Mr. Ricardo's Theory of Land Rent

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Mr. Ricardo's Theory of Land Rent

John F. McDonald

Abstract. The top award for research given by the American Real Estate Society is the David Ricardo Medal, and 2017 is the 200th anniversary of the publication of *The Principles of Political Economy and Taxation*. This paper is an introduction to and extension of Ricardo's theory of land rent. The paper also presents the basic Ricardian system in which the progress of society (e.g., population growth) results in an increase in land rent and a decline in returns to capital. The Ricardian system leads to the conclusion that the problem of diminishing returns to capital can be overcome by free international trade.

The top award given by the American Real Estate Society for research is named for David Ricardo. It is fitting that the award is named for Mr. Ricardo because he was a pioneer in the development of economic theory, and is especially known for his theories of comparative advantage and land rent. While authorities in the history of economic thought such as Stigler (1952) and Sraffa (1952) pointed out that the basic idea of Ricardo's theory of land rent did not originate with him, it is clear that his presentation and extension of the theory remain as landmarks in the development of economic analysis, and are the beginning of the study of land rent based on differences in natural advantage—a foundation of the analysis of real estate markets. The purpose of this paper is to reintroduce Ricardo to the modern real estate community.

In the first seven chapters of *The Principles of Political Economy and Taxation*, Ricardo (1821) develops an overall model of an economy. In this paper, I first examine Ricardo's theory of land rent by presenting the theory in its original form. Next is an examination of Ricardo's use of his model of land rent that includes an examination of what is called the Ricardo "paradox" in which an improvement in land productivity apparently causes land rent to decline. The discussion of theory as presented by Ricardo concludes with a short introduction to the Ricardian system in which the distribution of income to labor, capital, and land is determined and the argument for free trade is stated. The theory of comparative advantage, the theory that shows the benefits of international trade, in effect is the capstone of the first seven chapters.

Ricardo stated on the first page of the first edition of *The Principles of Political Economy and Taxation* that his purpose was to reveal the economic laws that determine the distribution of the production of an economy among the three basic inputs, land, labor, and capital, and that the problem had not been solved by earlier writers. As he said (1821, 1966 reprint, p. 1), "To determine the laws which regulate this distribution is the principal problem in Political Economy:

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much as the science has been improved by the writings of Turgot, Stuart, Smith, Say, Sismondi, and others, they afford very little satisfactory information respecting the natural course of rent, profit, and wages."

Furthermore, the theory of rent was the critical piece of the solution to the principal problem. As he stated regarding the theory of rent (1821, 1966 reprint, p. 1), ". . . without a knowledge of which it is impossible to understand the effect of the progress of wealth on profits and wages."

Following the discussion of the Ricardian system, in the next part of the paper, I translate Ricardo's version of rent theory into a simple supply-and-demand framework. I am aware of no direct translation of Ricardo's rent model into conventional supply and demand. The paper concludes with a short exposition of rent theory using conventional marginal analysis, a technique unknown to Ricardo. Marshall (1920, Appendix L) did present a Ricardo-type analysis using a continuous marginal product curve for corn output. This model is discussed. It should be noted that Von Thünen (1826) developed a theory of rent based on variation in the distance to the market that added location to Ricardo's theory based on fertility differentials. These two models became the foundations for modern models of land rent. See Alonso (1964) for a review and critique of writings on land rent post Ricardo and pre Alonso.

Ricardo's Land Rent Theory

Ricardo's (1821, 1966 reprint, pp. 35–36) basic rent model is as follows: "Thus suppose land—No. 1, 2, 3—to yield, with an equal employment of capital and labor, a net produce of 100, 90, and 80 quarters of corn. In a new country, where there is an abundance of fertile land compared with the population, and where therefore it is only necessary to cultivate No. 1, the whole net produce will belong to the cultivator, and will be the profits of the stock he advances. As soon as population had so far increased as to make it necessary to cultivate No. 2, from which ninety quarters only can be obtained after supporting the labourers, rent would commence on No. 1; for either there must be two rates of profit on agricultural capital, or ten quarters, or the value of ten quarters must be withdrawn from the produce of No. 1 for some other purpose. Whether the proprietor of the land, or some other person, cultivated No. 1, these ten quarters would equally constitute rent; for the cultivator of No. 2 would get the same result with his capital whether he cultivated No. 1, paying ten quarters for rent, or continued to cultivate No. 2, paying no rent." Ricardo went on explain that, when it became necessary to cultivate No. 3, rent to No. 1 would be 20 quarters and rent to No. 2 would be 10 quarters.

