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# AN EVALUATION OF DAVID RICARDO'S THEORY OF COMPARATIVE COSTS: DIRECT AND INDIRECT CRITIQUES

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Following Smith's advocacy of free trade and competition, David Ricardo attempts to strengthen his theory of absolute advantage, which excludes from international trade countries which have no advantages over others, by eliminating this weakness. To do so, Ricardo introduces to the economics literature a theory of comparative cost advantage which includes countries that do not have absolute advantages in international trade. In Ricardo's framework, these countries can still gain from free trade. We present direct and indirect critiques which reveal that their advocacy of free trade is questionable. In our direct critiques we find that Ricardo's attempt is questionable for the following reasons. First, the scale of production of cloth in Portugal and that of wine in England equal 1 even though there is no reason to believe that two countries have the same scale of production for two different commodities. Second, it is argued that his theory is incomplete because it is based on particular numbers, does not determine the terms of trade, and does not take into account the unintended curtailment of demand in both countries, which in turn can make trade non-beneficial for both countries. In our indirect critiques, first we argue that Ricardo assumes the equality between the relative price and relative labor cost of two commodities even though they are different. Second, it is shown that the outcome of complete specialization in his theory prevents a country from specializing in the production of a commodity that could generate for itself a substantial profit in the long run, locking the country out of industrialization. We then point out that Samuelson who supports Ricardo's theory to some extent does not consider in his proof the possible destruction of the domestic industry in the case of free trade, even though this might make domestic consumers worse off and also lock a country out of industrialization.

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## 1. INTRODUCTION

Free trade in Smith's sense excludes nations that have no absolute advantages over others. In his 1817 *Principles of Political Economy and Taxation*, David Ricardo attempts to strengthen Smith's theory of absolute advantage by eliminating this weakness. To do so, Ricardo uses Torrens' idea of comparative advantage and introduces to the economics literature a theory of comparative cost advantage, which includes countries that do not have absolute advantages in international trade.[1]

These countries can still gain from free trade in Ricardo's framework. However, in spite of Ricardo's advocacy of free trade, there always has been some protection throughout the world. This article aims 1) to present direct critiques to determine whether two trading partners always mutually benefit from free trade in Ricardo's theory and whether his theory is incomplete, and 2) to present indirect critiques of Ricardo's theory in order to determine whether the market price of a commodity converges toward its natural price and whether the outcome of complete specialization in his theory locks third world and developing countries out of industrialization.

## 2. PART I: DIRECT CRITIQUES

After analyzing Ricardo's theory, we present two direct critiques, which show that Ricardo's attempt is questionable.

### 2.1. David Ricardo's Theory of Comparative Cost Advantage

For clarity in the presentation, see the table below:

Men's Labor Per Year in the Autarkic Production of Cloth and Wine in England and Portugal

| | England | Portugal |
|---|---|---|
| Cloth | 100 | 90 |
| Wine | 120 | 80 |

[1] See Torrens (1808, 1815), Chipman (1965). Disagreeing with Chipman, Ruffin argues that although "Torrens had the insight that absolute advantage may not decide whether a good would be imported" (2002, p. 731), "Torrens cannot be given credit for the law of comparative advantage" (2002, p. 735) because he did not take the law of comparative advantage at its final stage as did Ricardo. It is as if Ruffin is arguing that Heckscher should not get any credit concerning the discovery of the theory of factor endowments because he did not take it at its final stage as did Ohlin. As far as the theory of comparative advantage is concerned, it will be very difficult to totally remove Torrens' contribution on the basis of historical facts.

In Ricardo's example of two countries (England and Portugal) and two commodities (cloth and wine),[2] England has no absolute advantage over Portugal because it costs more in England (100 men's labor; 120 men's labor) to produce annually both commodities than in Portugal (90 men's labor; 80 men's labor).[3] However, England will not be excluded from international trade in Ricardo's theory, whereas it was excluded from it in Smith's theory of absolute advantage. This is because England has a comparative cost advantage in producing cloth and Portugal in producing wine.[4] How do we translate Ricardo's theory of comparative cost advantage?

The pre-trade price of cloth in terms of wine in England is 100/120, whereas in Portugal it is 90/80. It appears that England has a comparative cost advantage in the production of cloth because (100/120)<(90/80). Similarly, Portugal has a comparative cost advantage in producing wine because (80/90)<(120/100).

Since the pre-trade or autarkic prices of cloth in terms of wine in England and Portugal satisfy the inequality (100/120)<(90/80), any price of cloth in terms of wine ($P_C / P_W$) between (100/120) and (90/80) after the opening of trade should benefit both countries. Formally, that is,

$$(100/120)<(P_C / P_W)<(90/80). \quad (1)$$

Since Portugal gains by producing wine and importing cloth, and England the reverse, according to Ricardo, Portugal should specialize completely in the production of wine and England in cloth. Thus, Portugal can use 80 men's labor annually to produce wine for its own consumption, and 90 men's labor to produce wine that will be used in part to exchange for English cloth. Similarly, England can use 100 men's labor annually to produce cloth for its own consumption, and 120 men's labor to produce cloth that will be used in part to exchange for Portuguese wine.

However, Ricardo writes that to produce "cloth may require the labour of 100 men for one year" in England, whereas it "might require the labour of 90 men" in Portugal.

[2] See Ricardo (1911, p.115-116).

[3] We use Ricardo's numbers to stick to his framework.

[4] Even if England has an absolute disadvantage with respect to Portugal in the production of both commodities, its disadvantage is less in the production of cloth (100 men's labor/year against 90) than in wine (120 men's labor/year against 80). Conversely, Portugal has an absolute advantage over England in the production of both commodities, but its advantage is greater in the production of wine than in cloth. Thus, Portugal has a comparative cost advantage over England in the production of wine, and a comparative cost disadvantage in the production of cloth. It would be then advantageous for Portugal to completely specialize in the production of wine and to exchange it for English cloth. Similarly, it would be more advantageous for England to completely specialize in the production of cloth. As a result, trade should take place between the two countries even if England has no absolute advantages over Portugal.

We thus are left to assume that England and Portugal produce annually the same number of units of cloth ($x$) with 100 and 90 men's labor respectively, and the same number of units of wine ($y$) with 120 and 80 men's labor respectively, where $x$ and $y$ could be equal to 1.[5]

Thus, the comparative unit cost of cloth with respect to wine in England is $(100/x)/(120/y) = (100/120)(y/x)$, and that of Portugal is $(90/x)/(80/y) = (90/80)(y/x)$. In other words, England has a comparative cost advantage in producing cloth because $(100/120)(y/x) < (90/80)(y/x)$.[6]

Let us assume that in the pre-trade era England annually consumes $y$ units of wine produced by 120 men's labor, and Portugal $x$ units of cloth produced by 90 men's labor. When trade opens, to completely specialize, England will divert 120 men's labor from the production of wine to cloth and Portugal 90 men's labor from the production of cloth to wine. How many units of cloth and wine do England and Portugal produce with these men's labor?

England annually uses 100 men's labor to produce ($x$) units of cloth. Therefore in England, 1 man's labor produces annually ($x$/100) units of cloth and 120 men's labor ($x$/100)120 units of cloth. Portugal annually uses 80 men's labor to produce ($y$) units of wine. Similarly, in Portugal 90 men's labor produce ($y$/80)90 units of wine. Thus, England will produce in addition to its own consumption of cloth ($x$), $(x/100)120 = 1.2x$ units of cloth, and would exchange ($x$) units of cloth with Portugal, thereby satisfying the latter's annual consumption of ($x$) units of cloth. At the same time, ($0.2x$) units of cloth would be saved by England, because in addition to its consumption,

[5] This premise enables us to compare the relative labor costs in both countries, and allows us to better understand the content of Ricardo's theory.

It could be argued that the number of units of cloth produced annually in England and Portugal, which require respectively 100 and 90 men's labor, are different from each other as those of wine, which require respectively 120 and 80 men's labor. However, in this case, the existence of the gain from trade is not guaranteed. For instance, the number of units of cloth could be ($x$) for England and ($0.9x$) for Portugal, and those of wine ($1.5y$) for England and ($y$) for Portugal. The unit pre-trade cost of producing cloth in England is ($100/x$) which in turn equals that of Portugal ($90/0.9x$); that of producing wine in Portugal is ($80/y$) which in turn equals that of England ($120/1.5y$). The comparative unit cost of cloth with respect to wine in England is $(100/x)/(120/1.5y) = (5y/4x)$ while in Portugal it is $(90/0.9x)/(80/y) = (5y/4x)$. Consequently, the comparative cost in England is equal to that of Portugal ($5y/4x$). As a result, there will be no need to trade English cloth against Portuguese wine because neither country will gain from trade. Therefore, England and Portugal produce the same number of units of cloth ($x$) with 100 and 90 men's labor respectively, and the same number of units of wine ($y$) with 120 and 80 men's labor respectively.

