On Absolute and Comparative Advantage in International Trade: a Pasinetti Pure Labour Approach

Pedro S. Machado

The Open University

Walton Hall, Milton Keynes, MK7 6AA, UK

pedro.siqueira-machado@open.ac.uk

Andrew B. Trigg

The Open University

Walton Hall, Milton Keynes, MK7 6AA, UK

andrew.trigg@open.ac.uk

(CORRESPONDING AUTHOR)

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Abstract

This paper builds upon Pasinetti's pure labour model, formalizing some of the insights that he has provided into the structure of international trade. A systematic approach is followed, starting with restrictive assumptions that are relaxed in subsequent stages of analysis. The starting point is a model in which two countries, one advanced and the other underdeveloped, have equal costs of production. This implies that there are no incentives for trade. At a second stage, we introduce and formalize the conditions required for these countries to exhibit absolute cost advantages, based on wage disparities. Finally, the paper establishes the conditions required for comparative advantage, based on relative differences in technology. Building on an interpretation of Ricardo's writings on trade, it is shown that absolute advantage is critical for the two countries to realise potential cost reductions afforded by comparative advantage. This abstract insight, based on the Pasinetti pure labour system, suggests that absolute advantage has a more fundamental role in international trade than given by previous studies, which focus more on either the international mobility of money capital or the international fragmentation of production.

1. Introduction

The main legacy of Ricardo's contribution to international trade theory is the theory of comparative advantage. Samuelson (1969, p. 9), for example, calls it one of the few propositions "in all of the social sciences which is both true and non-trivial". And for Krugman (2002, p. 35), "Ricardo's idea is truly, madly, deeply difficult. But it is also utterly true, immensely sophisticated – and extremely relevant to the modern world".

The usual interpretation is that comparative advantage represents a major analytical improvement over absolute advantage theory. Ruffin (2005, p. 746), for example, argues that Ricardo's true genius is to work out that a country can gain an advantage, compared to other countries, in its *relative* costs of production, as opposed to the 'fallacy of absolute advantage'. The bulk of the economics profession thus views absolute advantage as a mere stepping stone for trade theory.

There has, however, been some questioning of this deprecation of absolute advantage in studies of classical political economy, as associated with the production-based approach of Sraffa (1960).[1] One particular strand of this literature has developed an external critique of Ricardo's model that abandons the assumption of immobility of money capital between countries (Shaikh, 1999, 2016; Parrinello, 2010; Bellino and Fratini, 2019; Crespo et al., 2020). The introduction of free international mobility of money capital implies that capitalists can move their capital to other countries in search for higher rates of profit. The idea is that countries with lower costs of production, however defined, will support higher rates of profit and hence attract capital. In this way, it is suggested that the driver of international trade and specialization could be lower absolute costs.

An alternative study advocating the importance of absolute advantage is that of Baldone et al. (2007). Here, the criticism of comparative advantage is not based on mobility of money capital, but rather due to the complications associated with trade in (physical) intermediate goods. With the fragmentation of production there is a "lessening of the power

of the concept of comparative advantages (…) while it is the concept of absolute advantage that becomes increasingly relevant" (Baldone et al., 2007, p. 1727). Traditional measures of comparative advantage might suggest that a country should specialize in the production of a particular final commodity; but with fragmentation it might be cheaper for the country to export the intermediate inputs necessary for another country to produce the final commodity – which the original country then imports. It is argued, using a two-country model, with zero profits and traded intermediate capital inputs, that trade patterns can thus be explained by actual costs of producing the commodities: absolute advantage.

There is, however, a dimension to this analysis that has been somewhat neglected: it rests on a fundamental assumption that each country has a given money wage, both measured in a common unit of account (Baldone et al., 2007, p. 1733). This modelling of wage disparities allows for a comparison between money costs (and absolute advantage) between countries which, it may be argued, is more fundamental than Baldone et al.'s focus on intermediate inputs.

The contribution of this paper is thus to further investigate the role of wage disparities and absolute advantage in a production system with international trade that is more abstract than Baldone et al.'s formulation. The framework employed is perhaps the most abstract available in classical political economy, the two-country system developed by Pasinetti (1993) under pure labour technology, with zero profits and labour the only input to production. Our approach is to emphasize the role of money wage disparities in determining trade patterns and world prices. It will be shown that even in this simplified model absolute cost advantages can dominate competition between countries under given money wages. What sets our contribution apart is that we need not rely on either free mobility of money capital or trade in intermediate capital goods in order to establish a role for absolute advantage in international trade.

Though Pasinetti has much to say about international trade there has been very little attention to this aspect of his work. International trade is not, for example, considered in the intellectual biography of Pasinetti's work and the secondary literature provided by Baranzini and Mirante (2018). A further contribution here is thus to introduce a formalisation of the model of international trade developed in Chapter 9 of Pasinetti (1993).[2] It will be argued that Pasinetti's step-by-step approach, with the systematic relaxation of restrictive assumptions at each stage of the analysis, can throw light on some of the core aspects of complex trade relationships.

The structure of the paper follows a step-by-step approach. Section 2 starts by setting up Pasinetti's two-country model of trade in its most concise form. By starting with Pasinetti's assumption of a uniform ten-fold disparity in technology and wage rates, between the two countries, costs are shown to be the same, providing no inducement to trade. Section 3 then introduces absolute advantage into the model by relaxing the assumption of a ten-fold difference in wages. It is shown that under wage disparities one of the countries will have cheaper production costs across all commodities. Finally, by then relaxing the assumption of uniform differences in technology, the possibility of comparative advantage is introduced, together with a consideration of how absolute advantage may also retain its relevance. The final section provides a summary of the contribution and some concluding remarks.

2. The two-country Pasinetti model

Pasinetti (1993, Chapter 9) develops a rudimentary model of international trade in which there are two economic systems, each represented by a separate country. Each system has its own methods of production, with single commodity-producing industries employing direct (unassisted) labour to produce the same m commodities in each country. This is a pure labour economy in which there are zero profits and all income is allocated to labour. A key restriction is that the free movement of labour is allowed within each system but not between

countries. Free movement (trade) of commodities between countries is allowed in principle, depending on the configuration of prices.

