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Marx's Analysis of Ground-Rent: Theory, Examples and Applications

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Abstract

This paper offers a unified analytical treatment of Marx's theory of ground-rent, building on the analysis that is available in Volume Three of *Capital*. Since ground-rent is a transformation of surplus profit generated in agriculture, the main argument is developed in two steps. In the first step, I derive results on the existence of surplus profit in capitalist agriculture in the absence of landed property. In the second step, I used these results on surplus profit to arrive at the total ground-rent that is appropriated by the owners of land, and also decompose it into the three components that Marx highlighted: absolute rent, differential rent I, and differential rent II. I argue that the power of Marx's analysis lies in the fact that it can be generalised far beyond the domain of agriculture, which he had analysed, and can illuminate the emergence of rent in any system of capitalist commodity production that uses privately owned non-produced resources that is limited in quantity. Hence, Marx's analysis of ground-rent can be used to investigate many interesting issues in contemporary capitalism.

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1 Introduction

1.1 Motivation

Capitalist commodity production frequently relies on the use of non-produced resources. While the use of land, a key non-produced resource, for capitalist agricultural production is a prominent example, there are many other industries where non-produced resources are used. In the mining industry, where the particular mineral extracted is the commodity sold on the market, the ground in which the mine shaft is located is the non-produced resource. In much the same way, in the production of oil or natural gas, the ground beneath which the oil or natural gas is present, is the relevant non-produced resource. As another example, consider the part of the tourism industry that arrange tours to natural locations. In this case, the tourist service is the commodity and the forest, river, lake or mountain, whichever is the relevant natural object, is the non-produced resource used in the production of the commodity. As a last case, consider the housing industry. Here the produced commodity sold on the market is the house or apartment - residential or commercial - complex and the land on which these buildings are constructed is the non-produced resource. In each of these examples, and they could be multiplied, *if the non-produced resource is privately owned, and is limited in quantity* then its owner appropriates an income stream that we call capitalist rent (or, following Marx, ground-rent).

The existence of non-produced resources like land that are used in capitalist commodity production and the associated income stream that accrues to owners of the resource, rent, creates interesting problems for Marxist political economy. Non-produced resources, by definition, are not created by human labour. Hence they do not have *value* in the Marxian sense.¹ But in all capitalist economies, markets for many non-produced resources exist, where these are regularly bought and sold. Hence, non-produced resources have prices, even though they have no value. How does Marxist political economy explain the existence of items that have no value, and yet have prices?

The keys to answering this interesting question are the existence of capitalist rent and interest. Capitalist rent is the income stream that is appropriated by the owner of the non-produced resource per unit of time, for instance a year, for allowing use of the resource. Interest is the income stream accruing to owners of money capital per unit of time, for instance a year, for allowing the use of the money capital. For, once a financial system is in existence and a market interest *rate*, i.e. interest payment per unit of money borrowed, has emerged, any income stream, i.e. sums of money distributed over future periods, can be valued or ‘capitalized’.

The capitalized value of an income stream is the sum of the discounted income stream. The discounted value of an amount of money x , say, t years in the future, is $x/(1+i)^t$, where i is the annual market interest rate. Thus, the capitalised value of an income stream is the sum of discounted values of all amounts that comprise the income stream. For instance,

¹The value of a commodity is the amount of socially necessary abstract labour required to produce, and hence reproduce, the commodity. Marx presents his understanding of the labour theory of value in Part I of the Volume One of *Capital*. For details see Marx (1992, pp.126–163.).

consider a stream of money income that consists of \$1000 per year, for every year into the indefinite future. If the market interest rate is 10% per year, the capitalized value of the income stream is \$10000. This is because the infinite sum of the discounted income stream is 10000.² A more intuitive way to understand the capitalized value of an income stream is to see it as the principal, which would, in turn, generate the stream of money incomes under consideration as its annual interest income, given the market interest rate. Returning to our example, we can see that the capitalized value in question must be \$10000. This is because the annual interest payment on a sum of \$10000 is \$1000 when the market interest rate is 10% per year.

The principle of capitalization is relevant in this context because it allows us to derive a price of a non-produced resource as follows: *the price of a non-produced resource is the capitalized value of the stream of rent payments that is entailed by ownership of any non-produced resource.* For instance, using the example of the previous paragraph, if the rent on a plot of land is \$1000 per year and the market interest rate is 10% per year, then the price of the plot of land would be \$10000. While this provides us with a consistent Marxist theory for pricing non-produced resources and helps explain the puzzle of items with price but no value, it relies on a prior explanation of the phenomenon of capitalist rent. Such an explanation is presented by Marx as the theory of ground-rent in Volume Three of *Capital*.

1.2 The Place of Rent in *Das Kapital*

In *Capital*, Marx offers a penetrating, critical analysis of the structure and long term dynamics of the capitalist mode of production. The analysis and presentation in *Capital* is organized into three volumes and conducted at two primary levels of abstraction. Volumes One and Two operate at the level of what Marx calls ‘capital in general’, where competition between capitalists is abstracted from. Thus these two volumes analyse the interaction between capital and labour at the aggregate level. In Volume One of *Capital*, Marx analyses the process of production of capital, i.e. the processes of the generation of surplus value through the exploitation of labour, and the accumulation of surplus value to create additional capital. The analysis in Volume One implicitly assumes that commodities can be sold at prices necessary to realise the full value and hence surplus value embedded in them. In Volume Two Marx returns to an analysis of the issues related to the realisation of surplus value through the circulation of capital at the aggregate level. In Volume three of *Capital*, the analysis moves to a lower level of abstraction and analyses the distribution and re-distribution of surplus value. Competition between capitalists, and bargaining between capitalists and resource owners, e.g. owners of land, are the mechanisms through which the surplus value generated in production and realised through sale - analysed in Volumes One and Two - are distributed and redistributed in capitalist economies.³

In Volume Three, Marx’s discussion of the distribution of surplus value proceeds in two analytically separate steps. In the first step, the total surplus value generated in production

²Note that $\sum_{i=1}^{\infty} \{1000/(1+0.1)^i\} = (1000/0.1) = 10000$.

³For a discussion of the structure and content of *Capital*, see Basu (2017).

is distributed across different sectors through the competition between ‘industrial’ capitals.⁴ In the second step, some of the surplus value appropriated by ‘industrial’ capital, analysed in the first step, is further redistributed to other fractions of the ruling class as commercial profit, ground-rent and interest.

The capitalist who produces surplus-value, i.e. who extracts unpaid labour directly from the workers and fixes it in commodities, is admittedly the first appropriator of his surplus-value, but he is by no means its ultimate proprietor. He has to share it afterwards with capitalists who fulfil other functions in social reproduction taken as a whole, with the owner of the land, and with yet other people. Surplus-value is therefore split up into various parts. Its fragments fall to various categories of person, and take on various mutually independent forms, such as profit, interest, gains made through trade, ground rent, etc. (Marx, 1992, 709).

1.3 The Contribution of this Paper

This paper makes three contributions. First, this paper makes explicit an argument that is implicitly present in Volume Three of *Capital*, viz., that the analysis of ground-rent is applicable far beyond the domain of capitalist agricultural production. It can be applied to understand the income stream appropriated by owners of all privately owned non-produced resources, in the form of rent, when that resource is used in any form of capitalist commodity production. Thus, industries like fishing, mining, oil and natural gas, housing and real estate, tourism can be brought into the ambit of this analysis. To illustrate this point, I apply Marx’s theory of ground-rent, as presented in this paper, to think about some issues that are relevant to an understanding of contemporary capitalism.

Second, it provides a consistent, unified, analytical framework to think about the ‘fragment’ of surplus value known as ground-rent. While a voluminous literature has studied various issues analysed by Marx in Volume One of capital - like abstract labour, the labour process, the valorisation process, capital accumulation and the reserve army of labour - issues dealt with in Volumes Two and Three of *Capital* have been relatively neglected. While some attention has been devoted to volume two of capital following the pioneering work by Duncan Foley on the circuit of capital (Foley, 1982), the main issues discussed with regard to volume three of *Capital* have been the so-called transformation problem - which really took off with the Sraffa-based critique of the early 1970s (Steedman, 1977) - and the law of the tendential fall of the rate of profit - which drew lot of scholarly attention since the publication of the

⁴The term ‘industrial capital’ should be understood broadly as referring to capital that is involved in the production of commodities, which can be goods or services. It does not refer to industrial production only. Marx uses this term to distinguish capital involved in production from ‘merchant capital’, which is involved in the purchase and sale of commodities and ‘usurious capital’, which is involved in lending and borrowing of money. Both these forms of capital predate ‘industrial capital’ and are characterized by the fact that they appropriate value through unequal exchange but do not organize the production of commodities and the concomitant generation of surplus value.

Okishio theorem (Okishio, 1963). The processes of the distribution of surplus value in the form of interest, ground-rent and commercial profit has not been studied as extensively as the other issues. By providing an analysis of ground-rent, this paper tries to partly fill this lacuna.

The specific way in which I try to fill this lacuna also needs to be highlighted. While Eaton (1963), Mandel (1968), Foley (1986) and Fine (2006) offer insightful analyses of Marx's theory of ground-rent, this paper takes the discussion forward by *formalising* Marx's key ideas on ground-rent. While Marx used a series of examples in Volume Three of *Capital* to illustrate his arguments, and later authors followed him in presenting arguments mostly with the help of examples, there is a disadvantage in using such a methodology. Examples can illustrate quantitative arguments, but they cannot establish them. Specific examples are driven by specific assumptions, and so it is not possible to understand the general logic of the argument with the help of examples *only*. A formal, mathematical framework, on the other hand, can help us grasp general arguments. Such a framework also helps us identify the specific conditions under which Marx's insights about ground-rent are valid and the situations where Marx's analysis requires modifications and amendments.⁵

But a formal, mathematical presentation has the disadvantage that it reduces accessibility significantly. Hence, to make the argument accessible to a broader audience as also to highlight its full generality through a mathematical presentation, in this paper I adopt a strategy of using a mix of formal and non-technical modes of presentation. I present the overall argument in a primarily non-technical manner, with the help of examples, in the main text and provide a full mathematical treatment in the Appendix.

Third, it argues that a key assumption in Marx's analysis, viz., that the organic composition of capital in agriculture is lower than the economy-wide average organic composition can be relaxed. I show the role of this assumption in Marx's analysis and also demonstrate that the analysis of ground-rent can be carried out without relying on this assumption. This increases the applicability of the analysis because many of the industries that currently use non-produced resources, including agriculture in advanced capitalist countries, no longer have a lower than average organic composition of capital. Since one of the arguments of this paper is that rent incomes, and phenomena related to rent, in such industries can be explained by Marx's theory of ground-rent, it is important to develop the argument without relying on the assumption of lower than average organic composition of capital.

The rest of the paper is organised as follows. In section 2, I discuss the process of redistribution of surplus value and the emergence of the average rate of profit; this will provide the backdrop to the analysis of ground-rent in subsequent sections. In section 3, I present Marx's analysis of ground-rent and illustrate the argument with three examples. In section 4, I argue why Marx's analysis of ground-rent is relevant for understanding many features of contemporary capitalism and apply it to some issues from contemporary capitalism. I conclude the

⁵The discussion of rent in volume three of *Capital* shows that Marx was clearly aware of three types of ground-rent: (a) rent arising from monopoly price (Marx, 1993, pp. 898-899); (b) differential rent; and (c) absolute rent. While Marx briefly discusses the issue of rent that depends on monopoly price (for an illuminating example of a vineyard, see Marx (1993, pp. 910)), he devotes the bulk of the analysis to differential and absolute rent. In this paper, I follow Marx and only discuss differential and absolute rent.

discussion in section 5 with some ideas about extensions and future research directions. Appendix A presents the whole argument in mathematical form, and Appendix B discusses an example from chapter 44 in Volume Three of *Capital* where Marx demonstrates, incorrectly in my opinion, that differential rent of the second variety can arise on the worst plot of land.

2 Redistribution of Surplus Value and Surplus Profit

Let me briefly recapitulate the argument about the emergence of prices of production to create the background for the analysis of ground-rent. Natural differences in the conditions and technologies of production across different sectors of the economy implies variations in the organic composition of capital (OCC), i.e. the ratio of constant capital and variable capital used in production varies across sectors.⁶ Some sectors like machine production use lot more constant capital per unit of variable capital than the economy-wide average; on the other hand, some service sectors like the restaurant industry use much less constant capital per unit of variable capital than the average OCC for the whole economy.

Sectors with lower than the economy-wide average OCC exploit more labour-power per unit of invested capital than the social average. Hence, if the rate of exploitation is the same across all sectors of production, then the sectors with lower than average OCC generate more surplus value per unit of capital invested than the corresponding average in the whole economy. Using a variation of Marx's terminology, I will refer to the difference between the two as 'surplus profit' per unit of invested capital. In an analogous manner, sectors with higher than average OCC generate lower amounts of surplus value per unit of invested capital than the economy-wide average, i.e. they generate, again using a variation in Marx's terminology, 'deficit profit' per unit of invested capital. If each sector realized the surplus value it generated, then sectors with lower than average OCC would realize rates of profit on invested capital that are higher than the economy-wide average. Similarly, sectors with higher than average OCC would realize rates of profit on invested capital that are lower than the economy-wide average. But different rates of profit across different sectors of the economy cannot be a situation of long term equilibrium.

Sectors with lower than average OCC, which generate 'surplus profit', would attract capital; and sectors with higher than average OCC, which generate 'deficit profit', would lose capital. This movement of capital across sectors would continue until *all sectors that participate in this process* realize an *average rate of profit* on their invested capital. The prices of commodities which ensure the average rate of profit for each sector are called the *prices of production*. For instance, if the constant and variable capital used per unit of a commodity is denoted by c and v , and the average of profit in the economy is denoted by \bar{r} , then the price of production for the commodity, p , is given by $p = (c + v)(1 + \bar{r})$.