[6] This inequality is the one obtained previously when the comparative cost of England and Portugal in the production of cloth in terms of wine was determined. If one sets the annual unit of cloth and wine produced in both countries equal to 1, i.e., $x = 1 = y$, one obtains
$(100/120)(1/1) < (90/80)(1/1)$, i.e., $(100/120) < (90/80)$.

it produces $(1.2x = x + 0.2x)$ units of cloth. Similarly, Portugal will produce, in addition to its own consumption of wine ($y$), $(y/80)90 = 1.125y$ units of wine, where ($y$) units of wine would be exchanged with England, thereby satisfying England's annual consumption of ($y$) units of wine. ($0.125y$) units of wine would be saved by Portugal, which produces $(1.125y = y + 0.125y)$ units of wine.

So far, it seems that Ricardo's theory is correct, since both England and Portugal satisfy their consumption in cloth and wine and save, respectively, ($0.2x$) units of cloth and ($0.125y$) units of wine.

## 3. ELEMENTS OF CRITIQUE

Ricardo's theory, however, is questionable because in its setting the scale of production of cloth in Portugal and that of wine in England equal 1, moreover it is incomplete.

First, we have not found anywhere the assumption of equal scale of production. However, Ricardo bases his argument on the annual production of ($x$) units of cloth and ($y$) units of wine in both England and Portugal, instead of their annual production of total units of cloth and wine. Therefore, in Ricardo's theory the scale of annual production of $(x = 1.x)$ units of cloth and $(y = 1.y)$ units of wine in both Portugal and England are equal to 1, i.e., the scale of production of cloth in Portugal and that of wine in England equal 1. Since there is no reason to believe that the scales of production are the same or equal to 1, let us suppose that the scales of production of cloth and wine ($C_E, C_P, W_E, W_P$) are positive real numbers greater than 1, which differ from each other,[7] and that England and Portugal produce annually different total units of cloth and wine in pre-trade. How do we determine the total units of cloth and wine produced in England and Portugal?

The pre-trade unit costs of production of cloth and wine in England are ($100/x$) and ($120/y$) respectively and in Portugal ($90/x$) and ($80/y$). That unit costs of production are constant in pre-trade in both countries means that we are dealing with constant returns to scale in Ricardo's theory. If, for instance, we double the input, the output will be

[7] Unlike as it is implicitly assumed in many textbooks, these scales of production are different from the sizes of the two countries. Two countries can have the same size, however the scale of autarkic production of wine of one country can be larger than that of the other if inhabitants of the former consume more wine than those of the latter. Further, a country can be small, but if its inhabitants consume large amounts of wine in autarky, its scale of production of wine can be larger than that of a large country. Conversely, a country can be large, but if few people consume wine, its scale of production of wine in autarky can be smaller than that of a small country.

doubled. Thus, if in pre-trade, England uses ($100C_E$) and ($120W_E$) men's labor in the production of cloth and wine respectively, it will produce annually ($xC_E$) and ($yW_E$) units of cloth and wine for its consumption. Likewise, if Portugal uses ($90C_P$) and ($80W_P$) men's labor, it will produce annually ($xC_P$) and ($yW_P$) units of cloth and wine for its consumption.

In this case, the comparative cost of cloth with respect to wine in England is ($100C_E/120W_E$) and that of Portugal is ($90C_P/80W_P$). Again, any price of cloth with respect to wine ($P_C/P_W$) between ($100C_E/120W_E$) and ($90C_P/80W_P$) then results in a gain for both England and Portugal because of their comparative cost advantages in cloth and wine. Formally, that is,

$$(100C_E/120W_E) < (P_C/P_W) < (90C_P/80W_P). \quad (2)$$

In this context, if England specializes in the production of cloth, in addition to its own annual consumption in cloth ($xC_E$), it will divert ($120W_E$) men's labor from the production of wine to produce $(xC_E/100C_E)120W_E = (120/100)xW_E$ units of cloth to be exchanged for Portuguese wine. Similarly, in addition to its own annual consumption in wine ($yW_P$), Portugal will divert ($90C_P$) men's labor from the production of cloth to produce $(yW_P/80W_P)90C_P = (90/80)yC_P$ units of wine to be exchanged for English cloth.

However, for a mutual beneficial trade to take place in complete specialization, the consumption needs in cloth and wine must be satisfied in both countries. That is, in addition to its own consumption in cloth, England must produce a number of units of cloth $(120/100)xW_E$ greater than or equal to Portugal's annual consumption of cloth in pre-trade ($xC_P$). Similarly, Portugal must produce a number of units of wine $(90/80)$ $yC_P$ greater than or equal to England's annual consumption of wine in pre-trade ($yW_E$).[8] Formally, that is,

[8] However, in evaluating Pareto's argument, Chipman states:

*He [Pareto] went on to argue, less convincingly (p. 508-509), that "in order that Ricardo's conclusion be certainly true," the total output of each good should be larger when there is complete specialization than would be the corresponding equilibrium output (and consumption) that would obtain in the absence of trade (1965, p. 488).*

Chipman's conclusion is based on utility functions (1965, p. 489). However, since "satisfaction of ... tastes" or utility is not part of Ricardo's framework, Pareto could have disregarded the satisfaction of tastes in his argument (1971, p. 370). What is at issue is not a utility function, as in Chipman's examination of Pareto's argument, but whether the total outputs of the two goods in complete specialization can meet with

$$[(120/100)xW_E \geq xC_P \quad \text{and} \quad (90/80)yC_p \geq yW_E], \tag{3}$$

or

$$[(80/90) \leq (C_P/W_E) \leq (120/100)]. \tag{4}$$[9]

Inequalities (4) state that even if we have free trade where each country has a comparative cost advantage, contrary to Ricardo's theory, trade will not necessarily be mutually beneficial for England and Portugal in the case of complete specialization. For trade to be mutually beneficial, the ratio of the pre-trade scale of production of cloth in Portugal to that of wine in England ($C_P/W_E$) should be between the cost of production of wine in terms of cloth in Portugal (80/90) and in England (120/100).[10]

Scale of production is not problematic if it is supposed that the two countries' production scale is equal. This problem is avoided since the pre-trade scale of production of cloth in Portugal is ($C_P = 1$) due to ($xC_P = x = 1x$) and that of wine in England is ($W_E = 1$) because ($yW_E = y = 1y$). As a result, the ratio of the scales of production $(C_P/W_E) = (1/1) = 1$ is between the cost of production of wine in terms of cloth in Portugal $(80/90) = 0.888$ and in England $(120/100) = 1.2$, satisfying inequalities (4).

In evaluating Ricardo's theory of comparative costs, only the annual quantity of labor (120 men's labor) necessary to produce ($y = 1$) unit of wine was considered, instead of the total annual quantity of labor ($120W_E$) diverted from the production of

the two trading partners' consumption need. In this context, as we have seen, Pareto's argument would have been convincing.

[9] The values of the number of units of cloth ($x$) and wine ($y$), whether equal to 1 as in most textbooks, or different from 1, play no role in inequalities (4), because $x$ and $y$ disappear from these inequalities. However, due to the technical nature of Ricardo's theory, we work out the notion of comparative costs by using $x$ and $y$ to facilitate the introduction of scales of production into his theory.