A 'purely hypothetical' case (Pasinetti, 1993, p. 151) is developed in which there is an advanced country (A) and an underdeveloped country (U). To formalise this model, labour coefficients for each commodity i represent volumes of labour per unit of physical output: l_i^A for country A, and l_i^U for country U. These countries also have their own separate money wage rates (w^A and w^U), which form the basis for the total money costs of producing each physical unit (c_i^A and c_i^U). Since production occurs by means of unassisted labour, the costs of production are made up of the wage bill paid out in each sector. The labour coefficients are combined with the money wages for each country such that

$$c_i^A = w^A l_i^A \tag{1}$$

$$c_i^U = w^U l_i^U \tag{2}$$

Pasinetti considers the case of a ten-fold difference in the productivity of labour for each commodity produced; that is, country A is ten times more productive, and hence its labour coefficients are ten times smaller than in country U:

$$l_i^U = 10 l_i^A \tag{3}$$

In addition, the money wage available to the producers in country A is ten times higher than the money wage available in country U (Pasinetti, 1993, p. 153):

$$w^A = 10 w^U \tag{4}$$

Substituting (3) and (4) into (1) and (2) shows that the tenfold differences in technology and wages cancel each other out; the money cost of producing each commodity i is the same in each country:

$$c_i^A = c_i^U \tag{5}$$

On this basis, Pasinetti has a cost-based theory of prices with $p_i^A = c_i^A$ and $p_i^U = c_i^U$ such that under (1) and (2):

$$p_i^A = w^A l_i^A \tag{6}$$

$$p_i^U = w^U l_i^U \tag{7}$$

These prices, as determined by costs of production, are what classical political economists called 'natural prices' (or alternatively as supply-prices for Dvoskin & Feldman (2018a, 2018b)): the minimum price necessary for production to be carried out in each country. As stated by Adam Smith: "The commodity is then sold precisely for what it is worth, or for what it really costs the person who brings it to market" (Smith, 2007[1776], p. 47). Ricardo explicitly agrees with Smith: "In the 7th chap. of the Wealth of Nations, all that concerns this question is most ably treated" (Ricardo, Works, vol. 1, chap. 4, p. 89). If labour is the only input to production, what Smith calls cost simply becomes the wage bill.

It also follows from (5) that $p_i^A = p_i^U$: the prices of each commodity "are exactly the same in both countries" (Pasinetti, 1993, p. 151). This is explained by the differences in wages off setting differences in technology, as explained above. Hence, neither country can acquire any commodity at a cheaper price (cost) by means of importation. There is no incentive to trade between the two countries in this abstract starting point.

It should be noted that the law of one price is assumed to hold throughout, but the result in (5) is not a consequence of it. The law stipulates that the price of a tradable commodity must be the same (adjusted for transport costs and import/export duties) across all countries (see Shaikh, 2016, p. 517). This is simply a non-arbitrage condition: the possibilities of buying cheap in a country and selling dear in another have been exhausted. This assumption does not imply an equalization of costs of production, which may differ

between producers even though prices are uniform. Therefore, the equalization of costs in (5) is separate from the law of one price, since the convergence of prices is not sufficient to explain cost equalization.

For Pasinetti, this model clearly shows the asymmetry in power between the two countries. The advanced country benefits by having higher wages than the underdeveloped country, and it has nothing to gain from trade with the underdeveloped country. The underdeveloped country is therefore unable to trade, since it can only offer the goods at the same price as the advanced country, and has nothing to offer.[3] By denoting the world price of commodity i as p_i, it follows that

$$p_i = p_i^A = p_i^U \tag{8}$$

Commodity i's world price is equal to the price operating in both country A and country U. A corollary of this is that relative prices are the same in both countries. Consider commodities i and j. Since $p_i^A = p_i^U$ and $p_j^A = p_j^U$, it is evident that:

$$\frac{p_i^A}{p_j^A} = \frac{p_i^U}{p_j^U} \tag{9}$$

Pasinetti also points out a peculiarity of this model. Though the labour theory of value is in operation within each system, it does not operate between the two systems: "relative quantities of embodied labour will continue to regulate commodity prices *within* the boundaries of each country, but not across borders" (Pasinetti, 1993, p. 152, original emphasis). Comparisons between countries take place only in terms of physical, not labour embodied units.

This peculiarity can be demonstrated, using the price equations (6) and (7) to compare country A's ratio of prices for commodities i and j:

$$\frac{p_i^A}{p_j^A} = \frac{w^A l_i^A}{w^A l_j^A} = \frac{l_i^A}{l_j^A} \tag{10}$$

Since wages are uniform inside country A, the wage rates cancel out. Thus, relative prices inside country A are equal to relative embodied labour coefficients, consistent with the labour theory of value.

But consider the ratio of prices for commodities i and j between countries A and U. Since from (4) we know that $w^A = 10w^U$, relative prices are:

$$\frac{p_i^A}{p_j^U} = \frac{w^A l_i^A}{w^U l_j^U} = 10 \left(\frac{l_i^A}{l_j^U} \right) \tag{11}$$

It is evident here that the cross-country relative prices are not equal to the ratio of embodied labour coefficients. The labour theory of value does not hold at the international level, even under the pure labour assumption. The ratio of wage rates, 10 times higher in country A than in U, are critical to the comparison of cross-country prices.

Though Pasinetti does not state the origins of this two-country result, it can be found in David Ricardo's treatment of international trade, where he explores the trade of wine and cloth between Portugal and England:[4]

> The same rule which regulates the relative value of commodities in one country, does not regulate the relative value of the commodities exchanged between two or more countries. (…) The quantity of wine which she [Portugal] shall give in exchange for the cloth of England, is not determined by the respective quantities of labour devoted to the production of each, as it would be, if both commodities were manufactured in England, or both in Portugal. (Ricardo, Works, vol. 1, p. 113)

Illustration. Assume a two-commodity economy producing corn (c) and gold (g), as considered by Pasinetti (1993, p. 151). A concrete example of this two-country/two-commodity economy, with illustrative labour coefficients, is provided by Table 1.

Table 1   Labour coefficients with uniform ten-fold differences

	Country A	Country U
Corn	$l_c^A = 0.5$	$l_c^U = 5$
Gold	$l_g^A = 1$	$l_g^U = 10$

Table 1 shows that in country A it takes half a man-hour to grow one unit of corn and one man-hour to mine one unit of gold. Under the uniform ten-fold difference in technology, for country U it takes five man-hours to grow one unit of corn and ten man-hours to mine one unit of gold.

