Capital Accumulation and the Direction of Trade in a Ricardian Two-Country Model of International Trade

Giuseppe Freni, Neri Salvadori and Rodolfo Signorino[1]

Abstract: We study an implication of the Ricardian theory of differential extensive rent in a free trade regime. To this effect we develop a Ricardian two country two commodity open economy model. We assume that, unlike labour, land is heterogeneous both within and across countries and that the ratio of high to low quality land is different among the trading countries. By means of a numerical example we show that as the process of worldwide capital accumulation proceeds an industrial country may find it convenient to increase its domestic corn production and even reverse completely the pattern of its imports and exports.

Keywords: capital accumulation, international trade, structural change, Ricardian economics, Heckscher-Ohlin model

***JEL* Classification:** B12, B27

Introduction

Salvadori and Signorino (2016 and 2017a) develop an open economy variant of Pasinetti's 1960 mathematical formulation of Ricardo's economics. In the first paper they demonstrate that endogenous growth may obtain in a small open economy characterised by given international commodity prices. In the second paper they focus on a world economy scenario in which international commodity prices are determined by the interplay of supply and demand amongst several small trading countries. The main outcome of the latter paper is that, given technology, all trading countries eventually reach the stationary state. Freni, Salvadori and Signorino (2018) analyse the issue of structural change induced by international trade in Malthus (1817 and 1826), Torrens (1815) and Ricardo (1822). They show that all these authors were aware that free international trade triggers a process of structural change within the trading countries. Yet, Malthus apparently framed his own analysis *as if* structural change were a process going on *only* within agricultural and corn-exporting countries. By contrast, Torrens and Ricardo addressed the phenomenon of structural change on the assumption that the latter was a symmetrical process at work *both* in agricultural *and* manufacturing countries. Differences in their policy proposals (Malthus's endorsement versus Torrens's and Ricardo's rejection of food protectionism) are traced

[1] University of Naples "Parthenope", University of Pisa and University of Palermo, Italy, respectively. Corresponding author: Neri Salvadori, Dipartimento di Economia e Management, Università di Pisa, via Cosimo Ridolfi 10, 56124, Pisa – Italy; e-mail: neri.salvadori@unipi.it

back to differences in their analysis of the international dimension of the processes of structural change stimulated by free corn trade. As concerns Ricardo, he argued that, in the long-run free trade equilibrium, some of those less fertile plots of British land that initially would be abandoned, because of the free imports of cheap foreign corn, would be put back under tillage. Accordingly, in the absence of restrictive Corn Laws, Great Britain would have imported much less foreign corn than British protectionists dreaded. Yet, Ricardo did not analyse the whole of the analytical consequences deriving from the fact that differences in land fertility do not exist only within a given country but also among the various trading countries. In particular, he failed to consider the case that Great Britain could even become a corn-exporting country at a later stage of the worldwide process of capital accumulation.

In this paper we study an as-yet unexplored implication of the Ricardian theory of differential extensive rent in a free trade regime. Our main result may be summarized as follows. At the time free trade is universally established among the various countries, it may be convenient for a given country to feed its own population mainly by importing foreign food and paying its food imports by its exports of industrial commodities. Yet, at a later stage of worldwide capital accumulation, the very same country may find it convenient to reverse completely the pattern of its imports and exports. To substantiate our claim, in section 3 we develop an instance of a Ricardian world economy model in which there are two trading countries (*A* and *B*) and two commodities (one agricultural and one industrial). Only labour is required in the production of the industrial commodity. By contrast, the agricultural commodity is produced by means of labour and land. While labour is homogeneous within a given country and across countries, land is heterogeneous both within and across countries. Key to our results is the assumption that, although agricultural technology is the same in both countries, the production functions for the agricultural commodity may be different because of the different endowments of land qualities between the two countries.

The issue concerning the construction of the production function for the agricultural sector when extensive and intensive margins are involved has already been raised within a debate in this Journal (Kurz and Salvadori 1992 and 1998, Morishima 1996; we briefly recall this debate in section 2). From the perspective of this paper, the main outcome of this debate is the following. In the extensive margin case a production function may be built and it depends *not only* on the available technological processes but *also* on the amount of the different qualities of land. In this paper we provide an example to show the details of this case.