[10] One can see, for instance, that if the pre-trade scale of production of cloth in Portugal and wine in England are $(C_P = 160)$ and $(W_E = 360)$ respectively, the scale ratio $[(C_P/W_E = 160/360 = 40/90)]$ is less than the cost of production of wine in terms of cloth in Portugal (80/90). In this case, in addition to its own consumption of cloth, England's production of cloth $[(120x/100)360 = 432x]$ will be greater than Portugal's consumption of cloth ($160x$), satisfying our first inequality in (3), $(120x/100)W_E \geq xC_P$. However, in addition to its own consumption of wine, Portugal's production of wine $[(90y/80)160 = 180y]$ will be less than England's consumption of wine ($360y$), and therefore will not satisfy our second inequality in (3), $(90y/80)C_P \geq yW_E$. That is, Portugal will not be able to satisfy England's pre-trade consumption of wine. Therefore, in complete specialization, trade between England and Portugal will not benefit England, inasmuch as some of its consumers will not be able to have wine. Similarly, trade will not benefit Portugal if $C_P = 360$ and $W_E = 200$ (i.e., $C_P/W_E = 360/200 = 180/100$ greater than $120/100$), because the first inequality in (3), $(120x/100)W_E \geq xC_P$, will not be satisfied since $240x < 360x$. In other words, some consumers in Portugal will not be able to have cloth.

wine in England to the production of cloth. The same logic holds for the production of cloth and wine in Portugal. Therefore, it has been implicitly assumed in the economics literature that the scale of production of cloth in Portugal in pre-trade ($C_P$) and that of wine in England ($W_E$) are equal to 1. As a result, after complete specialization, the total annual quantity of cloth demanded and supplied in Portugal and that of wine in England vanish from the evaluation of Ricardo's theory of comparative cost advantage. Thereby, the possibility of a discrepancy between these quantities, which would have prevented the quantity of Portuguese wine demanded and supplied in England from equilibrating, is removed from the evaluation of Ricardo's theory.[11] This is why Ricardo's theory of comparative cost advantage has remained widely accepted in the economics literature.[12]

Second, Ricardo's theory of comparative cost advantage is incomplete because it is based on particular numbers, does not determine the terms of trade, and does not account the unintended curtailment of demand.

It is not based on the general case, but on particular numbers or "four magic numbers" according to Samuelson (1972, p. 378), Ruffin (2002, p. 729) and Maneschi (2004, p. 433). As a result, it cannot be raised to the status of international trade theory in which two trading partners always gain from trade.

Now, we will use Sraffa's interpretation to show that Ricardo's theory does not determine the terms of trade.

Sraffa quotes Mill's misinterpretation of Ricardo which was stressed by Pennington:

*Mr. Mill first says, that by exchanging corn for cloth, Poland will obtain three pieces for three quarters; and then he says that she will obtain four pieces for three quarters. Both propositions cannot be true (1930, p. 540).*

Then, he points out that "[t]he error was removed from the third edition of the Elements (1826)" (1930, p. 540) and turns to Ricardo's chapter on "Foreign Trade" to

[11] With a scale of production equals 1, Portugal's annual consumption of English cloth and England's annual consumption of Portuguese wine become *x* units and *y* units respectively. Since in pre-trade England uses 100 men's labor to produce *x* units of cloth and uses more men's labor to produce wine (120 against 100), it follows that, after complete specialization, when England transfers 120 men's labor to the production of cloth it will produce more than *x* units of cloth. Accordingly, England will be able to satisfy Portugal's annual demand of cloth which is *x* units. The same situation occurs with respect to the quantity of Portuguese wine supplied and demanded in England. Portugal will produce more than y units of wine when it transfers 90 men's labor to the production of wine, which requires 80 men's labor for the production of *y* units. Portugal will therefore be able to satisfy England's annual demand of wine, which is *y* units.

[12] Using the international marginal rate of transformation, the domestic marginal rate of transformation, the switching price ratio, and the closed economy price ratio of two commodities, Metcalfe and Steedman point out that complete specialization may not be beneficial for a country when it is engaged in international trade (1979, p. 53). However, their example does not conform to Ricardo's theory, which is based on the labor costs of two trading partners in the production of their two commodities in autarky.

present Ricardo's example on England and Portugal. However, his own interpretation does not correspond to Ricardo's statement. Ricardo did not state that "England **gives** the cloth produced by 100 Englishmen in exchange for the wine produced by 80 Portuguese; and since this quantity could have been produced by 120 Englishmen, she gains the labour of 20 Englishmen" (emphasis added, 1930, p. 541). Instead, Ricardo stated: "England **would** give the produce of the labour of 100 men, for the produce of the labour of 80" (emphasis added, 1930, p. 541). This does not necessarily mean that England **will** give the produce of the labor of 100 men for that of 80 men. This simply means that the exchange could be realized with the produce of the labor of 100 men against that of 80 men. In other words, the terms of trade are not determined in Ricardo's framework. This makes Ricardo's theory of comparative cost advantage incomplete.

Moreover, Jacob Viner has attempted to show that the terms of trade would settle "halfway" between the comparative costs ratio.[13] To do so, Viner interprets Ricardo's statement: "Thus England would give the produce of the labour of 100 men for the produce of the labour of 80" (1911, p. 115-116).[14]

However, Viner's interpretation is questionable because Ricardo does not necessarily mean that the labor of 100 men [$=1$ cloth] and the labor of 80 men [$=1$ wine]; he may mean that the labor of 100 men [$=x$ units of cloth] and the labor of 80 men [$=y$ units of wine], where $x$ is different from $y$. Even if Viner's assumption were correct, this does not necessarily imply that the terms of trade will settle "halfway" between the two comparative costs, for the terms of trade will depend on the willingness of the two trading partners to exchange their products at any given ratio between the two comparative costs. This is expressed by Mill as reciprocal demand.[15] Also, we have not found anywhere in Ricardo's theory of comparative costs a statement indicating what the terms of trade between England and Portugal should be. Viner acknowledges this point:

*Ricardo does not indicate whether he regards this precise ratio as required by the conditions of the problem as he stated them, or how the actual ratio would in practice be determined (1937, p. 446).*

Viner's determination of the terms of trade ratio is questioned by Chipman.[16] But Chipman argues that

*whether or not this is a correct interpretation of Ricardo, the solution happens to*

[13] See Viner (1937, p. 445-446).

[14] From this statement Viner assumes that 100 men [$=1$ cloth] and 80 men [$=1$ wine], and that the terms of trade will settle "halfway" between the comparative costs of cloth in terms of wine (100/120, 90/80), i.e., the terms of trade will be $[(100/120)+(90/80)]/2 = 47/48$.

[15] See Mill (1961, p. 592-593).

[16] See Chipman (1965, p. 482).

*correspond precisely to that which was later obtained by Mill (1852a, p. 158) on the basis of explicit assumptions about demand (1965, p. 483).*

However, Mill does not solve the problem of the determination of the terms of trade left open in Ricardo's model, because his example is different from Ricardo's and he introduces the demand side. Let us examine Mill's example.

*Suppose, for example, that 10 yards of broad cloth cost in England as much labour as 15 yards of linen, and in Germany as much as 20 (1844, p. 6).*

Here, the same quantity of labor ( $L_E$ ) is used to produce 10 yards of broad cloth and 15 yards of linen in England; and the same quantity of labor ( $L_G$ ) is used to produce 10 and 20 yards of broad cloth and linen in Germany.

In Ricardo's example Portugal has an absolute advantage over England in the production of both cloth and wine. However, in Mill's example we do not know which country has an absolute advantage in the production of both commodities, nor do we know if England and Germany produce broad cloth and linen with the same labor cost.[17] Therefore, contrary to Chipman, we argue that Mill has not solved the determination of the terms of trade in Ricardo's theory. But to Mill's credit, one can say that he determines the terms of trade outside Ricardo's framework.

In Ruffin's new interpretation of Ricardo's theory "$X$ ... quantity of wine ... is **traded** for $Y$ units of cloth" (emphasis added, 2002, p. 741). That is, the "terms of trade" of cloth per unit of wine are "$Y/X$" (Maneschi, 2004, p. 436). In addition, according to Ruffin, the inequalities, "$a_1/a_2 \le p_1/p_2 \le a_1^*/a_2^*$, (1) and $a_1/a_2 \le w/w^* \le a_1^*/a_2^*$, (2)", where $a_1/a_2$, $a_1^*/a_2^*$, $p_1/p_2$ and $w/w^*$ are respectively the relative unit labor-cost at home, abroad, the relative world price, and the relative wage rate at home and abroad expressed in the world currency, "may be called the Ricardian law of comparative advantage" (2002, p. 730).

