Labor Productivity and Comparative Advantage: The Ricardian Model

Gaurav Bhatia

Module: International Economics: Theory and Policy
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Lecturer: Prof. Dr. Jörg Flemmig

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1 Introduction

Last two centuries have witnessed the tremendous growth in trade among different nations and thus International Trade has emerges as important field for the development of country and world wealth respectively. In International Trade, the Ricardian Model is considered as the simplest, complete and general equilibrium model ever developed. Historically, Ricardian model is considered as the earliest model that had appeared in different literature's of esteemed economists and consider useful till date.

In the early 18^{th} century, Ricardo witnessed that with the Industrial revolution the income of certain nations were increasing. Ricardo researched more on this as initially it was very difficult to find factors responsible for the increase. He encountered different factors like efficiency in terms of hours worked, recent developments in new sources of energy, technologies etc. Ricardo was well determined to find the actual link between the International Trade and wealth creation and put forward his theory/model for the same.

Ruffin stated that in his research work (Ruffin 2002) stated that, Ricardo only stated a small portion of the model based on the concept of comparative advantage and focus majorly on traded goods and labour associated to produce that goods[1]. Ruffin also stated that it was Mill's research work (Mill 1844) where Ricardian model was first appear[2]. Even after almost two decades, Ricardian Model is still one of the important model where no other model is able to suppressed it, but instead Ricardin Model is the building block for introduction of new ideas. Gbetibouo in his research work (Gbetibouo & Hassan 2005) used ricardian model to measure climate change on South Africa field crops [3].Similarly Seo and Mendelsohn (Seo & Mendelsohn 2008) used Ricardian model to develop a cross sectional strategy to manage life stocks in Africa.[4] Melitz in his famous research work (Melitz 2003) modelled heterogeneous firms with a Ricardian Model[5]. Eaton Kortum (Eaton & Kortum 2001) in their research work try to examine links among innovation, technology, trade and growth where they incorporated geography into a Ricardian Model[6]. Dornbusch, Fischer Sameulson in their research (Dornbusch et al. 1977) discussed Ricardian trade and payment theory in the case of continuum of goods.[7]

[1]Ruffin, Roy. "David Ricardo's discovery of comparative advantage." History of political economy 34, no. 4 (2002): 727-748.

[2]Mill, John Stuart. "Of the influence of consumption on production." Some Unsettled Questions of Political Economy (1844).

[3]Gbetibouo, Glwadys Aymone, and Rashid M. Hassan. "Measuring the economic impact of climate change on major South African field crops: a Ricardian approach." Global and Planetary change 47, no. 2-4 (2005): 143-152.

[4]Seo, S. Niggol, and Robert Mendelsohn. "Measuring impacts and adaptations to climate change: a structural Ricardian model of African livestock management 1." Agricultural economics 38, no. 2 (2008): 151-165.

[5]Melitz, Marc J. "The impact of trade on intra industry reallocations and aggregate industry productivity." econometrica 71, no. 6 (2003): 1695-1725.

[6]Eaton, Jonathan, and Samuel Kortum. "Technology, trade, and growth: A unified framework." European economic review 45, no. 4-6 (2001): 742-755.

[7]Dornbusch, Rudiger, Stanley Fischer, and Paul Anthony Samuelson. "Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods." The American Economic Review 67, no. 5 (1977): 823-839.

This essay/report try to understand The Ricardian Model in detail and try to summarize the theory associated with the model. The report structure is as follows: In Section 2 the reason for International Trade is discussed. In section 3, Ricardian model is discussed in detail. In section 4, Strengths & Weaknesses of the Ricardian Model are discussed. Section 5 describes the conclusion/summary of the report.

2 The Reasons for Trade

Bhagwati (Bhagwati 1964) in his research put forward many interesting observations and reasons for international trade [8]. Krugman in his book (Krugman et al. 2018) highlighted & summarized the five important reasons which describes more about the reason of International Trade between the countries [9].