Finally, our paper contributes to another strand of literature. A scenario in which worldwide capital accumulation reverses the pattern of international specialization among trading countries

questions the interpretation of the open Ricardo-Pasinetti model as a variant of the textbook 2x2x2 Heckscher-Ohlin model. Findlay (1974) advanced this interpretation by stating that in the Ricardian system "the pattern of specialization would depend upon differences in any or all of the following: the technology for producing the two commodities, the natural wage-rate, the composition of landlord demand and the proportions of labour (and hence circulating capital) to land" and that "if all the other differences except the last were excluded by assumption the Ricardo-Pasinetti system would also lead to a factor proportions theory of comparative advantage" (Findlay 1974, p. 11). Burgstaller (1996, 2005) and Uchiyama (2005) have drawn further implications of the implicit assumption made by Findlay (1974) that two countries that share *the same technology* have *the same production functions*. In particular, Uchiyama (2005) pointed out that, in a Ricardian system with a single quality of land, the long-run direction of trade is determined by the difference in the factor proportions prevailing at the time the two countries adopt free trade. As for the analogous two-sector dynamic Heckscher-Ohlin model (see *e.g.* Chen 1992, Bajona and Kehoe 2010), this implies that a country that initially imports a given commodity can never become a country that exports the same commodity. When more than one quality of land is considered, this result ceases to hold since two countries sharing the same technology may have different production functions.

The example developed in this paper shows that when there are more factors of production than commodities, as in our version of the Pasinetti-Ricardo model or as in the Jones-Samuelson specific-factors model, differences in factor endowments mimic differences in technology and, therefore, one cannot expect that the basic propositions of the textbook Heckscher-Ohlin model continue to hold unaltered.

2. The Kurz-Salvadori-Morishima debate on the production function for corn in the extensive margin case

In his monograph on Ricardo's economics, Morishima (1989) criticized Pasinetti's presentation of the Ricardian system on several points. One of them concerns the theory of rent and the production function for corn used by Pasinetti (1960):

> Pasinetti does not classify various sorts of land according to their quality. He instead has only one aggregate production function for agriculture as a whole, with the logical consequence that he is unable to explain the rent of a land as the surplus which it yields ... His theory of rent, accordingly, can hardly be a theory of differential rent, though it may be called a marginal productivity theory of rent. (Morishima 1989, pp. 50-1; see also p. 38)

Morishima maintained that "there is no simple aggregate production function for agriculture" (p. 103), if land is heterogeneous in quality. The solution he suggested was a separate production

function for each quality of land. This claim, however, cannot be sustained. Indeed Samuelson (1959, pp. 28-32) produced an early discussion of the existence of a production function in the heterogeneous land case and Kurz and Salvadori (1992) clarified that, starting from a given set of technical processes describing the available technology and the existing amounts of the different qualities of land, a production function for agriculture as a whole can be constructed, given the simplifying assumptions used by Pasinetti. Moreover, both extensive and intensive rent can be analysed.[2] In his reply Morishima (1996, p. 94) acknowledged that

> [Kurz and Salvadori] derive the 'production function for agriculture as a whole' $X = F(N)$, where X is the total production of agriculture and N the total employment of agricultural labour. It is then evident, that it should be written, more precisely, as $X = F(N, h)$, where h is the vector of the available amounts of various qualities of land.

Differences concerning the definition of the notion of "production function" probably lie at the root of the controversy between Morishima, on the one side, and Kurz and Salvadori, on the other side. An educated guess is that, while the former gave to the concept of the "production function" also the property of being a purely technological construction, the latter, following Pasinetti, considered such a concept simply as a functional relationship having the set of potential amounts of labour employed in agriculture as its domain and the set of potential amounts of corn produced as its codomain. Accordingly, it was quite natural for Morishima to maintain that such a function cannot be constructed and for Pasinetti, Kurz and Salvadori that it can be constructed. Be what it may, both Morishima and Kurz and Salvadori agreed that the functional relationship mentioned above can actually be constructed. In this paper we refer to such functional relationship as the production function for the agricultural sector.

