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A Neo-Classical Supply-Based Approach to Land Prices

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Summary. Current interest in land-price theory is dominated by attempts to explain the structure of land prices and land uses in urban areas. Those theories, however, do not enable certain important political issues to be elucidated, in particular the relationship between produce price and land price. A different approach is therefore suggested, which considers the supply of land to consist of a supply of stocks of land differentiated by fertility, location, etc., the production function for an industry being different for each type of land used. By using the conventional tools of neo-classical analysis, the relationships between land price, product price, and the intensity of land use are derived, also the effect on land and product prices of competition for land between different industries.

In the last 25 years, most of the attention that has been paid to land-price theory has been in connection with theories of urban structure – that is, attempts to explain geographical patterns of urban land use, geographical patterns of urban land price, and the connections between them. One thinks of the pioneering work done by Wingo (1961), Alonso (1964), Muth (1969), and Mills (1972), of the developments of those theories such as offered by Evans (1973), and of the countless empirical studies which they have stimulated of land price patterns in cities throughout the world – in New Zealand (Moran, 1978), in Japan (Glickman and Oguri, 1978), in Belgium (Ministerie van Openbare Werken, 1978), and so on. Now, it is not the primary purpose of this paper[1] to add to those land-price theories of urban structure. Instead we want to propound a completely different approach to the study of land prices, one which owes more to Ricardo and Marshall than to Alonso and Muth, an approach which tries to answer a different set of questions. Nevertheless, precisely because the urban structure approach to land prices now dominates, it will be used as a background for the approach to be outlined here.

The current dominance of the urban structure approach to land prices is to be regretted in that it incorporates a rather limited land-price theory: a more general approach (which we do not pretend to offer here) would be able to explain not only the pattern of land rents, land uses, and densities in cities, but many other phenomena importantly and politically associated with land prices. Two of the major limitations of the urban structure approach are the following.

That approach concentrates on only one of the factors that are supposed to affect land prices, namely differences in transport costs. But it is widely supposed that other important factors are fertility (for agricultural land), the physical suitability of land for building upon (land preparation costs, foundation costs, etc.), adjacent land uses and hence the possibilities of external economies and diseconomies of scale, and the size of plot and hence the possibilities of internal economies of scale. A more general theory of land-prices should be able to include all such factors.

Secondly, the land-price theories propounded in that approach, theories which culminate in either the bid-price curves of Alonso (1964) or the rent-offer functions of Mills (1972) and in the interactions between those curves or functions, do not allow a

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satisfactory investigation of some important policy issues. Three such issues will be mentioned here.

One is the question of the relationship between land price and product price. With the factors of production labour and capital, it is generally accepted that the cost of those factors enter into the price of the product. Adam Smith in 1776 in connection with food prices (1846 edition, p. 61), Ricardo in 1817 in connection with the Corn Law debate (1913 edition), and in 1880 Henry George (1932 edition) more generally, argued that with land it is different, that the price of land has no effect on product price: and this argument is still widely accepted (especially in Britain, where none of the policy discussions on urban land, from the 1947 Town and Country Planning Act to the 1975 Community Land Act, has questioned the assumption that the price of private housing is independent of the price of housing land).

A second and related issue is: what is the effect on the price of land for one use of competition for that land by other uses? If competition by use X raises the price of land for use Y, does that then raise the price of product Y? If so, by what process and by how much?

A third policy issue, important for at least the last 150 years, is: what is the effect of a tax on land? Does it affect the price of land or the price of the product produced on that land? John Stuart Mill in 1848 said, unequivocally, No! 'A tax on rent falls wholly on the landlord. . . . It does not affect the value or price of agricultural produce' (Mill, 1900 edition, p. 496). This issue is not yet resolved, in spite of more than 30 years of intermittent land taxation in Britain.

The approach to land-price theory to be presented here addresses itself to just those points on which the urban structure approach is limited. Moreover, it is claimed that the approach taken here should be capable, with further development, of addressing also those issues of urban structure which have resulted in such brilliant but restricted theories of land price.

A Supply-based Approach

The urban structure approaches to land-price theory, and the standard work by Dunn (1954) on the location of agricultural production, regard land as a homogeneous (consumption or production) good. All units of land are identical in all respects except one – location. Differences in location are treated by varying the price which consumers are prepared to pay for the land – Wingo (1962) and Alonso (1964) – or the price which the consumers are prepared to pay for the product of the land – Mills (1972), Muth (1969), Dunn (1954): thereafter all units of land can be treated as being completely identical.

That approach has the advantage that the same production function can be applied to all units of land: but it has the disadvantage that differences between plots of land (besides differences in location) which might be important for land price cannot be incorporated in the approach. So, for example, the differences in fertility between agricultural sites which exercised Smith and Ricardo in their land-price theories has to be ignored: but so also do differences in plot size and shape[2], differences in the necessary site preparation costs, the possibilities of external economies of scale caused by the presence of adjacent complementary users, etc.

Those are all factors relevant to the *supply of land*. And it is just the peculiarities in the supply of land which distinguish the theory of land from the theory of other factors of production. The peculiarity of the *total* supply of land is commonly recognised: that land has no cost of production or reproduction (unlike other factors of production such as labour and capital); and that the stock of land in existence, therefore, does not depend upon the money received by the suppliers of the stock[3] (although the *making available* of that stock does depend on the supply price).

The difficulty of treating the supply of land to an *individual firm* is less widely recognised. With other factors of production we usually assume homogeneity – that all units of the factor are the same and that, as a result, all units of the factor have the same price. That price is set in the industry market for the factor, so individual firms face a market price and an infinitely price-elastic supply. With land, however, it is just the *differences* between different units of land, and the corresponding differences in unit land prices, which are important for the users of land and, therefore, for theory.

[2] One of the very few discussions of the effect of plot size on unit land price is given by Colwell and Sirmans, 1978.
[3] Writing from the Netherlands, we have to point out the exception to this statement – that land can be reclaimed from lakes and the sea.