The First Reason for Trade is Difference in Technology. It states that two countries can obtain advantages in the trade if technological ability of both the countries are different to produce gods and services. This very first reason was the building block of the Ricardian Theory.The second reason for trade is the difference in resource endowments: It states that 2 countries involved in trade can obtain advantages if the countries differ in endowments of resources. These resources can be skills, workforce, natural resources, machinery, communication system or infrastructure. This type of trade lays the foundation of pure trade model & Heckscher-ohlin model [10] (Leamer et al. 1995).

Whereas, The third reason for the international trade is based on Differences in Demand. It states that different countries have different demand for various products. For example, Germans may demand more beer, Indians will demand more rice, Japan need more fish, etc. There is no formal model for the same, although the monopolistic competition model include demand based on differences in choice or taste between costumers.Reason fourth states the existence of economics of scale in production. It states the production process in which with the rise of scale of production, production costs fall down.On the other hand fifth reason explains the government policies which are like tax subsidy, low tariffs etc, which encourages International Trade among nations.

Krugman highlighted that there are very few models that include all the five mentioned reasons at the same time. These types of models are very complicated to work and economist usually suggest the model that solve only one reason. Krugman also highlighted that The Ricardian Model concludes that everyone must benefits from the trade while Hackscher-Ohlin Model state that there are always winners and losers from the trade. That's make Ricardian model more interesting to research. Therefore in this essay we will look more on to the Ricardian Model and see whats the reason that it concludes that everyone benefits from the trade.

[8] Bhagwati, Jagdish. "The pure theory of international trade: A survey." The Economic Journal 74, no. 293 (1964): 1-84.

[9] Krugman, R. Paul, Maurice Obstfeld, and J. Marc Melitz. International trade: Theory and policy. Pearson Education Limited, 2018.

[10] Leamer, Edward E. "The Heckscher-Ohlin model in theory and practice." (1995).

3 The Ricardian Model

3.1 The concept of Comparative Advantage

Schumacherin his resaerch work put forward that it was Adam Smith in 1776 (Schumacher 2012) who laid the foundation of Absolute advantage.[11] It stated that if any of the country has higher productivity or absolute advantage over the trading partner on different industries, it must export goods produced by the respective industries[12].On the contemporary, Ricardian model is based on comparative advantage based on opportunity costs.While the previous model clearly focus on absolute advantage, Ricardian Model focus on comparative advantage which states that a country holds edge over other country if the opportunity cost of producing in same country is lower [13] (Suranovic 2010).

		Goods	
		A	B
Countries	India	1	10
	Germany	1	5

Figure 1: Production Output per hour

In Figure 1, Two countries Indian and Germany are chosen hypothetically. India can produce 1 unit of product A in one hour, contemporary in same amount of time, India can produce 10 units of product B. Whereas Germany has opportunity cost of one unit of product A are 5 units of product B. It can be clearly observe that for producing same amount of product A, Germany has to give up less units of product B. This clearly depicts that Germany has comparative advantage in producing product A whereas India has comparative advantage in producing product B. This was the main idea which shows how one country hold comparative advantage in one product if opportunity cost of this product is lower compared to other country. This formulate the idea that countries must focus on producing goods where resources involved in producing goods and productivity goes hand in hand and then trade these goods, resulting both the countries to get substantial benefit from it.

3.2 The simple Ricardian Model

The Simple Ricardian model is depicts on two countries, the home country & the foreign country where each countries producing two goods named A & B, based on Labour L as single factor of Expansion [14].(Krugman & Obstfeld 2009)

[11]Schumacher, Reinhard. "Adam Smith's theory of absolute advantage and the use of doxography in the history of economics." Erasmus Journal for Philosophy and Economics 5, no. 2 (2012): 54-80.

[12]Smith, Adam, 1723-1790. The Wealth of Nations / Adam Smith ; Introduction by Robert Reich ; Edited, with Notes, Marginal Summary, and Enlarged Index by Edwin Cannan. New York :Modern Library, 2000.

[13]Suranovic, Steve. International trade: Theory and policy. 2010.

[14]Krugman, Paul R., and Maurice Obstfeld. International economics: Theory and policy. Pearson Education, 2009.

