TEXTO PARA DISCUSSÃO

No. 526

The Ricardo Puzzle

Francisco L. Lopes

The Ricardo Puzzle
Francisco L. Lopes

Abstract

This paper tackles the puzzle of Ricardo's stubborn commitment to a labor theory of value that he himself saw as no more than an approximation to reality and which was heavily opposed by Malthus, his most respected contemporary. We show it is wrong to think that the theory had no analytical use. Quite to the contrary, it was the only defence Ricardo could find against Malthus' destructive criticism, which introduced an unacceptable degree of indetermination in his theory of profits. By adopting the labor theory of value, Ricardo drastically simplified the method of proof of his main proposition, which otherwise seemed to present unsurmountable analytical difficulties. The irony is that the proposition was correct, quite independently of the labor theory of value, but Ricardo was just unable to prove it.

1- Introduction.

Over the last two centuries many economists spent time interpreting Ricardo, in what often turned out to be a difficult and tricky endeavor. In a recent survey of the literature, Peach (1993, p. 143) concludes that the theoretical core of Ricardo's thinking by the end of his life included the labor theory of value, the natural wage analysis, progressively diminishing agricultural returns (and the related theory of differential rent), and the law of markets. The puzzle is why his theoretical core had to include a labor theory of value.

In the third edition of the *Principles*[1], Ricardo explicitly acknowledged that the labor theory of value is correct only for an economy in which the turnover of capital is exactly the same for all sectors.[2] Notwithstanding, and in spite of strong criticism from Malthus[3], he always maintained that the theory is a "tolerably accurate" approximation to reality even tough in

---

[1] All references to the *Principles of Political Economy and Taxation* are from the Piero Sraffa edition. References to other volumes of the complete works of Ricardo edited by Sraffa will be given as "Works" followed by the number of the volume, in latin algarithms, and the page number.

[2] *Principles*, chapter 1, sections IV and V. The literature shows divergent opinions on whether there has been a softening of Ricardo's position on the labor theory of value between the first and third editions of the *Principles* as suggested by J. Hollander (1904), Cannan (1929), Stigler (1965) and others. Sraffa (1951) and Peach (1993) disagree. Ricardo himself seems to corroborate Sraffa's position by stating in his unfinished paper on "Absolute Value and Exchange Value (written in the last few weeks of his life) that:

"...it cannot have escaped the attention of the reader that for the measure which I have proposed I have not claimed the character of perfection – I have now and at all other times acknowledged that it was not under every circumstance a measure against which no objections could be urged; on the contrary when I first proposed it I shewed that there were many cases of exception where it could not be correctly denominated an accurate measure of value..." (*Works*, IV, 176).

[3] Peach (1993) notes that:

"Malthus alone had recognised the faults in Ricardo's exposition, and he exposed them with consummate skill. If there was ever a time when Ricardo might have abandoned his labour theory, with good cause, it was in the wake of Malthus's criticisms" (p. 238).

no way essential to his conclusions[4]. In a famous letter to McCulloch he even stated that his theory of distribution was independent of his theory of value[5].

How to explain this stubborn commitment of Ricardo to a labor theory of value that he himself saw as no more than an approximation to reality and which was heavily opposed by Malthus, his most respected contemporary? If the theory was really not necessary for his conclusions and produced complications and controversies, why did he cling almost obsessively to it?

Myrdal (1955) has argued that the only possible explanation for Ricardo's narrow-minded position on value theory was his philosophical commitment to the notion that property has its natural justification in the labor applied by man on an object. In what other way would it be possible to explain this attachment to an "unsupported hypothesis which leads to insuperable difficulties without being of any analytical use" (p. 70). More recently Niehans (1990) was similarly puzzled by Ricardo's lifelong attachment to the theory and his related search for an invariable measure of value. "The reason", he writes, "is difficult to understand because the problem, except for special and artificial cases, is not only insoluble but also abstruse and devoid of substantive economic meaning" (p. 93).

There has been a long tradition of dismissing the puzzle by stating that Ricardo had only an "empirical" labor theory of value.[6] Peach (1993, p. 31), however, believes that "the claim that the labour theory appealed to Ricardo *because* he thought it was a good empirical approximation is an inversion of the truth.…The labour theory had supplied Ricardo with a graphic means of demonstrating that worsened conditions of agricultural production would 'permanently' depress general profitability".

