

The Supply of Land for a Particular Use

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A number of features of land markets in and around cities are not well explained by existing theories of the allocation of land. Although there has been a good deal of work on the demand for urban land, in particular how the demand varies with distance from major centres of activity, relatively little attention has been given to the supply of land for urban uses, or for particular urban activities within cities. Recent articles by Evans (1983) and Wiltshaw (1985) have put more emphasis on factors affecting supply. Using a quite different approach Titman (1985) has also added to our understanding of the supply process.

The supply of land is generally assumed to be fixed in the aggregate so that the aggregate supply curve is vertical. Supply of land to a particular activity, however, is very elastic as land will be used for that purpose which yields the highest rent; in principle the supply is perfectly elastic. Ricardo qualified this by recognising that land varies in fertility and von Thunen by recognising that land varies in location. Alonso's model applies the method of von Thunen to an urban context. Both the von Thunen and Alonso models assume that land will be used for the activity that can pay the highest rent so that land in a given location will have a horizontal supply curve for any given use, its level being its rental value for its next most profitable use.

Among the puzzling features of urban property markets is the fact that vacant and under-utilised land can be found in close proximity to highly

developed land. Around the fringe of cities this produces scattered development, which is difficult and expensive to service and makes the areas unattractive as well as taking land out of rural production a good deal earlier than is necessary to provide for urban requirements. Something similar occurs within cities when individual sites in and close to commercial centres are used for low density housing or for surface car parking. Both kinds of mixtures of land uses of very different densities often continue for long periods of time.

Another feature that requires explanation is the considerable margin that exists at the urban fringe between the price of land used for urban purposes and its price (value) for non-urban purposes. The models of Alonso (1964) and others that focus on demand implicitly assumed that at the margin of a city land for urban use could be purchased at a price only slightly above its rural value: just enough to bid it away from farmers. In reality, even at the urban fringe, urban values are frequently many times rural values. Again the same phenomenon occurs within cities where land used for commercial or office development generally changes hands at much higher prices than residential and industrial land even where they abut one another.

Together these two puzzling features produce situations where land at margins between different uses has a much higher market value than its current use value over a long time period and yet no development or redevelopment occurs.

Max Neutze is at the Urban Research Unit, in the Research School of Social Sciences, the Australian National University, Canberra. A number of people have made valuable comments on earlier drafts of this paper, including Alan Evans who was working along similar lines to Part 2 when the first draft was being prepared. I have benefited from discussions with Barry Pearce, Desmond Wiltshaw and Gavin Wood. Referees comments were also very helpful.

One possible explanation of the large price differences is that artificial shortages are created by land use controls. This is a specially popular explanation for the rural/urban land price difference. Although such controls may well contribute to the size of the margin they are certainly not a sufficient explanation. Large margins occur in places where there are few if any land use controls, and where such controls are far from binding in that there is a large enough supply of developable land with no regulatory limits to development to last for many years. Again, commercial developments are seldom highly constrained by land use controls. The controls cannot even help to explain scattered development and redevelopment. Indeed they are often used as a means of trying to make development more compact.

A similar, and perhaps more persuasive explanation is that accessibility to public and private urban services quite sharply distinguishes land with urban from land with non-urban value. In the case of utility services the boundary can be quite distinct and access to such services can add greatly to land values. Like land use controls access to services can explain major price differences but it cannot even help to explain scattered development or redevelopment. Services seldom constrain the conversion of land to high density commercial use. Yet another possibility is that much of the land available for development is owned by one or a few owners who can profit from releasing it only very slowly for development (Markusen and Scheffman, 1978). There is, however, not much evidence of very concentrated ownership and it would not normally lead to scattered development.

What seems to be needed is an explanation of why property owners and developers defer development and redevelopment even in circumstances where the returns from development appear to be high, and why some land owners and developers defer, while others in apparently very similar circumstances develop. The latter part of the explanation is needed to understand why the supply curve of land for a particular use in a particular location slopes upward. Deferral of development under these circumstances reduces the supply and creates the price margin. Differences in decisions about the timing of development by owners of adjacent land create scattered development. One explanation puts a good deal of emphasis on dynamic aspects of urban

development including speculation in property markets: owners defer development because they expect future development to be more profitable than current development by enough of a margin to more than offset the returns forgone by maintaining the lower level of use in the interim. Evans and Wiltshaw, however, advance an alternative, somewhat different explanation, relying on static rather than dynamic factors.

This paper examines the Evans and Wiltshaw explanations in turn to see to what extent they are alternatives to the dynamic-speculative explanation or whether both static and dynamic approaches can be used to explain the characteristics mentioned.