For a ten-fold difference in money wage rates, let the hourly wage in country A be $w^A = 1$, and the hourly wage in country U be $w^U = 0.1$.[5]

From these assumptions regarding technical coefficients and wage rates, it is possible to assess the costs of producing either commodity in one of the countries. By construction, the cost of producing a commodity is just made up of its money wage bill (see equations (1) and (2) above):

$c_c^A = 1 \times 0.5 = 0.5$

$c_g^A = 1 \times 1 = 1$

$c_c^U = 0.1 \times 5 = 0.5$

$c_g^U = 0.1 \times 10 = 1$

Table 2   Costs with no incentive to trade

	Country A	Country U
Corn	$c_c^A = 0.5$	$c_c^U = 0.5$
Gold	$c_g^A = 1$	$c_g^U = 1$

These costs are displayed in Table 2. It is immediately obvious that equation (5) holds: both countries are producing each commodity at the same cost, so the determination of world prices will be unambiguous. According to equation (8) above, the world price of gold will be $p_g = 1$ and of corn will be $p_c = 0.5$. This is a model with no inducement for the two countries to trade with each other.[6]

3. Absolute advantage

We have thus seen how Pasinetti's two-country model is constructed in such a way to exclude between-country differences in costs. Since there are no differences in costs between countries a world price is established for each commodity by construction. In this section we will introduce differences in absolute costs between countries in Pasinetti's model, keeping his assumption regarding a uniform ten-fold disparity in technologies. As a first step we consider the notion of absolute advantage.

A country will have an absolute advantage in the production of a commodity if its cost of production is lower than in another country. In Pasinetti's example, country A will have an absolute advantage in producing commodity i if it can produce and supply it at a cheaper cost than country U. Its cost of production must be lower than in country U. This is the same definition of absolute advantage as provided by Brewer (1985, p. 178) (see also Bellino & Fratini, 2019, p. 17).

It is important to stress that this definition of absolute advantage represents a departure from the canonical definition. Absolute advantage is usually defined for differences in the quantity of labour required to produce a commodity. For example, Krugman et al. (2018, p. 51) states that: "when one country can produce a unit of a good with less labor than another country, we say that the first country has an absolute advantage in producing that good". This is a purely technical definition based on labour technologies.

In contrast, absolute advantage is defined here as a scenario where a country can produce a commodity at a lower money cost than is possible in another country. This shift in definition brings absolute advantage closer to the classical concept of competition. One of the roles of competition in classical political economy is the "enforcement of minimum-cost production" among the readily available methods of production (Eatwell, 1982, n. 3). Absolute advantage is not simply a technical condition, but rather depends on "political and institutional elements" (Baldone et al., 2007, p. 1735, n. 15), which impact on the key role provided by wages.

Thus far, in our model the cost of production is simply the wage bill outlaid on workers, as specified in equations (1) and (2). Therefore, a country will have an absolute advantage in the production of a commodity if the wage bill necessary to produce that commodity is lower than the wage bill outlaid in the other country. So, the absolute advantage for commodity i will depend on whether:

$$c_i^A \lesseqgtr c_i^U \Leftrightarrow w^A l_i^A \lesseqgtr w^U l_i^U \tag{12}$$

If the wage bill necessary to produce commodity i in country A is higher than in country U ($w^A l_i^A > w^U l_i^U$) then the absolute cost of producing it in country A is higher than in country U: it is *absolutely* cheaper to produce commodity i in country U. The reverse is true if $w^A l_i^A < w^U l_i^U$: it is *absolutely* cheaper to produce the commodity in country A. Where the wage bill is equivalent ($w^A l_i^A = w^U l_i^U$), no country possesses an absolute advantage and hence both countries will tend to produce it simultaneously.

Absolute advantage can be established in the Pasinetti model, maintaining the technical assumption that for each commodity country U is ten times less productive than country A, but focusing here on differences in wages. Substituting the relationship between labour coefficients $l_i^U = 10 l_i^A$ into (12) gives the condition for absolute advantage as

$$w^A \lesseqgtr 10w^U \qquad (13)$$

Thus, whenever the wage in country A is more than ten times larger than in country U ($w^A > 10w^U$), it will be *absolutely* cheaper to produce commodity i in country U. At this point we say that country U has an absolute advantage in the production of commodity i. The reverse would be true if the wage in country A was less than ten times higher than the one in country U: $w^A < 10w^U$. If the wage in country A is exactly ten times higher than the one in country U ($w^A = 10w^U$), then neither country will have an absolute advantage in the production of commodity i. This last case is what we saw working in Pasinetti's model.

Notice, by assumption, that technology in country U is uniformly inferior, meaning that all goods use ten times more labour than in country A. So, whenever the wages in both countries are not in a ratio of one to ten, one of the countries will be able to supply all commodities at a cheaper price. This means that if country U has an absolute advantage in the production of one good it will also have an absolute advantage in the production of all goods.

Therefore, whenever country A's wage is more than ten times larger than country U's, country U will have an absolute advantage in the production of every commodity. Country A will be unable to compete in the production of any good. The tendency will be for country U to produce all goods and for country A to import everything. The recent literature on trade has explored similar outcomes where one country completely outcompetes the other; this has been referred to as 'an empty economy' (Parrinello, 2010), 'exclusion from trade' (Crespo et al., 2020), and 'desertification' (Bellino & Fratini, 2019).[7] The common feature is that one country is rendered unable to compete. This is an extreme example that emerges from the simplifying assumptions regarding technology. Later, it will be shown that these technological assumptions can be relaxed, generating similar results under a more realistic framework.

Since there are absolute differences in costs, there is an incentive for countries to trade with each other. Say that country U has an absolute advantage in producing commodity i because it can supply it cheaper than the other country. Anyone demanding commodity i in country A will see an advantage in importing it from country U. Producers in country A will be unable to compete with country's U low production costs and will tend to terminate its production. Countries will thus tend to produce commodities at a cheaper cost than their competitors.

Price competition implies, under the law of one price, that consumers from either country would rather buy from the country that offers the cheapest price. Hence, the world price of any commodity will simply be the price that covers the cost in the country with the lowest production cost. In the case of country U having an absolute advantage in the production of all goods, the world prices of commodities will be equal to the cost of producing those commodities in country U. In general, when $w^A > 10w^U$ the world price of any commodity i will be:

$$p_i = c_i^U = w^U l_i^U \tag{14}$$

At this level of the world prices, producers from country A are unable to cover its production costs ($c_i^A > p_i$).

This analysis shows that for Pasinetti's two-country model wage disparities are key to establishing conditions under which absolute cost advantages can exist. The role of absolute advantage is shown to be more fundamental than has been established by Baldone et al. (2007). By showing that absolute advantage is important even in the simple pure labour model with a uniform technological disparity, we preclude the need for introducing complications caused by trade in intermediate goods (as in the approach of Baldone et al. (2007)). Pasinetti's abstract foundations bring into clear focus the fundamental importance of wages. Following the logic of Pasinetti's step-by-step approach, the next section will

consider the more realistic conditions required for comparative advantage – still within the confines of Pasinetti's pure labour system.