3.2.1 Ricardian Model Assumptions

One of the main assumption of the Ricardian model is supply of Labour. It is a general equilibrium model which states that in a competitive market goods produced are homogeneous across country. It also based on assumption that there is no transportation cost of goods between the countries and different countries uses different technologies to produced the goods. It sates that available labour can work in any sector & is mobile within the country, but only available to work in that particular country only. Assumption clearly states that Labour can not go and work in any other country. It's also important to notice that the labor used in the production has constant return, which depicts that irrespective of quantity produced, amount of labour needed to produce one unit of good will always be the same. Let's resume Labour supply in both the countries can be denoted as L and L^* respectively. Note that anything related to second country will be represented with asterisk. Unit labour requirement for each good A and B can be denoted by a_i & a_i^*, where i denotes each good A & B respectively. In a perfectly competitive market,price for cost of production for wages w can be denoted as[15]: $p_i = w_i a_i$ & $p_i^* = w_i^*\ a_i^*$ (Goñi Córdoba 2017).

3.2.2 The autarkie equilibrium

The ricardian model is used to compare The autarkic equilibrium[16] of free trade. The autarky equilibrium states that each country needs to produced both goods to be consumed however to measure quantities of production and consumption, additional knowledge about the in differences curves of each country is required(Hammond 2011). The relative prices is equal to relative unit labour requirements (Opportunity cost of product A with respect to product B i.e. $a_A/\ a_B$), Based on assumption that Labour is free to work in any sector of the country as wages in all the sectors are same (So there is no high paying sector for which labour want to work). With the help of Labour constraints and and Production functions, one can define Production Possibility Frontier (PPF). It states that if there is no trade to occur, both the consumption and production of any country will be limited by the Labour it holds. $a_A\ Q_A + a_B\ Q_B <= \mathrm{L}$. Note: Some literature used a_A as $a_L A$, which denotes Labour used to produce good A, but as we mentioned already about the opportunity cost above, we will use only a_A, which means same to $a_L A$ & represent the use of Labour to produced good A respectively.

The above equation has known values of three exogenous variables(a_A, a_B & L) and two endogenous variables(Q_A, Q_B) whose values must be solved. It's is worth mentioning that PPF equation is a linear equation which denotes a straight line. The straight line equation Y = mx + c, with manipulations PPF equation can be written as: $Q_B = \mathrm{L}/a_B - (a_A/\ a_L)Q_B$

[15]Goñi Córdoba, Beatriz. "The Ricardian Model: theoretical and empirical review." (2017).

[16]Hammond, Peter J. "Competitive market mechanisms as social choice procedures." In Handbook of social choice and welfare, vol. 2, pp. 47-151. Elsevier, 2011.

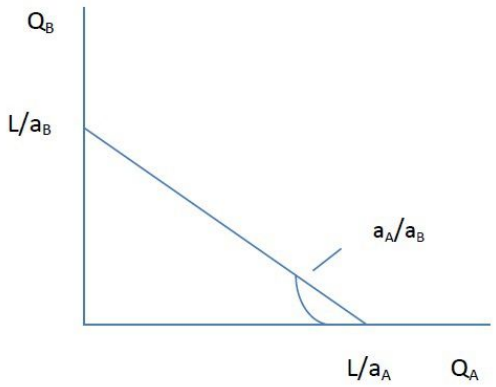

Figure 2: Home's Production Possibility Frontier
Source: Self Contribution

Figure 2 states that there is When $Q_B = 0$, maximum production of product A will be obtained. Similarly when $Q_A = 0$, maximum production of product B will obtained. With $Q_A = 0$, $Q_B = \mathrm{L}/a_B$ & with $Q_B = 0$, $Q_A = \mathrm{L}/\ a_A$ respectively. By connecting these 2 points. The straight line is the PPF. It describes all the possible combinations of two products that can be obtained by a country A(or B) economy. It also states that movement along curve represent labour resources transferring from one industry to another so all of the labor forces remain employed. Within the border and inside the area under the curve (Under the line and on the line), represents Production Possibility Set, which states all production possibilities regardless of full employments are fulfilled. In other words, PPF is combination of outputs that a country can produce even if some of the labor is unemployed.