Ricardo next considered the possibility that the capital employed on No. 3 could instead more productively be employed on No. 1 so that an additional 85 quarters would be produced instead of 80. He assumed that £1000 of capital is employed on No. 1 at first, and then £1000 more is added. In this case, the cultivator would

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Exhibit 1 Rendition of One of Ricardo's Tables

Land	Quarters	Cost	Cost per Quarter
No. 1	100	£1000	£1000/100 = £10
No. 2	90	£1000	£1000/90 = £11.11
No. 3	80	£1000	£1000/80 = £12.5

be obliged ". . . to pay fifteen quarters or an equivalent value for additional rent; for there cannot be two rates of profit." Rent on No. 2 land is reduced to 5 quarters. Ricardo (1821, 1966 reprint, p. 36) stated, "In this case, as well as in the other, the capital last employed pays no rent. For the greater productive powers of the first £1000, fifteen quarters, is paid for rent, for the employment of the second £1000 no rent whatever is paid."

In this example, the interests of the owner of No. 1 and No. 2 land and the cultivators are at odds. The cultivators can employ labor and capital more productively on No. 1 rather than No. 3 land, but the result is a smaller rent paid to the owners of the No. 1 and No. 2 land. The owners of No. 1 land would be motivated to limit the intensity of use of their own land, thereby forcing the cultivators to bring No. 3 land into use.

Ricardo made the following assumptions:

- The market for farmland is perfectly competitive; no landlord or renter has market power; Ricardo employed a rigorous version of the theory of perfect competition.
- Rent is the amount ". . . paid to the owner of land for the use of its original and indestructible powers."
- Ricardian rent theory is concerned with the long run. Matters of uncertainty and transitions from one state to another are ignored.
- Capital and labor are perfectly elastically supplied.
- Ricardo said that demand for corn grows with the population. At various points he assumed that output is constant for a given population—that demand is perfectly inelastic.

Ricardo used simple tables to illustrate the model. Exhibit 1 is a version of one of his tables. Suppose that there is one unit of each type of land, and as Ricardo assumed, that £1000 of capital and labor are employed on each when cultivated. The basic facts are shown in Exhibit 1. The reader is warned that Ricardo takes some getting used to.[1]

S_ It appears that Ricardo assumed that there are constant returns to scale on each
N_ type of land (e.g., employment of £500 on one-half of No. 1 land will yield 50

Exhibit 2 Data from a Table in Ricardo

Land Portion in Use	Capital	Wheat After Capital Cost	Profit 1st Portion	Rent 1st Portion	Percent Profit	Profit 2nd Portion	Rent 2nd Portion
1st only	200	100	100	0	50%	—	—
2nd added	210	90	86	14	43%	90	0

quarters of corn). It is assumed that there is no useable farmland beyond No. 3 land. Ricardo (1821, 1966, reprint, p. 110) briefly considered the effect of a tax on rent and reached the famous conclusion: "A tax on rent would affect rent only; it would fall wholly on landlords, and could not be shifted to any class of consumers."

As Sraffa (1952, Vol. 4, p. 8) concluded, Ricardo worked out his theory of profits and diminishing returns to capital first and needed a theory of rent to complete his theory of distribution. The first sentence of Ricardo's "An Essay on the Influence of a Low Price of Corn on the Profits of Stock Showing the Inexpediency of Restrictions on Importation" from 1815 (Sraffa, Vol. 4, p. 9) states: "In treating the subject of the profits of capital, it is necessary to consider the principles which regulate the rise and fall of rent; and rents and profits, it will be seen, have a very intimate connection to each other."