That peculiarity was described by Alonso (1964, p. 37) as: 'The total supply of land . . . cannot be regarded as a fixed finite quantity: rather it must be viewed as a collection of stocks of land differentiated by their location'. (We would say, more generally, '. . . it must be viewed as a collection of stocks of land differentiated by their location and other properties relevant to land price'.)

The difficulties which that creates for land-price theory were described by Dunn (1954, p. 107) as: 'Since land is heterogeneous, one use or industry utilises many different grades of land (graded in either quality or distance). Therefore the firm which is utilising a particular grade does not have the price of the land determined by some process external to the firm. It must be established as part of the firm equilibrium itself.'

The approach we shall take here, instead of trying to avoid or ignore these difficulties, will try to include them in the theory by starting from just those peculiarities in the supply of land.

We start from the technological fact that land is not a homogeneous factor of production, but that the supply of land consists of a collection of parcels of land, some of which are physically more suitable for production (because of location, fertility, etc.) than others. Now, the difference in physical suitability between two plots of land for one use (e.g. growing corn) might not be the same as the difference between the same two plots of land for another use (e.g. shops). The physical suitability of plots of land for production can be compared only within one industry: so we shall start by considering one industry X only.

For each plot of land, the technical production function for industry X if it produced on that land is, let us assume, known. Then the supply of land to industry X can be regarded as a heterogeneous supply of a known number of parcels of land of known size, each parcel with a known technical production function. Let us assume that X is produced by combining units of land L and units of all other factors of production N (we shall, following Marshall – book IV, chap. 2 of the 8th edition – regard capital and labour applied to land as consisting of equal successive 'doses', so we can talk about units or doses of the factor of production N).

This starting-point, it will be seen, is that taken by Ricardo and just expressed in more recent economic jargon.[4] So a short didactic digression might be useful here, to explain how we hope to improve upon Ricardo. One of the important theoretical weaknesses with Ricardo's land-price theory we can express as follows. As demand for a product increases, then production expands onto marginal and free land: that pushes up the minimum production cost and therefore the market price of the product: and the owners of the intra-marginal land can then extract higher rents from those who produce on their land. And there Ricardo stops. However, we would expect the producers to respond to those changed relative factor prices (L has become more expensive relative to N) by changing their production methods (substituting N for L, that is using land more intensively); that would change the non-land production costs on the intra-marginal land; and that would change the surplus which landowners could extract as rent.

According to Dunn (1954, p. 30) Ricardo did indeed realise that an increasing rent would cause factor combinations to change but Ricardo did not have the analytical tools to pursue the argument further. The 'marginal revolution' provided those tools – mainly, the idea of the marginal revenue productivity of a factor of production and the theory that a profit-maximising firm chooses a factor combination for which the marginal revenue productivity of each factor equals its price to the firm – and one looks to Marshall, the master craftsman, but even he did not apply them to this problem. Dunn (1954) solves the problem by expressing the production function of a good X made from two factors L and N in terms of a family of iso-product curves: but Dunn's solution does not lend itself to clarifying the relationship between product price and land price. The theory of land price that we put forward here can be seen as another attempt to solve this theoretical problem, but in such a way that it illuminates the practical problem of land price and product price.

[4] This Ricardian approach is not common, but it has not been totally neglected by modern economists. Samuelson in 1959 subjected a Ricardian economy to a rigorous theoretical treatment using modern analytical tools, and he devoted an appendix to land rent because 'though the theory of differential rent is straightforward, I have not been able to find a rigorous treatment of it in the old or the new literature'. Samuelson's starting point is similar to the one taken here. More recently, Hansen (1979) has departed from the same point in trying to develop theories of colonial economic development.

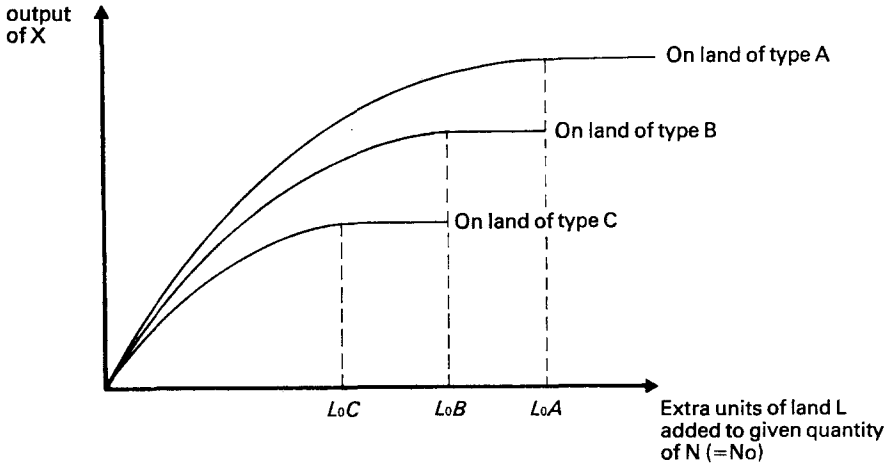


Fig. 1. The output of X as more units of land are combined with a given quantity of capital and labour, for lands of differing productivity.

Our starting point is, then, different types of land, each type with its own different production function for X. Let us suppose that that supply simplifies into a known stock of land of type A (i.e. all parcels of type A have the same production function), a known stock of type B, and a known stock of type C. Marshall (8th edition, 1959 reprint, footnote 2 on p. 129) represented this production function in terms of the marginal physical productivity of capital, when successive inputs of capital are applied to a given amount of land: and that he did because he wanted to investigate the limits to the profitable input of capital, by means of the marginal revenue productivity function of capital. Because our interest is in the changing intensity of land use in response to a change in land prices, we need to construct the marginal revenue productivity function of *land*. In order to do that, we represent the production function of X in terms of the changing output of X caused by applying successive inputs of land to a given amount of capital. The resulting graph (Fig. 1) is perhaps a little unfamiliar, but it is worth emphasising that it can be derived from Marshall's graph by a simple transformation: it is just a different way of representing the same production function.