Illustration. Modifying our earlier example, an illustration can be provided of how absolute cost differences can emerge, maintaining the same ten-fold difference in technology as in Table 1. We now assume that country A's wage is thirty times larger than in country U. For example, let the hourly wage in country A be $w^A = 3$ while the hourly wage in country U is $w^U = 0.1$.

From these technical coefficients and wage rates, it is possible to examine the costs of producing the two commodities, corn and gold, in each country. By construction, using (1) and (2), the cost of producing a commodity is just its wage bill (combining the wage rate and labour coefficient):

$c_c^A = 3 \times 0.5 = 1.5$

$c_g^A = 3 \times 1 = 3$

$c_c^U = 0.1 \times 5 = 0.5$

$c_g^U = 0.1 \times 10 = 1$

Table 3   Costs under absolute advantage

	Country A	Country U
Corn	$c_c^A = 1.5$	$c_c^U = 0.5$
Gold	$c_g^A = 3$	$c_g^U = 1$

These costs are displayed in Table 3, which is equivalent to Table 2 from the previous section. From this simple comparison it is easy to see that it is absolutely cheaper to produce

both corn and gold in country U ($c_c^U < c_c^A$ and $c_g^U < c_g^A$). Due to the thirty-fold disparity in wage rates, country A cannot compete in the production of either goods. If this situation were to persist, then the tendency would be for country U to produce and export both goods and for country A to import them.

As argued previously, if trade is allowed price competition will ensure that world prices are set by the country with the lowest production cost. In this case, world prices will be equivalent to the costs of production in country U: $p_c = 0.5$ and $p_g = 1$. At those world prices, country A cannot cover its cost of production, while country U can do so.

4. Comparative advantage

In the analysis thus far, we have assumed that technology is uniformly inferior in one country relative to the other country. Country U had to employ ten times more workers per unit of output in every industry. The consequence of this assumption is that relative costs, and hence prices, are the same in both countries, as shown in expression (9). In this section we follow Pasinetti (1993, p. 178) by relaxing this assumption, still under the rubric of the pure labour model. This will allow us to analyse Pasinetti's classical approach to comparative advantage and to make some connections with the original formulation in Ricardo's writings.

Assume that the technology for each sector in country U diverges from the equivalent sector in country A, but in different degrees, depending on the sector. Some sectors might use ten times more workers, some only five times more, some might be on par, and some might even use fewer workers. Technology is assumed as given, meaning that for every sector this disparity in labour inputs will not change in the analysis that follows. This new scenario may be formalized by introducing a variable δ_i measuring how much the technology of country U differs from that of country A in the production of commodity i:

$$l_i^U = \delta_i l_i^A \tag{15}$$

If $\delta_i > 1$, then country U uses more labour to produce commodity i than country A. If $\delta_i = 1$, then country U uses the same quantity of labour to produce commodity i as country A. If $\delta_i < 1$, then country U uses less labour to produce commodity i than country A. Every commodity has a δ-modifier that can vary between commodities.[8]

Inside each country the labour theory of value still regulates relative costs, because this only depends on the intra-country uniformity of wages (see equation (10)). However, relative costs may now differ between countries, in contrast to the analysis in sections 2 and 3. The relative cost of producing commodity i with respect to commodity j might be lower, higher, or the same in country A as compared to country U, depending on whether δ_i is less than, greater than, or equal to δ_j. For example, if $\delta_i > \delta_j$ then the relative cost of producing i with respect to j is lower in country A than in country U:

$$\frac{c_i^A}{c_j^A} = \frac{l_i^A}{l_j^A} < \frac{l_i^U}{l_j^U} = \frac{c_i^U}{c_j^U} \tag{16}$$

Under a uniform wage rate within each country relative costs are represented by relative labour coefficients. The left-hand equality in expression (16) states that relative costs in country A are equal to its ratio of labour coefficients; the right-hand equality states that relative costs in country U are equal to its ratio of labour coefficients. The inequality arises since $l_i^U = \delta_i l_i^A$, $l_j^U = \delta_j l_j^A$, and $\delta_i > \delta_j$.

It is standard procedure in the literature to assert that when expression (16) holds then country A will be compelled to specialise in the production of commodity i and country U to specialise in the production of commodity j. In Pasinetti's words: "this is a case in which, if international trade were allowed, goods would be induced to move across borders.

People in *A* would buy goods of the first type in *U*, where they are cheaper; and similarly people in *U* would buy goods of the second type in *A*" (Pasinetti, 1993, p. 159).

Under this two-country model, comparative advantage is thus defined when for a particular country the relative cost of producing a commodity is lower than the relative cost of its production of another commodity (see, for example: Steedman & Metcalfe, 1979; Brewer, 1985; Ruffin, 2002). In (16), for example, country *A* has a comparative advantage in its production of commodity i and country *U* for commodity j.

It is possible to use this definition of comparative advantage to interpret the classic cloth and wine example given by Ricardo: [9]

> England may be so circumstanced, that to produce the cloth may require the labour of 100 men for one year; and if she attempted to make the wine, it might require the labour of 120 men for the same time. (…) To produce the wine in Portugal, might require only the labour of 80 men for one year, and to produce the cloth in the same country, might require the labour of 90 men for the same time. (Ricardo, Works, vol. 1, chap. 7, p. 113-4)

Following Gehrke (2017) and Bhering & Serrano (2019), the numbers in Ricardo's example can be read as the quantities of labour to produce given quantities of cloth and wine: "the four numbers refer to the labour contents of given (unspecified) amounts of the two goods traded" (Gehrke, 2017). In order to translate these quantities into labour coefficients it is necessary to divide each one by the respective given quantity. In his example, the cost ratio between wine and cloth is lower in Portugal (= 80/90) than in England (= 120/100).[10] From our definition, this would imply that Portugal has a comparative advantage in the production of wine and England in the production of cloth.

If relative world prices lie in between the interval set by (16), then it could be advantageous for country *A* to specialize in commodity i and country *U* in commodity j:

$$\frac{l_i^A}{l_j^A} \leq \frac{p_i}{p_j} \leq \frac{l_i^U}{l_j^U} \tag{17}$$

The intuition is quite simple: suppose that the world relative price lies strictly in between the cost ratios (expression (17)) and someone from country A possesses some quantity of commodity i and wants to exchange it for commodity j; then she would find it beneficial to export commodity i and import commodity j from country U, obtaining a higher quantity of j. The general tendency would then be for country A to specialize in the production of commodity i and country U in the production of commodity j. If the four coefficients $(l_i^A, l_j^A, l_i^U, l_j^U)$ are aligned such that (17) is satisfied, then there is an incentive for trade to take place. These are what Samuelson (1969, p. 4) refers to as Ricardo's "four magic numbers".