Ruffin's new interpretation also falls in the trap similar to that of Sraffa. Ricardo did not state that to **trade** "cloth may require the labour of 100 men" in England. Instead, he stated that to **produce** "cloth may require the labour of 100 men" in England. Similarly, Ruffin's quotation of Ricardo, "[t]hus England **would** give the produce of the labour of 100 men for the produce of 80" (emphasis added, 2002, p. 742), does not necessarily mean that England **will** give the produce of the labor of 100 men for that of 80 men. Again, this simply means that the exchange could be realized with the produce of the

[17] If the quantity of labor ( $L_E$ ) used to produce 10 yards of broad cloth in England is the same as in Germany ( $L_G$ ), i.e., $L_G/L_E = 1$, then neither country has an absolute advantage in the production of broad cloth and linen because both use the same quantity of labor ( $L_E/10 = L_G/10$ ) to produce 1 unit of broad cloth. Mill's example is now different from that of Ricardo. Moreover, in his determination of the terms of trade in which he uses the reciprocal demand, Mill introduces the demand side which is not part of Ricardo's framework in the long-run price determination.

labor of 100 men against that of 80 men.

Now let us suppose that the terms of trade are $Y/X$ units of cloth per unit of wine in Ruffin and Maneschi's sense. This means that two countries, namely England and Portugal, produce annually in autarky exactly the same number of units of cloth $Y$ (respectively with 100 men labor and 90 men labor) and that of wine $X$ (respectively with 120 men labor and 80 men labor) so that exactly $Y$ units of cloth are traded against $X$ units of wine in the future. In other words, the terms of trade between England and Portugal are known in autarky. This is questionable because the terms of trade are not determined in Ricardo's framework. Moreover, the terms of trade cannot be known before the opening of trade and there is no reason to believe that two countries will annually produce exactly the same quantity of cloth ($Y$) and wine ($X$) in autarky. Therefore, $Y/X$ cannot be the terms of trade. Ricardo was simply giving the men's labor per year required to **produce** $Y$ units of cloth and $X$ units of wine in England and Portugal, but not the exact quantities of cloth and wine to be traded in the future.

In addition, Ruffin's inequalities (1) and (2) may not be called "the Ricardian law of comparative advantage" because in the case in which $a_1/a_2 = a_1^*/a_2^*$ no country has a comparative advantage. As a result, trade cannot take place in Ricardo's framework.

This paper's concern however is not to determine the terms of trade in Ricardo's framework, which is questionable, but evaluate his theory of comparative costs. Within this context, let us turn to Kindleberger's graphical proof.

Kindleberger uses the theory of opportunity cost to graphically show that two trading partners, producing at constant returns to scale, mutually gain in trade when scales of production are taken into account (1973, p. 21-24). However, this is also questionable when the two trading partners completely specialize in the production in which they have a comparative cost advantage.

In kindleberger's example, 1 man produces per week 10 yards of cloth and 6 bushels of wheat in the US, while he produces 6 and 2 in the UK. In Ricardo's framework, this means that 1/10 and 1/6 of 1 man's work per week produce 1 yard of cloth and 1 bushel of wheat in the US, while these are produced by 1/6 and 1/2 of 1 man's work per week in the UK. That is, the UK has a comparative cost advantage in producing cloth and the US in producing wheat since $(1/6)/(1/2) < (1/10)/(1/6)$ or $(2/6) < (6/10)$.

Suppose the scales of production of wheat ( $y_{UK}$ ) in the UK and cloth ( $x_{US}$ ) in the US are $W_{UK}$ and $C_{US}$ respectively. The UK's consumption of wheat will be ( $y_{UK}W_{UK}$ ), at the same time the US's consumption of cloth will be ( $x_{US}C_{US}$ ). If the UK specializes in the production of cloth, it will divert $(1/2)(y_{UK}W_{UK})$ men's labor from the production of wheat to produce $(1/2)(y_{UK}W_{UK})/(1/6)$ yards of cloth to be exchanged for the US's wheat. Similarly, the US will divert $(1/10)(x_{US}C_{US})$ men's labor from the production of cloth to produce $(1/10)(x_{US}C_{US})/(1/6)$ bushels of wheat to be exchanged for the UK's cloth.

For trade to be mutually beneficial for the two countries, the UK must produce a

number of yards of cloth $(6/2)(y_{UK}W_{UK})$ greater than or equal to the US's consumption of cloth ( $x_{US}C_{US}$ ) and the US must produce a number of bushels of wheat $(6/10)(x_{US}C_{US})$ greater than or equal to the UK's consumption of wheat ( $y_{UK}W_{UK}$ ). Formally,

$$[(6/2)(y_{UK}W_{UK}) \geq x_{US}C_{US} \text{ and } (6/10)(x_{US}C_{US}) \geq y_{UK}W_{UK}], \quad (3')$$

or

$$[(2/6) \leq (C_{US}/W_{UK}) \leq (6/10)], \quad (4')$$

since $y_{UK} = 2$ bushels of wheat and $x_{US} = 10$ yards of cloth.

Inequalities (4') state that trade will be mutually beneficial for the two countries if the ratio of pre-trade scale of production of cloth in the US to that of wheat in the UK is in the range of the unit costs of production of cloth in terms of wheat in the UK and US (or in the range of the ratios of output of wheat to cloth).

Instead of considering the two cases where the scale ratio is in the range of the output ratios and outside this range, Kindleberger considers only the case where the scale ratio $(C_{US}/W_{UK}) = (6/10)$ is in the range of the output ratios or more precisely is equal to the greatest output ratio. Perhaps because of this oversight, he concludes in his graphical proof that trade is beneficial for the UK and US. However, if Kindleberger had considered the second case with a complete specialization, he would have realized that trade is not mutually beneficial for the two trading partners, as we have seen from inequalities (4).

So far we have completed our critique on the terms of trade. But the incompleteness of Ricardo's theory of comparative cost advantage requires another critique.

This critique concerns the unintended curtailment of demand. Under free trade, after complete specialization, even if England has a comparative cost advantage in producing cloth and Portugal in producing wine, and even if England and Portugal can supply each other with the respective quantities of cloth and wine they demand, trade will not be beneficial for both countries if some English consumers do not like Portuguese wine or some Portuguese consumers do not like English cloth. In this case, England will not be able to get from Portugal the quantity of wine its consumers need, and the same thing will be true of Portugal in terms of cloth. Here, the existence of free trade, i.e., the absence of artificial barriers to trade imposed by governments among individuals and firms in different nations, does not result in a mutual gain for the two trading partners.

This difference of tastes, which unintendedly curtails demand and casts doubt on Ricardo's trade theory, is stressed by Pareto[18] and later acknowledged by Chipman.[19]

[18] See Pareto (1909, p. 507-508).

[19] He [Pareto] argued correctly, that without taking account of tastes, one could not justify the assumption that the increased world output of the other commodity would provide sufficient compensation (1965, p.

However, this is not presented by Pareto and Chipman as an example of unintended curtailment of demand. This curtailment of demand is at the root of the determination of the terms of trade in Ricardo's framework because its existence in a trading country prevents the terms of trade from being determined since demand is not part of his framework.

Another example of unintended curtailment of demand is due to a lack of distributors of foreign products in a country. Under free trade even if England and Portugal have a comparative cost advantage in their products, and can supply each other with the quantities needed, trade will not benefit both countries if there is a lack of distributors of their respective products in the other country, as we have seen in the Japanese market where foreign suppliers do not have distributors for their products.[20] In this situation, England will not be able to sell enough cloth in Portugal to meet Portugal's needs, and similarly Portugal will not be able to meet England's needs in wine.

More generally, under free trade and complete specialization, after the opening of trade, any conditions that unintendedly curtail demand in both countries in such a way that they cannot meet their respective needs will make trade non-beneficial. This critique can be raised against Ricardo's theory because, unlike neoclassical theory of perfect competition, Ricardo has not explicitly assumed that there is a large number of buyers and sellers and that consumers in both countries have the same taste.

Thus, our direct critique shows that not only free trade is not necessarily beneficial for England and Portugal in Ricardo's theory, but also that his theory is incomplete. Therefore, Ricardo has not strengthened Smith's theory.

## 4. PART II: INDIRECT CRITIQUES

It remains now to present two indirect critiques of Ricardo's theory of comparative cost advantage.

In Ricardo's theory, 100 and 120 men's labor are needed annually to produce cloth and wine in England.[21] In other words, the relative price of cloth with respect to wine ($P_{0C} / P_{0W}$) is expressed in relative labor cost ($100/120$). Formally, $(P_{0C} / P_{0W}) = (100/120)$.

However, commodities are given in exchange for each other at their market prices. Why does Ricardo assume that the relative market prices of two commodities, cloth and wine, equal their relative labor costs of production?

Let us consider Ricardo's theory of natural and market prices. In Chapter IV of *Principles of Political Economy and Taxation*, in making labor the foundation of the value of commodities, Ricardo writes that the comparative quantity of labor used in the

488).

