX 0867/09-8].

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