It is worth emphasizing that a similar argument applies to the textbook 2x2x2 Heckscher-Ohlin model. Since two different qualities of land are two different factors of production, at least three factors are required to take account of extensive rent in a model with labour and heterogeneous land. This means that the assumptions of the textbook Heckscher-Ohlin model are much more restrictive than usually thought. In particular, extensive rent cannot be considered within its domain.

3. The example

In this section, we present an instance of a Ricardian world economy, as modelled in Salvadori and Signorino (2016 and 2017a; see also 2017b). Salvadori and Signorino have argued, without a

[2] Kurz and Salvadori (1992) made use of some of the material contained in the *Laurea* thesis defended by Giuseppe Freni at the University of Catania (1987) and later published in Italian (Freni 1991). See also Freni (2015).

formal proof, that a given country's dynamics towards the steady state may be non-linear. In particular, a country that exports the agricultural commodity may become a country that exports the industrial commodity and vice versa. In this paper we provide a definitive proof under the form of an algebraic example. The relevance of this example for other strands of literature has been illustrated in the Introduction.

Let us consider a world economy in which there are two countries, *A* and *B*, two sectors, agriculture and manufactures, and three social classes, landlords, capitalists, and workers. Following Pasinetti (1960), we call 'corn' and 'gold' the two commodities produced. Corn, the agricultural commodity, indexed as commodity *1*, is produced by means of a diminishing returns technology that employs labour and land. Gold, the industrial commodity, indexed as commodity *2*, is produced by means of a constant returns technology that employs only labour. (We acknowledge that calling 'gold' the industrial commodity is somewhat unfortunate, but we prefer to stick to Pasinetti's original nomenclature, though we remind our readers that 'gold' is merely a label for the industrial commodity.) Workers and capitalists spend the whole of their income, namely wages and profits, respectively, on corn; while landlords spend the whole of their income, namely rents, on gold. Capitalists buy corn both for capital-accumulation and personal consumption purposes (different consumption patterns on the part of capitalists would make the analysis more complex but would not significantly change the results). In this model there is no capital good proper. Hence, 'capital' is simply the amount of corn capitalists have to anticipate, since production takes time, to feed their workers in both sectors. Universal free competition and Say's Law of Markets hold.

We assume that technology is the same in both countries. As clarified in the previous section, the assumption of common technology does *not* entail that both production functions (for corn and gold) are also the same in the two countries. We assume that there are two different qualities of land: high-quality and low-quality (*h* and *l*). Country *A* has both qualities of land; whereas country *B* has only high-quality land. The latter assumption is done only for the sake of simplicity: what really matters is that the ratio of high to low quality land in country *A* is different than the ratio of high to low quality land in country *B*. As the unit of measure of high quality land we choose the amount of such land available in country *A*; in country *B* there is an amount *L* of high quality land.

By contrast, only labour is required to produce gold; labour is homogeneous in each and any country. Therefore, the production functions for gold are the same in both countries.

In the light of our assumptions on technology and each country's land endowment, we may formalize the production functions for the two commodities as follows.

As concerns gold production, the two production functions in the two countries are:

$$X_{2A} = aN_{A2}$$

$$X_{2B} = aN_{B2}$$

where X_{2J} is the quantity of gold produced in country J ($J = A, B$); N_{J2} is the number of workers employed in gold production in country J; $a > 0$ is a constant because of constant returns in gold production.