There are two important features of this process of the emergence of prices of production and an average rate of profit that require our attention. First, the emergence of prices of

⁶Constant capital is the sum of money used to purchase the non-labour inputs, and variable capital is the sum of money used to purchase the labour input, into capitalist commodity production (Marx, 1992, Chapter 8).

production and the average rate of profit is a process of redistribution of the total surplus value created in production. While surplus value flows away from the lower than average OCC sectors, the higher than average OCC sectors gain surplus value. It is only then that all sectors can earn the same (average) rate of profit on invested capital. Second, the mechanism through which prices of production emerges (in the long run) is the free mobility of capital across sectors in search of higher rates of profit. If there are factors that impede the free mobility of capital, then it is *possible* for some sectors with lower than average OCC to appropriate the total surplus profit they generate. This is the entry point to the analysis of ground-rent in agriculture.

Agricultural production under capitalist relations of production in nineteenth century Europe had two important characteristics. First, there was a limited quantity of land that can be used for agricultural production. Second, the land that could be used for agricultural production was under private ownership. Marx refers to this as the ‘monopoly of landed property’ and clarifies the precise sense of this ‘monopoly’

Landed property presupposes that certain persons enjoy the monopoly of disposing of particular portions of the globe as exclusive spheres of their private will to the exclusion of all others (Marx, 1993, pp. 752)

Before proceeding further, it is important to note that while Marx explicitly referred to capitalist *agricultural* production with a limited quantity of land for the analysis of ground-rent, it can be applied to the case of any capitalist commodity production that uses some non-produced resource which is limited in quantity. Hence, for the analysis in this paper, I will use the term ‘agriculture’ to refer to capitalist commodity production that uses a generic non-produced resource that is limited in quantity, the latter being referred to as ‘land’, and the term ‘monopoly of landed property’, to refer to private ownership of ‘land’.

The monopoly of landed property implies that owners can legally prevent others from accessing or using the land. Under capitalist relations of production, these two factors - limited quantity and private ownership of the non-produced resource - come together to create impediments to the free movement of capital into agriculture. That creates the basis for the emergence of rent. This is because once *all* the available land has been appropriated as private property, no more land would be freely available for capital investment. In such a situation, new capital can be invested into agricultural production, which crucially uses land, only by displacing some existing capitalists. Therefore, the fixed quantity of privately owned land becomes a barrier to the mobility of capital into the agricultural sector. Since capital cannot freely enter into agriculture, the surplus value created in agriculture does not participate in the economy-wide process of redistribution of surplus value. This implies that the ‘surplus profit’ generated by capital invested in agriculture (because agricultural production has an OCC that is lower than the economy wide average), i.e. the profit over and above what is implied by the economy-wide average rate of profit, can remain in agriculture.

Depending on the exact structure of private ownership of agricultural land, the surplus profit in agriculture can take two forms. First, if the land used for agricultural production is owned by the capitalist-farmers (the agents who organise production), then the ‘surplus

profit' accrues to the capitalist-farmers as *supernormal profits*. Second, if monopoly of ownership of the land rests with the class of landowners - a situation Marx refers to as 'landed property' - then the 'surplus profit' is appropriated by landowners as *ground-rent*.⁷ This is referred to by Marx as the *transformation of surplus profit* into ground-rent.⁸

Landed property operates as an absolute barrier only in as much as any permission to use land, as a field of investment for capital, enables the landowner to extract a tribute. (Marx, 1993, 899).

In volume three of *Capital*, Marx analyses the second structure of private ownership of agricultural land, i.e. landed property, to understand the emergence of ground-rent (Marx, 1993, pp. 755-756). But it is analytically convenient to first analyse the case of capitalist agriculture without landed property, i.e. where land is owned by the capitalist-farmers themselves. This structure of private property in land allows us to see clearly the generation of surplus profit. This allows us, in the next step of the analysis, to easily grasp the phenomenon of ground-rent as the appropriation of the surplus profit by the class of landowners. This drives home the point that ground-rent is a *transformation* of surplus profit in the sense that (a) surplus profit can exist even in the absence of landed property, as Marx had indicated by referring to its 'natural basis' and as the analysis of capitalist farming without landed property shows, and (b) ground-rent arises only under certain property relations viz., monopoly of ownership of land by the class of landlords. The second point dispels any illusions about ground-rent as arising from some natural property of the land.

3 Surplus Profit and Ground-Rent in Agriculture

3.1 Surplus Profit without Landed Property

Let us begin the analysis by considering capitalist agricultural production without landed property, i.e. a situation where the plots of agricultural land are owned by the capitalist farmers themselves. Plots of land used for agricultural production naturally vary by their quality. This variation arises from *natural differences in fertility and location* (Marx, 1993, pp. 789). Differences in the quality of land give rise to differences in their productivity,

⁷Here the term 'monopoly' is used to refer to private ownership of land by the class of landlords. It has nothing to do with the structure of the market for the agricultural commodity, i.e. whether it is competitive or monopolistic. As I notes earlier, Marx is aware of the possibility of rent due to 'monopoly' price (in the sense of the market structure being monopolistic), but that is not the object of analysis in volume three of *Capital*. So, when I use the term 'monopoly' it will only be in the sense of monopoly of ownership.

⁸When the land is owned by landowners, there is an additional aspect of the barrier to capital investment. At the expiration of the lease contract, all the "improvements made to the land fall to the landowner as his property, as an inseparable accident of the substance, the land" (Marx, 1993, pp. 757). The new lease would be for a higher amount and so the benefits of the capital investments like irrigation that result in a permanent improvement of the land would be reaped by the landowner, and not the capitalist-farmer. Hence, the presence of landed property creates disincentives for capital investments that could lead to permanent improvements in the quality of land.

which, in turn, implies differences in the cost of production per unit of output across the plots of land. This leads to a hierarchy of rates of profit across plots of land, with the worst quality plot generating the lowest and the best quality plot generating the highest rate of profit.

To see the reason for the hierarchy of profit rates, recall that the profit rate is the ratio of profit income per unit of output and cost of producing a unit of the output, i.e. the unit cost of production, where profit income per unit of output is the difference between the price and the unit cost of production. Higher quality of land implies higher productivity, i.e., higher quantity of output from the same land area, which, in turn, leads to lower unit cost of production. Hence, the denominator in the definition of the rate of profit is lower for higher quality plots of land. Since the price of the agricultural commodity is the same for all producers no matter which plot of land they use, higher productivity translates into higher profit income per unit of output. Thus, the numerator in the definition of the rate of profit is higher. Hence, higher quality of land implies higher rates of profit. Thus, the capitalist-farmer with the worst quality plot of land earns the lowest rate of profit and the other capitalist-farmers reap higher rates of profit in the same rank order as the quality of their plots of land.

To make the argument in more precise terms it will be helpful to differentiate the plots of land, especially the worst plot from the rest. To do so, let us assume that there are N plots of land, each of which can be labelled with one of the numbers $1, 2, \dots, N$. Since plots of land vary by quality, we can always choose to do the labelling in increasing order of quality. Thus, plot 1 refers to the worst quality land, plot 2 to the next best quality land, and so on, with plot N referring to the best quality land. To make an argument about a generic plot of land, we will identify it with the label i , where i can take any of the following values: $1, 2, \dots, N$. For instance, the rate of profit on plot i will be denoted by r_i , where the subscript tells us that we are referring to plot i .

With this notational scheme, we can express the argument about the hierarchy of profit rates that we made above as follows: $r_1 \leq r_2 \leq r_3 \dots \leq r_N$, i.e. the rate of profit is the lowest on the worst quality plot, and increases with the quality of the plots to the the highest value for the best quality plot. An immediate implication, which will become important in the discussion of differential rent, is that all plots earn some ‘extra’ profit in relation to the worst quality plot of land.

If the economy-wide average rate of profit is given by α , then it is useful to compare the rate of profit generated on a generic plot of land, r_i , with this economy-wide average rate of profit. When a plot of land generates a rate of profit in excess of the economy-wide average rate of profit, it is said to generate ‘surplus profit’. To pin down the magnitude of the surplus profit on plot i , let c_i and v_i denote, respectively, the constant and variable capital used on that plot of land. Hence, the ‘capital advanced’ on plot i is given by $c_i + v_i$, i.e. the sum of constant capital and variable capital. If the capital advanced on this plot were to earn a rate of profit r_i , then the total profit income would be $(c_i + v_i) \times r_i$, i.e. the product of the capital advanced and the rate of profit. If, on the other hand, the capital advanced on plot i were to earn the economy-wide average rate of profit, denoted as α , then the total profit

income would be $(c_i + v_i) \times \alpha$. The difference between the two is the ‘surplus profit’, i.e. profit income over and above what would be implied by the economy-wide average rate of profit. Hence, if we denote by SP_i the surplus profit on plot i , then it is given by

$$SP_i = (c_i + v_i) r_i - (c_i + v_i) \alpha = (c_i + v_i)(r_i - \alpha). \quad (1)$$

3.2 Ground-Rent with Landed Property

Let us now turn to analysing capitalist agricultural production in the presence of landed property, i.e. a situation where the land used for agricultural production is owned by a class of landowners (that is different from the class of capitalist farmers). Capitalist agricultural production in the presence of landed property involves three economic agents: the capitalist-farmer who organizes the production process; the wage-worker who does the actual work of cultivation; and the landlord who owns the land and rents it out to the capitalist-farmer. The rental contract between the landlord and the capitalist-farmer involves payment of a fixed sum of money by the capitalist-farmer to the landowner in return for the permission *to use the plot of land* for a fixed period of time (specified in the contract). This sum of money is called *ground-rent*.

The presuppositions for the capitalist mode of production [in agriculture] are thus as follows: the actual cultivators are wage-labourers, employed by a capitalist, the farmer, who pursues agriculture simply as a particular field of exploitation of capital, as an investment of his capital in a particular sphere of production. At certain specified dates, e.g. annually, this capitalist-farmer pays the landowner, the proprietor of the land he exploits, a contractually fixed sum of money ... for the permission to employ his capital in this particular field of production. This sum of money is known as ground-rent, irrespective of whether it is paid for agricultural land, building land, mines, fisheries, forests, etc. It is paid for the entire period for which the landowner has contractually rented the land to the farmer (Marx, 1993, pp. 755-756)

Ground-rent arises from the fact that agricultural land, which is limited in quantity, is privately owned by the class of landowners. Private ownership of the limited quantity of land allows the landowners to bargain away a part of the surplus value generated in agricultural production in lieu of the right to use the land. This is what Marx means by the ‘transformation of surplus profit into ground-rent’.

In quantitative terms, what part of the surplus value can be appropriated by the landowners through bargaining? Landowners can bargain away the *whole of the* ‘surplus profit’ from the capitalist-farmers, leaving them with just the amount of surplus value which allows them to earn a rate of profit on their investment that is equal to the average rate of profit in the whole non-agricultural sector. If the landlord tries to ask for more, the capitalist-farmer will not agree because she would be able to earn a higher rate of profit elsewhere in the economy; if the capitalist-farmer asks for more, the landlord would refuse, and instead offer the land

to a different capitalist-farmer. The only stable situation would be when the landlord is able to appropriate the whole of the surplus profit. Hence, in quantitative terms, *ground-rent is the ‘surplus profit’ appropriated by the landowners.*

Since ground-rent is surplus profit, we can use the expression for the latter in (1) to express the former on plot i as

$$GR_i = (c_i + v_i)r_i - (c_i + v_i)\alpha = (c_i + v_i)(r_i - \alpha), \quad (2)$$

where GR_i denotes the magnitude of ground rent on plot i .

Marx argued that the total ground-rent on any plot of land can be decomposed into three parts, differential rent of the first variety, differential rent of the second variety and absolute rent. A little algebraic manipulation shows that this is indeed the case:

$$GR_i = DRI_i + DRII_i + AR = DR_i + AR \quad (3)$$

where

$$DRI_i = (c_i + v_i)(r_i - r_1)$$

is differential rent of the first variety,

$$DRII_i = [(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha)$$

is differential rent of the second variety, and

$$AR = (c_1 + v_1)(r_1 - \alpha)$$

is absolute rent, and the sum of DRI and $DRII$ is differential rent (without any prefix)

$$DR_i = DRI_i + DRII_i.$$

Differential rent of the first variety - what Marx refers to as DRI - arises from differences in the quality of plots of land (Marx, 1993, chapter 39). Differences in the quality of plots of land imply differences in unit costs of production, so that it leads to differences in the rates of profit earned, as we have noted above. In concrete terms, this difference is captured by the difference in the rate of profit on plot i with respect to the rate of profit on the worst plot of land, r_1 . Thus, the worst plot of land functions as the benchmark plot for the computation of DRI . The profit income generated on plot i is given by $(c_i + v_i)r_i$; if the capital invested on plot i were to earn the rate of profit earned by the benchmark plot, then the total profit income generated on the plot would be $(c_i + v_i)r_1$. The difference between the two is DRI_i . That is why differential rent of the first variety on plot i is given in (2) by $(c_i + v_i)(r_i - r_1)$.