Of the three types of land A, B, and C, let us assume that A is the most productive (is the most fertile, has the best location, etc.) and C the least productive. Then the production functions on each of the three types bear a relation to each other as shown on Fig. 1: with a given quantity of N and the same quantity of L, land A gives most output and land C least; and the addition of successive units of land ceases to produce more output first on C and last on A.[5] The factor combinations (units of land per unit capital, which we can think of as the converse of the intensity of land use) when the marginal returns to land become zero can be written as:

$$\text{for land } A, \quad L_0A/N_0 = F_0A$$
$$\text{for land } B, \quad L_0B/N_0 = F_0B$$
$$\text{for land } C, \quad L_0C/N_0 = F_0C$$

We shall assume that the price of N is given and constant. So the average non-land production cost of X, in terms of the unit price of N, can now be derived from Fig. 1 and can be shown to have the form shown on Fig. 2. (We may alternatively consider this graph as showing the average total production cost of X if land had zero price – see later.)

The Theory Outlined – Single Industry Case

With those analytical tools we can now re-examine Ricardo's land-price theory. We shall continue to work at the scale of the industry (which implies that all firms in the industry have the same production

[5] This form of production function has been used by other writers also. For examples, Rees (1973) assumes a production function for labour added to land in which 'ten poorly-paid men working for a week could cultivate a field so thoroughly that further cultivation would not increase its output, (and) the same point might be reached in a week by eight well-paid men' (p. 82).

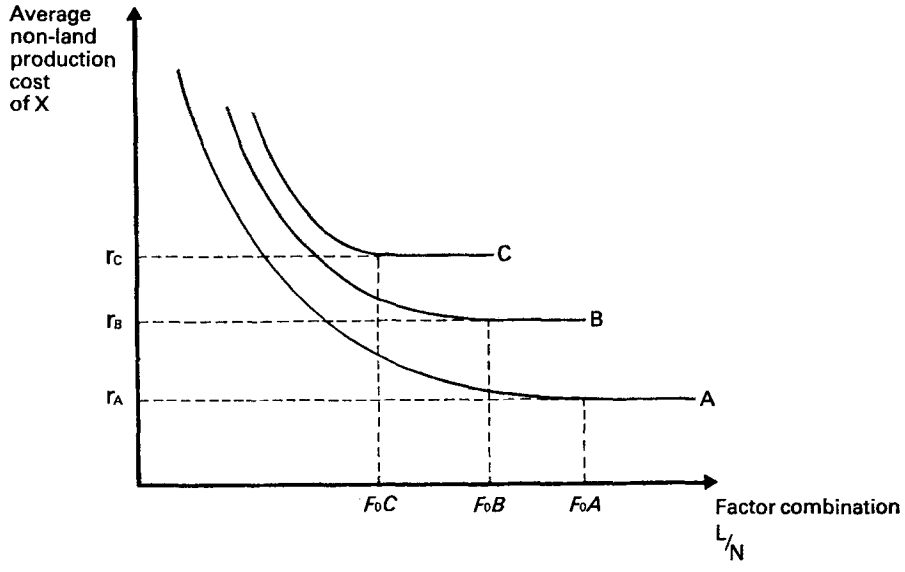


Fig. 2. The average non-land production cost of X as the factor combination varies, for lands of differing productivity.

function, that all are operating at the same optimum size, and that all face the same market price for the product – see Dunn 1954). And we assume that all firms face the same prices for the non-land inputs N, prices which are set outside the industry.

First, for simplicity, we shall assume that no other industries are competing for the land which industry X can profitably use. We shall assume further that there is perfect competition between landowners to supply their land and that land is perfectly divisible, and from those assumptions can be deduced that landowners will supply their land for nothing rather than not supply it to X. (The condition that there is free land available will be dropped later.)

This case could be treated as an example of competition between firms in the same industry, where the firms operate under differential cost conditions. That case is considered, both in general and when the differential costs are caused by differential land, in Henderson and Quandt (1971, pp. 118–124). Here, however, we are particularly interested in the relationship between land price p and product price r, so we need the rather different analytical tools as developed above. Moreover, we find it best to investigate the relationship by looking at a dynamic process, by which the demand for X starts very small and slowly increases. When demand for X is very small, producers of X will not want to use all the available land,[6] will not even want to use all of any one type of land (A, B or C): so the price of all land will initially be zero. In accordance with marginal revenue productivity theory, that factor combination will be chosen where the marginal productivity of land is zero (i.e. F_0A, F_0B, F_0C – Figs. 1 and 2). At zero land price and those factor combinations, the average total production costs will be r_A, r_B, r_C – Fig. 2. Producers will choose to produce on that land which gives cheapest production costs – i.e. land A. So production will take place on land A, product price will be r_A, factor combinat ion F_0A will be used, and all land prices will be zero.

Suppose the demand for X continues to grow so that, when market prices were r_A, the demand is for more than could be produced on the total stock of land A used at intensity F_0A. Production will thus expand on to the next most productive land, B. At first, not all of the stock of B will be used, so land B will be supplied free (and will be used at intensity F_0B). Minimum production cost on free land B is r_B ($>r_A$), and that price is now received by producers on A too. So producers on A can now make excess profits, that will increase the competition for land A for the production of X, producers will now be able to afford to pay for land A, and

[6] The form of the technical production functions implies that, when land is cheaper, more land-extensive production methods are used. But there is a limit to that extension (= F_0A, F_0B, F_0C), so if land were free, production would not spread so as to occupy all the available land.

landowners of A will be able to extract a rent for the use of A.

Now begins the process of adjustment on A. When producers have to pay for A, they will change their factor combination F on A in accordance with marginal productivity theory – i.e. they will substitute capital for land, for that will raise the marginal revenue productivity of land, which adjustment will be made according to the theory of the behaviour of a profit-maximising firm – because the price of land to the firm has risen. That change and the changing price of land will change the total production cost (including the costs of land) of X on land A which must rise up to, but not above, r_B. The process of adjustment can be demonstrated graphically as follows.