Less well known is an additional proviso that must be placed on the theory of comparative advantage: that the four magic numbers only open up the *possibility* of specialisation and trade. It is also necessary, for trade to actually take place, that the costs incurred by production – and hence prices – are competitive. Some justification for this argument can be found in Ricardo's writings.

Consider again Ricardo's example of Portugal and England trading wine and cloth. Ricardo examines what would happen if there was an improvement in the wine production in England. Before the introduction of the improvement, the situation is described by Portugal having lower monetary costs for producing wine and England for cloth:

> [S]uppose before the improvement in making wine in England, the price of wine here were 50*l.* per pipe, and the price of a certain quantity of cloth were 45*l.*, whilst in Portugal the price of the same quantity of wine was 45*l.*, and that of the same quantity of cloth 50*l.* (Ricardo, Works, vol. 1, chap. 7, p. 115)

The cost of producing wine in Portugal (£45) is lower than in England (£50); also, the cost of producing cloth in England (£45) is lower than in Portugal (£50).[11] It is thus advantageous for Portugal to produce and export wine, while England produces and exports cloth. For any

two goods i and j, the additional proviso for trade to take place is that costs in each sector are competitive:

$$c_i^A < c_i^U \tag{18}$$

$$c_j^U < c_j^A \tag{19}$$

Inequality (18) establishes that it is absolutely cheaper to produce commodity i in country A, while (19) establishes that it is absolutely cheaper to produce commodity j in country U. Thus, comparative advantage as a theory of specialization must explain how absolute money costs adjust so the specializing country has the lowest cost of production.

Introducing the law of one price to this analysis, price competition will imply that there is a single world price for each commodity. The world price for each good must then be able to cover the costs incurred in the country with lowest costs of production. In other words, it is the country with the lowest absolute money cost that determines the world price. This is also present, it might be argued, when Ricardo discusses the impact of England prohibiting the importation of corn from France:

> Corn, like every other commodity, has in every country its natural price, viz. that price which is necessary to its production, and without which it could not be cultivated: it is this price which governs its market price, and which determines the expediency of exporting it to foreign countries. If the importation of corn were prohibited in England, its natural price might rise to 6*l.* per quarter in England, whilst it was only at half that price in France. If at this time, the prohibition of importation were removed, corn would fall in the English market, not to a price between 6*l.* and 3*l.*, but ultimately and permanently to the natural price of France, the price at which it could be furnished to the English market (Ricardo, Works, vol. 1, chap. 28, p. 237-238)

The cost of producing corn in England is £6 for a quarter, while in France it is the equivalent of £3. If there is free trade the world price of corn in England will be £3 by importing it from France. At this price English farmers are unable to compete in the production of corn since the world price is insufficient to cover their costs of production.[12]

This interpretation has some resemblance to that of Ruffin (2002, p. 730)[13] who, in a reconstruction of Ricardo, postulates that "the Ricardian pattern of specialization requires that the world prices be":

$$p_i = w^A l_i^A \qquad (20)$$

$$p_j = w^U l_j^U \qquad (21)$$

Equations (20) and (21) indicate that world prices are determined by the costs of production in the country enjoying comparative advantage; the price of i is equivalent to the cost of production of country A and the price of j to the cost of production of country U. The implicit assumption here is that the country with comparative advantage has the lowest absolute cost. Based on the above interpretation of Ricardo, the actual realisation of a position of comparative advantage is also characterized by the establishment of absolute advantage.

In a criticism of comparative advantage, Schumacher (2013) also emphasizes that comparative advantage must be accompanied by absolute advantage. The author calls it a "transformation of comparative production cost advantages into absolute price advantages" (Schumacher, 2013, p. 90). The idea is also based on price competitiveness: "This transformation is vital, because consumers buy goods from whoever offers them at the lowest money price. Consumers are neither aware of nor interested in comparative production costs" (ibid.).

Substituting (20) and (21) into (17) yields

$$\frac{l_j^U}{l_j^A} \leq \frac{w^A}{w^U} \leq \frac{l_i^U}{l_i^A} \qquad (22)$$

which is the same formalisation provided by Ruffin (2002, p. 730). Expression (22) has the following interpretation: if the wage ratio is within these limits, then the two countries will

tend to specialize according to their comparative advantages. This is easy to see if we rearrange the first inequality to:

$$w^U l_j^U \leq w^A l_j^A \tag{23}$$

This means that country U has indeed a lower money cost for producing commodity j, for which it has a comparative advantage. In addition, country A has a lower money cost for producing commodity i, for which it has a comparative advantage.

However, we want to emphasize that expression (22) is not a simple rewriting of the definition of comparative advantage (expression (17) above). To demonstrate this point, it is possible to violate condition (22) without breaking with the definition of comparative advantage. This has important implications for specialization and the determination of world prices. Suppose that, instead of (22), the wage ratio is such that

$$\frac{l_j^U}{l_j^A} < \frac{l_i^U}{l_i^A} < \frac{w^A}{w^U} \tag{24}$$

From a comparison of the wage ratio with each labour ratio in (24) it may be concluded that country U has lower money costs in the production of both commodities: $w^U l_i^U < w^A l_i^A$ and $w^U l_j^U < w^A l_j^A$.

Price competition would ensure that country U would tend to produce and export both goods, and country A imports both. The world prices would be determined by the costs of production in country U: $p_i = w^U l_i^U$ and $p_j = w^U l_j^U$. And the world relative prices will simply be the ratio of labour coefficients from country U: $p_i/p_j = l_i^U/l_j^U$. Hence, world relative prices are at the right extreme of the interval set by (17), but still inside it:[14]

$$\frac{l_i^A}{l_j^A} < \frac{p_i}{p_j} = \frac{l_i^U}{l_j^U} \tag{25}$$

Despite the world relative prices being compatible with the definition of comparative advantage, it is absolute advantage that would determine trade patterns so long as the ratio of wages remains stable. It would also be erroneous to conclude that country A is able to compete in the production of commodity i (due to its comparative advantage) the reason being that country U can offer it at a cheaper money price (due to its absolute advantage).

Expression (17) thus only sets the *potential* for comparative advantage, while expression (22) would be required in order for comparative advantage to *actually* determine trade patterns.