Differential rent of the second variety - what Marx refers to as $DRII$ - arises from differences in the amount of capital invested on different plots of land (Marx, 1993, chapter 41). With the worst plot of land functioning as the benchmark, once again, the difference in capital invested on plot i is given by $[(c_i + v_i) - (c_1 + v_1)]$. The surplus profit generated on the worst plot is $(c_1 + v_1)(r_1 - \alpha)$. If the capital invested on plot i were to generate the

surplus profit *at the same rate*, then total surplus profit income would be $(c_i + v_i)(r_1 - \alpha)$. Hence, the excess surplus profit on plot i that can be attributed to the difference in invested capital is given by the difference between the two, i.e., $[(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha)$. This is differential rent of the second variety, *DRII*.

Since the worst plot of land functions as the benchmark for both quality of land and quantity of capital invested, it can earn neither *DRI* (which arise from difference in quality of land) nor *DRII* (which comes from differences in amounts of capital invested). Does it mean that the worst plot earns no rent? The answer is a resounding no. As long as landed property exists, no plot of land, including the worst plot, will be available *gratis* for use in commodity production (Marx, 1993, pp. 884–885, 890–891).

Assuming then that demand requires the taking up of new land which is, say, less fertile than that previously cultivated, will the owner of this land lease it for nothing just because the market price of its product has risen high enough for capital investment to pay the farmer the price of production and thus yield him the customary profit? In no way. The capital investment must yield him a rent. He leases only when a lease-price can be paid. (Marx, 1993, pp. 891)

The surplus profit that is earned on the worst plot of land is known as absolute rent (Marx, 1993, chapter 45).⁹ This explains why the expression for absolute rent on plot i in (2) is given by $(c_1 + v_1)(r_1 - \alpha)$. An important property of absolute rent is that, for all plots of land other than the worst plot, it gets added to *DRI* and *DRII* to generate the magnitude of total ground-rent (Marx, 1993, pp. 882–884). This is because each of these two types of differential rent, *DRI* and *DRII*, is computed with reference to the worst plot of land.¹⁰

Since no plot of land can be obtained for free, the magnitude of absolute rent will always be positive. Moreover, since absolute rent is a component of total ground-rent, it can never exceed the latter. Since total ground-rent is the sum of absolute rent, *DRI* and *DRII* this means that the sum of *DRI* and *DRII*, which we can call differential rent (without any postfixes), will always be positive. This is an important point because of the possibility for *DRII* to be negative. Since there are no restrictions on the amounts of capital invested (or advanced) on any plot of land, it is not inconceivable that the amount of capital invested on plot i is lower than the amount invested on plot 1, i.e. $(c_i + v_i) < (c_1 + v_1)$. Since $DRII_i = [(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha)$, this will make *DRII* negative, as long as $r_1 > \alpha$. But this does not create any problem for Marx's analysis because we know that the total differential rent, i.e. the sum of *DRI* and *DRII*, will always be positive. Thus, in such a scenario, i.e. with negative *DRII*, the magnitude of *DRI* will be large enough to nullify the

⁹In chapter 45, Marx refers to the worst plot of land as land of type A; for instance, see Marx (1993, pp. 882).

¹⁰The recognition of the existence of absolute rent differentiates the Marxist tradition from the Ricardian and Sraffian traditions. For Ricardo (1821), and following him for Sraffa (1960), the rent on the worst plot of land was zero. Marx, and the Marxist tradition, disagrees. The worst plot of land also earns positive magnitudes of rent, as long as private ownership of land is enforced and there is no free land to be used.

negative magnitude of *DRII*. Of course, whether it is probable that $(c_i + v_i) < (c_1 + v_1)$ for any plot i is a question worth thinking about, and I will return to this later.

3.3 Price of the Agricultural Commodity

The magnitude of ground-rent on any plot of land depends, as can be seen from the expression in (2), on three factors: the economy-wide average rate of profit, α , the capital advanced, $(c_i + v_i)$, and the rate of profit generated on the plot, r_i . The economy-wide rate of profit is external to the agricultural sector and can be taken as an exogenous parameter. The capital advanced is also taken as given, in the sense that the analysis of ground-rent does not investigate the determinants of the capital advanced on each plot of land. Rather, given the magnitudes of capital advanced, the analysis computes the magnitude of the ground-rent. Hence, the focus of the whole analysis is on the third factor: the rate of profit generated on any plot of land.

We now turn to the crucial question: what determines the rate of profit that is generated on any plot of land? Recall that the profit rate per unit of the agricultural commodity is the ratio of profit income per unit of the commodity and the unit cost of production. Profit income per unit of the commodity is the difference between the price and the unit cost of production. Hence, the rate of profit depends on the ratio of the price of the commodity and the unit cost of production. Since the analysis of ground-rent takes the constant and variable capital as datum, the key factor that determines the rate of profit is the price of the agricultural commodity. Is there any economic principle that could pin down the actual market price of the agricultural commodity?

The first thing to note is that the economic principle underlying the formation of long run prices of production will not be of help. Since there are barriers to the movement of capital in agriculture - due to the private ownership of a fixed and finite quantity of land - the surplus value generated in capitalist agricultural production does not participate in the economy-wide redistribution of surplus value. Hence agricultural commodities do not sell at the price of production even in the long run.¹¹ Since prices of production do not emerge in the market for agricultural commodities in the long run, we need an alternative economic principle to determine the long run price of the agricultural commodity.

Marx's analysis in Volume Three of *Capital* offers one important principle for the determination of the agricultural commodity's price: zero net flow of surplus value from agriculture. Marx argues that barriers to the movement of capital implies that the total surplus value (and hence value) generated in agriculture will remain in agriculture. This provides one possible economic principle to determine the price of the agricultural commodity, viz., the price of the agricultural commodity will be such as to ensure that the total surplus value (and hence value) generated in agriculture remains in agriculture.

We need to address one important question about the price level that ensures the full retention of surplus value in agriculture. Under what conditions will this price level ensure positive amount of ground-rent on all plots of land? The intuitive answer is the one that

¹¹That is why I have used the term 'notional' price of production.

Marx worked with: relatively low organic composition of capital in agriculture. If the organic composition of capital in agriculture is *sufficiently low* in comparison to the economy-wide organic composition, then agriculture will generate sufficiently large amounts of surplus profit at the aggregate level. If, given a sufficiently low organic composition in agriculture, all the surplus profit is also retained in agriculture, then it is possible for each plot of land to generate surplus profit, and hence ground-rent.

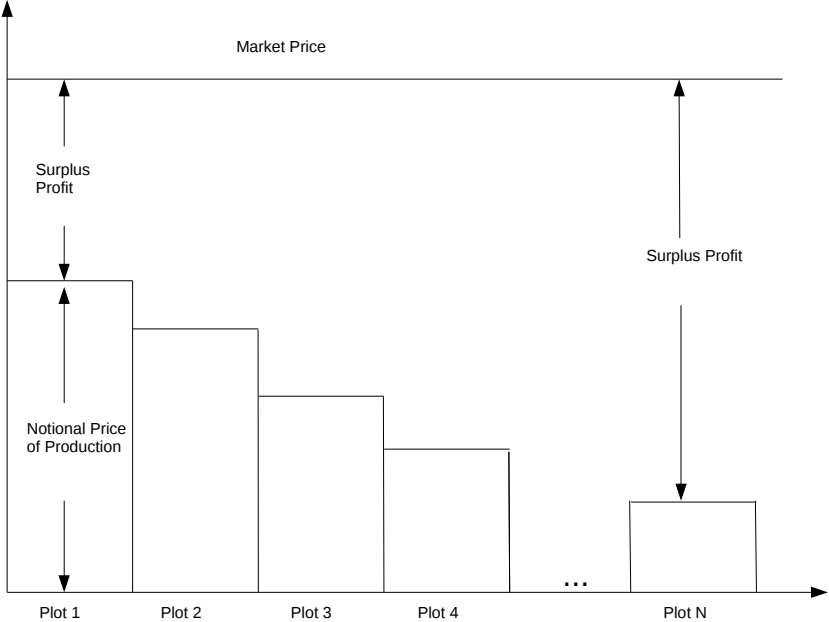


Figure 1: *Surplus profit in agriculture in the absence of landed property. The height of the horizontal line represents the market price and the height of the bars on each plot represent the notional price of production on that plot. The difference between the two represent surplus profit.*

Once the price of the agricultural commodity has been determined, we can use it to present the analysis of surplus profit and ground-rent, in Figure 1 and Figure 2, respectively. Figure 1 is used to show the existence of surplus profit in the absence of landed property. Agricultural production is organized on plots of land, which are arranged in increasing order of quality, with plot 1 the worst and plot N the best quality plot. Hence, the unit cost of production falls as we move from plot 1 to plot N . Since the notional price of production is the cost of production multiplied by $(1 + \alpha)$, that too falls across the plots of land. This is depicted by the height of the bars on the plots of land. The difference between the market price (measured by the height of the horizontal line) and the notional price of production (measured by the height of the bar) gives the surplus profit on any plot of land. Hence, the

surplus profit is lowest on the worst plot (plot 1) and increases secularly as we move to the best plot (plot N), as depicted in Figure 1.

The existence of ground rent, as transformed surplus profit, can be seen graphically in Figure 2. Plots of land have been arranged in increasing order of quality, as in Figure 1, with plot 1 the worst and plot N the best quality plot of land. Surplus profit on the worst plot of land is absolute rent, which is also the total ground-rent on the worst plot of land. On all other plots of land, total ground-rent is the sum of absolute and differential rent, the latter being the sum of DRI and $DRII$.

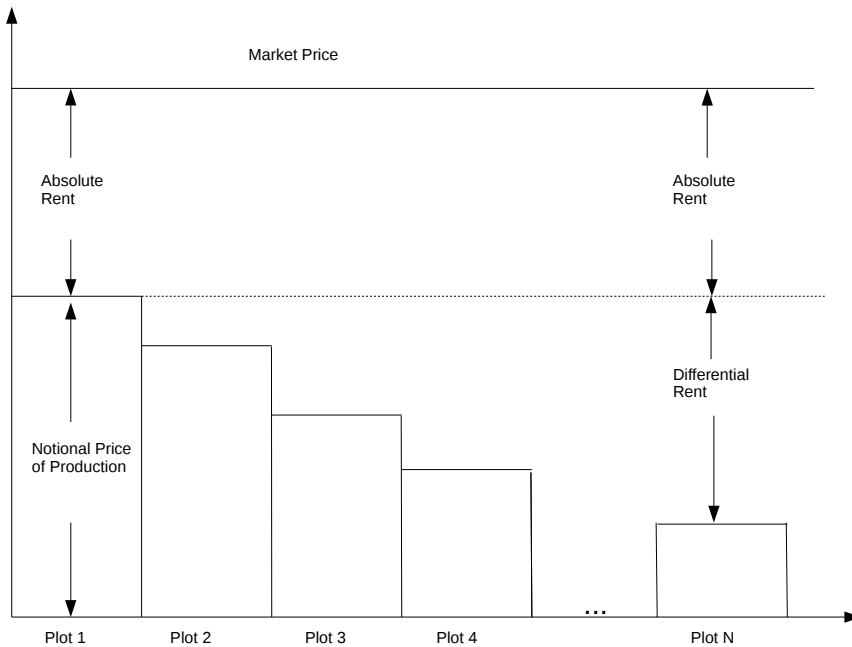


Figure 2: *Surplus profit transformed into ground-rent in agriculture in the presence of landed property. The height of the horizontal line represents the market price and the height of the bars on each plot represent the notional price of production on that plot. For any plot of land, the difference between the two represent total ground rent. The ground rent on the worst plot of land is the absolute rent in this economy, which is earned on every plot of land. Hence, for any other plot of land, the difference of the total ground rent and the absolute rent is the differential rent.*

I will now illustrate the basic features of Marx's analysis of ground-rent using three examples. In the first example, we will study a capitalist agricultural economy where there is no landed property, i.e., the land is owned by the capitalist farmers. This example will clearly show the emergence of surplus profit. In the next two examples, we will study capitalist agricultural economies with landed property. We will see how surplus profit is

transformed into ground-rent once landed property is brought into the analysis, and how the total ground-rent can be decomposed into absolute and differential rent.

3.4 Example 1: Surplus Profit in Agriculture without Landed Property

Suppose there are 3 plots of land with varying quality, each owned by a different capitalist-farmer. The worst plot of land produces 100 kgs of the agricultural commodity (wheat, say); the medium plot of land produces 120 kgs/acre; and the high quality land produces 150 kgs/acre. All plots of land have the same cost of production: constant capital of 500 and variable capital of 500. Suppose the rate of exploitation is 100% so that the amount of surplus value generated on each plot of land is 500. Suppose the economy-wide average rate of profit is 10%. This information is summarised in Table 1.

Table 1: *Surplus Profit in Capitalist Agriculture without Landed Property^a*

	Land Quality		
	Low	Medium	High
Quantity of output (kgs/acre)	100	120	150
Constant capital (\$)	500	500	500
Variable capital (\$)	500	500	500
Surplus value (\$)	500	500	500
Value (\$)	1500	1500	1500
Constant capital (\$/kg)	5.00	4.17	3.33
Variable capital (\$/kg)	5.00	4.17	3.33
Surplus value (\$/kg)	5.00	4.17	3.33
Value (\$/kg)	15	12.50	10
Market price (\$/kg)	12.16	12.16	12.16
Total revenue (\$/acre)	1216.22	1459.46	1824.32
Profit (\$/acre)	216.22	459.46	824.32
Profit rate (%)	21.62	45.95	82.43
<u>Memo:</u>			
Average rate of profit (%)	10	10	10
Surplus profit (\$/acre)	116.22	359.46	724.32
Surplus profit rate (%)	11.62	35.95	72.43

^a The land used for cultivation is owned by the class of capitalist-farmers themselves.