Figure 1 can be redrawn as a marginal physical productivity curve of land, which can be translated into a family of marginal revenue productivity curves of land, each curve corresponding to a different price of X (see Fig. 3). Figure 2 can be developed to a family of average total cost of X curves (cost of N *plus* cost of L), each curve corresponding to a different price of L (see Fig. 4).

Then, on land A a new factor combination $F_1A\left(=\frac{L_1A}{N_0}\right)$ is chosen which, on the marginal revenue product curve when product price $= r_B$, gives a marginal revenue product of land ($= MRP_1A$: see Fig. 3) – which must equal land price ($= p_1A$) by marginal revenue productivity theory – such that the average production cost on A equals r_B when land has a unit cost p_1A and the factor combination is F_1A (see Fig. 4).

Alternatively, the process of adjustment just demonstrated graphically may be thought of mathematically as follows:

Fig. 3 expresses the relationship
$MRP_L = f(F, r)$

Fig. 4 expresses the relationship
$r = f(F, p)$

by marginal revenue productivity theory, adjustment will take place until $p = MRP_L$

r is given ($= r_B$).

There is now a simultaneous solution of the two equations represented by Figs. 3 and 4 to give values for the two unknowns F and p.

After this adjustment:

product price $= r_B$ (received by all producers)

production on B takes place at intensity F_0B, price of land B = zero

production on A takes place at intensity F_1A, price of land $A = p_1A$.

Note that the intensity of production on land A has increased, so on the total stock of land A the production of X is now greater. That is, some of the increase in demand for X has been absorbed by more intensive production on land A.

Let us now assume that the demand for X continues to grow so that, at price r_B the demand is for

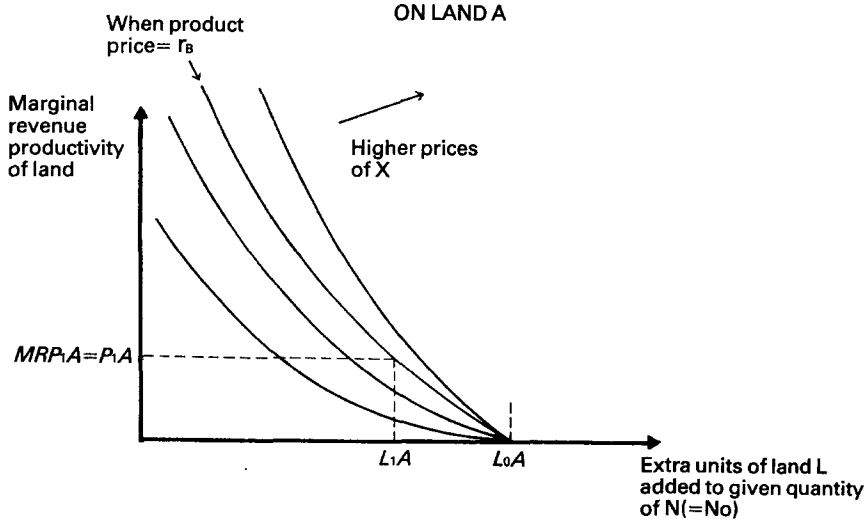


Fig. 3. The marginal revenue productivity of land at varying product prices, for land of one productivity.

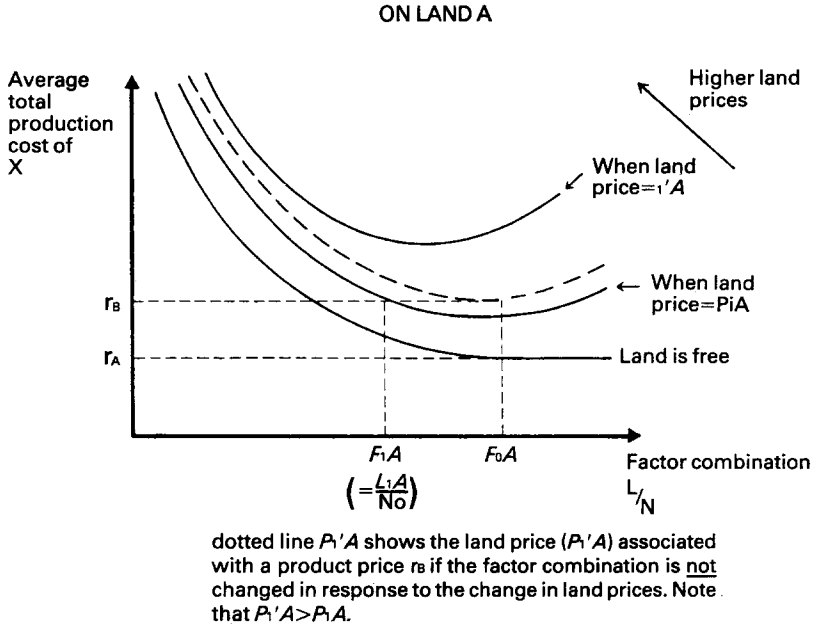


Fig. 4. The average total production cost of X as the factor combination varies, for different unit prices of land, for land of one productivity.

more than can be produced on the stock of land A at intensity F_1A and on the stock of land B at intensity F_0B. So production of X will expand on to C. Then:

product price = r_C (received by all producers)

production on C takes place at intensity F_0C, price of land C = zero, and adjustments take place on A and B so that

production on B takes place at intensity F_1B, price of land $B = p_1B$

production on A takes place at intensity F_2A, price of land $A = p_2A$.

The relationships between the growing demand for X, the price of X, the output of X, the amount of land on which X is produced, and the intensity of production on that land, are all shown on Fig. 5. The supply curve of land to industry X is shown on Fig. 6.