As concerns corn production, we first remark that a description of technology in terms of production processes as that adopted by Kurz and Salvadori (1992) would certainly be preferable, but it would also be very burdensome to manage. It is convenient, instead, to consider that on each quality of land we have a production function described by a simple formula (such as a Cobb-Douglas or a parabola) and combine them. This means that intensive rent is always present, whereas extensive rent appears only when a new quality of land is cultivated. The two production functions for corn in the two countries are:

$$X_{1A}\left(N_{A1}\right) = \max\left\{N_{A1h}^{m} + \alpha N_{A1l} - \beta N_{A1l}^{2} : N_{A1h} + N_{A1l} = N_{A1},\, N_{A1h} \geq 0,\, N_{A1l} \geq 0\right\}$$

$$X_{1B}\left(N_{B1}\right) = L^{1-m} N_{B1}^{m}$$

where X_{1J} is the quantity of corn produced in country J ($J = A, B$); N_{J1} is the number of workers employed in the corn production in country J; $0 < m < 1$, $\alpha > 0$, $\beta > 0$ are constants and the inequalities result from diminishing returns in corn production. Note that necessarily $N_{A1l} \leq \alpha/2\beta$.

The production function for corn in country A can be written, in a more explicit form, as

$$X_{1A}\left(N_{A1}\right) = \begin{cases} N_{A1}^{m} & \text{if} \quad 0 \leq N_{A1} \leq \left(\dfrac{m}{\alpha}\right)^{\frac{1}{1-m}} \\ g\left(N_{A1}\right) + \alpha\left[N_{A1} - g\left(N_{A1}\right)\right] - \beta\left[N_{A1} - g\left(N_{A1}\right)\right]^{2} & \text{if} \quad N_{A1} \geq \left(\dfrac{m}{\alpha}\right)^{\frac{1}{1-m}} \end{cases}$$

where $N_{A1h} = g\left(N_{A1}\right)$ is equivalent to the equation

$$\frac{\alpha - mN_{A1h}^{m-1}}{2\beta} + N_{A1h} = N_{A1}$$

Since the left-hand side of this equation is an increasing function in N_{A1h}, function $g\left(N_{A1}\right)$ is well defined.

The above equations conclude the description of technology in the two countries. The main analytical element to be stressed is that, even though both countries share the same agricultural technology, their production functions for corn turn out to be different because their high to low quality land ratio is different and the actual employment of the various qualities of land in corn production is different. Let us consider two alternative situations. If only high-quality land is employed in each country, that is, if low-quality land is left idle in country *A*, then the production functions for corn are the same in both countries. This is so if $0 \leq N_{A1} \leq \left(m/\alpha\right)^{\frac{1}{1-m}}$. By contrast, if $N_{A1} > \left(m/\alpha\right)^{\frac{1}{1-m}}$, then the low-quality land is cultivated in country *A* and the production functions for corn are inevitably different.

We may now derive the main results of our model. At first a strict protectionist legislation prevails in both countries and, therefore, international trade is outlawed. Subsequently, at time t_0, protectionist legislation is repealed worldwide and both countries choose to open their economies to international trade. Moreover, at time t_0 the available amounts of labour (and therefore capital) in the two countries are such

- land of low quality is cultivated in country *A* in the no-trade regime;
- land of low quality is not cultivated in country *A* in the free trade regime: it is more advantageous to import foreign corn than to produce corn domestically on the low-quality land;
- both countries produce gold in the free trade regime even if country *A* exports it and country *B* imports it:

If the last condition is not met, the rates of profit would be different in the two countries (see Salvadori and Signorino, 2017a and 2017b). This would not be an awkward problem, but, if the rates of profit are different in the two countries, we need to introduce further assumptions on determination of the rates of growth in the two countries. In the transition from the no-trade to the free trade regime country *A* has reduced its production of corn whereas country *B* has increased it (vice versa for production of gold, rates of profit and rates of growth).

In the free-trade scenario at time t_0 the variables N_{A1}, N_{A2}, N_{B1}, N_{B2}, p_2, r_A, and r_B (p_2 is the price of gold in terms of corn, common to both countries, r_A is the rate of profit in country *A*, and r_B is the rate of profit in country *B*) are determined by the following equations:

$$LN_{A1} = N_{B1} \quad (2)$$

$$(1+L)(1-m)N_{A1}^{m} = ap_2\left(N_{A2} + N_{B2}\right) \quad (3)$$

$$N_{A2} = N_A - N_{A1} \qquad (4)$$

$$N_{B2} = N_B - N_{B1} \qquad (5)$$

$$\bar{x}\left(1+r_A\right) = \bar{x}\left(1+r_B\right) = mN_{A1}^{m-1} = ap_2 \quad (6)$$

where $\bar{x}$, the rate of wages in terms of corn, is the same in both countries. Equations (2) and (6) hold because the rate of profit is uniform among countries and among sectors; equation (3) holds because the value of gold produced equals the overall amount of rents earned by landlords in both countries; equations (4) and (5) are straightforward.