We would like to compute the magnitudes of surplus profit on each plot of land. To do so, we need to calculate the market price of wheat. We know that the price will be such as to ensure that all the surplus value generated in agriculture remains in agriculture. This can be ensured if the market price of wheat is equal to its value. Now, the total value generated in agriculture is 4500 and the total amount of wheat produced is 370. Hence the price of wheat which would ensure that all the value generated in agriculture is retained in agriculture is given by $12.162 = (4500/370)$.

With this information on the price of the agricultural commodity, we can calculate the total profit generated on the worst plot of land as $216.22 = ((12.162 * 100) - 1000)$. Since the economy-wide average rate of profit is 10%, the surplus profit on the worst plot of land becomes $116.22 = (216.22 - 1000 * 0.1)$. In a similar manner, the total profit on the medium quality plot of land is given by $459.46 = ((12.162 * 120) - 1000)$, so that the surplus profit on the medium quality plot of land is $359.46 = (459.46 - 1000 * 0.1)$. Using the same logic, we see that the total profit on the high quality plot of land is $824.32 = ((12.162 * 150) - 1000)$, so that the surplus profit on that plot is $724.32 = (824.32 - 1000 * 0.1)$.

3.5 Example 2: Ground-rent in Agriculture-I

We would now like to study the emergence of ground-rent in capitalist agriculture with landed property. To facilitate comparison, we will work with the same data as used in the previous example. All the technical conditions of production will remain as before and the only change will relate to the structure of ownership. Instead of capitalist-farmers owning the land, now the land will be owned by a class of landowners (who are different from the class of capitalist-farmers). This will help in highlighting the social origins of ground-rent and dispel any illusion that it derives from some natural property of land.

As before, suppose there are 3 plots of land with varying quality. The worst plot of land produces 100 kgs of the agricultural commodity (wheat, say); the medium plot of land produces 120 kgs/acre; and the high quality land produces 150 kgs/acre. The important difference comes from the following fact: *each plot of land is owned by a landowner*. Capitalist-farmers rent land from the landowners for a rental payment called ground-rent.

As before, all plots of land have the same cost of production: constant capital of 500 and variable capital of 500. Suppose the rate of exploitation is 100% so that the amount of surplus value generated on each plot of land is 500. This information is summarised in Table 2.

We would like to compute the magnitude of ground-rent, and its decomposition into absolute and differential rent, on each plot of land. Since we have already calculated the surplus profit on each plot of land in Example 1, we can draw on that information. We know that the absolute rent is the surplus profit on the worst plot of land. Hence, using the results in the first column of Table 1, we find that absolute rent in this economy is 116.22. Using results from the second and third columns of Table 1, we see that the surplus profit on the medium and high quality land is 359.46 and 724.32, respectively. This tells us the magnitude of the total ground-rent on these plots: 359.46 and 724.32, respectively.

Next, we would like to decompose the total ground-rent into its components. The worst

Table 2: *Transformation of Surplus Profit into Ground-Rent in Capitalist Agriculture with Landed Property^a*

	Land Quality		
	Low	Medium	High
Quantity of output (kgs/acre)	100	120	150
Constant capital (\$)	500	500	500
Variable capital (\$)	500	500	500
Surplus value (\$)	500	500	500
Value (\$)	1500	1500	1500
Constant capital (\$/kg)	5.00	4.17	3.33
Variable capital (\$/kg)	5.00	4.17	3.33
Surplus value (\$/kg)	5.00	4.17	3.33
Value (\$/kg)	15	12.50	10
Ground-rent (\$/acre)	116.22	359.46	724.32
Ground-rent (\$/kg)	1.16	3.00	4.83
Average rate of profit (%)	10	10	10
Price of production without rent (\$/kg)	11.00	11.00	11.00
Market price with rent (\$/kg)	12.16	12.16	12.16
Total revenue (\$/acre)	1216.22	1459.46	1824.32
<u>Capitalist-farmer:</u>			
Profit after rent (\$/acre)	100	100	100
Profit rate after rent (%)	10	10	10
<u>Landowner:</u>			
Absolute rent (\$/acre)	116.22	116.22	116.22
Differential rent I (\$/acre)	0	243.24	608.10
Differential rent II (\$/acre)	0	0	0
Total Ground-rent (\$/acre)	116.22	359.46	724.32

^a The land used for cultivation is owned by the class of landowners, who charge a monetary payment called ground-rent to let capitalist-farmers use it for cultivation of commodities.

plot of land earns no differential rent. Hence, the total rent on the worst plot of land is equal to the absolute rent, which implies that differential rent is zero. This is shown in the first column of Table 2. Turning to the medium quality plot, we can find the differential rent as the difference between the total ground-rent and the absolute rent: $243.24 = (359.46 - 116.22)$. In a similar way, we can find the differential rent on the best quality plot as $608.10 = (724.32 - 116.22)$. Note that the differential rent in this example is entirely of the first variety, *DRI*. This is because, by assumption, the capital invested is the same on each plot of land. Since *DRII* arises from the difference in the magnitudes of capital invested on different plots of land, in this example *DRII* is zero.

This example shows how the emergence of ground-rent entails a redistribution of surplus value generated in capitalist agriculture between the class of capitalist-farmers (who organize the production) and the class of landowners (who own the land). The landowners appropriate the whole of the surplus profit on each plot of land. This leaves just enough surplus value with the capitalist-farmers to ensure the average rate of profit, 10%, earned in the non-agricultural economy.

3.6 Example 3: Ground-rent in Agriculture-II

In the example discussed in Table 2, differential rent of the second variety was ruled out by construction. This was because the magnitude of capital advanced was the same on all the three plots of land. In the next example I remove that restriction by letting the magnitude of constant capital vary across the plots of land. For simplicity of calculations, I keep all other aspects of the example same as in the previous example. The information relating to this example is summarised in Table 3.

We are interested in computing the magnitude and decomposition of ground-rent on each plot of land. To do so, we need to compute the price of the agricultural commodity and then use the price data to compute surplus profit on each plot of land. Let us start with the market price of the agricultural commodity.

The total value generated in agriculture is 4650 and the total output is 370. Hence the price of the agricultural commodity - the price which keeps all the surplus value generated in agriculture within agriculture - is $12.57 = (4650/370)$. With this information we can now find the surplus profit on each plot of land. On the worst plot, the total profit is $256.76 = (12.57 * 100 - 1000)$, so that the surplus profit is $156.76 = (256.76 - 1000 * 0.1)$, using the economy-wide average rate of profit of 10%. The total profit on the medium quality plot is $458.11 = (12.57 * 120 - 1050)$ and on the best quality plot is $785.14 = (12.57 * 150 - 1100)$. Thus, the surplus profit on the medium and best quality plots are, respectively, $353.11 = (458.11 - 1050 * 0.1)$ and $675.14 = (785.14 - 1100 * 0.1)$.

Since the absolute ground-rent in this economy is the surplus profit on the worst plot of land, we see that its magnitude is 156.76. This is also the total ground-rent on the worst quality plot of land, as shown in the first column in Table 3. Turning to the medium quality plot, we can calculate the total differential rent as the difference between the surplus profit and the absolute rent. Hence, total differential rent is $196.35 = (353.11 - 156.76)$. To decompose this into *DRI* and *DRII*, we need to compute the rate of profit generated on

Table 3: *Transformation of Surplus Profit into Ground-Rent in Capitalist Agriculture with Landed Property^a*

	Land Quality		
	Low	Medium	High
Quantity of output (kgs/acre)	100	120	150
Constant capital (\$)	500	550	600
Variable capital (\$)	500	500	500
Surplus value (\$)	500	500	500
Value (\$)	1500	1550	1600
Unit cost of production (\$/kg)	10.00	8.75	7.33
Average rate of profit (%)	10.00	10.00	10.00
Price of production before rent (\$/kg)	11.00	11.00	11.00
Market price with rent (\$/kg)	12.57	12.57	12.57
Total revenue on sale (\$/acre)	1256.76	1508.11	1885.14
Ground-rent (\$/acre)	156.76	353.11	675.14
Ground-rent (\$/kg)	1.57	2.94	4.50
Capitalist-farmer:			
Profit after rent (\$/acre)	100	105	110
Profit rate after rent (%)	10	10	10
Landowner:			
Absolute rent (\$/acre)	156.76	156.76	156.76
Differential rent I (%)	0	188.51	502.70
Differential rent II (%)	0	7.84	15.68
Total Ground-rent (\$/acre)	156.76	353.11	675.14

^a The land used for cultivation is owned by the class of landowners, who charge a monetary payment called ground-rent to let capitalist-farmers use it for cultivation of commodities.

each of the plots.¹²

On the worst plot of land, the total profit generated is 256.76 and the cost of production is 1000. Hence the rate of profit generated on the worst quality plot is 25.67%. Similarly, the total profit on the medium quality plot is 458.11 and the total cost of production is 1050. Hence, the rate of profit is 43.63%. Using the same logic, the rate of profit on the best quality plot is 71.38% = (785.14/1100). With this information, we can now compute *DRI* on the medium and best quality plots.

The magnitude of *DRI* on the medium quality plot is the product of the capital advanced and the difference of the rate of profit with the worst quality plot: $188.51 = (1050 * (0.436 - 0.257))$. Similarly, the magnitude of *DRI* on the best quality plot is $502.70 = (1100 * (0.714 - 0.257))$. The difference of the total differential rent and *DRI* gives us the magnitude of *DRII* on both plots, as shown in the second and third columns of Table 3.

4 How Relevant is this Analysis?

4.1 Two Issues

There can be at least two sources of scepticism about the usefulness of Marx's theory of ground-rent as a framework for the investigation of contemporary capitalism. First, Marx's analysis focused on the phenomenon of ground-rent in the context of European capitalist agricultural production in the presence of landed property. How relevant is that analysis for contemporary capitalism where the class of landlords, i.e. what Marx referred to as landed property, has virtually disappeared from large parts of the world? Second, Marx's analysis of ground-rent, as we have seen, relies quite heavily on the assumption that the organic composition of capital in agriculture is lower than the economy-wide average. It is well known that capital intensity of production processes in agriculture has increased across large parts of the world, so that it is no longer possible to argue that agriculture is characterized by a lower than average organic composition of capital.¹³ For many other industries where the use of non-produced resources is important, like mining, oil and natural gas, construction, the capital intensity of production is in no obvious sense lower than other sectors of the economy. Thus, a question that needs to be addressed is whether Marx's analysis remains valid even when the sector under investigation does not have lower than average organic composition of capital. I will address these two concerns in turn.

While the disappearance of the class of landowners in agriculture from large parts of the world might suggest that Marx's analysis of ground-rent is no longer relevant, that is incorrect. While Marx had analysed the emergence of ground-rent with reference to agricultural production in the presence of landed property, the analysis can be equally well applied to understand rent income in a variety of contemporary settings, like mining, real

¹²For the expression for *DRI* and *DRII*, refer to equation (3) in the text.

¹³In many developing countries, the assumption is, of course, still largely valid. But in these countries, capitalism is still dominated by petty commodity production. That complicates the straightforward application of Marx's theory.

estate, oil and natural gas production, tourism. What is important is the structure of relationship that is established in the production process between, on the one hand, the capitalist commodity producer, and on the the other, the owner of some non-produced resource that is used for that production. As long as capitalist commodity production uses some privately owned non-produced resource that is limited in quantity, as is the case, for instance, in mining, in oil and natural gas production, in real estate development, the owner of that resource can bargain away a part of the surplus value in the form of rent. Whether the commodity produced is wheat or natural gas or tourism services is not very germane to the analysis. Thus, the fact that Marx referred primarily to agriculture in Volume Three of *Capital* does not in any way reduce the relevance of that analysis for contemporary capitalism.

How crucial is the assumption of lower than average organic composition of capital in the sector where rent is generated? It is far less important that seems apparent at first. What is crucial for the emergence of rent in a sector with privately owned non-produced resources is that the market price of the commodity produced with the non-produced resource be such that it generates surplus profit on each plot of 'land'. In Volume Three of *Capital*, Marx had proposed a *specific mechanism* for the determination of the market price that relied on the assumption of lower than average organic composition of capital. But as I had pointed out earlier, what Marx had proposed was only one possible mechanism. There can be other mechanisms for the determination of the market price of the relevant commodity. These alternative mechanisms need not rely on a lower than average organic composition of capital.

Consider, as an example, a sector with a higher than average organic composition of capital. If the market price for the commodity of this sector were to equal the price of production, then this sector would lose surplus value on a net basis. But if some conjunctural factors led to a sudden increase in demand, which ensured, in turn, that the market price was above the price of production, then this sector would generate surplus profit on an aggregate level even though it had a higher than average organic composition of capital. Moreover, if the market price was sufficiently higher than the price of production then each plot of 'land' would generate surplus profit, so that the owner of the plot could appropriate ground-rent. If, instead of a spurt of demand, there was intervention by the State, in favour of some influential class of resource owners, to keep the relevant price high, the same result would arise.

What might be examples of such scenarios? An example with contemporary relevance is the agricultural, mining and oil production sectors in Latin America. In the 2000s, there was a spurt of demand for minerals and oil, driven largely by the phenomenal growth of China. This spurt of demand led to a sustained increase in the market price of ores and oil. In such a situation, owners of non-produced resources like land in Latin American countries that produced oil, copper, iron, soy, etc. were able to earn ground-rent even though the production processes in many of these industries were quite capital intensive. Thus, ground-rent might have been generated even when the organic composition of capital in these industries were higher than the economy-wide average. Another example might be a

case where big capital influences the State in a Third World country to enact import barriers to keep the price of a commodity high. If the commodity is produced with a highly capital intensive technology and also uses some non-produced resource, like land, then the owners of that resource might be able to appropriate ground-rent. If the resource is owned by the capitalists themselves, then a part of their profit would come from ground-rent. The bottom line is that the generation of ground-rent in a sector does not need to be necessarily based on a lower than average organic composition of capital in that sector.