This paper elaborates on Peach's insight, using simple models to make it accessible to a modern economist that is not a Ricardo specialist. Our goal is to show that it is indeed wrong to say that the labor theory of value was of no analytical use to Ricardo. Quite to the contrary, it was a very convenient way to protect the line of argument of the *Principles* from the criticism that had been used by Malthus against the *Essay on the Influence of a Low Price of Corn on the Profits of Stock* (henceforth *Essay on Profits*). By adopting the labor theory of value as a torelably accurate approximation, Ricardo drastically simplified the method of proof of the central theorem of the *Essay on Profits*, which otherwise seemed to present unsourmountable analytical difficulties. The labor theory of value was the only defence he could find against Malthus' destructive criticism, a criticism which introducced

---

[4] Ricardo wrote in his *Notes on Malthus*:
    "Mr Malthus shews that in fact the exchangeable value of commodities is not exactly proportioned to the quantity of labour which has been employed on them, which I not only admit now, but have never denied. He proves then that the quantity of labour is not a perfect measure of value; but what are its deviations from a perfect measure ...?...if they are slight, as I contend they are, then we are still in possession of a measure tolerably accurate, and in my opinion more nearly approximating to truth than any that has yet been proposed..."(*Works*, II, 66).
[5] "After all, the great questions of Rent, Wages and Profits must be explained by the proportions in which the whole produce is divided between landlords, capitalists and labourers, and which are not essentially connected with the doctrine of value"(*Works*, VII, 194).
[6] See, for example, Stigler (1958), Barkai (1967), Wilson and Pate (1968), S. Hollander (1979).

an unnaceptable degree of indetermination in his theory of profits, shattering the foundations of his whole theoretical construction[7].

But this paper is not just concerned with Ricardo's analytical difficulties and on how he resorted to the labor theory of value to overcome them. We also want to find out who after all had the winning hand in the Ricardo-Malthus dispute.

We start in the following section with a simple statement of the so-called "corn model" which is a handy way to introduced Ricardo's chief theoretical proposition. Section 3 shows how the controversy with Malthus can be understood as resulting from a quite realistic expansion of the model, and section 4 gives the exact solution for this expanded model. At this point we discover Ricardo was right after all, though he seemed unable to prove it. Section 5 shows how the labor theory of value comes into scene as a method of proof, therefore solving the puzzle.

2. The Theory of Profit in the Corn Model.

In early 1815 there was much public concern and intense parliamentary debate in England on whether a new law should be enacted to protect local agriculture from the foreign competition that would necessarily come from the reestablishment of peace in Europe.[8] Among the many pamphlets on the issue published at the time was Ricardo's *Essay on Profits*. His argument was based on the notion that the rate of profit for the economy as a whole was regulated by the rate of profit in agriculture and that this was bound to decline as agricultural production increased. This point had been argued in the Ricardo-Malthus correspondence since 1813 and was already clearly formulated by March 1814 when he wrote to Trower:

> "...it is the profits of the farmer which regulate the profits of all other trades, and as the profits of the farmer must necessarily decrease with every augmentation of Capital employed on the land, provided no improvements be at the same time made in husbandry, all other profits must diminish and therefore the rate of interest must fall" (*Works*, IV, 3).

The *Essay on Profits* derived from this theorem the practical implication that any additional restriction to the importation of cereals would only benefit the landlords, while with free importation all other classes, including farmers, would gain:

---

[7] From his letters to McCulloch of December 1819 and May and June 1820 we see that Ricardo was deeply shaken by Malthus's criticism. See Peach (1993, p. 207).

[8] This was one of the so-called Corn Laws. It seems that the 1815 law, which prohibted the importation of wheat as long as the domestic price remained bellow 80 shillings per quarter, was not very popular. There was street rioting in London in the 6, 7 and 8th of March but the law passed in the House of Commons on March, 10th. Ricardo's interesting reaction in a letter to Malthus on March 9th shows his deep personal involvement with the issue:

> "The opposition to the bill is more formidable than I expected, but they appear so determined in the House of Commons that I suppose it will finally pass. I regret that the people should have proceeded to acts of riot and outrage. I am too much a friend to good order to wish to succeed through such means, besides that I am persuaded that they hurt rather then promote the object which they and I have in view" (*Works*, VI, 180).

> "after the exchange of capital from land to manufactures had been effected, the farmers themselves, as well as every other class of the community, except the landholders, would very considerably increase their profits" (*Works*, IV, 33).