In Autarky, it's very clear that combination of both the goods (in the PPF) will be produce & consume by the home country. Exact one good can be chosen to maximize the utility function. Similar PPF can be expected from foreign production but with different slope $a_A^*/\ a_B^*$ (as mentioned above also that * denotes foreign country).Let's assume that $a_A/\ a_B < a_A^*/\ a_B^*$,which states that, opportunity cost of good A in terms of good B is smaller in home than foreign. In simple words, Home has comparative advantage on good A while foreign has comparative advantage on good B.

3.2.3 Relative Prices & Free Trade

As stated above that in autarky, relative prices equals relative unit labour requirements, $p_A/\ p_B = \mathrm{p} < p^* = p_A^*/\ p_B^*$. It states that if countries started trade among themselves excluding other factors (transportation cost etc.), relative prices will change & become equals.

World relative demand and supply determined the unique relative world price p^w. It will further analyzed on a general equilibrium analysis (Goñi Córdoba 2017). Relation between markets of goods A & B are taken into consideration for the same. Figure 3 shows relative demand denoted by RD, relative supply function with RS. In the Figure one can see that the RD is slopping downwards

which shows the relative price of product A in terms of B decreasing, the relative demand of A in terms of B increases(Krugman & Obstfeld 2009)

Relative Supply function has different segments.In the first segment $p^w < a_A/\ a_B$, with relative supply of 0 & represented by vertical segment to origin (0, $a_A/\ a_B$)(Goñi Córdoba 2017). It states that there will be no supply of A, since if $p_A/\ p_B = wa_A/\ wa_B$ & $p_A/\ p_B < a_A/\ a_B$. It shows the difference in wages and implies that due to less wages (salary) no one wants to work to produce A for small salary as one can earn by producing good B. As previously mentioned, $a_A/\ a_B < a_A^*/\ a_B^*$, so the same will apply to foreign.

The first flat section appears in the figure when $P^w = a_A/\ a_B$, at this point, both the sectors pays the same wage and thus home workers it's indifferent to produce product A or product B. Home workers produces both the goods and exact quantity of each good is defined by the RD (Goñi Córdoba 2017). On the other hand, flat section shows foreign workers still continue to be specialized in good B for the same reason as before.

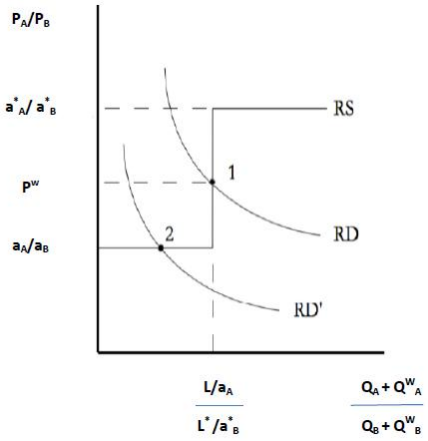

Figure 3: World's Relative Supply & Demand
Source: Self elaboration

The next segment is once again a vertical line, happens when $a_A/\ a_B < P^w < a_A^*/\ a_B^*$. This is a condition when world's relative price is higher then opportunity cost of product A at the home. Now, all the workers want to work on it as they can earn more wages for product B, so home gains a full specialization on the production of product A.Meanwhile as foreign continues to be fully specialized on good B so it can prepare it's workforce to work on the same. As long as the world relative price is in between the autarkic price of each country, both the countries will develop a workforce specialized in the product i which they hold comparative advantage, and thus the relative supply to the world will be : $L/a_A/L^*/a_A^*$[17]: $p_i = w_i a_i$ & $p_i^* = w_i^*\ a_i^*$ (Goñi Córdoba 2017)

Also to be noted that when world's relative price equals to the Foreign opportunity cost of A, foreign workers can work in any sector while home workers will

[17]Goñi Córdoba, Beatriz. "The Ricardian Model: theoretical and empirical review." (2017).

continue to work for specialization. Similarly, if world relative price becomes greater then that, both country's will only work to produce product A and thus A will be produced in infinite number while there is no product B produced.