Next, I highlight the power of Marx's theory of ground-rent by discussing two applications relevant to contemporary capitalism. The first is an analysis of the price of real estate; and the second is an issue that has puzzled commentators of the contemporary Indian economy: rentier orientation of big capital.

4.2 Application-I: Real Estate Prices

Can we explain the price of real estate using Marx's theory of ground-rent? By real estate, I refer to commercial or residential buildings. Since buildings are constructed on pieces of land, the price of the real estate comes from two sources: (a) price of the building, and (b) price of the land on which the building is constructed. Of course, the two prices are determined by very different principles. Since the building is a commodity, its price is determined like any other commodity, i.e. in the long run, the price of the building is its price of production. On the other hand, the price of the land, which is a non-produced resource (and not a commodity), is the capitalized value of the rent income entailed by ownership of the land.¹⁴

Thus, the price of real estate is the sum of the price of the building (the commodity) and the price of the land (the non-produced resource). Hence real estate prices can increase if either of the two terms in the sum increase. If we take a long run perspective, then the price of the building (the commodity) is either going to be stable or fall, the latter coming from technological change and the former arising when there is no technological change. On the other hand, there is no such principle determining or limiting the price of the land. One can conclude that the long run increase in real estate prices comes largely from the increases in the price of land. But why does the price of land increase in the long run?

Capitalist development rests on the primitive accumulation of capital. The population uprooted from agricultural production in rural areas gradually move to urban areas, at different speeds across different countries, in search of livelihood in the form of wage-labour. This increases the demand for housing, and by implication, the demand for land on which houses could be constructed. As population pressures increase and transportation costs decline, the size of urban centers of industrial production increases. Hence, more and more

¹⁴In this context, it is important to clarify that the commonly used term 'rent' to refer to payments made to use a building, or apartment, for a fixed period of time is conceptually very different from 'ground-rent' that we have been discussing in this paper. When a building or apartment is rented out, the transaction involves a piecemeal sale of a commodity (the building or the apartment). Thus the rent one pays to use a building or apartment for a fixed period of time is a portion of the price of the building or apartment. Ground-rent, on the other hand, is a portion of the surplus value appropriated by an owner of a *non-produced* resource that is limited in quantity and can be used in capitalist commodity production.

land is used for construction of residential and commercial buildings. In an approximate sense, this process of urban expansion is like the expansion of agricultural production from the best to worse quality plots of land. While in the case of agriculture, ‘quality’ refers to fertility of the soil, in the context of urban expansion, ‘quality’ refers to locational advantages. Locational advantage is, in turn, determined by many factors like public infrastructure, the density of networks of firms, production hubs, transportation networks, educational and health facilities, etc. The important implication is that as demand for housing increases, increasingly worse quality land is used for construction, which increases the *differential rent* earned by infra marginal, i.e. better than the worst, plots of land, just as in the case of agriculture.

There is another factor which increase the amount of differential rent earned by the infra marginal plots of land: state investment. As the State builds better infrastructure in the ‘center’ of the cities, that investment activity improves the locational advantage of the ‘center’. It is as if the ‘quality’ of the plots of land at or near the center of the city improves. This increases the differential rent earned by these plots of land.¹⁵

A slightly different way to understand the effect of State investment on land prices is to compare it to agricultural production under a lease contract between a landowner and a capitalist-farmer, a situation discussed in Marx (1993, pp. 757). All improvements in the fertility of the land that come through investments by the capitalist-farmer is finally captured by the landowner at the end of the lease period because the improvements are embodied in the land, and land is owned by the landowner. Thus, when a new lease is worked out, the landowner adds the interest payment on the capital investment to the previous ground-rent. The total amount of the rent income of the landowner increases. In an analogous manner, when investments are made by the State to improve infrastructure in an urban area, the interest on the capital investment is captured by the owner of the plot of urban land as an addition to ground-rent proper.

Thus, pushed up by increasing demand - which comes from population growth, urbanization and income growth due to capitalist development - and public spending to build better infrastructure, the differential rent earned by infra marginal plots keep increasing. Since the price of land is the capitalized value of ground-rent entailed by ownership of the land, it increases with the increase in ground-rent, the latter being driven up by the increase in differential rent.

There is an important political economy angle here that is worth noting. The increase in differential rent arises partly from the continuous improvements in the urban environment - coming largely through capital investments by the State in building roads, lighting and other public infrastructure - that translates to improvements in the *locational* aspects of plots of infra marginal land. Since the improvements in the quality of the land accrues to its owners, the rapid increase in the price of urban real estate is an example of the *private appropriation*

¹⁵I use ‘center’ with quotes because it might not be the geographical center of an urban area, but rather the economic center. For instance, in the US, inner city neighbourhoods have been systematically starved of infrastructural development, even as resources have been ploughed into developing the suburbs. In this case, the geographical center - the inner city neighbourhoods - and the economic center - the suburbs - are different.

*of the benefits of public investments.*¹⁶

4.3 Application-II: Indian Big Capital's Rentier Orientation

Ever since the initiation of market oriented reforms in India in the early 1990s, the State has provided big capital with access to natural resources like land at throwaway prices. What has puzzled many activists and commentators is the fact that in most cases where the State has provided land to big capital for the purposes of setting up manufacturing and service sector production units, large parts of that land has not been used for this purpose. Instead, capitalist have rented out significant parts of the State-provided land provided to real estate operators and builders.

One way to make sense of this puzzling phenomenon is to compare the rate of return from two alternative uses of the land. In the first scenario, the capitalist might use it to set up a production unit and make profit by selling some commodity, which could be manufacturing sector items like cars or computers, or services like IT and IT-enabled services. In the second scenario, the capitalist rents out the land for real estate development, and earns ground-rent. In the context of the contemporary Indian economy, it is easy to see why the second option provides a far higher rate of return.

Market-oriented reforms has led to a highly disequalizing growth process over the last few decades. Large parts of the income that is accruing at the top end of the income distribution is used by the rich and wealthy to purchase real estate for speculative purposes. This has created a spurt in the demand for houses, apartments, shopping malls, multiplexes, either directly or in a derived manner. The growth in speculative demand operates on top of growth in real demand for housing that arises from capitalist development, urbanization and some undeniable income growth across the income distribution.

The spurt in demand, coming from real and speculative sources, has pushed up prices of real estate, probably much higher than its price of production. On the other hand, the technology of production has also become increasingly capital intensive as large real estate firms have started accounting for increasingly larger shares of the construction industry, especially in big cities. This has probably meant an increase in the organic composition of capital in the construction industry. All these together imply that owners of land stand to gain handsome sums of ground-rent, even as the sectoral organic composition of capital has increased. Hence, renting out land for real estate development ensures a far higher rate of return than what is available in the production of cars or IT services. This might be one of the reasons why big capital rents out significant parts of the land it gets from the State for real estate development instead of using it for developing manufacturing or service

¹⁶Discussing the same issue, Marx notes how landowners reap benefits of investments made by others. "His rent thus swells; or, if he plans to sell the land ... its value has now risen. He does not sell just the land, but rather the improved land, the capital incorporated into the earth, which has cost him nothing. This is one of the secrets ... of the increasing enrichment of the landowners, the constant inflation of their rents and the growing money value of their estates as economic development progresses. Thus they put away in their own private purses the result of a social development achieved without their participation - they are *frege consumere nati*." (Marx, 1993, pp. 757).

industries. It clearly prefers rentier income to profits from production because the former are far higher than the latter.

The underlying political economy is also worth paying attention to. Land, often prime agricultural land, is forcibly taken away from peasants by the State and handed over to big capital with the stated goal to promote industrialization or service sector-led labour-intensive growth. In the backdrop of the robust and rising demand for real estate, big capital has strong incentives to rent out significant parts of the land it got from the State to the real estate sector. Thus, the intention of the State to foster industrialization or service-sector growth is willy nilly frustrated, not because of lack of land but because of the operation of perverse incentives. But the vulnerable peasants pay a heavy price, nonetheless. While it is true that the construction sector employs a large segment of the working population, it has become increasingly capital intensive over time, so that it absorbs fewer workers now than a decade ago. Moreover, a long run growth strategy can hardly rely on the growth of the construction in place of the manufacturing or services sector.

5 Conclusion

In this paper, I have presented an analytical exposition of Marx's theory of ground-rent. I have demonstrated that Marx's claim about ground-rent being a transformed form of surplus profit can be rigorously established and analysed. Surplus profit, which arises in agriculture because the organic composition of capital in agricultural production is lower than the economy-wide average rate of profit, can be transformed into ground-rent in the presence of landed property, i.e. ownership of land by a class of landowners (who are different from the class of capitalist-farmers). The total ground-rent can be seen to be composed of two components: differential rent and absolute rent. Differential rent, in turn, is composed of differential rent of the first variety (which arises from differences in the quality of land) and differential rent of the second variety (which arises from the differences in the magnitude of capital investment on different plots of land). Absolute rent, on the other hand, arises from the ability of the class of landowners to collude and prevent even the worst quality of land being given *gratis* for cultivation.

I have also argued that Marx's theory of ground-rent can be extended in at least two directions that make it relevant as a framework for analysing many features of contemporary capitalism. While Marx had primarily analysed agriculture, the analysis applied to any capitalist commodity production which uses some privately owned non-produced resource that is limited in quantity. Moreover, the assumption that the sector generating ground-rent have a lower than average organic composition of capital is not essential. If alternative mechanisms can ensure the price of the commodity to be sufficiently higher than the price of production, then the sector can generate ground-rent even with a higher than average organic composition of capital. These two extensions imply that Marx's theory of ground-rent can be used to analyse some features of industries like mining, oil and natural gas, housing and real estate, in contemporary capitalism.

An interesting direction for future analysis is the political economy of the determination

of the price of agricultural commodities, price of oil, natural gas, and minerals. The analysis of ground-rent shows that the total surplus value created in the production of the relevant commodity is divided between the class of capitalist producers and the class of landowners. Moreover, the proportion in which this division takes place is impacted crucially by the price of the agricultural commodity. Thus, the determination of the price of the agricultural commodity in the presence of landed property will involve class struggle between landowners and capitalist-farmers, as witnessed in mid-nineteenth century England during the debate over the repeal of the Corn Laws. There might very well be parallels in the contemporary world.

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6 Appendix A

In this appendix I will present the argument in mathematical form.

6.1 Surplus Profit and Ground-Rent in Agriculture

Let $i = 1, 2, \dots, N$ index the plots of land arranged in *increasing order of their quality*. Thus, plot 1 refers to the worst and plot N refers to the best plot of land. Let $y_i > 0$ denote the output produced on plot i , and let $c_i \geq 0$ and $v_i > 0$ denote the constant and variable capital used for producing the output on plot i .¹⁷ Thus, the total cost of production (which is also the total capital investment) on plot i is given by $c_i + v_i$, the sum of constant and variable capital.¹⁸ Let k_i denote the cost of production per unit of output on plot i , i.e.,

$$k_i = \frac{c_i + v_i}{y_i}. \quad (4)$$

The hierarchy of the quality of plots of land is an important characteristic of the agricultural economy and is captured by the fact that the unit cost of production stands in a relationship of hierarchy, with the worst plot of land having the highest cost and the best plot having the lowest costs. We state this important characteristic of the agricultural economy as

Assumption 1. *Let $i = 1, 2, \dots, N$ index the plots of land arranged in increasing order of quality, and therefore in decreasing order of unit cost of production. Then, we have*

$$k_1 \geq k_2 \geq \dots \geq k_N, \quad (5)$$

where

$$k_i = \frac{c_i + v_i}{y_i}$$

denotes the unit cost of production on plot i .

Let α denote the economy-wide average rate of profit, and let r_i denote the rate of profit earned by capitalist agricultural production, in the absence of landed property, on plot i . The ‘surplus profit’ on plot i is the profit income in excess of what is implied by the economy-wide average rate of profit. Hence, if SP_i refers to surplus profit on plot i , then we have

$$SP_i = (c_i + v_i)r_i - (c_i + v_i)\alpha = (c_i + v_i)(r_i - \alpha). \quad (6)$$

When agricultural production is organized along capitalist lines with *all the cultivable land owned by the class of landlords*, it is this surplus profit that is appropriated as ground-rent. Thus, *ground-rent is the ‘surplus profit’ appropriated by the landowners*. Thus, given

¹⁷The variable capital needs to be bounded away from zero to ensure that the organic composition of capital does not increase without bounds. The economic content of this assumption is that production cannot take place without labour, a most meaningful assumption.

¹⁸I ignore fixed capital in this paper.

the magnitude of ‘capital advanced’ on plot i , i.e. the value of constant and variable capital, we can define the magnitude of ground-rent on that plot as

$$GR_i = (c_i + v_i)(r_i - \alpha). \quad (7)$$

Marx argued that the total ground-rent on any plot of land can be decomposed into three parts, differential rent of the first variety, differential rent of the second variety and absolute rent. A little algebraic manipulation shows that this is indeed the case:

$$GR_i = DRI_i + DRII_i + AR \quad (8)$$

where

$$DRI_i = (c_i + v_i)(r_i - r_1)$$

is differential rent of the first variety,

$$DRII_i = [(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha)$$

is differential rent of the second variety, and

$$AR = (c_1 + v_1)(r_1 - \alpha)$$

is absolute rent.

To quantify the flow of ground-rent, defined in (2), we begin with an analysis of a benchmark case of capitalist agricultural production without landed property. This will allow us to clearly see the logic for emergence of surplus profit and also help us in quantifying its magnitude. Since ground-rent is a transformation of surplus profit, this will allow us to immediately arrive at a quantitative measure of the magnitude of total ground-rent. In the next step, we will be able to quantify its three components: absolute rent (AR), differential rent of the first variety (DRI), and differential rent of the second variety ($DRII$).