The pamphlet had a clear political message. It showed that the true conflict of interest in the issue of prohibiting the importation of cereals was not between industry and agriculture but rather between the "productive" and "unproductive" classes, that is, between industrialists and farmers, on the one side, and landlords, on the other side[9]. As Ricardo put in one of his letters:

> "It follows then, that the interest of the landlord is always opposed to the interest of every other class in the community. His situation is never so prosperous, as when food is scarce and dear; whereas, all other persons are greatly benefited by procuring food cheap". (*Works*, IV, 21)

In what follows we use the so-called corn-model to derive Ricardo's basic proposition in the *Essay on Profits.* It is a matter of controversy whether this model is a faithful or complete representation of Ricardo's early thinking.[10] No one denies, however, that the corn model is implicit in some of his calculations and in the numerical table of the *Essay*, and we believe this is sufficient for our purposes. We do agree, however, that he seemed quite aware of its limitations and was most of the time striving for a more realistic formulation.

It is probably fair to say that in the *Essay* Ricardo used the corn-model to demonstrate his basic theoretical proposition on the rate of profit (through table and calculations) tough being aware that the model was a rather simplified description of reality. In this sense we may say he was using a "toy model" to deal with a recalcitrant complex reality.[11] As we will see bellow, Malthus' criticism against the *Essay* was exactly that Ricardo's basic theoretical proposition did not survive a more realistic expansion of the corn model.

Ricardo's corn-model argument (or calculation) was based on two assumptions, which should be seen as simplifying abstractions of reality. One was that the agricultural sector of the economy produced a homogeneous good – call it corn – using only labor, land and corn itself. Suppose the production of one unit of corn in the less fertile piece of land in use

---

[9] This distinction between the owners of land and farmers is fundamental in Ricardo. The owners get the rent of the land while the farmers get the profit produced by the agricultural business after paying rent, wages and other expenses. The distinction seems to reflect the reality of British agriculture by the end of the eighteenth century where large rural properties where units of ownership not of production and very few landowners of the upper classes were actively concerned in agriculture. See Habakkuk (1940) and Habakkuk (1952).

[10] See Bharadwaj (1983), Blaug (1985, p. 7n), Eatwell (1975), Garegnani (1982) and (1990), Hicks (1985), S. Hollander (1979, p. 146), Langer (1982), Meek (1973), O'Brien (1981), Ong (1983), Peach (1993, p. 85), Rankin (1984), Roncaglia (1982).

[11] Freeman (1985, p. 41) describes the use of toy models by theoretical physicists: "When the real world is recalcitrant, we build ourselves toy models in which the equations are simple enough for us to solve. Sometimes the behaviour of the toy model provides iluminating insight into the behavior of the real world." Of course, since Ricardo, much of economic theory has been based on toy models, a phenomenon Joan Robinson (1973) once described as the "Ricardo Bicycle".

requires a_a units of corn (as seeds, for example) and h_a units of labor. Since no rent is paid on the least productive land in cultivation, the unit cost of production on this land is $(a_a p_a + h_a w)$ where p_a is the price of corn and w is the wage rate.[12] If the capital advanced by the farmer consists of his expenses on the corn-input and on wages, it follows that the price of corn is:

(1) $p_a = (a_a p_a + h_a w)(1+r)$

where r is the profit rate. For a given profit rate the price of corn is proportional to the unit cost of production in the marginal land.

The second simplifying assumption was that wages were fully spent on corn and that the real wage was constant:

> "We will…suppose that no improvements take place in agriculture, and that capital and population advance in the proper proportion, so that the real wages of labour continue uniformly the same"(*Works*, IV,12).

Hence, the real wage (v_a) was equal to a constant corn wage[13]:

(2) $w = v_a p_a$

The beauty of Ricardo's argument is that these two assumptions imply that the model of the economy is block-recursive, with equations (1) and (2) being sufficient to determine the rate of profit, independently of all other equations of the model (such as equations similar to (1) for the prices of all other goods and equations determining the output of each good). Indeed, from (1) and (2) we get:

(3) $(1+r)(a_a + h_a v_a) = 1$

---

[12] It has been shown by Samuelson (1959) that in general one cannot get rid of rent as a cost element by going to an extensive margin because in a multi-sectoral model, in which land is an input in the production of many goods, the extensive margin is itself a variable that can only be determined as part of the general equilibrium solution of the model. In the case of Ricardo, however, this problem is avoided by the implicit hypothesis that land is an input only in the production of the homogeneous agricultural good, corn. To assume that rent is an insignificant element of cost in manufacture is not that bad as a first approximation.