Two key results have been provided. First, for comparative advantage to be established the outcome must also be characterized by countries having the lowest cost of production in the commodity in which they enjoy a comparative advantage. From our definition of absolute advantage (see section 3), this means that countries must also have an absolute advantage in the production of such a commodity. Second, it is also analytically possible for one of the countries to persistently have the lowest cost of production in goods for which it does not have a comparative advantage. This framework brings absolute advantage to the fore at a fundamental level of abstraction, without requiring either trade in intermediate inputs or the international mobility of capital, as considered in the recent trade literature.

Illustration. We can further modify our previous example to illustrate the case of comparative advantage. Let the hourly wage rates have the same values from the previous example: $w^A = 3$ and $w^U = 0.1$. However, suppose that the labour coefficients are now as shown in Table 4. There is no longer a uniform ten-fold difference for both sets of labour coefficients; comparing 0.5 with 8, the labour coefficient for corn in country U is now 16 times larger than that for country A.

Table 4   **Labour coefficients with non-uniform differences**

	Country A	Country U
Corn	$l_c^A = 0.5$	$l_c^U = 8$
Gold	$l_g^A = 1$	$l_g^U = 10$

From the definition of comparative advantage in (16), these labour coefficients mean that country A has a potential comparative advantage in the production of corn and country U in gold: $l_c^A / l_g^A = 0.5 < 0.8 = l_c^U / l_g^U$.

Since costs are made up of the wage bill, these wage rates and labour coefficients allow us to calculate the costs in each country:

$c_c^A = 3 \times 0.5 = 1.5$

$c_g^A = 3 \times 1 = 3$

$c_c^U = 0.1 \times 8 = 0.8$

$c_g^U = 0.1 \times 10 = 1$

These costs are reported in Table 5.

Table 5   **Costs under comparative advantage**

	Country A	Country U
Corn	$c_c^A = 1.5$	$c_c^U = 0.8$
Gold	$c_g^A = 3$	$c_g^U = 1$

It is clear that, despite country A enjoying a potential comparative advantage in the production of corn, and country U in the production of gold, country U can produce both corn and gold at a cheaper money cost ($0.8 < 1.5$ and $1 < 3$). This happens because the difference in wages is more than enough to compensate the relative technical 'backwardness'

in country U's production of both commodities. Country A will then be unable to compete in the production of either commodity. The tendency will be for production to be concentrated in country U, while country A imports both commodities for consumption purposes.

Price competition will lead world prices to be set at a level sufficient to cover the costs in country U: $p_c = 0.8$ and $p_g = 1$. At those world prices, country A cannot cover its cost of production, while country U is able to cover its costs.

5. Conclusions

Pasinetti's writings on international trade have not hitherto been formalised as a mathematical system. Filling this gap in the literature, this paper explores in equation form the structure of the of the two-country model of international trade developed in Chapter 9 of Pasinetti (1993). This is a pure labour model, in which labour is the sole input of production to be considered under international trade.

The first contribution is to formalise Pasinetti's analytical starting point in which costs of production are the same in each country. This model is based on a uniform ten-fold disparity in technology and wages between two countries, one advanced the other underdeveloped. There are no incentives for countries to trade with each other.

Second, under the same technology as in the first model, absolute cost differences are introduced to the Pasinetti model by allowing wage rates to differ from the ten-fold disparity. Whenever the wage rates between countries are not in the ratio of one to ten, the opportunity arises for one of the countries to produce all commodities at a cheaper cost. The possibility emerges of one country enjoying absolute cost advantage across all commodities. Absolute advantage can therefore be established in this abstract Pasinetti framework without assuming money capital mobility (as, for example posited by Shaikh, 2016), and without consideration of intermediate capital inputs (as, for example, posited by Baldone et al., 2007)

– since this is a pure labour system in which labour is the only input to production. Wage disparities are key to establishing the conditions required for absolute advantage in this Pasinetti framework.

A final modification relaxes the ten-fold difference in technology between the two countries. Differences in relative costs between the two countries emerge, giving each country the opportunity to specialise in the production of specific commodities that they can produce at (relatively) high levels of productivity. If trade is allowed, each country may export these specific commodities to the other country. Based on a reading of Chapter 7 in Ricardo's *Principles* we show, however, that relative cost differences only afford the possibility of export-based specialisation. A second condition is required for specialisation to take place: that the absolute cost of producing the commodity is lower than that of the country's competitor. Otherwise, unless the absolute cost (and hence the price) is competitive (lower than can be delivered in the importing country), there will be no incentive for the importing country to purchase the commodity from the other country. A secondary role is therefore established for the notion of absolute advantage. For a country to capitalise on its opportunity to specialise, as afforded by comparative advantage, it must also ensure that a commodity will display absolute advantage to be fit for purpose as export material.

This role for absolute advantage is thus argued to be more fundamental to international trade than has been suggested by writers such as Shaikh and Baldone, who, as indicated above, have focused more on either international mobility of money capital or trade in intermediate goods. As an abstract starting point, Pasinetti's pure labour approach enables the core role played by absolute advantage to be identified with more clarity than is revealed in more complex modelling. The advantage of Pasinetti's systematic approach is that as a next step capital inputs, and the role of profits, can be easily introduced to this rudimentary input-output system.

References

Baldone, S., Sdogati, F., & Tajoli, L. (2007). On some effects of international fragmentation of production on comparative advantages, trade flows, and the income of countries. *The World Economy, 30*(11), 1726-1769.

Baranzini, M., & Mirante, A. (2018). *Luigi L. Pasinetti: An Intellectual Biography.* London: Palgrave Macmillan.

Bellino, E., & Fratini, S. (2019). Absolute Advantages and Capital Mobility in International Trade Theory. *Centro Sraffa Working Papers, 38.*

Bhering, G., & Serrano, F. (2019). There is no room: The Role of Reciprocal Effectual Demands in Ricardo's Theory of Foreign Trade. *Texto para Discussão - IE UFRJ*(021).

Brewer, A. (1985). Trade with Fixed Real Wages and Mobile Capital. *Journal of International Economics, 18*, 177-186.

Crespo, E., Dvoskin, A., & Ianni, G. (2020). Exclusion in 'Ricardian' Trade Models. *Review of Political Economy*. doi:10.1080/09538259.2020.1817669

Deardorff, A. V. (2005). Ricardian Comparative Advantage with Intermediate Inputs. *The North American Journal of Economics and Finance, 16*(1), 11-34. doi:https://doi.org/10.1016/j.najef.2004.11.003

Dornbusch, R., Fischer, S., & Samuelson, P. A. (1977). Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods. *The American Economic Review, 67*(5), 823-839.