Exhibit 2 contains data from a table in that essay. In this example, there are two types of land (1st portion and 2nd portion). Land in the 2nd portion is less productive than land in the 1st portion; more capital is required to produce the same amount of output. At first only land in the 1st portion is needed. In Exhibit 2, land in the 1st portion produces 300 quarters of wheat using 200 wheat-equivalent units of capital (and labor), leaving a profit of 100 quarters and zero rent. An increase in population requires that the land in the 2nd portion be used. Production of 300 quarters of wheat requires 210 wheat-equivalent units of capital (the assumption of diminishing returns to capital because of the use of less productive land). Remuneration to 210 units of capital is 90 quarters of wheat, a profit rate of 43%. Rent on land in the 2nd portion is zero, of course. The critical assumption in the model is that capital cannot earn a higher return in one place compared to another. The profit rate of 43% must prevail, so the profit for land in the 1st portion is 86 quarters of wheat, and rent is 14 quarters. Expansion into less productive land reduced the rate of profit and increased rent.

Variations in the Productivity of Land and Ricardo's Paradox

Ricardo used the model to explore the effects of improving the productivity of land through the use of better crop rotation methods or improved fertilizer (manure in his case). He assumed that the improvement would increase output

Exhibit 3 Ricardo's Data for Improving the Land Productivity

Land	Initial Output	Initial Corn Rent	Potential Output	Potential Corn Rent	Final Output	Final Corn Rent
No. 1	100	30	125	30	125	20
No. 2	90	20	115	20	115	0
No. 3	80	10	105	10	100	0
No. 4	70	0	95	0	0	
Total	340	60	440	60	340	30

by equal amounts on the different classes of land. In his example, an increase of 25 quarters for each type of land is assumed. The data from Ricardo are shown in Exhibit 3.

At first four types of land yield 340 quarters of corn and generate a total of 60 quarters of corn as rent. With improved productivity potential, output rises to 440 quarters, but total potential Corn Rent remains at 60 quarters because the differences in output between No. 4 land and the other types of land remain the same. However, Ricardo assumed that output would remain constant at 340 quarters even though the price of corn would decline from £14.29 to £9.52 per quarter.[2] In that case, total output can be cut back to 340 quarters by removing No. 4 land from cultivation and cutting back slightly on the amount of No. 3 land in cultivation. Corn rent for No. 1 and No. 2 land is then based on the productivity of No. 3 land, and total Corn Rent falls to 30 quarters. The landlord loses doubly in that Corn Rent falls and the price of corn falls as well. Here is Ricardo's paradox: agricultural improvements take the least productive land out of cultivation and reduce rent. Is that always true, or is it true only under certain conditions unspecified by Ricardo?

This analysis of the effects of agricultural improvement shows Ricardo's emphasis on the long run in full flower. The agricultural improvement is adopted by all cultivators, No. 4 land is removed from cultivation, and any surplus corn disappears. Any problems with the suggested massive transition of society do not appear.

Mill (1848, 2004 edition, pp. 663–664) reiterated Ricardo's analysis assuming an agricultural improvement that increases output on each type of land by some given proportion. In his example, an output increase of 33% is assumed and is displayed in Exhibit 4, and also shows a decline in Corn Rent resulting from the agricultural improvement.

Marshall (1920, Appendix L) was motivated to take on Ricardo and Mill to show that Ricardo's paradox is not always true, if the demand for corn is perfectly inelastic. He supplied a contradictory numerical example, as shown in Exhibit 5.