6.2 Capitalist Agriculture without Landed Property

In the absence of landed property, the class of capitalist-farmers own the land used for agricultural production and hire landless labourers to do the actual work of cultivation. We make the simplifying assumption that the total land area is divided equally among the capitalist farmers and that the area of each capitalist farmer’s land is normalised to one unit (one acre, say).¹⁹ They use their own (or borrowed) money capital to purchase means of production and labour-power to produce agricultural commodities.

¹⁹We abstract from the possible unequal distribution of land among the farmers because that is not the main issue under investigation in this paper.

6.2.1 Hierarchy of Profit Rates

A key feature of the agricultural plots of land is that they vary by quality, as noted in Assumption 1. Hierarchy of quality of plots of land will imply a hierarchy of rates of profit when agricultural production is organized along capitalist lines. This will be useful below when we prove that differential rent of the first variety, DRI , is positive. Hence, we state this below as

Proposition 1. *Let r_i denote the rate of profit earned by capitalist-farmer i (who owns plot i), where $i = 1, 2, \dots, N$; then, we have*

$$r_1 \leq r_2 \leq \dots \leq r_N. \quad (9)$$

Proof. Let us denote the price of a unit of the agricultural commodity as p and note that it will be determined by the cost of production in the *worst* plot of land (Marx, 1993, pp. 797). Since the rate of profit earned by the capitalist-farmer with the worst quality of land, i.e. the capitalist-farmer indexed by $i = 1$, is given by r_1 ,

$$py_1 = (c_1 + v_1) + r_1(c_1 + v_1)$$

so that the price of an unit of the agricultural commodity is given by

$$p = \left(\frac{c_1 + v_1}{y_1} \right) (1 + r_1) = k_1 (1 + r_1). \quad (10)$$

All capitalist-farmers will be able to sell their output at the price given in (10). Hence, the revenue earned by capitalist-farmer i is given by py_i . Since the total cost of production on plot i is $(c_i + v_i)$, using the expression for the price of the agricultural commodity given in (10), we see that the total profit earned by capitalist i is given by

$$\pi_i = py_i - (c_i + v_i) = k_1 y_i (1 + r_1) - (c_i + v_i), \quad i = 1, 2, 3, \dots, N. \quad (11)$$

Hence, the rate of profit earned by capitalist-farmer i is given by

$$r_i = \frac{\pi_i}{c_i + v_i} = \left[\frac{k_1}{k_i} (1 + r_1) - 1 \right]. \quad (12)$$

Hence,

$$\frac{1 + r_{i+1}}{1 + r_i} = \frac{k_i}{k_{i+1}} \geq 1,$$

where the last inequality comes from the use of (5). Hence,

$$r_1 \leq r_2 \leq \dots \leq r_N \quad (13)$$

This completes the proof. \square

6.2.2 Existence of Surplus Profit in Agriculture as a Whole

Price of the agricultural commodity plays an important role in the emergence of surplus profit and ground-rent, and we now turn to its analysis. Suppose p denotes a generic market price of the agricultural commodity. If r denotes the corresponding *average* rate of profit in agriculture, then

$$pY = (C + V)(1 + r)$$

where $C = \sum_{i=1}^N c_i$ is the total constant capital used, $V = \sum_{i=1}^N v_i$ is the total variable capital used, and $Y = \sum_{i=1}^N y_i$ is the total output in agriculture. Hence,

$$p = \left(\frac{C + V}{Y} \right) (1 + r) \quad (14)$$

which is the product of the average unit cost of production, $(C + V)/Y$, and $(1 + r)$.

Let \bar{p} denote the notional price of production in agriculture, i.e. the price of the agricultural commodity at which agriculture as a whole earns the *economy-wide average rate of profit*, α .²⁰ Then,

$$\bar{p} = \left(\frac{C + V}{Y} \right) (1 + \alpha). \quad (15)$$

A comparison of (14) and (15) shows that whenever the price of the agricultural commodity is above its notional price of production, the agricultural sector as a whole will generate surplus profit, i.e. the average rate of profit in agriculture will be higher than the economy-wide average rate of profit.

Proposition 2. *Let p denote the price of the agricultural commodity and let the corresponding average rate of profit in agriculture be r . Let \bar{p} denote the notional price of production for the agricultural commodity. If $p > \bar{p}$ then the average rate of profit earned in agriculture, r , is higher than the economy-wide average rate of profit, α , i.e. $r > \alpha$.*

Proof. The proof follows immediately from a comparison of (14) and (15). □

6.2.3 Existence of Surplus Profit on the Worst Plot of Land

Let \tilde{p} denote the price of the agricultural commodity which ensures the economy-wide average rate of profit, α , *on the worst plot of land*, i.e. the plot of land indexed by $i = 1$. Since the output on plot 1 is given by y_1 , we have

$$\tilde{p}y_1 = (c_1 + v_1)(1 + \alpha)$$

²⁰I call it the ‘notional’ price of production because agriculture does not participate, due to barriers to the movement of capital into agriculture, in the formation of the average rate of profit and prices of production.

so that

$$\tilde{p} = \left(\frac{c_1 + v_1}{y_1} \right) (1 + \alpha) \quad (16)$$

The price level of the agricultural commodity given by \tilde{p} is an important benchmark. Whenever the price of the agricultural commodity is higher than \tilde{p} , *all* plots of land will generate surplus profit. This follows from a conjunction of two facts: (a) that the price level of \tilde{p} ensures surplus profit on the worst plot of land, and (b) that there is a hierarchy of profit rates in agriculture with profit rates increasing with the quality of the plot of land (see Proposition 1).

How does the notional price of production, \bar{p} , compare with the price that ensures surplus profit on the worst plot of land, \tilde{p} ? Intuitively, the latter should be higher than the former. The notional price of production ensures the economy-wide average rate of profit for agriculture as a whole. Since there is a hierarchy of rates of profit, as shown in Proposition 1, this means that if the agricultural commodity sells at its notional price of production, the rate of profit on the worst plot of land will be lower than α , the economy-wide average rate of profit. Hence, the price which can ensure the economy-wide average rate of profit on the worst plot of land has to be higher than the notional price of production for agriculture. I formalise this intuition in

Proposition 3. *Let \bar{p} denote the price of the agricultural commodity at which agriculture as a whole earns the economy-wide average rate of profit, α , and let \tilde{p} denote the price of the agricultural commodity which ensures the economy-wide average rate of profit, α , for the worst plot of land; then $\bar{p} < \tilde{p}$.*

Proof. Using (15) and (16), we see that

$$\frac{\tilde{p}}{\bar{p}} = \frac{(c_1 + v_1)/y_1}{(C + V)/Y}.$$

Note that

$$\frac{C + V}{Y} = \frac{1}{Y} \sum_{i=1}^N c_i + v_i = \sum_{i=1}^N \left(\frac{c_i + v_i}{y_i} \right) \left(\frac{y_i}{Y} \right) = \sum_{i=1}^N k_i \lambda_i$$

where $k_i = (c_i + v_i)/y_i$ is the unit cost of production on plot i and $\lambda_i = y_i/Y$ so that for $i = 1, 2, \dots, N$, $0 < \lambda_i < 1$. Under Assumption 1 and the fact that $0 < \lambda_i < 1$, we have

$$\lambda_i k_1 > \lambda_i k_i, \quad i = 2, 3, \dots, N.$$

Hence

$$\sum_{i=2}^N \lambda_i k_1 > \sum_{i=2}^N \lambda_i k_i$$

so that adding $\lambda_1 k_1$ to both sides, we have

$$\lambda_1 k_1 + \sum_{i=2}^N \lambda_i k_1 > \lambda_1 k_1 + \sum_{i=2}^N \lambda_i k_i = \sum_{i=1}^N \lambda_i k_i$$

which shows that

$$k_1 \sum_{i=1}^N \lambda_i > \sum_{i=1}^N \lambda_i k_i.$$

Since $\sum_{i=1}^N \lambda_i = 1$, this shows that

$$k_1 > \sum_{i=1}^N \lambda_i k_i.$$

But $(c_1 + v_1)/y_1 = k_1$ and $\sum_{i=1}^N \lambda_i k_i = (C + V)/Y$, which completes the proof. \square

6.2.4 Determination of the Price of the Agricultural Commodity

In Marx's analysis the price of the agricultural commodity is determined by the principle that agriculture retains all the surplus value it generates. Let p^* denote the price of the agricultural commodity at which agriculture as a whole realises the total surplus value it generates. Then,

$$p^* Y = (C + V)(1 + r^*)$$

where

$$r^* = \frac{eV}{C + V} = \frac{e}{1 + (C/V)} = \frac{e}{1 + OCC_A} \quad (17)$$

and e is the *common* rate of exploitation (ratio of surplus value and variable capital) that obtains in all sectors of the economy, and

$$OCC_A = \frac{C}{V}$$

is the organic composition of capital for the agricultural sector as a whole. Hence,

$$p^* = \left(\frac{C + V}{Y} \right) (1 + r^*) \quad (18)$$

At this point we need to introduce one important characteristic of the agricultural economy: it has a lower organic composition of capital than the whole economy. We state this as

Assumption 2. Let OCC_A denote the organic composition of capital in the agricultural sector as a whole, and let

$$OCC_E = \frac{\bar{C}}{\bar{V}}$$

denote the organic composition of capital in the economy as a whole. A characteristic feature of agriculture is that

$$OCC_A < OCC_E.$$

This assumption about the organic composition of capital in agriculture has an immediate implication.

Proposition 4. *If Assumption 2 holds, then $\bar{p} < p^*$.*

Proof. The proof follows immediately by comparing (15) and (18), and noting that, by Assumption 2, we have

$$\frac{e}{1 + OCC_A} = r^* > \alpha = \frac{e}{1 + OCC_E}.$$

□

What is the meaning of Assumption 2 and what is the implication of Proposition 4? This proposition shows that if the price of the agricultural commodity is such as to ensure that all the surplus value generated in agriculture is retained in agriculture, then the agricultural sector as a whole generates surplus profit. How do we know this? This is where Assumption 2 comes in. It tells us that agriculture has a lower organic composition of capital than the whole economy. Hence each unit of capital invested in agriculture generates higher amounts of surplus value. Thus, if agriculture is able to retain all the surplus value it generates, it will earn a higher rate of profit than the economy-wide average rate of profit. That is why \bar{p} , which ensures the economy-wide average of profit, is lower than p^* . Moreover, this ensures that all the surplus value generated in agriculture is retained in agriculture.

We are now ready to prove one of the main results of this paper as

Proposition 5. *Let $z_1 = 1 + OCC_A$, $z_2 = 1 + OCC_E$, and*

$$\beta = \frac{(c_1 + v_1)/y_1}{(C + V)/Y}$$

be the ratio of the unit production cost on the worst plot of land and the economy-wide average unit production cost. Suppose $1 + e > \beta$, and $z_2 > e\beta / (1 + e - \beta)$. Let us define a function

$$f(z_2) = \frac{ez_2}{(\beta - 1)z_2 + e\beta}.$$

For any z_2 , if $z_1 < f(z_2)$ then $p^ > \tilde{p}$.*

Proof. Note that, by Proposition 3, $\beta > 1$. Hence $(\beta - 1)z_2 + e\beta > 0$ (since $z_2, e > 0$). Thus, if

$$z_1 < \frac{ez_2}{(\beta - 1)z_2 + e\beta}$$

then, multiplying through by $(\beta - 1)z_2 + e\beta$, we have

$$\begin{aligned} z_1z_2(\beta - 1) + e\beta z_1 &< ez_2 \\ \beta(z_1z_2 + ez_1) &< z_1z_2 + ez_2 \end{aligned}$$

which, on division through by z_1z_2 (which is a positive quantity), gives

$$\begin{aligned} \beta \left(1 + \frac{e}{z_2}\right) &< \left(1 + \frac{e}{z_1}\right) \\ \beta \left(1 + \frac{e}{1 + OCC_E}\right) &< \left(1 + \frac{e}{1 + OCC_A}\right) \\ \left(\frac{c_1 + v_1}{y_1}\right) \left(1 + \frac{e}{1 + OCC_E}\right) &< \left(\frac{C + V}{Y}\right) \left(1 + \frac{e}{1 + OCC_A}\right) \\ \tilde{p} = \left(\frac{c_1 + v_1}{y_1}\right) (1 + \bar{r}) &< \left(\frac{C + V}{Y}\right) (1 + r^*) = p^*. \end{aligned}$$

This completes the proof. □

What is the meaning of, and intuition behind, this result? From the definition of \tilde{p} in (16), we know that any price which is higher than \tilde{p} will ensure surplus profit on the worst plot of land. Proposition 5 provides conditions under which $p^* > \tilde{p}$. Hence, Proposition 5 provides conditions under which the price level p^* (which is the price level of the agricultural commodity which ensures that all the surplus value generated in agriculture is also retained in agriculture) is adequate to ensure that the worst plot of land generates surplus profit.