Dvoskin, A., & Feldman, G. (2018a). Income distribution and the balance of payments: a formal reconstruction of some Argentinian structuralist contributions Part I: Technical dependency. *Review of Keynesian Economics, 6*(3), 352-368.

Dvoskin, A., & Feldman, G. (2018b). Income distribution and the balance of payments: a formal reconstruction of some Argentinian structuralist contributions Part II: Financial dependency. *Review of Keynesian Economics, 6*(3), 369-386.

Eatwell, J. (1982). Competition. In I. Bradley, & M. H. (eds.), *Classical and Marxian Political Economy: essays in honour of Ronald L. Meek.* London: Macmillan.

Garegnani, P. (1983). The Classical Theory of Wages and the Role of Demand Schedules in the Determination of Relative Prices. *The American Economic Review, 73*(2), 309-313.

Gehrke, C. (2015). Ricardo's Discovery of Comparative Advantage Revisited: A Critique of Ruffin's Account. *The European Journal of the History of Economic Thought, 22*(5), 791-817.

Gehrke, C. (2017). Foreign trade, international values, and gains from trade: Ricardo, Pennington, Whewell, and John Stuart Mill. In S. Senga, M. Fujimoto, & T. Tabuchi (Eds.), *Ricardo and International Trade* (pp. 139-163). London: Routledge.

Gibson, B. (1980). Unequal Exchange: Theoretical Issues and Empirical Findings. *Review of Radical Political Economics, 12*(3), 15-35.

Graham, F. D. (1948). *The Theory of International Values.* Princeton: Princeton University Press.

Krugman, P. (2002). Ricardo's Difficult Idea: Why intellectuals don't understand comparative advantage. In G. Cook (Ed.), *The Economics and Politics of International Trade: Freedom and Trade* (Vol. 2, pp. 22-36). London: Taylor & Francis e-Library.

Krugman, P., Obstfeld, M., & Melitz, M. J. (2018). *International Trade: Theory and Policy.* Global Edition: Pearson Education.

Metcalfe, S. (1998). Comparative Advantage. In H. D. Kurz, & N. Salvadori (Eds.), *The Elgar Companion to Classical Economics* (pp. 170-174). Cheltenham: Edward Elgar.

Parrinello, S. (1973). Distribuzione, Sviluppo e Commercio Internazionale. *Economia Internazionale, 26*(2).

Parrinello, S. (2010). The Notion of National Competitiveness in a Global Economy. In J. Vint, J. S. Metcalfe, H. D. Kurz, N. Salvadori, & P. A. Samuelson (Eds.), *Economic Theory and Economic Thought: Essays in Honour of Ian Steedman* (pp. 49-68). London and New York: Routledge.

Pasinetti, L. L. (1981). *Structural Change and Economic Growth.* Cambridge: Cambridge University Press.

Pasinetti, L. L. (1988). Technical Progress and International Trade. *Empirica, 15*, 139-147.

Pasinetti, L. L. (1993). *Structural Economic Dynamics: A Theory of the Economic Consequences of Human Learning.* Cambridge: Cambridge University Press.

Ricardo, D. (2005). *The Works and Correspondence of David Ricardo.* (P. Sraffa, & M. Dobb, Eds.) Indianapolis: Liberty Fund.

Ruffin, R. (2002). David Ricardo's Discovery of Comparative Advantage. *History of Political Economy, 34(4)*, 727- 48.

Ruffin, R. (2005). Debunking a Myth: Torrens on Comparative Advantage. *History of Political Economy, 37*(4), 711-722.

Samuelson, P. A. (1969). Presidential Address: The Way of an Economist. In P. A. Samuelson (Ed.), *International Economic Relations. International Economic Association Series.* London: Palgrave Macmillan.

Schumacher, R. (2013). Deconstructing the Theory of Comparative Advantage. *World Economic Review, 83*(105), 83-105.

Senga, S., Fujimoto, M., & Tabuchi, T. (2017). *Ricardo and International Trade.* New York: Routledge.

Shaikh, A. (1999). Real Exchange Rates and the International Mobility of Capital. *Levy Institute Working Papers 265*.

Shaikh, A. (2016). *Capitalism: Competition, Conflict, Crises.* New York: Oxford University Press.

Smith, A. (2007[1776]). *An Inquire into the Nature and Causes of the Wealth of Nations.* (S. M. Soares, Ed.) Lausanne: ΜεταLibri.

Sraffa, P. (1930). An Alleged Correction of Ricardo. *The Quarterly Journal of Economics, 44*(3), 539-545.

Sraffa, P. (1960). *Production of Commodities by Means of Commodities.* Cambridge: Cambridge University Press.

Steedman, I. (1979a). *Trade Amongst Growing Economies.* Cambridge: Cambridge University Press.

Steedman, I. (Ed.). (1979b). *Fundamental Issues in Trade Theory.* London: The Macmillan Press Ltd.

Steedman, I., & Metcalfe, S. (1979). On Foreign Trade. In I. Steedman (Ed.), *Fundamental Issues in Trade Theory* (pp. 99-189). London: The Macmillan Press Ltd.

Appendix   A multi-commodity extension

This appendix extends our approach to a model with two countries and m commodities, where m is greater than 2. We show that the key role for money wages and absolute advantage, can be established in this more general framework.

Let our two countries compete in the production of m commodities. Each commodity is produced by unassisted labour. As in section 4, we relax the previous assumption of uniform technology across sectors. The cost equations for country A are:

$$
\begin{aligned}
c_1^A &= w^A l_1^A \\
&\ \ \vdots \\
c_m^A &= w^A l_m^A
\end{aligned}
\tag{26}
$$

while for country U:

$$
\begin{aligned}
c_1^U &= w^U l_1^U \\
&\ \ \vdots \\
c_m^U &= w^U l_m^U
\end{aligned}
\tag{27}
$$

As we have seen, the criteria for a country to produce a good is that such a country has the lowest cost of production; this is the definition of absolute cost advantage (see section 3). Country A will produce good i if its cost of production is lower than in country U:

$$
c_i^A < c_i^U \Leftrightarrow w^A l_i^A < w^U l_i^U \Leftrightarrow \frac{w^A}{w^U} < \frac{l_i^U}{l_i^A}
\tag{28}
$$

Equation (28) establishes a boundary condition for where commodity i will be produced: if $w^A/w^U < l_i^U/l_i^A$ then country A has the lowest cost of production and it will produce commodity i; if $w^A/w^U = l_i^U/l_i^A$ then both countries have the same cost and can both produce commodity i competitively; if $w^A/w^U > l_i^U/l_i^A$ then country U will produce this commodity.