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Exhibit 4 Mill's Reiteration of Ricardo's Analysis Assuming an Agricultural Improvement Increases Output

Land	Initial Output	Initial Corn Rent	Final Output	Final Corn Rent
No. 1	100	40	133.33	26.67
No. 2	80	20	106.67	0
No. 3	60	0	0	
Total	240	60	240	26.67

Exhibit 5 Marshall's Contradictory Numerical Example of Ricardo's Paradox

Land	Initial Output	Initial Corn Rent	Final Output	Final Corn Rent
No. 1	115	55	153.33	66.67
No. 2	65	5	86.67	0
No. 3	60	0	0	
Total	240	60	240	66.67

In Marshall's example, the agricultural improvement increases output by 33% on both No. 1 and No. 2 land, as assumed by Mill. However, No. 1 land starts with much higher productivity than No. 2 land. The outcome is an increase in total Corn Rent, but Marshall did not point out that the total Money Rent would decline because the price of corn falls from £16.67 to £11.54. It is easy to invent an example in which both the Corn Rent and Money Rent increase as a result of an agricultural improvement. One can simply assume that the agricultural improvement affects only No. 1 land. For example, assume that output on No. 1 land increases by 60 quarters so as to replace the output of No. 3 land, but output on No. 2 land remains at 65 quarters. Rent on No. 1 land increases to 115 quarters and No. 2 land receives no rent.

Introduction to the Ricardian System

This section provides an introduction to Ricardo's system. Stigler (1952, p. 202) stated that Ricardo borrowed his theories of population and rent, but "In the synthesis of these theories into a general theory of value and distribution, he struck out on his own. The peculiar combination of doctrines that makes up his system is truly original."

Ricardo (1821, 1966 edition, Chapter V) adopted a Malthusian-type theory of population in which there exists a "natural" price of labor that depends on the price of food, necessaries, and conveniences required to enable laborers to

subsist. When the price of labor rises above (falls below) the natural price, population increases (decreases) and the price returns to its natural level. Ricardo (p. 55) recognized that the natural price of labor varies from country to country depending ". . . on the habits and customs of the people."

Ricardo assumed that, in the long run, population and capital grow at the same rate because an increase in capital increases the demand for labor. As Ricardo (p. 53) put it, ". . . if the increase in capital be gradual and constant, the demand for labour may give a continued stimulus to an increase in people." But the basic result of the synthesis is to show that the rate of profit falls with the advancement of society (i.e., with the growth of population).

Ricardo actually employed a two-sector model that included manufacturers and agriculture. In the simplest case, manufacturers used no land and paid workers the same wage and capital earned and the same return per unit as in agriculture. Recall that both labor and capital are assumed to be elastically supplied (in the long run). Manufacturers expand at constant returns to scale with the expansion of society, and capital earns the same return in both agriculture and manufacturing. The addition of manufacturers to the theory means that the natural price of labor includes the price of necessaries other than food.

Return to the original Ricardian example with three grades of land. When only No. 1 land is used, 100 quarters of corn are produced at a price of £10. Rent is zero and £1000 is available to pay for the capital and labor inputs. Ricardo (*p*. 65) assumed that 10 workers and a given amount of capital were employed on the land, and that each worker was paid £60, equal to 6 quarters of corn. Total wages of £600 leave £400 (40 quarters of corn) for the return to capital. Ricardo assumed that the demand for corn was inelastic at 3 quarters per worker, and that other necessities are purchased for £30.

Now consider the case in which population and capital have increased and all three grades of land are cultivated. As shown in Exhibit 1, the price of corn is £12.5 per quarter. As before, Corn Rent on No. 1 land is 20 quarters of corn, 10 on No. 2 land, and zero on No. 3 land. Total revenue on No. 1 land is £1250 and Money Rent on No. 1 land is £250, leaving £1000 to pay for the capital and labor inputs. A full accounting is shown in Exhibit 6.