[13] This assumption of the *Essay on Profits* can be seen as an alternative definition of the "natural wage", which was defined in the *Principles* in terms of an stationary population. In the present case, the natural wage is that which maintains the proper proportion between capital and population and is not inconsistent with capital growing at a constant percentage rate over time. With this definition, one does not have to assume, as Ricardo implicitly does in the *Principles*, that population is always at a Malthusian equilibrium in spite of continuing capital accumulation. See Samuelson (1978) for a discussion of this latter, "short-circuited", variant of the model. See also Peach (1993, p. 103-123) for a discussion of the alternative "new view" assumption of a secularly declining commodity wage as part of Ricardo's model. On the "new view" see Hicks and S. Hollander (1977), Casarosa (1978), S. Hollander (1979) and (1990).

which shows that the rate of profit in agriculture depends only on the technical coefficients of prodution in the less fertile piece of land in cultivation (a_a and h_a) and on the constant corn-wage (v_a). Since under competition the rate of profit must be the same for all sectors of the economy, we have, as Ricardo would say, the rate of profit of the farmer regulating the rates of profit of all other trades.

The key proposition of the *Essay on Profits* can be demonstrated as a direct corollary of this. If importation of corn is restricted, more food will have to be grown domestically, using land of worse quality. This will increase the input of labor per unit of output in the marginal land[14], reducing the rate of profit for the whole economy. In terms of equation (3), the expansion of home agriculture increases h_a and, ceteris paribus, reduces r.

3. Malthus' Reaction.

Malthus reaction to the *Essay on Profits* was strongly critical. Less than three weeks had gone after its publication, when he wrote Ricardo:

> "I confess I think the kind of calculation which I mentioned to you in Town, shews in what manner profits on land may rise decidedly from the alteration in the relative value of corn, and therefore shews that general profits may be determined by the general supply of stock compared with the means of employing it, and not merely by the stock employed on the land." (*Works*, VI, 182)

Unfortunately the calculation mentioned by Malthus was never put down in writing in his correspondence with Ricardo, and that is most likely the reason it has remained somewhat unnoticed by historians of economic thought. But it is reasonable to assume the same calculation was again reproduced in a letter from Maltus to Homer written four days latter (Works, VI, 187-188), so we can easily figure out its nature.

The point of Malthus numerical counter-example (his "calculation") was that an expansion of domestic agriculture will increase the price of corn relative to manufactured commodities, and therefore, because part of the working capital of farmers and of the wages of agricultural laborers is spent on manufactured goods, it is possible that as a consequence the rate of profit in agriculture will rise.

> "...will it not follow that, as the real capital of the farmer which is advanced does not consist merely in raw produce, but in ploughs, waggons, threshing machines etc: and in the tea, sugar, clothes, etc, etc used by his labourers, if with a less quantity of raw produce he can purchase the same quantity of these commodities, a greater quantity of raw produce will remain for the farmer and landlord, and afford a greater surplus from the land for the maintainance and encouragement of the manufacturing and mercantile classes"(*Works*,VI,187).

---

[14] For analytical convenience, we are assuming that the input of corn per unit of output (a_a) is the same for all grades of land.

The basic point of Malthus' criticism was that the corn model implicit in the *Essay on Profits* ignored two important characteristics of the real world: that agriculture uses manufactured goods as intermediate inputs and that workers also spend part of their wages in industrial goods. Hence equation (1) has to be rewritten as:

(4) $\qquad p_a = (a_a\, p_a + m_a\, p_m + h_a\, w)(1+r)$

where m_a is the input of manufactures needed to produce one unit of corn in the less fertile piece of land in use.

Likewise, equation (2) becomes:

(5) $\qquad w = v_a\, p_a + v_m\, p_m$

It assumes (as a simplifying hypothesis) that the average worker spends his wages on fixed quantities v_a of corn and v_m of manufactures.