3.2.4 Gain from Trade

Gains from the trade are based on assumption that both the countries which are involved in the trade expect some gain from the trade. Also, with trade, both countries will get specialized in certain products. Trade provides countries the possibility to consume goods other than they produced. Fig 4, shows PPF before and after trading. Before trading, PPF was a straight continuous line, After trading a discontinued line shows the expansion in purchasing capabilities. "This discontinued line also represents the budgetary restriction with a negative slope, equals to the world's relative price."[18][19](Goñi Córdoba 2017)(Krugman & Obstfeld 2009).

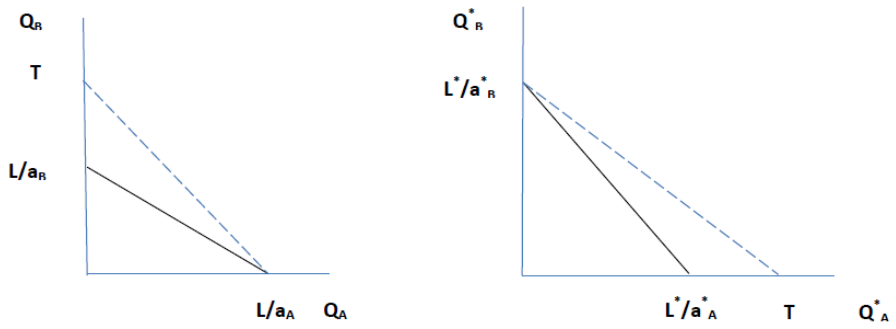

Figure 4: Expansion of Consumption Possibility
Source: Self elaboration

After trading, both the countries(which were involved in trade), people can choose different mixes and can obtain higher indifference curves. It's also interesting to observe that discontinued lines can now be use to substitute each point of the PPF by another and thus having more of both goods. With better options to enlarge consumption, International Trade has definitely helped people of both the countries to become more better off.

3.2.5 Relative wages

There exists a substantial difference between that wages of countries that trade.It's a general concern among many people that this trade model (International trade) will affect the countries with low wages to the workers.It will make then more poor and they will not get much benefit out of this trade model. As prices equal the cost of goods production, thus every country must get cost advantages

[18]Goñi Córdoba, Beatriz. "The Ricardian Model: theoretical and empirical review." (2017).
[19]Krugman, Paul R., and Maurice Obstfeld. International economics: Theory and policy. Pearson Education, 2009.

by relative wages of workers which have to be in order with relative production of goods. Many different factors like productivity differences are responsible for this differences. These challenges are discussed in more detail under weakness section of this essay. Let assume that India need twice as much labour needed as compared to Germany to produce good B, but wages are 1/4 of the Germany, it is obviously cheaper to produce it in India even twice as much labour is needed for the same.So for India to have cost advantage on good A & Germany on god B, both of the following inequalities must be satisfied: w$a_A < w^*\ a_A^*$ and w$a_B > w^*\ a_B^*$

So, relative wages must be in between relative productivity of good A and B, $a_A/a_A^* < w^*/\mathrm{w} < a_B/a_B^*$

4 Strength & Weakness of Ricardian Model

4.1 Weaknesses

The first weakness of Ricardian model can be outlined as assumption about the specialization that every country hold in manufacturing a particular good.In reality, it's very unlikely to witness that an industry vanished completely because of comparative disadvantage. Different examples are quoted for the same. One of the very famous Example is by (Goñi Córdoba 2017) with skills of tailor.He mentioned that even though importing low to medium quality, budget friendly clothing is available, still there are many people who prefer local tailors for there wardrobe. Some of the major points which supports incomplete specialization argument are listed below:

4.1.1 Disequilibrium effects

The Disequilibrium effect states that the slow process of price and quantity equalization, if not completed in due time then it leads to incomplete specialization.It state that difference in prices, labor cost, etc., will disappear with time, but (Giovannini 1988) research work stated the deviation from PPP (Purchsing Poer Parity) does not disappear with time. Even on basic goods it does not disappears. Giovannini specifically stated that " co-movements of prices of individual traded goods and exchange rates are not only depend of Demand and Supply parameters, but also on the stochastic process followed by the exchange rate."[20] This interception clearly states that an explanatory variable is necessary to underline that relative unit labour cost instead of relative productivity. It will help to allow sectional wage differences as source in return (Goñi Córdoba 2017).