[20] See Bayard and Elliot (1994).

[21] See Ricardo (1911, p. 115-116).

production of commodities is the rule which determines the respective quantities of commodities that shall be given in exchange for each other. However, he acknowledges the deviation of the market price of a commodity from its natural price.[22] According to Ricardo, this deviation from the natural price is accidental and temporary. The deviation is temporary because of competition among capitalists. Capitalists divert their funds from less to more profitable employment.[23] Since the causes of the deviation of market price from natural price are ably treated by Smith in *The Wealth of Nations*, Ch.VII, Ricardo argues it is not necessary to be concerned with this temporary deviation. Instead, one should look at the laws that regulate the natural price.[24]

What guarantees that competition will drive the market price of a commodity to its natural price, justifying Ricardo's rejection of the market price in favor of the natural price? Ricardo relies here on Smith's explanation in Ch.VII. What is then the relationship between market and natural prices in Smith's sense? And what are the natural and market prices of a commodity?

According to Smith, the natural price of a commodity is the average rate of rent, wage, profit of stock, and transportation cost needed to raise and bring it to the market place. That is, the natural price of a commodity is its average cost of production plus an average profit, where the transportation cost is included in the average cost of production.[25] On the other hand, the market price of a commodity is the price at which it is sold on the market; and this market price is regulated by the quantity of the commodity brought to market and the demand of those who are willing to pay the natural price.[26] Finally, according to Smith, the relationship between the market price of a commodity and its natural price might be seen as the gravitation of the first around the latter, which is the center or central price. Furthermore, in gravitating around the natural price of a commodity, the market price tends toward this center.[27] However, Smith acknowledges that due to particular accidents, natural causes, and regulations of police, sometimes the market price of a commodity deviates from its natural price and can be kept above it for a long time. Also, according to Smith, when the quantity demanded or the effectual demand of a commodity increases, its market price rises above its natural price, generating a great profit. If this is known, new rivals attracted by this profit enter the market to supply the commodity. As a result, the market price of the commodity will

[22] Ibid. (p. 65).

[23] Ibid. (p. 68).

[24] Ibid. (p. 69).

[25] See Smith (1937, p. 55).

[26] Ibid. (p. 56).

[27] The natural price, therefore, is, as it were, the central price, to which the prices of all commodities are continually gravitating. Different accidents may sometimes keep them suspended a good deal above it, and sometimes force them down even somewhat below it. But whatever may be the obstacles which hinder them from settling in this center of repose and continuance, they are constantly tending towards it (1937, p. 58).

soon sink to its natural price or even below it. If this market is far away from the residence of suppliers, they may be able to keep the secret of great profit for several years and enjoy it without any new rivals. But since this type of secret can seldom be kept long, it follows that this extraordinary profit will be reduced by the competition of new rivals.[28]

Thus, Smith uses Newton's paradigm of gravitation, in which the sun is the center around which other planets gravitate and toward which they tend, to explain the relationship between the natural price, representing the sun, and the market price, representing a planet.[29] Similarly, the natural price of a commodity is the fixed element from which its market price deviates and toward which its market price tends.

Since Ricardo shares Smith's view about this, Ricardo's main concern becomes the fixed element that is the natural price instead of the market price.

We have seen that the natural price of a commodity is equal to its average cost of production plus an average profit. Thus, the natural price can be written as: $P = (r+1)wL$ .[30]

Insofar as the average rate of profit ($r$) and wage ($w$) is the same in all lines of production in a country, according to Ricardo, the natural prices of cloth and wine in England (0) and Portugal (1) will be respectively:

$$[P_{0C} = (r_0 + 1)w_0 L_{0C}, \quad P_{0W} = (r_0 + 1)w_0 L_{0W}], \tag{5}$$

and

$$[P_{1C} = (r_1 + 1)w_1 L_{1C}, \quad P_{1W} = (r_1 + 1)w_1 L_{1W}]. \tag{6}$$

The relative price of cloth in terms of wine in England is then $(P_{0C} / P_{0W}) = (L_{0C} / L_{0W})$

[28] See Smith (1937, p. 59-60).

[29] For instance, in the case of the earth and the sun, the revolution of the earth around the sun takes one year; at its highest distance from the sun, $94.45x10^6$ mi, the earth is at apogee, whereas at its shortest distance from the sun, $91.34x10^6$ mi, the earth is at perigee. The earth then moves away, in its gravitation, from the fixed planet, the sun, and then comes back closer to it. See Mclean and Nelson (1988, p. 240).

[30] Natural Price = Average Profit + Average Cost of Production. However, this average profit is based on the average cost of production of the commodity. Therefore, the average profit can be written as: Average Profit = $r$ (Average Cost of Production), where r is the average rate of profit. Finally, the natural price of the commodity becomes: Natural Price = $r$ (Average Cost) + Average Cost. If we factor out the average cost of production, we obtain: Natural Price $= (r+1)$ (Average Cost of Production). Formally, we obtain: $P = (r+1)A$ , where $P$ is the natural price of the commodity, $r$ its average rate of profit, and $A$ its average cost of production. Since, according to Ricardo, labor is the foundation of the value of commodities, then the average cost of production becomes equal to the average quantity of labor ($L$) used in the production of the commodity multiplied by the average wage rate ($w$). That is, $P = (r+1)wL$ .

$= (100/120)$ while in Portugal it is $(P_{1C}/P_{1W}) = (L_{1C}/L_{1W}) = (90/80)$.[31]

Since the relative natural price of cloth in terms of wine equals the relative labor cost of cloth in terms of wine, Ricardo is able to use the latter as the price of cloth in terms of wine.

However, Steedman and Metcalfe find in their article, "On Foreign Trade,"[32] that the natural prices of cloth and wine in England are respectively $P_1^A = 100(1+r^A)^5$ and $P_2^A = 120(1+r^A)$. Where $P_1^A, P_2^A$ are the natural prices of cloth and wine; 100 and 120 the labor costs of producing cloth and wine; $r^A$ the rate of profit; and 5 and 1 the number of years required to produce cloth and wine. As a result, the relative natural price of cloth in terms of wine $(P_1^A/P_2^A)$ is different from its relative labor cost $(100/120)$, because $P_1^A/P_2^A = 100(1+r^A)^5/120(1+r^A) = 100(1+r^A)^4/120$. To prove that the ratio of the natural prices of two commodities can be different from their labor ratios, Steedman and Metcalfe assume that the natural price of cloth is a compound interest of its labor cost. Let us examine the accuracy of this assumption.

For natural price to be a compound interest of labor cost, no direct labor (100) should be applied and paid for in the production of cloth after the second year. Only the "fixed capital" or indirect labor should be used in the production of cloth during the remaining 3 years.[33] This however does not correspond to Steedman and Metcalfe's following assumption:

*"We assume that the labour required for the production of 1 in A, must be applied and paid for five years before the commodity is available" (1979, p. 103).*

However, if the direct labor of 100 is applied and paid for each year, the natural price of cloth after the first year equals the profit on the sum of the "fixed" and "circulating capital", plus the "circulating capital".[34]

[31] For the quantities of labor in England (100, 120) and Portugal (90, 80), see Ricardo (1911, p. 115-116). Notice, however, unlike Ricardo, Smith does not have a labor theory of value because his average rate of profits and wages are not the same in all lines of production in a country and his costs of production are not reduced to labor costs.

[32] See Steedman and Metcalfe (1979, p. 103).

[33] The natural prices of cloth of the first, second, third, and fifth years are respectively:

$P_1^{A1} = 100 + 100r^A = 100(1+r^A)$,

$P_1^{A2} = 100(1+r^A) + 100(1+r^A)r^A = [100(1+r^A)+100]r^A + 100 = 100(1+r^A)^2$,

$P_1^{A3} = 100(1+r^A)^2 + 100(1+r^A)^2 r^A = 100(1+r^A)^3$,

$P_1^A = P_1^{A5} = 100(1+r^A)^4 + 100(1+r^A)^4 r^A = 100(1+r^A)^5$.