From (4) and (5) we get:

(6) $\qquad (1+r)\,(a_a + m_a\, q + h_a\, v_a + h_a\, v_m\, q) = 1$

with $q = p_m / p_a$ being the corn price of manufactures. This equation shows that the rate of profit in agriculture depends on technical coefficients of production in the less fertile piece of land in cultivation (a_a, m_a and h_a), on wage consumption coefficients (v_a and v_m) and also on the relative price between manufacture and agriculture (q).

Consider now the behavior of the rate of profit when there is an increase in the input of labor per unit of output in the marginal land (h_a). Both Ricardo and Malthus believed this would increase the cost of production of corn, hence reducing the corn price of manufactures (q). But the impact on profits is ambiguous. It is obvious from equation (6) that we cannot determine a priori the required adjustment for the rate of profit (r) when we have both an increase in the labor coefficient (h_a) and a decrease in the corn price of manufactures (q). It necessarily depends on the relative sizes of the movements.

Malthus criticism introduced an uncomfortable degree of uncertainty in the main result of Ricardo's model. An increase in the input of labor per unit of output in the marginal land will by itself reduce the rate of profit, but a reduction in the corn price of manufactures will cause the opposite effect. The net result seems indeterminate a priori.

4. The Exact Solution.

The Ricardo-Malthus controversy on the rate of profit is a remarkable example of how the lack of analytical tools may hinder the progress of economic knowledge. If Ricardo had at his disposal the techniques of a modern economist, he would have easily overcome Malthus' criticism. All he had to do was to write down the equations for the model of the economy and work out its comparative statics for the case of a reduction of labor productivity in the agricultural frontier.

Consider the relevant model of the economy for the issue under consideration, on which probably there would be wide agreement among the disputants. The price of corn is given by equation (4) above, which can be reframed in corn units as:

$$(7) \qquad 1 = (a_a + m_a q + h_a v)(1+r)$$

where q is the corn price of manufactures and v is the real wage in corn units. Obviously the corn price of corn equals one by definition.

The price of manufactures follows from a similar equation:

$$p_m = (a_m p_a + m_m p_m + h_m w)(1+r)$$

or, in terms of corn units:

$$(8) \qquad q = (a_m + m_m q + h_m v)(1+r)$$

The model is completed by the corn units equivalent of equation (5) above:

$$(9) \qquad v = v_a + v_m q$$

Equations (7) to (9) are sufficient to determine the three endogenous variables, namely v, q and r. Using this model, a "modern Ricardo" could easily check the sign of the relevant derivative dr/dh_a and settle the controversy.

It is tedious but easy to verify that:

$$(10) \qquad dr/dh_a = - (a_m + h_m v_a) v (1+r) / (a_m + h_m v_a + q v)$$

which has an unmistakable negative sign.

Hence Ricardo was right! Even tough part of the circulating capital of agriculture and part of the expenditures of wage earners were directed towards manufactured goods, a reduction of labor productivity in the marginal land would lead to a reduction in the rate of profit. After this exact demonstration, Malthus would be forced to acknowledge that an expansion of domestic agriculture in detriment of imports would necessarily reduce the profitably of circulating capital all over the economy.

It should be pointed that the same conclusion can be reached by means of a simple reduction to absurd argument. Suppose the effect of an increase in the labor coefficient of agriculture (h_a) is an increase in the rate of profit (r). Hence from (8) we conclude that, if the real wage does not fall, the corn price of manufactures must increase. Equation (9) reinforces this conclusion by showing that an increase in the corn price of manufactures must also increase the real wage. But consider now equation (7). It shows that if, an increase in the labor coefficient of agriculture is followed by an increase in the corn price of manufactures and an increase in the real wage, the rate of profit has to fall, which contradicts the initial assumption (QED).

5. The Labor Theory of Value as a Method of Proof.

Ricardo's performance in the Malthus controversy and in his *Principles* shows a fine mind, quite capable of abstract reasoning. It also shows he had an adequate understanding of the relevant model of the economy. But the challenge of figuring out the comparative statics of a coefficient shift in a system of simultaneous equations was far beyond his capabilities.[15] Ricardo's analytical arsenal was obviously inferior to that used in the previous section, but his problem was not so much a lack of mathematical skill. What seemed really difficult for him was thinking in terms of a general equilibrium type of model in which there is the simultaneous determination of a set of endogenous variables. His technique of analysis was always typically recursive and we know it is very hard to analyze the comparative statics of a general equilibrium model by any process of recursive reasoning.