Since the rate of profit is uniform among countries, the rate of growth of both countries is the same: $n_A = n_B = sr_A = sr_B$, where s is the saving ratio of capitalists, assumed to be uniform among countries and constant.

Obviously, as the rate of profit is decreasing over time, the rate of growth is likewise decreasing, but both rates are positive before the stationary state obtains. By a suitable choice of the parameters we reach time t_1 in which $N_{A1} = \left(m/\alpha\right)^{\frac{1}{1-m}}$. A further increase of labour implies that low quality land is cultivated in country A. This means that in proportion, country A produces more corn than country B. This in turn implies that country B increases its production of gold more quickly than country A. Eventually, patterns of international trade are reversed at time $t_2 > t_1$: country A starts exporting corn and country B starts exporting gold. More precisely, for $t > t_1$ variables N_{A1h}, N_{A1l}, N_{A1}, N_{A2}, N_{B1}, N_{B2}, p_2, r_A, and r_B are determined by the following equations:

$$LN_{A1h} = N_{B1} \quad (2^*)$$

$$N_{A1h} + N_{A1l} = N_{A1} \qquad (7)$$

$$\left(1+L\right)\left(1-m\right)N_{A1h}^m + \beta N_{A1l}^2 = ap_2\left(N_{A2} + N_{B2}\right) \qquad (3^*)$$

$$N_{A2} = N_A - N_{A1} \qquad (4)$$

$$N_{B2} = N_B - N_{B1} \qquad (5)$$

$$\bar{x}\left(1+r_A\right) = \bar{x}\left(1+r_B\right) = mN_{A1h}^{m-1} = \alpha - 2\beta N_{A1l} = ap_2 \quad (6^*)$$

Hence, for $t_0 \le t \le t_1$ workers are employed in the agricultural sector in the proportion $1 : L$ in the two countries. Since in country A the working population is in proportion larger than in country B, A produces more gold in proportion than B and therefore it exports gold. By contrast, for $t > t_1$ the working population employed in agriculture is in proportion larger in country A than in country

B and the difference is increasing over time. Consequently, even if the working population of country A is still larger than the working population of country B, now country B needs to produce more gold and eventually to export it.

By means of the simple diagram of Figure 1 it is possible to describe the example. On the horizontal axis there is labour in country B, which multiplied by $\bar{x}$ gives the capital in country B. On the vertical axis there is labour in country A, which multiplied by $\bar{x}$ gives the capital in country A. Both countries produce corn, but it is not necessarily the case that both countries produce gold. The surface in which both countries produce gold is that between the blue line and the red line. In this region both countries have the same rate of profit and therefore the same rate of growth. Consequently, within this region N_A and N_B grow in proportion as on the black line. The green line is the locus of all the pairs (N_B, N_A) in which the gold produced in each country is exactly equal in value to the rents obtained in that country, so that no trade takes place between the two countries. Hence, any time the black line crosses the green line there is a switch from autarky to free trade. The light blue decreasing line represents all pairs (N_B, N_A) in which the economy is stationary. The purple decreasing line represents all pairs (N_B, N_A) in which in the open economy $N_{A1h} = N_{A1} = (m/\alpha)^{\frac{1}{1-m}}$: below that line the land of low quality is left idle in country A whereas above that line the land of low quality is cultivated in country A.