[34] The natural prices of cloth of the first, second, third, and fifth years become respectively:

$P_1^{A1} = 100 + 100r^A = 100(1+r^A) = 100(1+r^A)[1]$,

In a more general case, where the average wage rate in country $A$ ($W^A$) is different from 1, and the quantities of direct labor $L_1^{A1}, L_1^{A2}, L_1^{A3}, L_1^{A4}, L_1^{A5}$ of the first to the fifth year in country $A$ are not all equal 100, the natural price of cloth of the fifth year is $P_1^{A5} = (1+r^A)[L_1^{A5} + L_1^{A4}r^A + L_1^{A3}(r^A)^2 + L_1^{A2}(r^A)^3 + L_1^{A1}(r^A)^4]W^A = (1+r^A)L_1^A W^A$. Where $L_1^A = L_1^{A5} + L_1^{A4}r^A + L_1^{A3}(r^A)^2 + L_1^{A2}(r^A)^3 + L_1^{A1}(r^A)^4$ is the sum of the quantities of direct labor ($L_1^{A5}$) and indirect labor $L_1^{A4}r^A, L_1^{A3}(r^A)^2, L_1^{A2}(r^A)^3, L_1^{A1}(r^A)^4$.[35]

Therefore, the natural price is determined as a simple interest of the labor cost $(1+r^A)L_1^A W^A$. Also, in Chapter IX (Of The Profits of Stock) of *The Wealth of Nations*, Smith states that:

*In raising the price of commodities the rise of wages operates in the same manner as simple interest does in the accumulation of debt (1937, p. 98).*

But the rise of wages does not operate like compound interest, as Steedman and Metcalfe assume in their article. We then will remain in the spirit of classical economics by considering as the natural price of cloth the first equation in (5), $P_{0C} = (r_0 + 1)w_0 L_{0C}$, instead of $P_1^A = (r^A + 1)^5 100$. That is, we argue that the relative natural price of cloth in terms of wine is equal to the relative labor cost of cloth in terms of wine in Ricardo's framework.

It can be argued in Steedman and Metcalfe's sense that:

*Having recognised clearly that price ratios would normally diverge from the corresponding ratios of quantities of embodied labour, Ricardo maintained that the magnitude of these divergences would be small. It was perhaps on this ground*

$$P_1^{A2} = [100(1+r^A)+100]r^A + 100 = 100(1+r^A)^2 = 100(1+r^A)[1+r^A],$$

$$P_1^{A3} = [100(1+r^A)^2 + 100]r^A + 100 = 100(1+r^A)[1+r^A+(r^A)^2],$$

$$P_1^A = P_1^{A5} = \{100(1+r^A)[1+r^A+(r^A)^2+(r^A)^3]+100\}r^A + 100$$
$$= 100(1+r^A)[1+r^A+(r^A)^2+(r^A)^3+(r^A)^4].$$

The natural price of cloth of the fifth year can be written as:

$$P_1^A = (1+r^A)[100+100r^A+100(r^A)^2+100(r^A)^3+100(r^A)^4].$$

[35] Notice that the natural price of cloth of the second year ($P_1^{A2}$) can be expressed as a compound interest of its labor cost $100(1+r^A)^2$ due to the equality of the quantities of labor (100) used the first and second year. Perhaps from this particular result Steedman and Metcalfe assume, in general, that the natural price of cloth is a compound interest of its labor cost. Also, notice that if we apply our formula of the natural price to Ricardo's example where $r^A = 10\%$, $L_1^{A1} = L_1^{A2} = 100$, and $W^A = 50$ l., we obtain his natural price of the second year $P_1^{A2} = (1+r^A)(L_1^{A2} + L_1^{A1}r^A)W^A = (1+10\%)[100+100(10\%)]50 = 6{,}050$ l. See Ricardo (1986, p. 34).

*that...Ricardo assumed that no-trade price ratios would equal the corresponding ratios of quantities of embodied labour (1979, p. 99).*

It is true that from his discussion of the causes of variations in relative prices, in the cases of unequal production times or unequal proportions of fixed and circulating capital used in the production of two commodities,[36] Ricardo concludes that the great variations in the relative value of commodities are due to the variations in labor required for their production. However, this does not mean Ricardo assumes that autarkic natural price ratios equal the corresponding ratios of quantities of embodied labor. Instead, it means that the quantities of labor required for the production of commodities have greater effects in the variations of their relative prices than the rise or fall of the rate of profit.[37] It appears then that the relative natural price of two commodities equals their

[36] See Ricardo (1986, p. 33-37).

[37] The reader, however, should remark, that this cause of the variation of commodities is comparatively slight in its effects. With such rise of wages as should occasion a fall of one [percent in profits], goods produced under the circumstances I have supposed, vary in relative value only one [percent].

In estimating, then, the causes of the variations in the value of commodities,... in the subsequent part of this work, though I shall occasionally refer to this cause of variation, I shall consider all the great variations which take place in the relative value of commodities to be produced by the greater or less quantity of labour which may be required from time to time to produce them (1986, p. 36-37).

For instance, if the production times of two types of commodities are both one year each, the ratio of their natural prices ( $P_1^A / P_2^A$ ) equals that of the quantities of direct labor ( $L_1^{A1} / L_2^{A1}$ ) used in producing them since $P_1^A / P_2^A = (1+r^A)L_1^{A1}W^A/(1+r^A)L_2^{A1}W^A = L_1^{A1} / L_2^{A1} = L_1^A / L_2^A$ . This is the case in Ricardo's theory of comparative costs where the relative price of cloth and wine in England is $P_1^A / P_2^A = L_1^{A1} / L_2^{A1} = 100/120$ . Here, the relative price can vary only if the quantities of direct labor 100 and 120 vary. Notice that this case is different from Steedman's and Metcalfe's where 5 years are required to produce cloth and 1 year to produce wine. However, if the production time of commodity 2 is one year, and that of commodity 1 more than one year, say two years, the relative price of commodity 1 in terms of commodity 2 is $P_1^A / P_2^A = (1+r^A)[L_1^{A1}r^A + L_1^{A2}]W^A/(1+r^A)L_2^{A1}W^A = L_1^{A1}r^A + L_1^{A2} / L_2^{A1} = L_1^A / L_2^A$ . The relative price ( $P_1^A / P_2^A$ ) is, then, the ratio of the sum of the "fixed" and "circulating capital" ( $L_1^{A1}r^A + L_1^{A2}$ ) required for the production of commodity 1 to the "circulating capital" ( $L_2^{A1}$ ) needed for the production of commodity 2. In this case, the causes of variations in the relative price ( $P_1^A / P_2^A$ ) are the variation of the rate of profit ( $r^A$ ) and that of the quantities of labor $L_1^{A1}, L_1^{A2}$ and $L_2^{A1}$ since $P_1^A / P_2^A = (L_1^{A1}r^A + L_1^{A2}) / L_2^{A1}$ . This case corresponds to Ricardo's example of the relative price of cloth (commodity 1) and corn (commodity 2):

"[T]he relative value of corn to cloth [or cloth to corn]...must be altered by a rise of labor. There can be no rise in the value of labour without a fall of profits...So if cloth or cotton goods be divided between the workman and his employer, the larger the proportion given to the former, the less remains for the latter. Suppose then, that owing to a rise of wages, profits fall..., [the price of] the manufactured goods in which more fixed capital was employed, would fall relatively to corn or to any other goods in which a less

relative labor cost or the ratio of the sum of the quantities of indirect and direct labor required for their production in Ricardo's framework.[38]

This equality between the relative natural price and labor cost hinges on Newton's paradigm of gravitation, because Smith and Ricardo use this to strengthen their argument about the tendency of the market price toward a commodity's natural price.

One might assume that the use of Newton's paradigm by Smith-Ricardo is simply a metaphor. However, since Ricardo uses this paradigm to ignore the market prices of commodities for the benefit of their natural prices in establishing his theory, Newton's paradigm is more than a metaphor. Newton's theory, therefore, should be examined to understand the tendency of the market price of a commodity toward its natural price.

proportion of fixed capital entered" (1986, p. 35).

In this example, Ricardo argues that the rise of wages ( $W^A$ ), i.e., the rise of the value of labor ( $L_1^{A1}W^A$ , $L_1^{A2}W^A$ ), decreases the profit, which in turn decreases the rate of profit ( $r^A$ ). As a result, the fixed capital ( $L_1^{A1}r^A$ ) employed in producing manufactured goods decreases. Since $P_1^A / P_2^A = (L_1^{A1}r^A + L_1^{A2}) / L_2^{A1}$ , it follows that the price of cloth falls relatively to that of corn in the production of which only direct labor ( $L_2^{A1}$ ) is employed. Ricardo finds that the variation in the relative value of commodities due to the variation in the value of labor is small. He then states that the great variations in the relative value of commodities ( $P_1^A / P_2^A$ ) are due to the variations in the quantity of labor required to produce them from time to time. For instance, if we double the quantities of labor $L_1^{A1}, L_1^{A2}$ used in producing cloth and hold constant the rate of profit ( $r^A$ ) and the quantity of labor used in producing corn ( $L_2^{A1}$ ), the relative price of cloth in terms of corn will be doubled. That is, $[(2L_1^{A1})r^A + (2L_1^{A2})] / L_2^{A1} = 2[(L_1^{A1}r^A + L_1^{A2}) / L_2^{A1}] = 2(P_1^A / P_2^A)$ .