There is an interesting letter from James Mill to Ricardo which highlights this notion of recursive reasoning:
> "…I have been reading once more your last pamphlet (The Essay on Profits). And it has suggested this to be given to you, as an advice…never set down any material proposition without its immediate proof. You must never leave any such proposition to be inferred, through a number of steps, by yours readers themselves… It is this which has made the pamphlet, in question, be reckoned obscure, and not unjustly….You have stated repeatedly this proposition, That improvements in agriculture…raise the profits of stock…But you have no where stated the proof…My meaning is, that you should successively answer the question, What comes next? First of all is the improvement, What comes next? Ans. the increase of produce. What comes next? Ans. a fall in the price of corn. What comes next? – and so on."(*Works*, VI, 339-340)

Ricardo's difficulty seems to stand out in a letter to Malthus:
> "The whole appears to me a labyrinth of difficulties; one is no sooner got over than another presents itself, and so in endless succession." (*Works*, VI, 214)

It is clear that Ricardo was looking for a simple way out of the maze of circular arguments and lack of precision that seemed to spun from the expanded version of his early corn

---

[15] See Morishima (1989) for a somewhat similar argument, though we cannot agree with this author's dim view on historians of economic thought. See also Peach (1993, p. 285).

model after taking into account Malthus' criticism. And the labor theory of value turned out to be just the simple trick needed.

Let us see how Ricardo constructed the "proof" for his proposition in the *Principles*:

> "We have seen that the price of corn is regulated by the quantity of labour necessary to produce it…We have seen, too, that all manufactured commodities rise and fall in price in proportion as more or less labour becomes necessary to their production.
>
>   …Suppose corn to rise in price because more labour is necessary to produce it; that cause will not raise the price of manufactured goods in the production of which no additional quantity of labour is required. If, then, wages continued the same, the profits of manufacturers would remain the same; but if, as is absolutely certain, wages should rise with the rise of corn, then their profits would necessarily fall". (pp. 110-111)

In a footnote Ricardo acknowledges the assumption of a labor theory of value with money (or gold) taken as the numeraire:

> "The reader is desired to bear in mind that, for the purpose of making the subject more clear, I consider money to be invariable in value, and therefore every variation of price to be referable to an alteration in the value of the commodity" (p. 110)

– that is to say, referable to an alteration in the <u>labor value</u> of the commodity.

This use of money as an (approximate) invariable measure of value, that is, as a commodity with the magical property that the relative price of any other commodity with respect to it is equal to the ratio of labor inputs in their production, was justified in chapter 1, On Value, of the *Principles*:

> "Neither gold, then, nor any other commodity, can never be a perfect measure of value for all things; but I have already remarked that the effect on the relative prices of things, from a variation of profits, is comparatively slight; that by far the most important effects are produced by the varying quantities of labour required for production; and therefore, if we suppose this important cause of variation removed from the production of gold, we shall probably possess as near an approximation to a standard measure of value as can be theoretically conceived." (p. 45)

Ricardo's proof assumes a simpler version of our equation (8)

(11) $$p_m = (m_a p_m + h_m w)(1+r)$$

in which there is no corn input in the production of manufactures[16]. But the crucial assumption is the labor theory of value which can be stated as:

---

[16] He wrote in a letter to Malthus: "I think the price of commodities will be vey slightly affected either by a rise or a fall in the price of corn" (*Works,* VI, 213).

(12) $p_a = h_a$ and $p_m = h_m$

if we assume that prices are expressed in monetary units (that is, in terms of the numeraire, gold) and that the unit of measurement for labor in chosen so that its input per unit of output in the production of gold equals one.

If the price of corn (p_a) increases, "because more labour is necessary to produce it" (a higher h_a), there will be no change in the price of manufactures if "wages continued the same"(that is, if w remained constant). The price of manufactured goods (p_m), "in the production of which no additional quantity of labour is required" (hence h_m remains fixed) would not change in this case. But since wages depend on the price of corn (as in equation (5) above), it is "absolutely certain" that wages will rise. Hence, from (11), the rate of profit has to fall, QED.

A more sophisticated proof, taking into account the full model of equations (7) to (9), can also be derived from the fact that the labor theory of value implies that the corn price of manufactures is determined by the ratio of direct labor inputs in their production:

(13) $q = h_m / h_a$

Substituting this into (8) and (9) gives

(14) $h_m = [(a_m + h_m v_a) h_a + (m_m + h_m v_m) h_m](1+r)$

which shows that the labor value of manufactures is made up of the labor value of direct agriculture inputs in the production of manufactures and indirect agriculture inputs in wages, plus the labor value of direct manufactured inputs in the production of manufactures and indirect manufactured inputs in wages, plus profits. This equation shows that an increase in labor input in agriculture (h_a) will necessarily produce a fall in the rate of profits (r).