It is assumed that workers buy 3 quarters of corn for £12.5 and continue to pay £30 for other necessities, so the natural price of labor is now £67.5 rather than £60. Exhibit 1 shows that the return to capital employed on No. 1 land declined from £400 to £325 (from 40 to 26 quarters of corn) as the society grew to require cultivation of less productive land. The amount of revenue available to pay labor and capital is still £1000. The money wage increased to maintain the natural price of labor at the amount needed to purchase 3 quarters of corn and £30 of other necessities. Wages in units of corn equal 5.4 quarters per worker (3 quarters of corn plus £30/£12.5 = 2.4 for other necessities). Corn and money

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Exhibit 6 A Case in Which Population and Capital Increased and All Three Grades of Land are Cultivated

Land	Output	Revenue	Corn Rent	Money Rent	Corn Wages	Money Wages	Corn Profit	Money Profit
No. 1	100	£1,250	20	£250	54	£675	26	£325
No. 2	90	£1,125	10	£125	54	£675	26	£325
No. 3	80	£1,000	0	0	54	£675	26	£325

profits per unit of capital declined, and Money Rent increased. And so we reached what Stigler (1952, p. 204) terms the "great conclusion."

Ricardo (pp. 75–76) summarized the result: "Thus we again arrive at the same conclusion which we have before attempted to establish—that in all countries, and all times, profits depend on the quantity of labour requisite to provide necessaries for the labourers on that land or with that capital which yields no rent."

"On Foreign Trade" is the final chapter in the first part of *The Principles of Political Economy and Taxation*, the seven chapters devoted to general economic theory. Ricardo introduces the theory of comparative advantage as follows (pp. 82–83):

> "England may be so circumscribed that to produce cloth may require the labour of 100 men for one year; and if she attempted to make wine, it might require the labour of 120 men for the same time. England would therefore find it in her interest to import wine, and to purchase it by the exportation of cloth.
>
> To produce 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. It would therefore be advantageous for her to export wine in exchange for cloth. This exchange might even take place notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England. Though she could make cloth with the labour of 90 men, she would import it from a country where it required the labour of 100 men to produce it, because it would be advantageous to her rather to employ her capital in the production of wine, for which she would obtain more cloth from England than she could produce by diverting a portion of her capital from cultivation of vines to the manufacture of cloth.
>
> Thus England would give the produce of the labour of 100 men for the produce of the labour of 80. Such an exchange could not take place between the individuals of the same country. The labour of 100 Englishmen cannot be given for that of 80 Englishmen, but the produce

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> of the labour of 100 Englishmen may be given for the produce of the labour of 80 Portuguese."

In Ricardo's system, the progression of society through population growth brings into cultivation land of lesser productivity and results in a lower return to capital and higher rents. What can society do to overcome this dilemma of diminishing returns to capital? One answer is international trade in which the nation deploys its labor and capital to the production of goods for which it has a comparative advantage. Importing agricultural products in exchange for exporting manufactured products can eliminate the need to cultivate land of lesser productivity, thereby expanding the quantity of goods available to the population and avoiding a reduction in the return to capital and an increase in money wages.

In particular, suppose that England allocates 100 men (and associated capital goods) to cloth production instead of agricultural (wine) production. England can trade the cloth for wine to the advantage of both England and Portugal. For example, suppose that the trade is cloth produced by 100 men in exchange for wine that would have required 120 men in England, but only requires 80 men in Portugal. Both nations have an incentive to strike such a trade deal. England gains the output of 20 men, and Portugal gains the output of 10 men. Furthermore, suppose that the allocation of 100 men to cloth production eliminates the use of No. 3 land in England. Rents decline and the returns to capital rise as men (and associated capital goods) are allocated to higher productivity work. Ricardo is well known as an advocate for free trade and a vehement opponent of the "Corn Laws" that placed an import duty on agricultural products. He had, in seven chapters, constructed a complete theoretical system that demonstrated the benefits of free trade. And the theory of rent is the critical piece in the theoretical system.