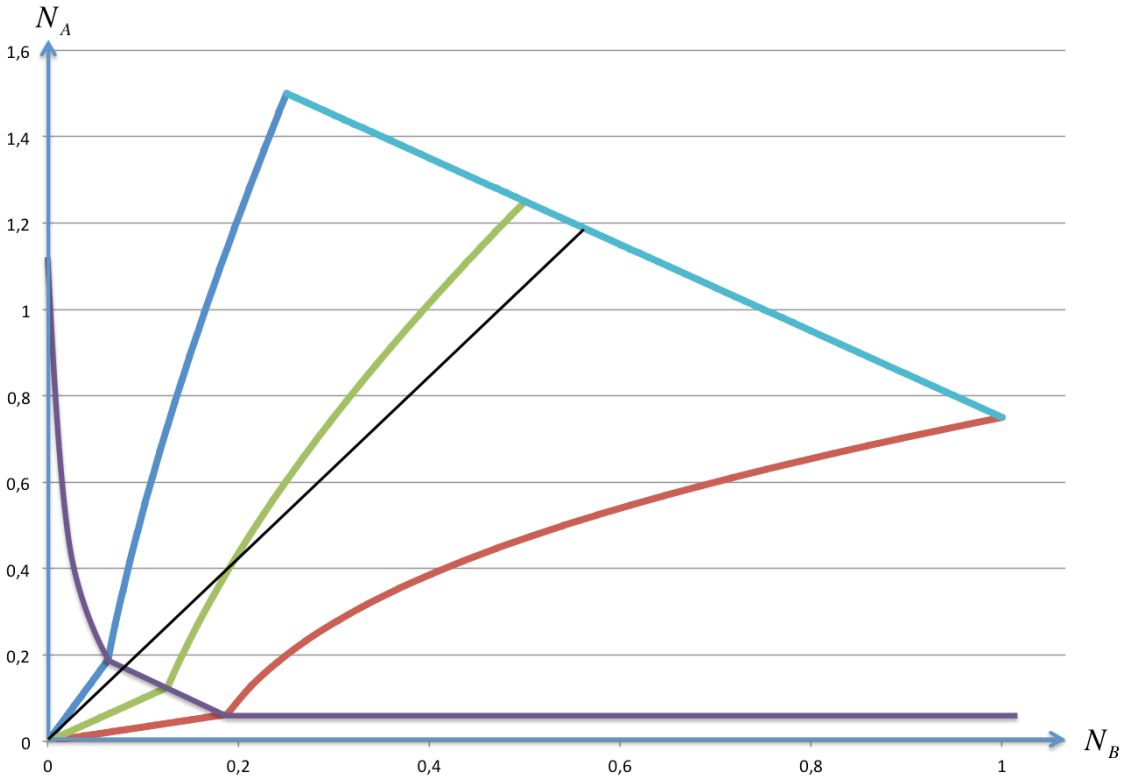

Figure 1. The example when $L=1,\ m=1/2,\ \alpha=2,\ \beta=1/2$

The example we refer to describes the following international trade dynamics: in country *A*

i) low-quality land is cultivated when protectionist legislation forbids foreign corn imports,

ii) low-quality land is left uncultivated as soon as protectionist legislation is repealed and foreign corn imports are freely allowed,

iii) low-quality land is cultivated again as a consequence of capital accumulation.

To construct our example, we make two choices. First, (as in Figure 1) we choose the slope of the black line in such a way that the black line cuts the purple line on the left of the green line and cuts the light blue line on the right of the green line. Second, at time t_0, when protectionism is repealed, we choose the amount of labour in the two countries at a point on the black line below the purple line, but so close to it that in the no-trade regime (and therefore with a lower rate of profit in country *A*) the low-quality land is cultivated. Hence, the fact that in a free-trade regime low-quality land is left uncultivated in country *A* does not imply that country *A*'s agricultural sector is doomed to *irreversible* stagnation. Indeed, the world economy's dynamics pushes the economies *A* and *B* along the black line until the green line is crossed and therefore not only is the low-quality land cultivated again, but the other country also becomes an economy that exports the industrial commodity.