6. Conclusion

The labor theory of value dominated much of economic thinking for a long time after its introduction by Ricardo, but it has always been a puzzle to explain why it was used in the first place, since Ricardo himself acknowledged it could be no more than a "tolerably accurate" approximation to reality. Malthus, his greatly respected adversary, remained always stubborn on this point, writing as late as 1817 that:

> "I have read over your book with much satisfaction… but I still cannot agree
> with you that labour alone in the sense you understand it is either in theory of
> fact the best measure of exchangeable value..." (*Works*, VII, 176).

Why vitiate a complex theoretical argument with an empirical approximation that was not essential for the conclusions? The answer is that the labor theory of value provided a simple method of proof for Ricardo main proposition on the theory of profits. The irony is that the proposition was correct, quite independently of the labor theory of value, but he was just unable to prove it.

7. References

Bharadwaj K. 1983. 'On a controversy over Ricardo's theory of distribution'. *Cambridge Journal of Economics,* volume 7, pp. 11-36.

Bharadwaj K. and Schefold, B. (eds) 1990. *Essays on Piero Sraffa: Critical Perspectives on the Revival of Classical Theory*. London: Unwin Hyman.

Blaug, M. 1985. 'What Ricardo Said and What Ricardo Meant'. In Caravale G. A. (ed)

Barkai, H. 1967. 'The Empirical Assumptions of Ricardo's 93 Per Cent Labour Theory of Value'. *Economica*, Volume 34, pp.418-23

Cannan Edwin. 1929. *A Review of Economic Theory.* Frank Cass and Co. (second edition 1964).

Casarosa, C. 1978. 'A New Formulation of the Ricardian System'. *Oxford Economic Papers,* vol I, pp. 38-63

Caravale, G. A. (ed) 1985, *The Legacy of Ricardo.* Oxford: Basil Blackwell.

Eatwell, J. L. 1975. 'The Interpretation of Ricardo's *Essay on Profit'. Economica,* vol 42, pp. 182-7.

Feeman, D. 1985. *Origins of Life.* Cambridge: Cambridge University Press.

Garegnani, G. 1982. 'On Hollander's interpretation of Ricardo's early theory of profits'. *Cambridge Journal of Economics*, vol. 6, pp. 65-77.

----------------- 1990. 'Sraffa: Classical versus Marginalist Analysis', in Bharadwaj, K. and Schefold, B. (eds)

Habakkuk H. J. 1940. 'English Landownership, 1680-1740'. *The Economic History Review.* 10, pp. 2-17

Habakkuk H. J. 1952. 'Economic Function of Landowners in the Seventeenth and Eighteenth Centuries'. *Explorations in Entrepreneurial History,* 6

Hicks J. 1985. 'Sraffa and Ricardo: A Critical View'. In Caravale, G. A. (ed) 1985.

Hicks, J. and Hollander, S. 1977. 'Mr. Ricardo and the Moderns'. *Quaterly Journal of Economics,* vol. 91, pp 351-69.

Hollander, Jacob H. 1904. 'The Development of Ricardo's Theory of Value'. *Quaterly Journal of Economics*, vol XVIII, pp. 455-91

Hollander, Samuel 1979. *The Economics of David Ricardo*. London: Heinemann.

---------------------- 1986. 'On a "New Interpretation" of Ricardo's Early Theory of Profitability'. *Economic Journal,* Volume 96, pp.1091-7.

---------------------- 1990. 'Ricardian Growth Theory: A Resolution of Some Problems in Textual Interpretation'. *Oxford Economic Papers,* vol. 42, pp. 730-50.

Langer, G. F. 1982. 'Further evidence for Sraffa's interpretation of Ricardo'. *Cambridge Journal of Economics*, vol. 8, pp235-51.

Meek, R. L. 1973. *Studies in the Labour Theory of Value.* London: Lawrence and Wishart.

Myrdal, Gunnar. 1955. *The Political Element in the Development of Economic Theory.* Cambridge: Harvard University Press.