Some Implications of that Theory

That is the basic-land price theory deduced from an approach which starts from the supply of land. It will be seen that this approach incorporates Ricardo's theory, and confirms Ricardo's statement that the price of the product (in the absence of competition for land) is determined by the price of production on the least suitable land. Moreover, we can 'modernise' Ricardo by showing that the rent of the better land is less than Ricardo, with his assumption of fixed factor combinations, would have deduced. The reason is that the existence of rent stimulates a substitution of capital and labour for land which (at any rate, with the form of the production function we have here assumed) increases the average non-land production costs and so reduces the ability (the so-called 'surplus' or 'residual') to pay rents. (That can be read off Fig. 4: if the factor combination F_0A is unchanged as Ricardo assumed, the product price r_B is satisfied on a cost curve corresponding to a *higher* land price = p_1^1A.)

The approach can also incorporate the land-price theories which concentrate on location as the explanation of differential land prices. If we assume that producers everywhere receive the same price in the market for their products, then the differences in cost of transporting the product to the market can be included in the production function: and the assumption of one city centre would lead to systematic and predictable differences in the production functions on concentric rings of land.

Further, the approach can be applied to residential land as follows. Assume that households demand

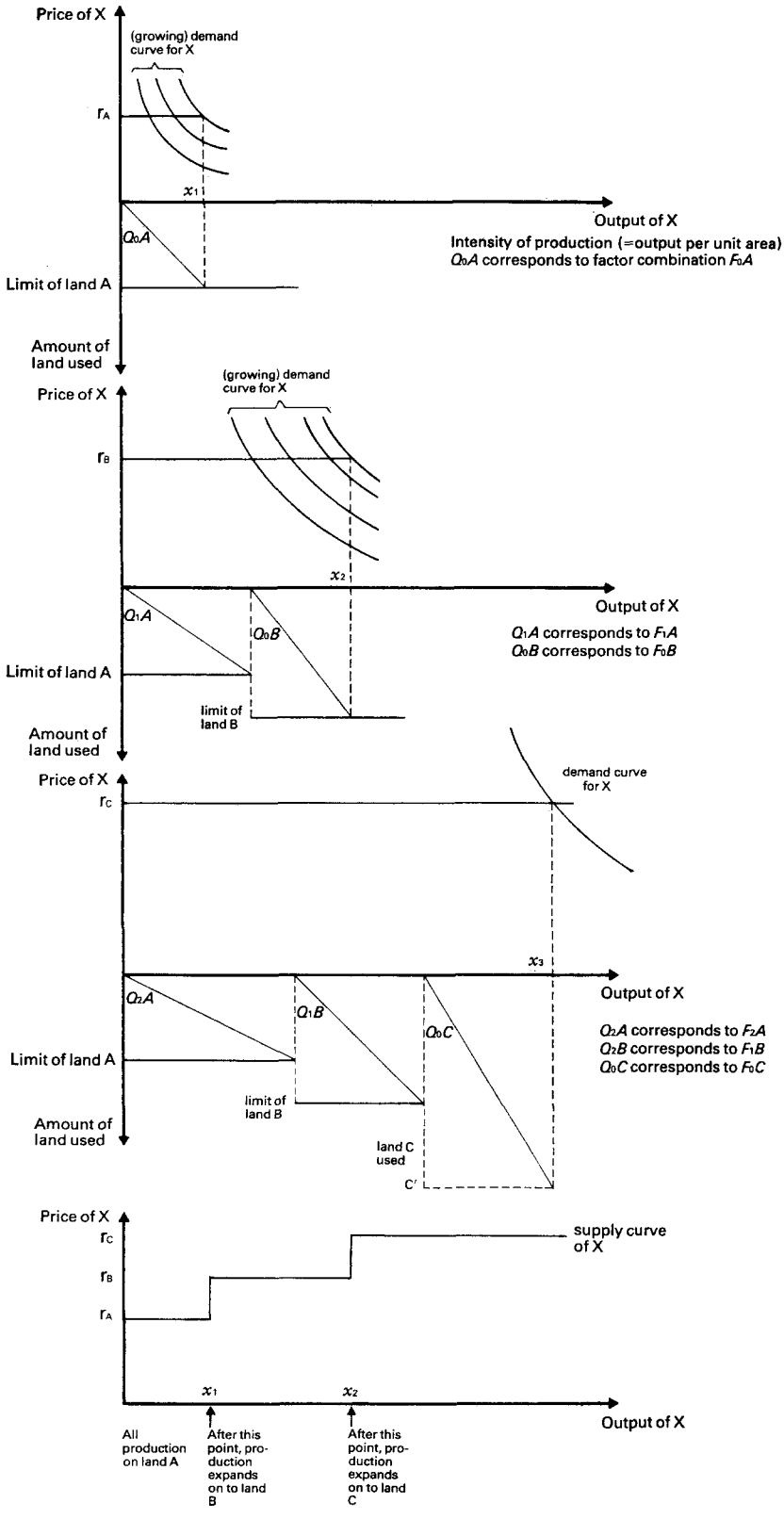
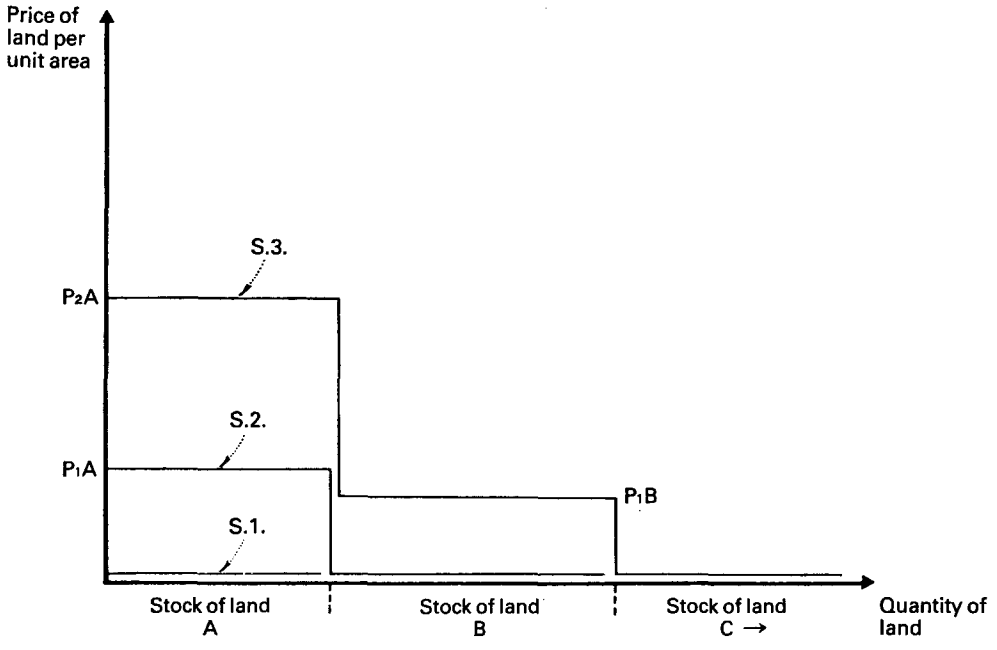