4.1.2 Product Differentiation

Product differentiation is terminology used when on product sets itself apart from other products in terms of quality. It is worth noticing that if product differentiation is allowed then price equalization, productivity differences & incomplete specialization will be consistent issues. (Krugman 1981) explained

[20]Giovannini, Alberto. "Exchange rates and traded goods prices." Journal of international Economics 24, no. 1-2 (1988): 45-68.

this consistency[21] with help of Dixit-Stiglitz[22] monopolistic competition model (Dix et al. 2004). For Example if India has competitive advantage for Computers then car industry when comparing with Germany, then India will produce more varieties of Software and become net exporter (net exporter, not the only exporter) of software on Computer industry.

4.1.3 Transport costs

(Krugman & Obstfeld 2009) mentioned about the evidences highlighting low international trade in goods with high weight to value ratio. The main reason behind this is transportation cost which offset the cost advantage, even if one country holds comparative advantage in that particular good.

4.1.4 Tariffs

Similar to transportation costs, sometimes nation want to promote and protect their national productions by putting tariffs on imported products, which distort he relative cost advantage of countries. For example, even if Germany hold cost advantage on sports car, if India put high tariff on cars, will make cars more expensive for Indian buyers. It may lead to buy cars which are available at a much cheaper price in India and thus there are high chances that German sport cars become non-tradable with India.

4.2 Strengths

Nowadays raw materials & financial capital are more mobile inputs as compared to Labor, which is less trade-able. This fact decrease the importance of raw materials and financial capital in terms of comparative advantage. Many available research support the argument. Research work of (Jones 1980) states that, with input are mobile, locations of these inputs are not given and thus comparative advantage can not be originated by it.[23] Similarly (Ferguson 1978) also highlighted that with perfect capital mobility, the only source for comparative advantages is relative labor productivity.[24] One important point that need to be underlined here is in some cases trade and capital mobility are substitutes if factor prize equalization is observed with trade. On the other hand, if there are industry specific technology difference between the countries then price equalization is less likely to be observed.

Many other studies have identified the difference in Labour Productivity in different sectors. These differences shows the technological differences in different sectors(which we discussed above). If we try to relate is with trade, we realized that Ricardian model is justified here, because that was one of the main reason of the comparative advantage and International trade. One more important

[21] Krugman, Paul R. "Intraindustry specialization and the gains from trade." Journal of political Economy 89, no. 5 (1981): 959-973.

[22] Dixit, Avinash K., and Joseph E. Stiglitz. "Monopolistic competition and optimum product diversity." The American economic review 67, no. 3 (1977): 297-308.

[23] Jones, Ronald W. "Comparative and absolute advantage." Swiss Journal of Economics and Statistics (SJES) 116, no. III (1980): 235-260.

[24] Ferguson, Donald G. "International capital mobility and comparative advantage: The two-country, two-factor case." Journal of International Economics 8, no. 3 (1978): 373-396.

point that support or strengthen The Ricardian Model is ease to obtain the labour productivity data for other cost of production.

Lastly, Deardroff (Deardorff 1984)in his book advocates that productivity based models such as The Ricardin models are compatible with factor-endowment models [25](discussion about factor endowment models are beyond the scope of this research work). He mentioned that if differences in factor endowments encourage specialization then specific sector specialization with country give boost to higher productivity.

5 Summary

This essay on Labour Productivity & Comparative advantage is focused on the analysis of the Ricardian theory in an empirical way. It can be concluded that even it is written almost two hundred year back and economic & social frameworks has changed a lot in this period, it still helps to explain concepts of International Trade. Many latest research still holds around Ricardin model. It support the argument that relative productivity continues to be the main driver in exports(Goñi Córdoba 2017).It also outlined the fact that along productivity, unit labour cost is also an important source of comparative advantage, which helps relative exports on the countries. To Conclude, it can be said that with his theory, Ricardo contributed to increase international world wealth and promote International Trade among nations.

[25]Deardorff, Alan V. "Testing trade theories and predicting trade flows." Handbook of international economics 1 (1984): 467-517.

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