Two remarks are in order. First, assume that a third, very low, quality of land exists. This lowest quality of land is present in country *B*, but not in country *A*. In this case a further time t_3 can be found so that country *A* can become a gold-exporting country once again for some $t > t_3$. (Country *A* may also become a gold-exporting country once again if the black line is chosen in such a way to cut the green line twice.) Second, what matters is not that a quality of land is available in one country and unavailable in another, but that the proportions of the various qualities of land are different among trading countries. In the case in which both countries have the same qualities of land in the same proportion the green line becomes a straight line: a gold-exporting country and a corn-exporting country are such for ever. This is obviously only a sufficient condition and a gold-exporting country and a corn-exporting country are such for ever also if the black line is always below the green line (and above the red line) or above the green line (and below the blue line).

4. Final remarks

As the debate among Morishima, on the one hand, and Kurz and Salvadori on the other hand, has clarified, the assumption of common agricultural technology among trading countries is not a

sufficient condition for them to have the same production functions for the agricultural commodity. In this paper we ~~have~~ started from this result and analysed a Ricardian open economy model with two commodities, an industrial one, 'gold', and an agricultural one, 'corn'. While the only input required in the production of 'gold' is labour and labour is homogeneous within a given country and among countries, 'corn' is produced by means of labour *and* land. Unlike labour, land is not homogeneous either within a given country or among countries. We have analysed, by means of a simple numerical example, the case in which there is no uniform ratio of land of different qualities among the trading countries. We have shown that while it is true that some plots of low-quality land previously under tillage are left uncultivated as soon as free foreign corn imports are allowed into a manufacturing country, subsequently, those plots of low-quality land may be cultivated again in a free trade regime due to capital accumulation. Moreover, we have shown that when different qualities of land are considered, the standard prediction of the 2x2x2 Heckscher-Ohlin model concerning the export status of a country − a corn-exporting (gold-exporting country) country never exports gold (corn) − holds only if the high to low quality land ratio is the same in the two trading countries.

In a letter to Malthus (dated November 9, 1819), Ricardo wrote that "With respect to my calculations, I have only this to say in defence of them, that I never brought them forward for any practical use, but merely to elucidate a principle" (*Works* VIII, p. 130).[3] In the wake of Ricardo, our numerical example has been built to "elucidate a principle" and vindicate one of the arguments raised by Ricardo in his 1822 pamphlet, *On Protection to Agriculture*, against the British supporters of food protectionism. We refer to Ricardo's claim that, though at the first opening of British ports to cheap foreign corn, British low-quality plots of land will surely be left uncultivated, British domestic agriculture is not doomed to *permanent* and *irreversible* stagnation in the long-run free trade equilibrium. To help the intuition of historically minded readers, think to Great Britain in the years of the Napoleonic Continental blockade (when domestic corn production was imposed by war contingency) and after Napoleon's defeat at Waterloo (when free corn trade was again an available policy option) as our country *A*. By the same token, France, or Germany or Poland or any other agricultural and corn-exporting country in the 1810s - early 1820s is a fitting candidate to the role of our country *B*. Yet, our example allows us to go further than Ricardo ever did and contemplate the case of a full reversal of the export status of a given country. In a nutshell, assume that both countries *A* and *B* have a large territory, but *A* is endowed with only a limited extension of high-quality land, the rest of its land being of low-quality; while the opposite situation holds in *B*. As

[3] Ricardo excelled in the art of devising numerical examples to help his readers' grasp of the economic principle under scrutiny: see Kurz (2015).

soon as free trade is established between these two countries, given the international prices of the two commodities, it is convenient for *A* to cultivate only its high-quality plots of land and feed its population mainly by importing corn from *B*. Corn imports from *B* are obviously paid by the exports of gold to *B*. Accordingly, at first, *A* is a typical industrial and corn-importing country; while *B* is a typical agricultural and gold-importing country. As worldwide capital accumulation goes on and both countries' population increases, a time arrives when, in order to feed the world population, the cultivation of low-quality land is required. When this happens, world production of corn increases more rapidly in that country endowed with the larger extension of low-quality land, *i.e. A*. This effect may be so strong that *A* may even become a corn-exporting country. Obviously, such a result cannot hold if the two qualities of land are uniformly distributed among the two trading countries, *i.e.* if *A* and *B* have the same high to low quality land ratio.