Fig. 5. The supply of and demand for X and the intensity of land use, as the demand for X grows.



S.1.=supply curve of land to industry X when output$\leqslant x_1$
S.2.=supply curve of land to industry X when output$\leqslant x_2$
S.3.=supply curve of land to industry X when output$> x_2$

Fig. 6. The supply of land to industry X, as the demand for X grows.

'housing services' made up of housing capital + housing land + transport services. Then from the usual assumptions of all households having the same tastes and the same incomes, it can be deduced that the price for 'housing services' is the same for all locations (provided that households do not actively dislike commuting). The differences in transport costs between different locations can be incorporated in the different production functions for housing services. (For comparison, let it be pointed out that Muth, 1969 and Mills, 1972 both assume that households demand 'housing services' made up of housing capital + housing land. Then they deduce that, in a concentric city, the price at which housing services are demanded varies systematically with location because the consumers have to pay transport costs separately.)

We have said that it is our aim to derive a theory of land price which makes explicit the relationship between land price and product price. In the theory as developed so far, that relationship is plain: product price is determined by production cost on the marginal land (which is free). Product price is, thus, determined by the quantities of the various types of land of varying suitability, by the production functions on those types of land, by the price of non-land factors of production, and by the size of demand: but the price of land does not enter into the product price. (That is not to say, however, that the existence of land rent does not affect product prices. If no rent were charged, there is the possibility that production on the better land would be expanded by employing more labour and capital there. That would increase non-land average production costs on the better land – see Fig. 2 – but remove the necessity to produce on the worst land; the resulting market price might be lower than if land rents were charged. We return to this point later.)

If No Land were Free?

We shall now investigate the implications of dropping the assumption that there is always free land available. This assumption can be incorrect because there are other industries which are prepared to occupy and pay a price for all the available land, which case is examined in the following section: but the assumption might also be incorrect because competition

between landowners is not perfect, in which case landowners might not be prepared to supply their land at zero prices. It might also be so that landowners prefer to keep their land for their own pleasure – the view, walking, shooting, conspicuous consumption – rather than supplying it free.

Suppose that, for any of those reasons, all landowners have the same minimum price (p_0) below which they will not supply their land. Producers will now calculate unit production costs on the different types of land A, B and C when those factor combinations have been chosen which result in a marginal revenue productivity of land which equals p_0 on each type of land. Producers will choose the cheapest land to produce on, which as before will be land A when demand is small, expanding on to land B and then on to land C. And the price at which X is sold will, as before, be the production cost on the least productive land in use.

The difference between this and the case when land is free is that p_0, the minimum supply price of land, *will* enter into that production cost on the marginal land and hence will enter into product price. However, it will still be the case that the price of the intramarginal land ($>p_0$) will *not* enter into product price: to that extent, at least, land prices are still 'price-determined' and not 'price-determining'.

Competition for Land between Different Industries

That simple (lack of) relationship between land price and product price holds, however, only for products *produced on land for which there is no competition.* We shall now investigate the effects of that competition by introducing another industry Y, which can produce profitability on (at least some of) the land used by X. The investigation will take the form of assuming that industry X is well established, then industry Y starts to grow.

In place of our earlier assumption that the supply of land to industry X consists of just three different types, we shall make the more realistic assumption that there is a large number of different types of suitable land, categorised and ranked by the production functions on them. So some of the production of X will take place on free land. The supply of land to industry Y also consists of stocks of a large number of different types of land: but the ranking of those stocks by production function for Y need not be the same as the ranking by production function for X.

When Y begins to grow, it will use either the free land (i.e. unused by X) or some land already used by X. Y will produce at a factor combination which is appropriate to the price of land (either free or the price set by X): and Y will actually produce on that land which gives the lowest product price.

If Y chooses to produce on the free land, Y will have no effect on the price or the production of X. But if that land chosen by Y is not the most productive land for Y (X occupies that land already, and pays a rent which excludes Y in view of the alternative availability of free land), then the production cost of Y will be higher than in the absence of X: the price of land will not enter into the production cost of Y (because that land is free) but the restriction by X on the supply of land to Y increases the cost of Y.

If Y chooses instead to produce on land already occupied by X, it will displace some X on to less productive land. That land will be free to X, and so it could be said that the price of land does not enter into the production cost of X: but this displacement of some of the production of X on to less productive land raises the minimum production cost and hence the price of X. (That seems to be the mechanism described by Marshall, 8th edition, 1959 reprint, p. 373.) Y is now producing on land which has a price set by another industry (but that method of production is still cheaper for Y than producing on the free but less productive land that is available), so the cost of that land must enter into the production cost and hence the price of Y. If industry Y continues to grow, it could happen that production expands on to some of the free land, when the price of Y would increase (now set by the production cost on marginal land) and the price of the land from which Y ousted X would rise, now set by industry Y itself.