The key condition driving the result in Proposition 5 is defined with the function $f(z_2)$, which is depicted on the domain $z_2 \geq 1$ in Figure 3 (since $z_2 = 1 + OCC_E$, it does not make sense to consider value of z_2 which are strictly less than 1 because OCC_E is always positive). The function $f(z_2)$ is concave (because $f' > 0$ and $f'' < 0$).²¹ For $z_2 = 1$ it takes the value $e/(\beta - 1 + e\beta)$, and it asymptotically approaches the value $e/(\beta - 1)$ as z_2 increases without bound. Since $1 + e > \beta$, which is one of the assumptions underlying Proposition 5,

$$\frac{e}{(\beta - 1 + e\beta)} < 1 < \frac{e}{(\beta - 1)}$$

so that the function lies partly above and partly below 1. Since $z_1 = 1 + OCC_A$, the only meaningful region to consider is when the value of the function is equal to or above 1 (which

²¹ $f'(z_2) = e^2\beta/[(\beta - 1)z_2 + e\beta]^2 > 0$; $f''(z_2) = [-2(\beta - 1)\beta e^2\{(\beta - 1)z_2 + e\beta\}] / \{[(\beta - 1)z_2 + e\beta]^4\} < 0$ for $z_2 \geq 1$.

is equivalent to the requirement that $OCC_A \geq 0$). A little algebra shows that $f(z_2) > 1$ for $z_2 \geq e\beta / (1 + e - \beta) > 1$. That is why this requirement is additionally specified as one of the conditions in Proposition 5.

What is the intuition behind the result in Proposition 5? The condition involving the function $f(z_2)$ shows that, given any level of OCC_E (the organic composition of capital in the whole economy), as long as OCC_A (the organic composition of capital in agriculture as a whole) is lower than some threshold value (defined by the concave function of OCC_E), p^* will be greater than \tilde{p} . Thus, if OCC_A is lower than the threshold defined by $1 - f(1 + OCC_E)$, then the price of the agricultural commodity determined by the retention of the whole surplus value is high enough to ensure surplus profit on the worst plot of land, and hence on all plots of land. This condition can also be seen geometrically in Figure 3: as long as the economy operates in the shaded region, p^* will be larger than \tilde{p} .

The intuition for this condition is the following: when the organic composition of capital in agriculture is lower than this threshold, a large enough volume of surplus profit is generated in agriculture. This makes intuitive sense because the magnitude of surplus profit depends on the difference of the profit rate in agriculture with the economy-wide average rate of profit. The condition tells us that the difference between OCC_A and OCC_E is large enough to ensure that, if all of the surplus value is retained in agriculture, surplus profit is generated even on the worst plot of land. This immediately shows that if the price of the agricultural commodity is given by $p = p^*$, then surplus profit will be generated on all plots of land (because of the hierarchy of rates of profit).

Figure 3 also allows us to see a potential limitation of Marx's analysis. In Volume Three of *Capital*, Marx worked with the assumption that the organic composition of capital in agriculture as a whole is lower than the organic composition of capital in the whole economy. Proposition 5 and Figure 3 shows that this is not enough to generate surplus profit on all plots of land. One needs a more stringent condition,

$$z_1 \leq f(z_2) = \frac{ez_2}{(\beta - 1)z_2 + e\beta}$$

to ensure that the price level of $p = p^*$ generates surplus profit on all plots of land. Since ground-rent is just a transformation of surplus profit, this shows that Marx's analysis of ground-rent would remain incomplete if the condition $z_1 < f(z_2)$ were not imposed.

The fact that this condition is more stringent than the simple requirement of lower OCC in agriculture than the OCC in the aggregate economy can also be seen from Figure 3. The curve representing $f(z_2)$ lies completely below the 45 degree line.²² Hence, any point on or below the curve automatically satisfies the condition that $OCC_A < OCC_E$. But there are points in Figure 3 that are above the curve and below the 45 degree line. These points satisfy the requirement that $OCC_A < OCC_E$ but do not ensure positive surplus profit on all plots of land. Hence, the condition that Marx works with, viz., $OCC_A < OCC_E$, is a necessary but not a sufficient condition to give all the results that he thought would hold with regard to ground-rent.

²²This is because $f(1) < 1$ and $f'(1) < 1$.

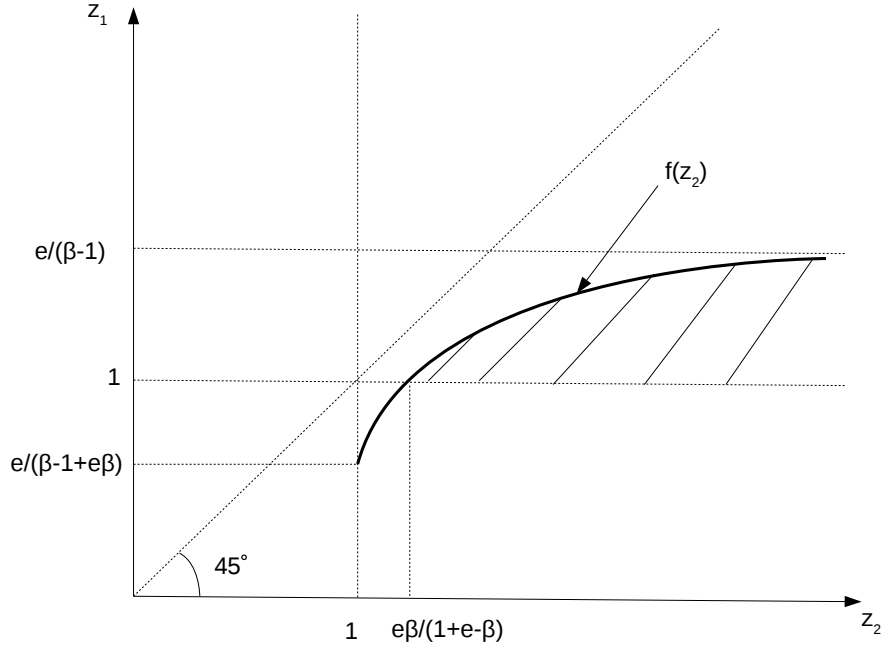


Figure 3: Upper bound function for the organic composition in agriculture. For any value of $z_2 = 1 + OCC_E$, the function $f(z_2)$ gives the upper bound on $z_1 = 1 + OCC_A$ that ensures the result in Proposition 5.

Drawing on the above discussion, we can characterise the agricultural economy with two crucial conditions necessary for the analysis of surplus profit and ground-rent. The first condition relates to the price of the agricultural commodity and the second relates to the organic composition of capital in agriculture.

Assumption 3. Let the price of the agricultural commodity, p , be determined by the principle that there is zero net flow of surplus value from agriculture, so that $p = p^*$, with p^* defined in (18).

Let

$$z_1 \leq f(z_2) = \frac{ez_2}{(\beta - 1)z_2 + e\beta}$$

where $z_1 = 1 + OCC_A$, $z_2 = 1 + OCC_E$,

$$\beta = \frac{(c_1 + v_1)/y_1}{(C + V)/Y}$$

and $1 + e > \beta$, $z_2 > e\beta / (1 + e - \beta)$.

I would like to draw out three important implications of the two conditions stated in Assumption 3. First, the agricultural economy characterised in Assumption 3 generates a positive amount of surplus profit at the aggregate level. This is because the price of the agricultural commodity is given by p^* , which is higher than the notional price of production, \bar{p} (by Proposition 4). Since any price higher than \bar{p} generates surplus profit in agriculture as a whole, the price level of p^* will also do so. This conclusion is necessary for our subsequent analysis because, in Marx's understanding, ground-rent is a transformation of surplus profit in agriculture. Thus, without surplus profit there would be no ground-rent.

Second, the market price of the agricultural commodity is determined by the principle that agriculture retains all the surplus value it generates, the latter being justified by the fact of existence of barriers to movement of capital in agriculture. This implies that the price of the agricultural commodity is given by $p = p^*$. It is important to point out that this is only one, though by no means the only, way to determine the market price of the agricultural commodity. We use it in this paper because this is close to the intuitive idea Marx worked with: barriers to the movement of capital into agriculture would allow agriculture to retain the surplus profit (and hence the total surplus value) it generates.²³

Third, the conjunction of the first and the second condition ensures, as Proposition 5 shows, that each plot of land generates surplus profit. This conclusion is used to ensure that all plots of land are under cultivation. But it is also useful to note that this conclusion is not analytically restrictive because we can always include in the analysis *only* those plots of land that generate surplus profit, and hence are under cultivation in a capitalist economy with landed property.²⁴

We are now ready to introduce the landowner into the analysis and see how this transforms the surplus profit in agriculture into ground-rent and how that is decomposed into absolute and differential rents (of varieties I and II).

²³If the price of the agricultural commodity deviates from p^* defined in (18), there can be net transfer of surplus value from agriculture even if there are barriers to capital investment. For instance if there is such a high demand for the agricultural commodity that its price rises above p^* , then there can be a net inflow of surplus value into agriculture, as can be seen from the definition of p^* in (18). On the other hand if the demand for the agricultural commodity falls to such an extent that its price falls below p^* , then the agricultural sector might see a net outflow of surplus value. In the extreme case, if the price of the agricultural commodity falls to the extent that production on the worst plot of land cannot give the economy-wide average rate of profit, then it will lie fallow. These are interesting cases that can be explored in future research.

²⁴In the absence of landed property, zero surplus profit on the worst plot of land is compatible with all plots of land being under cultivation. This is because the capitalist-farmer operating the worst plot of land is guaranteed the economy-wide average rate of profit. Thus, with the existence of landed property, there is a chance for some land to remain fallow.

6.3 Ground-Rent in Agriculture

6.3.1 Existence of Positive Ground-Rent

We have created the apparatus that will allow us to quantify the magnitude of ground-rent and its three components, given in (7), which we reproduce below for easy reference

$$GR_i = (c_i + v_i)(r_i - \alpha) = DRI_i + DRII_i + AR \quad (19)$$

where

$$DRI_i = (c_i + v_i)(r_i - r_1)$$

is differential rent of the first variety,

$$DRII_i = [(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha)$$

is differential rent of the second variety, and

$$AR = (c_1 + v_1)(r_1 - \alpha)$$

is absolute rent.

Recall that the agricultural economy that we are studying is characterised by the two conditions given in Assumption 3. Our first task is to prove that *this* economy produces positive magnitudes of ground-rent on all plots of agricultural land.

Proposition 6. *Suppose the conditions prevailing in the economy is captured by Assumption 3. Then, the total ground-rent appropriated by the landowner of the i -th plot of land, GR_i , is positive. This is because $r_i - \alpha > 0$, where r_i is the rate of profit on plot i and α is the economy-wide average rate of profit.*

Proof. By Assumption 3, $z_1 < f(z_2)$. By Proposition 5, this implies that $p^* > \tilde{p}$, i.e. the price level that arises from zero net flow of surplus value from agriculture, p^* , is larger than the price that ensures positive surplus profit on the worst plot of land, \tilde{p} . Hence, intuitively, when Assumption 3 holds, each plot of land generates surplus profit.

To see this more formally, let $A = p^* - \tilde{p} > 0$. Since the price of the agricultural commodity is p^* , the rate of profit on the i -th plot, r_i is given by

$$1 + r_i = \frac{p^*}{k_i} = \frac{\tilde{p} + A}{k_i} = \frac{\tilde{p}}{k_i} + \frac{A}{k_i}$$

where $k_i = (c_i + v_i)/y_i$ is the unit cost of production on plot i . Hence

$$1 + r_i = \frac{\tilde{p}}{k_i} + \frac{A}{k_i} = \frac{\tilde{p}}{k_1} \frac{k_1}{k_i} + \frac{A}{k_i} \frac{k_1}{k_1}.$$

Let $\lambda_i = k_1/k_i$ for $i = 1, 2, \dots, N$. By Assumption 1, we know that $k_1 \geq k_2 \geq \dots \geq k_N$. Hence $\lambda_i \geq 1$ for $i = 1, 2, \dots, N$. Thus,

$$1 + r_i = \lambda_i \frac{\tilde{p}}{k_1} + \lambda_i \frac{A}{k_1}. \quad (20)$$

By the definition of \tilde{p} as the price level that ensures the economy-wide average rate of profit on the worst plot of land, we have $\tilde{p}/k_1 = 1 + \alpha$, where α is the economy-wide average rate of profit. Hence,

$$r_i = -1 + \lambda_i(1 + \alpha) + \lambda_i \frac{A}{k_1} = (\lambda_i - 1) + \lambda_i \alpha + \lambda_i \frac{A}{k_1}.$$

Hence

$$r_i - \alpha = (\lambda_i - 1)(1 + \alpha) + \lambda_i \frac{A}{k_1} > 0$$

because $\lambda_i \geq 1$, $\alpha \geq 0$ and $A > 0$. This completes the proof. \square

We can use the results of Proposition 6 to quantify magnitudes of the three components of ground-rent. To begin, note that since $r_i > \alpha$ for $i = 1, 2, \dots, N$, this means that $r_1 - \alpha > 0$. Hence the absolute rent

$$AR = (c_1 + v_1)(r_1 - \alpha)$$

is positive. Turning to differential rent of the first variety,

$$DRI_i = (c_i + v_i)(r_i - r_1),$$

we see that with positive quantities of capital invested on all plots, DRI is also positive because $r_i \geq r_1$ by Proposition 1. Since no production can take place without labour, the magnitude of variable capital on plot i is bounded away from zero (while the magnitude of constant capital is non-negative). Hence $c_i + v_i > 0$, which implies that $DRI_i \geq 0$ (since $r_i - r_1 \geq 0$ by Proposition 1).

So far in the analysis, we have not imposed any conditions on the magnitudes of the capital investments on different plots of land. Thus, there are no restrictions on the relative magnitude of $c_i + v_i$ in comparison to $c_1 + v_1$. This imposes some ambiguity on the sign of the differential rent of the second variety

$$DRII_i = [(c_i + v_i) - (c_1 + v_1)](r_1 - \alpha).$$

As long as the total capital invested on plot i is higher than the capital invested on the worst plot of land, $DRII$ will be positive. But, if the total capital invested on plot i were to fall below the capital investment on the worst plot, then the magnitude of the differential rent of the second variety will turn negative. As we have noted earlier, this does not create any problems for the overall analysis because the sum total of DRI and $DRII$ will always be positive.