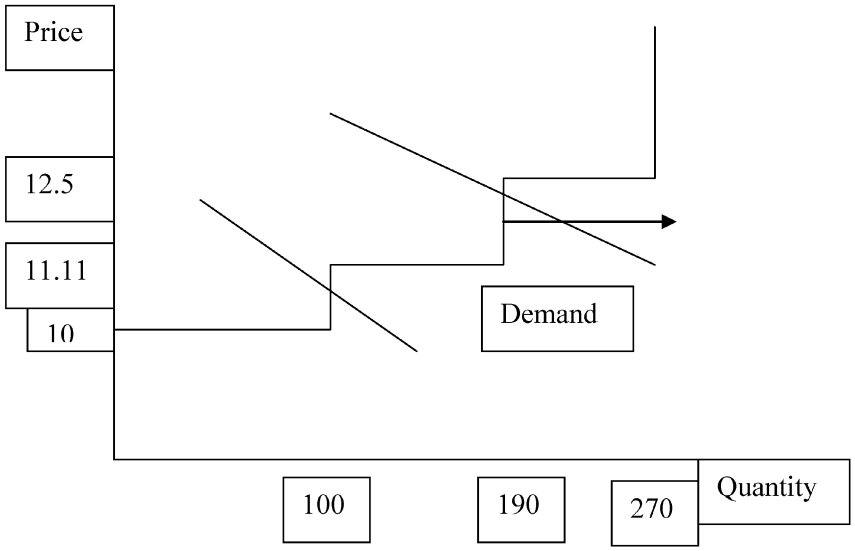
The Ricardian system has been the subject of numerous extensions and critiques. Examples include Nobel Prize awardees Stigler (1952), Samuelson (1959a, 1959b), and Hicks (1972). The nine-volume edition of Ricardo's complete works was compiled and edited by Sraffa (1952).

Reinterpretation of Ricardo's Model

This section recasts Ricardo's rent model with three grades of land as a basic supply-and-demand model. Continue to assume for simplicity that there is one unit of each type of land, and that £1000 of capital and labor are employed on each when cultivated. The basic facts are shown in Exhibit 1. These basic facts are used to construct a supply relation in Exhibit 7 assuming constant returns to scale on each type of land.

S_ Suppose that Ricardo's inelastic demand curve for corn intersects the supply
N_ curve at a quantity less than or equal to 100 quarters. The price of corn is £10

Exhibit 7 Supply and Demand for Corn



and rent is zero. However, use of the model as shown in Exhibit 7 permits us to assume that the demand is not perfectly inelastic. If the demand curve has a negative slope and intersects the supply curve in the vertical section at quantity 100 as shown, the price p will be equal to or greater than 10 but less than 11.11 and Money Rent will be:

$$\text{Money Rent} = £(p - 10)100.$$

Rent in terms of corn is Money Rent divided by p, or:

$$\text{Corn Rent} = (p - 10)100/p = 100 - (1000/p).$$

If p = £10, Money Rent and Corn Rent are both zero. If p = £10.5, Money Rent is £50 and Corn Rent is 4.76 quarters, etc. Money rent and Corn Rent rise with the price.

It is important to recognize that rent in this case arises because of the inelastic supply of No. 1 land. When demand increases to intersect the supply function at quantity greater than 100 (and less than 190), the rent is based on differential productivity between No. 1 and No. 2 land. These are the two sources of rent: inelastic supply and differential productivity.[3]

Now suppose that demand shifts so that demand and supply are equal at quantity equal to or greater than 100 and less than 190 such that the price of corn is £11.11. Money Rent on No. 1 equals:

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$$\text{Money Rent} = £(11.11 - 10)100 = £111.1.$$

Corn Rent is £111.1/£11.11 = 10 quarters, as Ricardo stated. No. 2 land pays no rent.

If the demand curve intersects the vertical portion of the supply curve at quantity 190 as shown, then both No. 1 and No. 2 land are paid rent. (Ignore the line with the arrow for now.) The Money Rent for No. 1 is still:

$$\text{No. 1 Money Rent} = £(p - 10)100.$$

As before the Corn Rent for No. 1 is:

$$\text{No. 1 Corn Rent} = (p - 10)100/p.$$

For example, if p = £12, then No. 1 Money Rent is £200 and No. 1 Corn Rent is 16.67 quarters.