References

Bajona, Claustre and Timothy J. Kehoe (2010). Trade, Growth and Convergence in a Dynamic Heckscher-Ohlin Model. *Review of Economic Dynamics,* **13** (3): 487 – 513.

Burgstaller, André (1986). Unifying Ricardo's Theory of Growth and Comparative Advantage. *Economica*, **53** (212): 467 – 481.

Burgstaller, André (2005). Factor Proportions and Ricardian Comparative Advantage: Thoughts on Uchiyama. *Economica*, **72** (288): 719 – 723.

Chen, Zhiqi (1992). Long-Run Equilibria in a Dynamic Heckscher-Ohlin Model. *The Canadian Journal of Economics*, **25** (4): 923 – 943.

Findlay, Ronald (1974). Relative Prices, Growth and Trade in a Simple Ricardian System. *Economica*, **41** (161): 1 – 13.

Freni, Giuseppe (1991). Capitale tecnico nei modelli dinamici ricardiani. *Studi Economici*, **44**: 141 – 59.

Freni, Giuseppe (2015). Mathematical Formulations of Ricardian Economics. In Kurz, Heinz D. and Neri Salvadori (eds). *The Elgar Companion to David Ricardo*. Cheltenham (UK) and Northampton, MA (USA): Edward Elgar, pp. 299 – 309.

Freni, Giuseppe, Neri Salvadori and Rodolfo Signorino (2018). Back to Agriculture? Malthus (1817 and 1826), Torrens (1815) and Ricardo (1822) on International Trade and Structural Change. mimeo (resubmitted to *History of Political Economy*).

Kurz, Heinz D. (2015). David Ricardo: on the art of "elucidating economic principles" in the face of a "labyrinth of difficulties". *European Journal of the History of Economic Thought*, **22** (5): 1 – 34.

Kurz, Heinz D. and Neri Salvadori (1992). Morishima on Ricardo: a review article. *Cambridge Journal of Economics*, **16** (2): 227 – 247.

Kurz, Heinz D. and Neri Salvadori (1998). Morishima on Ricardo: a rejoinder. *Cambridge Journal of Economics*, **22** (2): 227 – 239.

Morishima, Michio (1989). *Ricardo's Economics. A General Equilibrium Theory of Distribution and Growth*. Cambridge: Cambridge University Press.

Morishima, Michio (1996). Morishima on Ricardo: two replies. *Cambridge Journal of Economics*, **20** (1): 91 – 109.

Pasinetti, Luigi Lodovico (1960). A Mathematical Formulation of the Ricardian System. *Review of Economic Studies*, **27** (2): 78 – 98.

Ricardo, David (1951 – 1973). *The Works and Correspondence of David Ricardo*, edited by Piero Sraffa with the collaboration of Maurice H. Dobb. 11 Vols. Cambridge: Cambridge University Press, in the text referred to as *Works*, vol. no., page no.

Salvadori, Neri and Rodolfo Signorino (2016). From Stationary State to Endogenous Growth: International trade in the mathematical formulation of the Ricardian system. *Cambridge Journal of Economics*, **40** (3): 895 − 912.

Salvadori, Neri and Rodolfo Signorino (2017a). From Endogenous Growth to the Stationary State: The world economy in the mathematical formulation of the Ricardian system. *The European Journal of the History of Economic Thought*, **24** (3): 507 – 527.

Salvadori, Neri and Rodolfo Signorino (2017b). The Ricardian System. A Graphical Exposition. In Masatomi Fujimoto, Shigeyoshi Senga and Taichi Tabuchi (eds). *Ricardo and International Trade*. London and New York: Routledge, pp. 60 – 81.

Samuelson, Paul Anthony (1959). A Modern Treatment of the Ricardian Economy: I. The Pricing of Goods and of Labor and Land Services; II. Capital and Interest Aspects of the Pricing Process. *Quarterly Journal of Economics*, **73** (1): 1 – 35 and 217 – 31.

Uchiyama, Takashi (2005). The Validity of the Long-Run Heckscher-Ohlin Theorem in the Ricardian System. *Economica*, **72** (288): 705 – 718.