What is the intuition behind the possible negative magnitude of $DRII$ on plot i ? Since plot i is more productive than plot 1 (the worst plot of land), each unit of capital invested on plot i in excess of the corresponding amount on the worst plot brings in some additional profit income. If for some reason, that additional investment is not forthcoming on plot i , or if it falls short of that magnitude, some profit income will be lost.

Is this a likely scenario? A full answer to this question would require us to develop a theoretical framework to analyse the decisions that underlie the choice of the exact magnitudes of constant and variable capital on each plot of land. In this paper, I have taken the magnitudes, c_i and v_i as given, and a full analysis of their determinants is beyond the scope of this paper. But I can offer some initial thoughts on this by thinking about the possible forms of the rental contract. If landowners offer take-it-or-leave-it rental contracts after calculating the full amount of ground-rent given in (19), then it will be in the interest of the capitalist-farmer to make the full capital investment, $c_i + v_i$, i.e. to make sure that the extra surplus profit that is represented by $DRII$ is not lost. This is because any decline in the total surplus profit due to a negative magnitude of $DRII$ will eat into her profit income, not the rent income of the landowners.²⁵

While we can see easily that the source of differential rent of both varieties arise from differences with respect to the worst plot of land - DRI from differences in quality, and $DRII$ from differences in capital invested - it is not completely clear as to what the source of absolute rent is. How can we think about the source of absolute rent?

Absolute rent arises due to the monopoly of ownership of landed property in the precise sense that the existence of absolute rent requires collusion (or some other form of collective action) by the landowners. Why? Absolute rent gets added to the ground-rent of each and every plot of land. Hence, enforcement of absolute rent has positive externalities for the class of landowners. If a landowner who owns many plots of land, including the plot of the worst quality, decides to rent out the plot of worst quality for free, possibly as part of a deal to rent out other, better, plots of land, every landowner loses revenue, not only this particular landowner who owns the worst plot. Thus the action of the landowner of the worst plot of land has implications beyond her own welfare. Hence, to actualise the total benefit of absolute rent, there needs to be collusion (or some other form of collective action) by the class of landowners. The class of landowners must come up with some mechanism to ensure that no landowner allows any, including the worst, plot of land for zero rent. It is in the interest of the class of landowners to do so because they gain revenue in the form of absolute rent as a class.

While the existence of absolute rent rests on the possibility of collusion by the class of landowners, its magnitude is determined by the demand for the agricultural product, and

²⁵The analysis of $DRII$ by Marx is not wholly satisfactory. He adopts a ‘marginal’ perspective in thinking of $DRII$ as arising from different ‘doses’ of capital on the same plot of land. This is problematic because the magnitudes of the three types of rent can only be defined meaningfully once we know the amounts of capital advanced on all plots of land. Hence, the computation is carried out only when all ‘doses’ of capital investment on different plots of land have been taken into account. A better procedure, in my opinion, is to consider differences in total (not marginal) capital invested across different plots of land, as I have done in this paper, i.e. compute rents only after the magnitudes of total capital advanced on each plot of land is given. My analysis also suggests that there can be neither DRI nor $DRII$ on the worst plot of land. Marx argues, through an example in chapter 44 (Marx, 1993), that there can be $DRII$ on the worst plot of land. His calculations, and also Engels’ corrections of those calculations, have a basic conceptual error: the price of production is not calculated correctly. If it is calculated correctly, the price will be £3 in the second table on page 873 in Marx (1993), and in that case there will be no rent on the worst plot of land. For details see Appendix B.

through that, by the demand for land.²⁶ Note that the magnitude of the absolute rent is given by $(c_1 + v_1)(r_1 - \alpha)$. While α is the average of profit in the whole economy and is determined by the factors external to the agricultural sector, r_1 is the rate of profit on the worst plot of land when production is organised by capitalist-farmers who are also owners of the land. This rate of profit, in turn, is determined by the unit cost of production, k_1 , and the price of the agricultural commodity, p^* , as

$$1 + r_1 = \left(\frac{p^*}{k_1} \right).$$

In our analysis, following Marx, we take the price of the agricultural commodity to be determined by the condition of zero net flow of surplus value from agriculture. If the price of the commodity increases above p^* , the surplus profit on the worst plot of land can increase (through an increase in r_1). In the presence of landed property, that will be appropriated by the whole class of landowners as additional absolute rent.

6.3.2 Summary

This completes the presentation of Marx's theory of ground-rent in a mathematical form. I have demonstrated that Marx's idea that ground-rent is a transformation of surplus profit generated in agriculture can be rigorously established and that it can be decomposed into three components: absolute rent, differential rent of the first variety, and differential rent of the second variety. In particular, I have demonstrated in Proposition 6 that under Marx's assumption about the determination of the price of the agricultural commodity - zero *net* flow of surplus value from agriculture - the agricultural sector will generate positive amounts of ground-rent on each plot of land as long as two conditions are satisfied: (a) there is a hierarchy in the quality of the plots of land, as captured by Assumption 1, and (b) the organic composition of capital in agriculture is sufficiently lower than its economy-wide counterpart, as captured by Assumption 3. Given the capital invested on each plot of land and the economy-wide average rate of profit, we can then compute the exact magnitude of the ground-rent using (19).

²⁶“Even though landed property can drive the price of agricultural products above their price of production, it does not depend on this, but rather on the general state of the market” (Marx, 1993, pp. 898).

Appendix B

In this Appendix, I discuss an example that Marx used at the beginning of Chapter 44 to demonstrate that DRII can arise on the worst plot of land. I show that Marx's analysis has problems, and that, if those problems are addressed, DRII will be zero on the worst plot of land, as I have argued in this paper. Since the focus is on differential rent, the analysis abstracts from absolute rent.

Initial Situation

The initial situation is depicted in panel A in Table 4. Marx specifies that the price of production “refers to the sum of capital advanced plus 20 percent profit” (Marx, 1993, pp. 873). Thus, on plot A, the price of production of 3 implies that the capital advanced is 2.5 ($=3/1.2$). Similarly, on plots B, C and D, the amount of capital advanced is 5 ($=6/1.2$).

We would like to work out the details of the rental agreement that would arise in the initial situation. To do so we would need to know the market price of the commodity. How is the market price determined? It is determined by the principle that the capital advanced on the worst plot of land earns the average rate of profit (because there is no absolute rent). But what is the worst plot of land? It is the land which has the highest *unit cost of production*, i.e. it is the plot on which each unit of output costs the highest amount of labour time to produce.

The unit cost of production on plots A, B, C and D are 2.5, 1.43, 0.91 and 0.67, respectively. Since plot A has the highest unit cost of production, the market price gets determined by the condition of production on plot A. Hence, the market price is $3 = 2.5 * 1.2$. Once we know the market price, we are able to compute the money rent in the last column of panel A in Table 4. Hence, the rental agreement on plot A, B, C and D involves money rent payments of 0, 4.5, 10.5 and 16.5. Capitalist-farmers must pay these amounts to use the plots of land for capitalist commodity production.

Increase in Demand

Suppose there is an increase in demand for the agricultural commodity. The capitalist-farmer on plot B, having received this signal of increased demand, is deciding whether to increase his production by another unit.²⁷ Suppose he knows that to increase production by another unit would involve a “production cost” of 3.5 (which implies a capital advance of $3.5/1.2$). The question is whether the capitalist-farmer on plot B has any incentive to undertake the additional investment and increase production by another unit. If there is an additional investment of $3.5/1.2$ on plot B, the capitalist-farmer's total capital advanced will be $7.92 = (5 + 3.5/1.2)$. If the price of the commodity remains at 3 (the situation depicted in panel A, Table 4), then the capitalist-farmer on plot B will earn 13.64% ($((9 - 7.92)/7.92)$)

²⁷Marx only considers the case of an increase in production on plot B. I follow him and do not consider other possibilities.

Table 4: *Differential Rent on the Worst Plot of Land^a*

Type of Land	Price of Production	Units of Output	Market Price	Rent
<i>Panel A</i>				
<u>Original Situation:</u>				
A	3	1	3	0
B	6	3.5	3	4.5
C	6	5.5	3	10.5
D	6	7.5	3	16.5
<i>Panel B</i>				
<u>Final Situation:</u>				
A	3	1	3.5	0.5
B	9.5	4.5	3.5	6.25
C	6	5.5	3.5	13.25
D	6	7.5	3.5	20.25
<i>Panel C</i>				
<u>Corrected Final Situation:</u>				
A	3	1	3	0
B	9.5	4.5	3	4
C	6	5.5	3	10.5
D	6	7.5	3	16.5

^a This table reproduces, panel A and panel B, the two tables on page 873 in Marx (1993). In panel C, I give the corrected version of the the situation depicted in panel B.

rate of profit. Since this is lower than the economy-wide average rate of profit of 20%, the capitalist does not have the incentive to undertake the additional investment.

If the additional investment is not forthcoming on plot B, there will be a shortfall of supply. This will increase the price of the agricultural commodity. Marx probably thinks that the price will need to increase to the extent that will ensure the additional production on plot B. Let us follow Marx in this line of reasoning and ask: what will be the required level of the price of the agricultural commodity to ensure the additional investment on plot B? Marx's answer is 3.5. How did he arrive at this answer? Marx argues that the price of the commodity will be determined by the "production cost" (capital advanced plus profit) of the *marginal unit of capital*. In his example, the "production cost" associated with the additional dose of capital is 3.5, so that the "capital advance" needed to produce another unit of the commodity on plot B is 2.92 (= 3.5/1.2). "In this case," argues Marx, "3.5 would be the governing price for the total production." (Marx, 1993, pp. 872). He calculates the surplus profit, and therefore the rent, on the basis of this price. This is depicted in panel B in Table 4. But Marx's calculations are incorrect.

Suppose the price of the agricultural commodity is p . On plot B, the output is 4.5 units, and the capital advanced is 7.92. Since the capitalist-farmer has *already paid the rent* of 4.5, this is an additional component of cost for her to consider. Hence, the price that will ensure a 20% rate of profit on the total capital advanced on plot B must satisfy the following equation:

$$0.2 = \frac{4.5p - 7.92 - 4.5}{7.92}.$$

This computation shows that $p = 3.11$, i.e. the price must be 3.11 to ensure a 20% rate of profit on the total capital advanced on plot B. This is exactly the price Engels came up with when he corrected Marx's calculations (Marx, 1993, pp. 874).

Thus, if the price of the agricultural commodity increases to 3.11, it will justify the additional investment on plot B because this will ensure 20% rate of profit on the total capital invested. Marx is incorrect in thinking that the price needs to increase to 3.5. Hence, the additional calculations about money rent, shown in panel B in Table 4, are also incorrect.²⁸ In fact there would be no *additional* money rent because they have already been agreed upon and paid. What Marx probably has in mind is the terms of the *new* rental agreement that would arise after the existing ones expire, at which point landowners would probably factor in the new level of demand into their computations of ground rent. We will see soon that he is wrong on that count too. But before we do so, it is important to reiterate that Engel's calculations are indeed correct as far as it addresses the following question: what must the level of the price be for capitalist-farmer B to produce an additional unit of output *after* the rental agreement has been worked out? But this does not still answer the question relevant for our discussion: how will this impact the next round of rental agreement?

²⁸In Appendix II, Fine (2006) repeats Marx's mistake because he thinks that "Marx demonstrated that the selling price must rise at least to $3\frac{1}{2}$ to induce the additional capital on B." In advancing this argument, he criticizes Engels. But, the above calculations demonstrate that his criticism of Engels is not valid.

New Rental Agreement

When the new rental agreement is being negotiated, the situation will be as depicted in panel C in Table 4. This means that the cost of production and the associated outputs on each plot of land is exactly as appeared in panel B in Table 4. To determine the rent, we need to find the market price of the commodity. To do so we need to apply the same principle that we applied in panel A in Table 4: the market price is determined by the principle that the capital advanced on the worst plot of land get the average rate of profit. Which is the worst plot in the new situation? To identify the worst plot of land, let us compute the cost of producing one unit of the commodity on the plots.

For plot A: unit cost of production is $2.5 (= 2.5/1)$. For plot B: the unit cost of production is $1.76 (= (9.5/1.2)/4.5)$ because the total capital advanced is $9.5/1.2$ and the plot produces 4.5 units of output. It can be easily seen that the unit cost of production on plots C and D are even lower. Plot A remains the worst plot. Hence the market price remains the same as before: 3. The calculation of money rent with this “corrected” price is given in panel C in Table 4. There is zero differential rent on plot A, the worst plot. Thus, Marx was wrong in asserting that, within the framework of analysis that he developed for ground-rent, there can be positive differential rent on the worst plot of land.

What is the source of Marx’s errors? The main problem is that Marx does not consistently follow the logic of his own analysis. If there is an increase in demand after the rental agreement has been fixed, it can have no effect on the magnitude of rent because it has already been paid or at the least agreed upon. Of course, if the increase is relatively permanent, it will be taken into account when new rental agreements are worked out. But in that case too, it will be possible to compute the magnitudes of rent on each plot only when we know the capital advanced and output produced on each plot of land. Only with this information will be able to identify the worst, and hence benchmark, plot of land. Since absolute rent is zero, by assumption, the price of the agricultural commodity will be such that the worst plot of land will only earn the average rate of profit. Once the price of the commodity is determined, that will allow us to compute the magnitude of rent on all plots of land. Marx gives up this principle when he considers the case of an increase in the demand for agricultural commodities. That is the source of his error.