The Money Rent for No. 2 is:

$$\text{No. 2 Money Rent} = £(p - 11.11)90, \text{ and}$$

Corn Rent is:

$$\text{No. 2 Corn Rent} = (p - 11.11)90/p.$$

If p = £11.11, both No. 2 Money Rent and No. 2 Corn Rent are zero, of course. But if p = £12, No. 2 Money Rent is £80.1 and No. 2 Corn Rent is 6.675 quarters.

Lastly, suppose that demand is great enough that the quantity produced is 190 quarters or greater. In this case, No. 3 land is brought into cultivation. Money Rent and Corn Rent for No. 1 and No. 2 land are computed as before with a price of £12.5. The results are:

No. 1 Money Rent	£250
No. 1 Corn Rent	20 quarters
No. 2 Money Rent	£125
No. 2 Corn Rent	10 quarters

If No. 1, No. 2, and No. 3 lands constitute the only supply of farmland, and if demand is sufficiently great that the price exceeds £12.5 per quarter, then all three types of land will receive rent. The formulas for Money Rent and Corn Rent for No. 1 and No. 2 land are the same as before. The equations for No. 3 land are:

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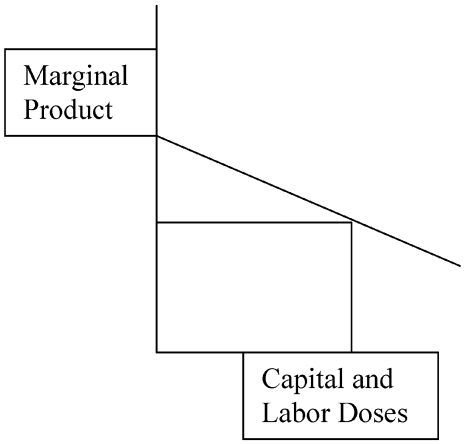
Exhibit 8 Marginal Product



No. 3 Money Rent = $(p - 12.5)80$ and

No. 3 Corn Rent = $(p - 12.5)80/p$.

Return to the case in which the addition of £1000 of labor and capital to No. 1 land increases output by 85 quarters. This case is a straightforward use of Ricardo's basic model. This alters the supply curve in Exhibit 7 so that, at output of 190 up to 270 quarters, the cost of an additional quarter is £11.765 (instead of £12.5). The reduction in cost is depicted by the line with the arrow in Exhibit 7. For output in this range the rent calculations are:

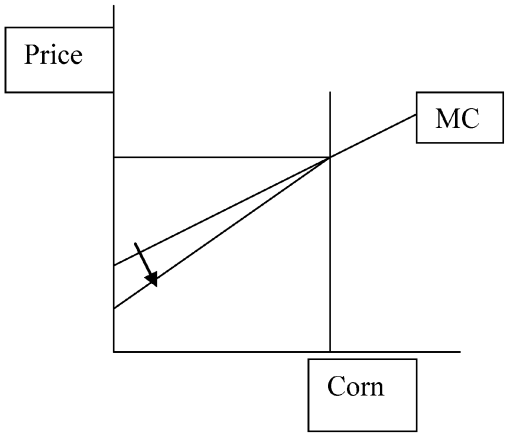
No. 1 Money Rent	£176.5
No. 1 Corn Rent	15 quarters
No. 2 Money Rent	£58.8
No. 2 Corn Rent	5 quarters

This case is one in which Ricardo's assumption of perfectly inelastic demand for corn matters. Exhibit 7 shows that a demand curve with a negative slope intersecting supply at an output of 190 implies the reduction in the price of corn. This reduction results in an increase in corn output when 1000 of capital and labor are added to No. 1 land rather than used with No. 3 land.

Marginal Analysis and Rent Theory

Ricardo did not have the tools of marginal analysis, so his analysis seems awkward to the modern student of economics (and is awkward). Marginal analysis was developed by several writers in the last decades of the 19th century, and was taught to generations of students by Alfred Marshall (1920). Marshall's

Exhibit 9 Supply and Demand



Book VI, Chapter ix covers rent theory, and Appendix L (1920) is a critique of Ricardo's rent theory.