A comparison between the absolute costs of all commodities gives us m boundary conditions. Following the indexing of commodities provided by Dornbusch et al. (1977, p. 823), we may put these boundary conditions in order such that:

$$0 < \frac{l_1^U}{l_1^A} < \frac{l_2^U}{l_2^A} < \cdots < \frac{l_m^U}{l_m^A} \qquad (29)$$

This is very close to what has been referred to as a 'chain of comparative advantage' (Deardorff, 2005, p. 1008; see also Metcalfe, 1998, p. 172).[15] Wherever the wage ratio sits with respect to the boundary conditions will determine which country has the lowest cost of production for each good. For example, if $w^A/w^U < l_1^U/l_1^A$ then country A produces all goods at a lower absolute cost than country U. If $l_i^U/l_i^A < w^A/w^U < l_{i+1}^U/l_{i+1}^A$ then it is absolutely cheaper to produce goods 1 through to i in country A and goods $i + 1$ through to m in country U. Finally, if $l_m^U/l_m^A < w^A/w^U$ then it is absolutely cheaper to produce every good in country U.

This analysis follows up on the insight provided by Baldone et al. (2007, p. 1735) into the key role of relative wages and absolute advantage in the chain of comparative advantages: without, of course, involving a role for intermediate inputs in this multi-commodity pure labour framework. This Pasinetti-based interpretation brings the analysis much closer to that of classical political economy (Garegnani, 1983); it provides a possible alternative to neoclassical trade theory with its emphasis on perfect competition and market clearing (as summarised by Dornbusch et al., 1977 and Deardorff, 2005).

Footnotes

[1] See Parinello (1973) and Steedman (1979a; 1979b) for some of the key pioneering studies in Sraffian trade theory.

[2] See also Pasinetti (1981, Chapter 11) and Pasinetti (1988).

[3] For Pasinetti (1993, p. 153) "this aspect of the situation only emerges as a very minor part of the whole picture". If the underdeveloped country could improve its productivity, say by learning from the more advanced techniques used in the other country, then there is a possibility that opportunities for trade can emerge. Recognising that learning has this important role, our analysis focuses only on price comparisons under given technologies. Future extensions of our analysis could develop the role of technological change and economic growth, drawing on the insights provided, for example, by Pasinetti (1981, pp. 163-6).

[4] See Ruffin (2002) and Bhering & Serrano (2019) for similar results from a reconstruction of Ricardo.

[5] Prices in each country are anchored to gold, as assumed by Pasinetti (1993, p. 151): under (1) and (2), the money wage allows the physical units of output to be measured in units of gold. The money wage rates have been chosen to make the cost of gold in each country (and hence its price) equal to 1, the numéraire. Other wage rates could have been assumed without changing the results below, so long as wages were kept in a proportion 10 to 1. The only implication would be to alter price levels.

[6] This example also shows that relative prices (relative costs) are governed by embodied labour coefficients within each country, as shown by (10). For example, the ratio of costs (prices) for producing the two commodities in country U (as shown in Table 2) is $1/2$ divided by 1, which equals $1/2$, the same as the ratio of labour coefficients (Table 1) of $5/10 = 1/2$. Consider, however, the ratio of costs (prices) between countries to produce corn: $1/2$ divided by $1/2$, equal to 1. This is not the same as the ratio of labour coefficients: $1/2$ divided by 5, which is equal to 0.1. As shown in (11), the labour theory of value is not in operation between countries.

[7] As mentioned previously, these works achieve such results by abandoning the assumption of international immobility of money capital.

[8] In sections 2 and 3 the δ coefficients are equal to 10 for every commodity.

[9] The interpretation of Ricardo here is strongly influenced by the so-called Sraffa-Ruffin interpretation. Since the time of John Stuart Mill, Ricardo's exposition of comparative advantage has been regarded as incomplete by not determining the world prices. This new strand of literature has roots in Sraffa's short note (Sraffa, 1930) that defends Ricardo from some claims of being wrong. It is argued that Ricardo's exposition is not incomplete, and world prices are determined by a condition of balanced trade and given quantities traded (see Ruffin, 2002; Senga et al. (2017); and Bhering & Serrano (2019)). There is no consensus in the literature regarding the determination of the quantities traded in Ricardo's analysis. For Gehrke (2017) these are unspecified amounts; while Bhering & Serrano (2019) argue that these given quantities are not arbitrary, but actually determined by known levels of effectual demands. This debate is outside the scope of this paper, it being sufficient for our purposes to assume that the quantities traded are given.

[10] Ricardo specifies the labour costs for levels of production given by quantities actually traded. For example, the 100 men needed to produce cloth in England can be taken to be the amount of labour necessary to produce a given quantity of cloth. From the point of view of the pure labour model adopted in this paper, these 100 units of labour would equal the unit labour coefficient multiplied by the quantity of cloth produced: $100 = l_c^E Q_c$. The unit labour coefficient is achieved by dividing the total labour by the given quantity traded: $l_c^E = 100/Q_c$ (see Gehrke, 2017, pp. 141-2). Since the given quantities traded are the same for Portugal and England, we may compare the unit labour coefficients without knowing their values; Portugal has a comparative advantage in wine production if and only if:

$$\frac{l_w^P}{l_c^P} < \frac{l_w^E}{l_c^E} \Longleftrightarrow \frac{\left(\frac{80}{Q_w}\right)}{\left(\frac{90}{Q_c}\right)} < \frac{\left(\frac{120}{Q_w}\right)}{\left(\frac{100}{Q_c}\right)} \Longleftrightarrow \frac{80}{90} < \frac{120}{100}$$

The last inequality is given by the numbers in Ricardo's example. Hence, with given quantities traded, comparative advantage can be directly defined by the unit labour coefficients (see also Bhering & Serrano, 2019).

[11] As argued in section 2, Ricardo and the classics were interested in the study of 'natural prices', as opposed to 'market prices'. Natural prices are equivalent to what we have been calling costs of production.

[12] It is still possible for England to produce some corn if it has lands of better quality that can produce it at a lower cost than France. Thus, the farmers that cannot compete are those working with marginal land. If constant

returns to scale are not assumed, more information is required to make assertions regarding farmers in other lands (see Gehrke, 2015).

[13] Gehrke (2015) provides a critical evaluation of Ruffin's (2002) reconstruction of Ricardo.

[14] Graham (1948) argues that these extremes are the only stable positions.

[15] We would like to thank an anonymous referee for suggesting the resemblance between our approach and the chain of comparative advantages.