The relationship between land price and product price when there is competition for land can now be generalised as follows. If some of the production of industry Y takes place on free land, the production cost on that land sets the price of Y: but if there exists other land which is more productive for Y than that free land but which has been competed away from Y by another industry X, then the price of Y is higher than in the absence of competition, the increase in price being determined by the supply

conditions of land to Y. (For example, if households want to live as near the city centre as possible, but no households live actually in the centre because industry pays more for that land, then households will have to live further out. Land costs on the edge of the city might be zero, but because commuting costs there are higher, the cost of the total packet of 'housing services' is now higher.)

If none of the production of Y takes place on free land, then the price of Y is set by its production cost on the least productive land which it occupies, and the price of that land (set by some other industry X) enters into the production cost of Y. The increase in the price of Y caused by competition is thus the difference between the actual price and the production cost on that (free) land on to which Y would have expanded in order to produce that same output in the absence of competition for land. (For example, in a city centre, the shopping area merges into the office area. In the absence of competition from office uses, the shopping centre would spread further out at lower densities on to cheaper or even free land and the price of shopping services would be less.)

We can conclude, therefore, that the frequently repeated statements 'land costs do not enter into product price' and 'the price of the product is set by its production cost on marginal land' are at best an over-simplification and at worst misleading and wrong.

We can contrast the above treatment of the effect of competition on land and product prices with the treatment in some other land-price theories. Alonso (1964) develops an analytical method which does not even permit the issue to be considered: for the family of bid-price curves for a particular industry is derived on the assumption that the product price is given, and competition for land between industries affects the particular bid-price curve on which an industry must operate and thereby the profits to be made in the industry, but it has no effect on product prices. Mills (1972) works with the similar concept of 'rent-offer functions' and proposes the following process when industries compete for land. Suppose two industries X and Y have rent-offer functions as shown in Fig. 7. Then the competition between suppliers of land will ensure that all the land between the centre and d will go to

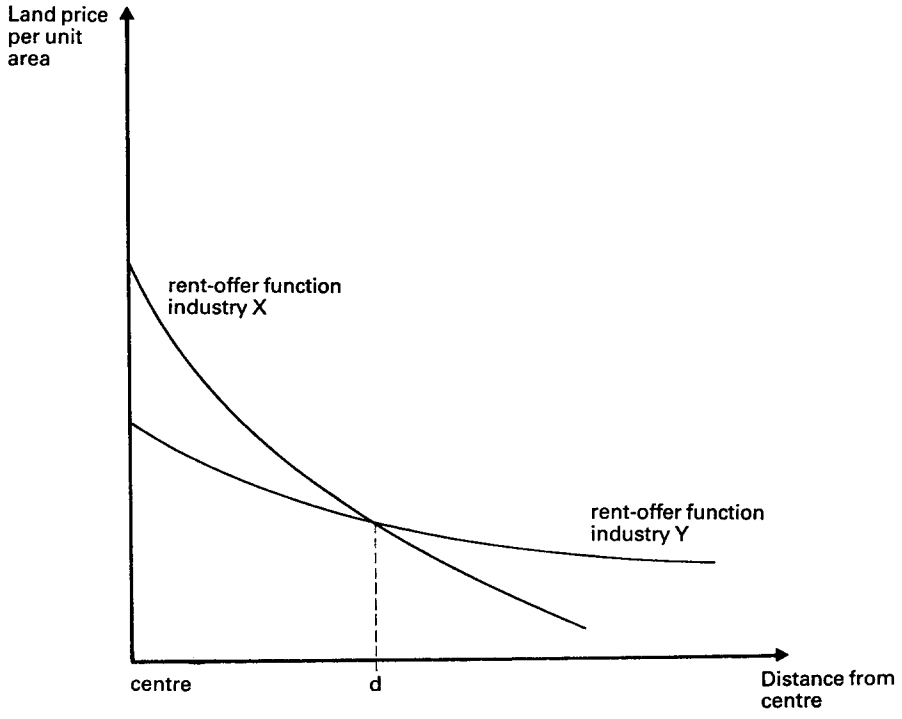


Fig. 7. Competition for land between different industries, according to Mills (1972).

industry X, all further land to Y. Such a statement is repeated in most introductory textbooks on land prices (e.g. Barrett, 1973; Balchin and Kieve, 1977; Newell, 1977): but it ignores the fact that a rent-offer function for an industry Y depends on the market price for Y which depends on the total supply of Y. If industry X competes some land away from Y, that will affect the supply, price, and rent-offer function of Y.[7]

Lipsey (1972) mentions the problem and takes us a little further towards its solution. He points out that 'the old examination question, "Discuss the view that the price of cinema seats is high in central London because the price of land is high", should be answered in the affirmative, not in the negative as examiners often seem to expect' (footnote, p. 355) and discusses land prices in terms of the distinction between transfer earnings and economic rent. The transfer earnings of a plot of land (or of any factor of production) are the payments necessary to prevent the supplier transferring the land to its next most profitable use: as our interest is in land prices and product prices and as we have assumed that prices are set at industry level we can concentrate on inter-industry transfers. If the price of a plot of land to an industry is higher than its transfer earnings, then that land is receiving an 'economic rent' equal to the difference or 'surplus'. If the industry *is* paying an economic rent for its land, then land prices are price-determined, otherwise they are price-determining.

The limitation of that approach is that it does not enable us to understand why, in the competition between industries for land, industry Y might occupy land the price of which is determined by industry X (Y pays the full transfer earnings for the land) or instead might occupy land the price of which it sets itself (Y pays an economic rent for the land): why, for example, do cinemas locate on office land in central London rather than on much cheaper land elsewhere?

Using the analytical tools developed above we can now offer an answer: Y will occupy land and pay prices determined by X if that results in the cheapest production costs for Y, given the demand for Y, the stocks of land available to Y, the competition for those stocks by other industries, and the production functions for Y on the different types of land.

A Tax on Land

This was the third political issue in order to discuss which we wanted a practical land-price theory. The question is: what is the effect of a tax on land on the price of the land and the price of the product produced on the land? The very useful distinction which Lipsey (op. cit.) makes between transfer earnings and economic rent can be used as a starting point here also, and with it we can deduce the following (for a more detailed treatment see Kruyt and Needham, 1980).