Marshall (1920, p. 687) employed marginal productivity analysis, as shown in Exhibit 8. He assumed that the marginal product of "doses" of labor and capital applied to the land of the whole country (regarded as one farm) have a marginal product that declines continuously. Marshall's marginal product curve can be converted into a supply curve (marginal cost) by writing:

$$\text{Marginal Cost} = \text{Input Price/Marginal Product.}$$

Ricardo assumed that inputs are elastically supplied—the price of another dose of labor and capital is a constant. Marginal cost rises with output because marginal product declines. The supply curve, along with a perfectly inelastic demand curve, is shown in Exhibit 9. The Money Rent is shown as the area of the triangle between the supply curve and the line indicating the equilibrium price. One example of a shift in the marginal cost curve is shown in Exhibit 9. The sign of the change in Money Rent can be positive or negative. The example in Exhibit 9 shows an increase in Money Rent because the improvement is greatest for the most productive land. Corn Rent increases as well because the price of corn does not change.

A demand curve with elasticity less than zero can easily be inserted into Exhibit 9 with no change in result. Money Rent can be written $\Sigma(P - MC)$, where the sum runs from zero to the quantity demanded. Corn Rent is $[\Sigma(P - MC)]/P$. The change in Money Rent arising from an increase in productivity is:

$$\text{Change in Money Rent} = [\Sigma(P_2 - MC_2)] - [\Sigma(P_1 - MC_1)].$$

S_ N_ Here subscripts 1 and 2 refer to the before-and-after price and marginal cost figures. The change in Corn Rent generated by an increase in productivity is:

$$\text{Change in Corn Rent} = [\Sigma(P_2 - MC_2)]/P_2 - [\Sigma(P_1 - MC_1)]/P_1.$$

This quantity can be of either sign as well.

Conclusion

In this paper, I summarized Ricardo's theory of rent and his complete theoretical system as he presented them. The theory of rent is the centerpiece of the Ricardian system in which there are diminishing returns to capital. The problem of diminishing returns can be overcome by international trade in which the nation specializes in those goods for which it has a comparative advantage. Rent theory and comparative advantage thus are essential to his argument in favor of free trade, an argument he voiced strongly in his numerous reports and letters and as a Member of Parliament.

I also converted Ricardo's model of land rent into the conventional supply-and-demand framework. This conversion makes Ricardo's model more transparent to the modern student, and clarifies the computation of Money Rent and Corn Rent, a point that is obscure in Ricardo. The supply-and-demand version also shows that "Ricardo's paradox" is not a general result. Ricardo's numerical example showed that an agricultural improvement reduces total Corn Rent. In fact, the changes in Corn Rent and Money Rent depend on whether the improvement tends to increase output on the more productive land or the less productive land. This point is made easily in standard marginal analysis.

Stigler (1952, p. 207) noted that Ricardo did not use detailed empirical studies, but:

> "Economics is also an engine of analysis, and Ricardo, with his great powers of abstraction and synthesis, was a master analyst. Population, natural resources, capital accumulation, and the distribution of income—these were woven into a sweeping theoretical system. Measured by the significance of the variables and the manageability of the system, he fashioned what is probably the most impressive of all models in economic analysis.
>
> It is here that Ricardo's service to economics lies. His naked logic and pseudo-logic helped to establish a professional frame of mind which did much to reduce promiscuous fact-gathering and ad hoc theorizing and to incite order and precision. This was the basic "Ricardo effect"; and, even with our modern knowledge of the painful extremes to which it can be carried, we must thank him for it."

As Professor Fogarity put it in his introduction to the 1966 reprint of Ricardo (1821, 1966 reprint, p. xv): "One lays down this book with the feeling of having been in contact with a genuinely great man."

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Endnotes

1. Fractions of pounds are expressed in decimal form rather than in shilling and pence as in Ricardo to render the analysis understandable to non-English persons.
2. The initial corn price is keyed to No. 4 land at £1000/70 = £14.29. The final price is keyed to the higher productivity of No. 3 land at £1000/105 = £9.52.
3. Thanks to the referee for emphasizing this point about the two different sources of rent.

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