This conclusion does not mean Ricardo assumes that price ratios equal the corresponding ratios of quantities of embodied labor.

[38] Steedman and Metcalfe have obtained a relative natural price $P_1^A / P_2^A = 161.05/132.00 = 29.282/24$ different from the relative labor cost of cloth and wine $L_1^A / L_2^A = 100/120 = 20/24$ because they have determined the natural price of cloth as a compound interest of its labor cost, and used the relative labor cost $L_1^A / L_2^A = L_1^{A1} / L_2^{A1} = 100/120$ where the production time of cloth and wine are one year instead of five and one year respectively. If Steedman and Metcalfe had determined the natural price of cloth as a simple interest of its labor cost, and used the relative labor cost where the production time of cloth is five years and that of wine one year, the relative natural price of cloth and wine $P_1^A / P_2^A$ would have been equal to their relative labor cost $L_1^A / L_2^A = 22.222/24$ . One can see that

$P_1^A / P_2^A = (1+r^A)[L_1^{A5} + L_1^{A4}r^A + L_1^{A3}(r^A)^2 + L_1^{A2}(r^A)^3 + L_1^{A1}(r^A)^4]W^A / (1+r^A)L_2^{A1}W^A$ , or

$P_1^A / P_2^A = L_1^{A5} + L_1^{A4}r^A + L_1^{A3}(r^A)^2 + L_1^{A2}(r^A)^3 + L_1^{A1}(r^A)^4 / L_2^{A1} = L_1^A / L_2^A$ , or

$P_1^A / P_2^A = L_1^A / L_2^A = 100[1+10\% + (10\%)^2 + (10\%)^3 + (10\%)^4]/120 = 20[1.1111]/24 = 22.222/24$ , since

$r^A = 10\%, L_1^{A1} = L_1^{A2} = L_1^{A3} = L_1^{A4} = L_1^{A5} = 100$ , and $L_2^{A1} = 120$ .

The question is whether the relationship between the natural and market prices of a commodity conforms to Newton's theory.[39]

We have seen that the market price of a commodity is regulated by its quantity brought to the market and the demand of those willing to pay its natural price. That is, the market price of a commodity is regulated by its quantity supplied and demanded. Therefore, the market price $P_m$ of a commodity is a function of its quantity sold $Q$. Formally, $P_m = f(Q)$. Whereas the natural price $P_n$ of the commodity in Ricardo's sense is $P_n = (r+1)wL$.

Thus, for market and natural prices to fit Newton's theory, the masses $m$ and $n$ of the two particles can be represented respectively by the quantity of the commodity sold $Q$ and by its labor cost $L$ or by its natural price $P_n$ and its market price $P_m$. In the first case, the attractive force $F$ that the two particles exert on each other can be represented by the vector price $P$. Thus, the two vector prices $P_m$ and $P_n$ should be equal, since the force that the two particles of masses $m$ and $n$ exert on each other, according to Newton's theory, is the same ($F$). Therefore, we should have $F = P_m = P_n$. However, since the market price $P_m$ varies and can be different from the natural price $P_n$, the masses of the two particles cannot be represented by the quantity of the commodity sold $Q$ and the labor cost $L$.[40]

If, however, the masses $m$ and $n$ are respectively represented by the two prices $P_m$ and $P_n$, where the natural price $P_n$ of the commodity is the source of a gravitational field, the force that natural price exerts on market price can be thought of as $F = [(G.P_n)/d^2]P_m = g_n P_m$.[41]

Thus, the market price $P_m$ can gravitate around and be attracted toward the natural price, which will be the central price according to Smith-Ricardo. As a result, the attractive force $F$, created by the natural price, could determine the position of the

[39] What does Newton say? Newton's law of gravitation states that any two particles of masses $m$ and $n$ separated by a distance $d$ exert attractive forces on each other of magnitude $F = (G.n.m)/d^2$, where $G = 6.67x10^{-11} Nxm^2/kg^2$ is the gravitational constant, $Nxm^2/kg^2$ is a unit of measurement, Newton by meter square per kilogram square, and $F$ the force which is along the line connecting the two particles. The particle of mass $n$ is the source of a gravitation field which has a field intensity of magnitude $g_n$ at the distance $d$ from $n$. The magnitude of $g_n$ at the distance $d$ is $g_n = (G.n)/d^2$. Therefore, the mutual attractive force $F$ becomes $F = [(G.n)/d^2]m = g_n m$. Thus, the gravitational field exerts the force $F = mg_n$ on the particle of mass $n$ at the distance $d$ from the particle of mass $n$. See Wells and Slusher (1983, p. 118).

[40] A similar analysis applies when Smith's cost of production is used instead of that of Ricardo.

[41] One can think of $P_m$ as the varying mass of the commodity or particle m inasmuch as the market price of a commodity varies, while in Newton's theory the masses of the two particles are fixed.

market price. However, we have seen that the market price $P_m$ of a commodity is determined by individuals' decisions to supply and demand the quantity $Q$ of the commodity given its natural price. Therefore, the position of the market price $P_m$ is determined in the space of a Cartesian diagram, where the vertical axis represents the price and the horizontal axis the quantity, by individuals' decisions but not by the attractive force F that the natural price $P_n$ could exert on the market price $P_m$. It follows that the market price $P_m$ does not gravitate around the natural price in the Newtonian sense and does not converge or tend toward it. Moreover, since the market and natural prices coincide in the long run, the earth should have crashed into the sun. However, this does not happen. Consequently, the relationship between natural and market prices does not fit Newton's paradigm of gravitation. Is there another theory or mechanism that proves the convergence or the tendency of the market price toward the natural price in Ricardo's framework?

Ricardo is aware of the influence of supply and demand on market price he analyzes in Ch.XXX. But he dismisses this influence by arguing that it is only a temporary phenomenon. To show that market price tends toward natural price, Ricardo argues that if one diminishes the cost of production of hats, their prices will fall to their new natural prices, although their quantities demanded should double, treble, or quadruple.[42] However, the decrease in the cost of production of hats that leads to the decrease in their natural prices does not mean that market price is attracted or convergent toward natural price. It simply means that they move in the same direction, because both of them are related to the cost of production of hats.[43] Therefore, the decrease in the cost of production of a commodity results in the decrease of both natural and market prices and the increase in the quantity sold, but not in the tendency of market price toward natural price.

Finally, Smith's purpose in using the paradigm of gravitational theory is to show that

[42] See Ricardo (1911, p. 373).

[43] The natural price of a commodity is related to its cost of production because $P_n = (r+1)wL$. Any decrease in the cost of production ($wL$) results in a decrease in the natural price $P_n$. Also, because the market price is determined by individuals' decisions to supply and demand a quantity $Q$ of a commodity, the market price depends on the quantity supplied, which in turn depends on the cost of commodity's production. If the quantity demanded of a commodity remains the same, any decrease in the cost of production results in the shift of the supply curve to the right. This in turn results in the decrease in the market price of the commodity and an increase of the quantity sold. Further, given the supply curve of hats or their unit cost of production, the natural price of hats is fixed because their unit cost is fixed. Thus, the market price of hats is not attracted toward their natural price, but is determined by individuals' decisions to demand hats. If the demand curve of hats shifts to the right, their market price increases or moves away from their natural price, whereas if the demand curve of hats shifts to the left, their market price decreases or moves toward their natural price.

the market price gravitates around and tends toward a fixed element or, more precisely, a less fluctuating element in the price system. Compared to the market price, the natural price is thought to be this less fluctuating element in the price system.

However, since goods in the real world are differentiated, suppliers to some extent can isolate their markets from one another in order to set their prices above their marginal costs. Since there is no guarantee that this differentiation will disappear, the market prices of these goods will not be driven down to their natural prices.