Suppose that a tax is levied on land in a particular use. Then, if the owner of that land can receive more by allowing his land to remain in that use at the pre-tax price *and* pay the tax than he could by switching his land to the next most profitable use (i.e. the tax is less than the economic rent – in Lipsey's sense – received by the land), land price and product price will be unaffected by the tax. However, the competition for the land between uses and the supply conditions of land (including the possibility that some landowners would prefer to keep their land for their own use rather than supply it at the taxed price – i.e. they have a high minimum price p_0) could well lead to a tax on land in one use reducing the supply of land to that use. What happens then?

Pearce, Curry and Goodchild (1978) suggest the following process. Owners decrease their supply to that use, the supply of the product of that land use declines, its price climbs whereby the producers can afford to offer more for the land, so the tax on land causes indirectly product and therefore land prices to rise. However, in order to be able to work out the details of that process and its effects on other land and land uses we need better analytical tools than either Lipsey or Pearce *et al.* offer. We claim that the approach offered here can be used to develop a better understanding of the effects of taxing land.

[7] It might be useful to distinguish between goods and services sold in local markets and those sold in national markets (as Broadbent, 1975 does). For the latter, a restriction in the supply locally (e.g. caused by competition for the land necessary for its production) is unlikely to affect the nationally determined price. For the former, however (which includes housing, the biggest urban land user) local competition for land *is* likely to affect the locally available supply and thus the locally determined price.

If All Land were Free?

Writers taking a Marxist standpoint have little interest in trying to explain the *levels* of land rent, rather they are concerned to understand the *forms* of rent and the effects of private ownership of land on capitalist production (see e.g. Murray, 1977–1978); Massey and Catalano, 1978). In that investigation they have considered the question: is differential rent necessary for the functioning of a capitalist system? If all land were nationalised and thus controlled by the State but otherwise capitalist production continued, would the State have to charge the (previous ruling) differential rents in order to equalise the intra-sectoral rates of profit earned by different capitalists operating on land of varying suitability?

That is an interesting question, and not to be dismissed because that extreme political step is thought to be unlikely: for the question is relevant to less radical political changes, such as the following. The allocation of land between land uses in Britain is by the Town and Country Planning machinery, and within the broad land-use classes thus established the allocation of land between users is by the price mechanism. Suppose land-use controls were extended so that land was allocated between users at less than market prices (by, e.g. a system of licences and controls on land prices). What would happen then? The extreme case of free land can be used as an illustration, and we shall apply the analytical tools developed above.

Suppose land prices were abolished overnight. Then, within any one industry, producers on the more suitable land would be receiving more profit per unit output than producers on the less favourable land. The response to be expected would be: the producers earning extra profits per unit output would try to increase those profits by increasing output by employing more capital on that land. That is, the better land would be used more intensively. The effect would be to increase the average non-land production costs (see Fig. 2) and the total production on the better land.

From that analysis, we can draw two interesting conclusions. The first is that the existence of land rent might indeed raise product prices, even in the absence of competition for land between industries. For, if land rents were abolished, the extra production brought about by extra investment on the better land[8] might remove some production from the worst land, thus establishing a new margin where the (product-price-determining) average production costs were lower. (Ball, 1977, using a Marxist analysis and considering agriculture, comes to the same conclusion.)

The second conclusion is that land rent is not necessary for the functioning of a capitalist economy. If land were free, producers would adapt their production methods accordingly. But then, of course, the allocation of land between different users would be no longer achieved by the rent mechanism, and would have to be performed by, e.g. an extension of government land-use planning. And the results might easily be undesirable. If land were free and producers adapted their land-use intensities accordingly, the effect would be to increase even more the intensity (and building heights) at the centre of cities. If the government intervened and allocated land subject to restrictions on such higher densities, but took no other measures, then the effect would be to allow the central land users to make extra profits.

Conclusion

This supply-based approach to land prices is put forward for consideration as a complement to the approaches which focus on the geographical structure of urban land price. It must be stressed that we have done no more here than to outline the approach: in particular, as the approach is based on the technical production functions upon different types of land, an algebraic (in place of this graphical) treatment with different forms of production function would be interesting in order to test the applicability of the approach and the robustness of the conclusions drawn here. (See, for example, Fallis, 1979, on the importance for the gradient of employment density of the amount of factor substitution assumed within the production function. And Samuelson, 1959, discusses the technical conditions which could lead to less productive land being used more intensively than the more productive.)

Other limitations of this approach should be pointed out, in order to indicate ways in which the approach could be tested and, perhaps, improved. Not only are the results dependent on the form of the production function which we have assumed, but

[8] As Ball (1977, p. 391) says 'Landed property has acted as a barrier to the investment of capital'.

also on our assumptions about the behaviour of a profit-maximising firm (that it will choose a factor combination in accordance with the marginal revenue theory), about the form of the land market (perfect competition) and the form of the product market (also perfect competition).

Even with those simplifying assumptions (which, it must be said, are those also of many of the other theories in this field) it must be admitted that this approach does not produce such elegant theories as do the urban structure approaches – although there is no reason why the geographical and cost conditions of a monocentric city should not be incorporated in the production function of land, when the supply-based approach would be able to predict a geographical structure of urban land price. That, moreover, would be a further useful development of this approach, in order to compare its predictions about the gradient of the price and density functions with those of other approaches.

However, this supply-based approach has been developed precisely in order to cope with the irregular vagaries that characterise the supply of land, so elegant solutions are not to be expected. Nor to be expected are any explanations – geographically regular or not – of the complete pattern and level of land prices in an area, for such explanations require a factual knowledge of the details of the land supply and of the production possibilities on that supply of land for different industries.

Rather, it is suggested that this approach would find its best application in explaining and predicting the effects of known changes. If change (such as a new road or a new technology or a change in relative factor or product prices) affects the production functions on known stocks of land, then it should be possible to predict the effects on the type and intensity of land use, on land prices, and on the price of the products produced on that land.

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