Niehans, Jürg. 1990. *A History of Economic Theory.*Baltimore: The John Hopkins University Press.

O'Brien, D. P. 1981. 'Ricardian Economics and the Economics of David Ricardo'. *Oxford Economic Papers,* vol. 33, pp. 352-86

Ong, N-P. 1983. 'Ricardo's Invariable Measure of Value and Sraffa's Standard Commodity'. *History of Political Economy*, vol 15, pp. 207-27

Peach, Terry 1993. *Interpreting Ricardo.* Cambridge: Cambridge University Press.

Rankin, S. 1984. 'The Wage Basket in Ricardo's *Essay on Profit'*. *Cambridge Journal of Economics,* vol. 8, pp. 83-6

Ricardo, David.1966. *The Works and Correspondence of David Ricardo,* Piero Sraffa and M. H Dobb (eds). 10 vols. Cambridge: Cambridge University Press.

--------------------.*On The Principles of Political Economy and Taxation,* in vol I of *The Works and Correspondence of David Ricardo.*

--------------------.*Notes on Malthus,* in vol II of *The Works and Correspondence of David Ricardo.*

--------------------.*An Essay on the Influence of a Low Price of Corn on the Profits of Stock,* in vol IV of *The Works and Correspondence of David Ricardo.*

Robinson, J. 1973. 'An Open Letter from a Keynesian to a Marxist'. Collected Economic Papers, volume 5, Oxford: Basil Balckwell.

Roncaglia, A. 1982. 'Hollander's Ricardo'. *Journal of Post-Keynesian Economics,* vol 4, pp. 339-59.

Samuelson, P. 1959. 'A Modern Treatment of the Ricardian Economy: I. The Pricing of Goods and of Labor and Land Services'. *Quarterly Journal of Economics,* February, 73, pp 1-35.

----------------. 1978. 'The Canonical Classical Model of Political Economy'. *Journal of Economic Literature,* December,vol XVI, pp 1415-1434

Sraffa, Piero. 1951. 'Introduction' in *The Works and Correspondence of David Ricard.* volume I

Stigler, George J. 1958. 'Ricardo and the 93% Labor Theory of Value', *American Economic Review*, Volume 48, pp. 357-67.

-----------------------.1965. *Essays in the History of Economics*. Chicago: University of Chicago Press.

Wilson, G. W. and Pate, J. L. 1968. 'Ricardo's 93 Per Cent Labor Theory of Value: A Final Comment'. *Journal of Political Economy*, Volume 76, pp. 128-36

8. Appendix: Derivation of Equation (10)

Equations (7) to (9) can be reduced to:

(15) $\qquad 1 = (a_a + m_a q + h_a v_a + h_a v_m q)(1+r) = \theta_1(1+r)$

(16) $\qquad q = (a_m + m_m q + h_m v_a + h_m v_m q)(1+r) = \theta_2(1+r)$

where θ_1 and θ_2 stand for the first expression within parenthesis in each equation.

Let $r' = dr/dh_a$ and $q' = dq/dh_a$. Taking derivatives in (15) with respect to h_a gives:

(17) $\qquad 0 = \theta_1 r' + v(1+r) + (m_a + h_a v_m)(1+r) q'$

where we are using the fact that $v = (v_a + v_m q)$.
Taking derivatives in (16) with respect to h_a gives:

(18) $q' = \theta_2 r' + (m_m + h_m v_m)(1+r) q'$

hence:

(19) $q' = \theta_2 r' / \theta_3$

where $\theta_3 = [1- (m_m + h_m v_m)(1+r)]$

Substituting (19) into (17) leads to:

(20) $0 = \theta_1 \theta_3 r' + \theta_3 v + (m_a + h_a v_m)(1+r) \theta_2 q'$

But from (16) we have

(21) $\theta_3 = [1- (m_m + h_m v_m)(1+r)] = (a_m + h_m v_a)(1+r) / q$

Substituting (21) into (20) and solving for r' leads to:

(22) $r' = - (a_m + h_m v_a) v / \theta_4$

where $\theta_4 = \theta_1(a_m + h_m v_a) + \theta_2 v$

From (15) and (16) we have $\theta_1 = 1/(1+r)$ and $\theta_2 = q/(1+r)$. Substituting into (22) gives

(23) $r' = - (a_m + h_m v_a) v (1+r) / (a_m + h_m v_a + q v)$

which is equation (10), showing that sign(r')<0.