When the products are differentiated, each product has one supplier. Thus, at a given quantity demanded, only the supplier decides, depending on the elasticity of substitution between his product and others, on the quantity of goods to be supplied to determine his market price.[44] As a result, the market prices of differentiated goods fluctuate less than those of identical goods. Therefore, the market price of a differentiated good can represent this less fluctuating element in the price system for which Smith and Ricardo were looking. Thus, given the fact that there certainly were varieties of wine and cloth in England and Portugal, Ricardo could have used their relative market prices to establish his trade theory, instead of their relative labor costs that were derived from their natural prices.[45]

It appears that the relationship between market and natural prices does not conform to Newton's paradigm of gravitation. As a result, not only can the market price of a commodity differ from its natural price, but the market price need not necessarily approximate the latter, in its long-run position. Consequently, Ricardo should not have assumed that the relative natural price of cloth and wine equals their long-run relative market price. It follows that the relative price of cloth in terms of wine, at which cloth is

[44] The elasticity of substitution plays a key role. If it is infinite that means that the products are identical, whereas if it is finite and different from zero the products are differentiated. Finally, if it is equal to zero the products are completely different. When the degree of substitution of differentiated products is high, if the supplier sets a high price, consumers may leave him for the benefit of his competitors. That is why the supplier of a differentiated product sets his price depending on the elasticity of substitution between his product and others. On the other hand, if the products are identical, at a given quantity demanded, there are many suppliers of the product. The entry and exit of suppliers or the variation of the quantity supplied on the market leads to the variation of the product's market price.

[45] It could be argued in the neoclassical sense that given that Ricardo's theory is established under the assumption of perfect competition, it is not unrealistic to assume that in this case the market price of a commodity can be equal to its natural price or unit cost of production since the rate of profit r becomes zero. In the neoclassical perfect competition, the market price is equal to the marginal and average cost, and the profit is equal to zero in the long run; the natural price, $P = (r+1)wL$, is equal to the average cost $wL$ because $r$ equals zero due to the zero profit. As a result, the market and natural prices of a commodity are equal. However, in the long-run neoclassical perfect competition, given that the profit is equal to zero, there will be no production in the context of classical economics, and therefore no exchange of commodities. That is, trade will not take place.

exchanged for wine in the market, is different from the relative labor cost of cloth in terms of wine. As a result, Ricardo's theory of comparative cost advantage, based on the relative labor costs of cloth and wine, is questionable.

The second indirect critique of Ricardo's theory of comparative cost advantage concerns the outcome of complete specialization of his theory. We have shown that this theory is questionable because some additional conditions are needed. However, even if Ricardo's theory were accurate, it would still be questionable in its outcome of complete specialization in the production of the commodity in which each country has a comparative cost advantage. Ricardo's theory is a static theory, not a dynamic one. Yet, a country without a comparative cost advantage today could improve its technology and gain a comparative cost advantage in the future to pursue its industrialization. A case in point is the Japanese auto industry.[46]

It can be argued, in the real world, that Japan's performance in its automobile industry is not solely due to the quantity of labor used. Although this is correct, it remains certain that if Japan had earlier abandoned its production of cars because it had a comparative cost advantage in the production of potato chips, as required by Ricardian theory, Japan would not have gained an edge over its competitors in the production of cars today. No country has ever acquired the wealth of industrial nations by selling only potato chips or coconuts.[47] Foreign potato chips and coconuts are neither needed in the consumption of most countries nor in the production system of most domestic and foreign industries. Therefore, the outcome of complete specialization in Ricardo's theory might lock a country out of industrialization in the case of a commodity that does not

[46] Let us take the example of two countries (U.S. and Japan) and two commodities (cars and potato chips) produced in pre-trade in both countries around 1955. Let us suppose that at that time, the U.S. had a comparative cost advantage in producing cars since it was the dominant power in the world, and that Japan had a comparative cost advantage in the production of potato chips. If Japan had followed the outcome of Ricardo's theory of comparative cost advantage, Japan would have specialized completely in the production of potato chips, and would never have enjoyed the wealth of an industrial country by gaining a comparative cost advantage in producing cars. Instead, Japan would have sacrified its auto industry and locked itself out of industrialization to remain a third world country selling potato chips around the world. Potato chips do not generate the same wealth from sale as do cars, given that the quantity of potato chips demanded in the world is insignificant compared to that of cars. Further, potato chips do not generate positive externalities on several domestic industries as do cars, given that to make potato chips a country needs potatoes and frying pans, whereas to make cars it needs steel, rubber, electronic products, and highways for their use, etc. As a result, car production has more positive side effects on more domestic industries than potato chip production.

[47] See the industrialization of England, Germany, France, the U.S., Japan, and Korea respectively in Mathias (1983), Henderson (1961), Clément (1874)/ Henderson (1961), Hamilton (1968), Beasley (1974)/ Johnson (1982), Amsden (1989). Also, for the productive power of manufacturing industries compared with agriculture, see List (1928, p. 217-218, 226-227, 259, 270).

generate substantial wealth.[48]

It appears again that Ricardo's attempt to strengthen Smith's theory of absolute advantage is questionable. As a result, it seems to us that Ricardo's theory is unable to totally dismiss mercantilists' insistence that domestic industries that can be destroyed by imported goods be protected.[49] This is so as long as countries, which are at a disadvantage in the world trading system, are seeking to protect their economic interests and concerned with an attempt to become or remain industrial nations.

To establish his theory, we have seen that Ricardo assumes the equality between the relative price of two commodities and their relative labor cost. That is, Ricardo assumes that the labor cost regulates commodities' prices and makes the labor value the foundation of the price of a commodity. Samuelson dismisses this idea together with the opportunity cost,[50] even though he also supports "Ricardo's law of comparative advantage" according to Ruffin (2002, p. 727).

Further, he introduces the revealed preference to show that free trade is better than no trade, showing the existence of gain from free trade. Samuelson returns to the same topic in 1962 in "The Gains from International Trade Once Again" to show that free trade is better than no trade, strengthening the foundation of free trade with a two-by-two model free from Ricardian theory of labor value.

Samuelson's proof requires some comments. It does not take into account the possibility that the domestic production of one of the two commodities might cease with free trade due to the elimination of the industry, because the shape of his production possibility frontier remains the same after the opening of trade. However, the imported product may have a monopoly on the domestic market if the domestic industry is destroyed. As a result, the producer of the imported good can raise its price and make domestic consumers worse off. Also, many workers laid off by the elimination of the domestic industry will suffer from unemployment.

Moreover, positive side effects enjoyed by other domestic industries, through the intermediate goods bought from them as inputs of the production of the one that was destroyed, will be subtracted from the nation's wealth. Some of these industries may disappear if they cannot sell their products elsewhere, further reducing the nation's

[48] The issue of dynamic comparative cost advantage is an old one (see Pasinetti (1977), Steedman and Metcalfe (1979), Grossman and Helpman (1992)). However, to our knowledge the implication for abandoning, in the name of static comparative cost disadvantage, an existing production which can generate substantial wealth in the long run, has not been raised in the literature of dynamic comparative cost advantage.

[49] See Smith (1937, p. 418).

[50] It is obvious that a labour theory of value cannot be of any aid in the analysis of this, since two factors of production have been assumed. The opportunity cost doctrine as presented by Professor Haberler could be applied only to case III, where the total amounts of the various factors of production remain unchanged after trade has taken place (1939, p. 200-201).

wealth. Thus, Samuelson's proof is incomplete, unless he excludes the possibility of the destruction of domestic industry after the opening of trade. On the other hand, if Samuelson excludes this possibility, his statement, "free trade is better than no trade," is questionable. With free trade, a domestic industry can be eliminated in some countries, thereby destroying the industrial base which in the long run could generate more wealth than an imported product.

It could be argued that this destruction can be creative for the domestic industry. However, there is no guarantee that "creative destruction" will generate a domestic industry, which provides the country with a substantial wealth in the long run. That is, the country might again be locked out of industrialization.

## 5. CONCLUSION

The direct and indirect critiques of our evaluation, which necessitated a revisit of many influential articles, show that Ricardo's theory of comparative cost advantage and its outcome of complete specialization are questionable. In the light of the evaluation, it appears that Ricardo's theory is an inadequate basis of free trade for countries which are at a disadvantage in the world trading system because they do not necessarily gain from free trade in his framework. Although imperfect competition contributed to move away the basis of international trade from Ricardo's theory of comparative cost advantage and establish strategic trade policies in many developed, developing and third world countries for their economic development, the points we stress either have been presented in a new light in this paper or have not been addressed in the literature. However, this paper should not be seen as an opposition to trade, but rather an attempt to shed a light on the foundation of free trade in Ricardo's framework.

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