1. A Static Theory Including Non-Financial Returns

Evans (1983) focussed on the supply of land for urban uses by assuming an Alonso type city and examining the market in a particular ring within which accessibility, the relevant aspect of location in such a model, can be assumed uniform. He argued that in such circumstances the supply schedule for land for urban uses, rather than being a horizontal line, is upward sloping because the occupants of the land derive varying amounts of economic surplus from its occupation. Each owner will be willing to sell his or her land for urban use at a margin above the current use value which varies with the size of the surplus the owner gets from the current use. Since, at any time, the remaining rural users presumably derive a substantial surplus from rural use, a margin between rural and urban values can be expected. Since there is no reason why those occupants who derive the lowest surplus from occupation of their land should be adjacent to the fringe of development, the result is likely to be that scattered properties are developed first for urban use.

Wiltshaw (1985) elaborated on this analysis by adapting to the supply of land the standard model used to analyse the supply of labour. In the analysis of labour supply it is generally assumed that work involves a loss of utility so that people have to be compensated by wages for forgoing leisure. Figure 1 is the standard diagram in which OH represents the total number of hours in a week or a year, HW' the non-wage income of the person concerned, II' one of a family of indifference curves showing the rate at which a worker is prepared to work for more or

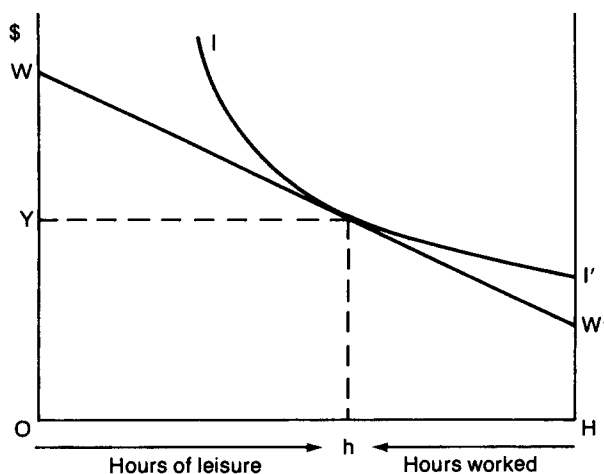


Fig. 1. Leisure and work.

fewer hours for greater or less income and the slope of WW' the wage rate. In this case the person will work Hh hours, have a total income of OY and Oh hours of leisure.

Wiltshaw believes that the supply behaviour of the owners of land can usefully be analysed in the same way as the supply behaviour of the owners of labour. Just as workers are assumed to prefer leisure, land owners are assumed to get the greatest satisfaction from using their land for some non-commercial use such as landscaped parks, and have to be compensated through rent for the loss of direct utility if they are to commit it to a commercial use. A non-commercial use is defined as one that produces direct utility but no rent. Commercial and non-commercial use are regarded as the equivalent of work and leisure.

A choice between different commercial uses is portrayed by Wiltshaw in the same way as Mishan (1981, p. 211) portrays a choice between jobs. He uses a diagram similar to Figure 1 but with another quadrant to the right of the vertical axis through H which is a mirror image of Figure 1 and which applies to a different commercial land use. Such a diagram can be used to make such a comparison by lining up indifference curves so that they intersect the common vertical axis at the same points. In effect a conversion from one commercial use to another is assessed by comparing both with the utility obtainable from the non-commercial alternative.

This approach seems unnecessarily laboured and artificial even for heuristic purposes. While the zero

point on the horizontal axis of the labour supply diagram is easily understood as a position at which all of the person's time is available for leisure, it is not nearly as obvious what it means in the case of land. Few owners use any of their land for non-commercial purposes but we all have some leisure. Furthermore the comparison between a non-commercial use and some particular commercial use is seldom the important one: it is much more likely that owners will want to compare salient alternative commercial uses for their land.

A more fundamental difficulty with adapting the labour supply analysis to land is that its primary objective is to throw light on the aggregate supply of labour through analysing the decision of an individual about how many hours to work. By contrast if we want to understand the supply of land for urban development we are examining its supply to a particular industry or use. Given its fixed aggregate supply, supply of land for one use involves its withdrawal from another and any analysis should be concerned with both aspects. It seems both simpler and more correct, then, to analyse the supply of land to a particular use by making comparisons between alternative "commercial" uses. The alternatives may, of course, return different levels of income and yield different levels of direct utility. In some cases one alternative may even yield direct utility and no rent but we should not limit ourselves to such comparisons. For example, either a landlord or an owner occupant could get greater satisfaction, but a lower level of rent, from farming than from urban use. Similarly, an owner occupant of a house could derive a good deal of direct satisfaction from the house, in addition to its imputed rent (market rental value), but little, if any, if it is used for offices. A landlord may prefer to deal with residential rather than commercial tenants, or the reverse.

Figure 2 is drawn in a way that assumes that the present (preferred) use is the one that provides greater direct utility. It, in some respects, takes the place of Wiltshaw's non-commercial use and is shown with its vertical axis on the right hand side of the diagram. It can be used to analyse the allocation of a specific site between alternative uses. The greater direct utility provided by the use with its vertical axis on the right is reflected in the downward slope of the indifference curve II' : the owner is willing to give up income in order to use more of the site for its present and less for the alternative use. A

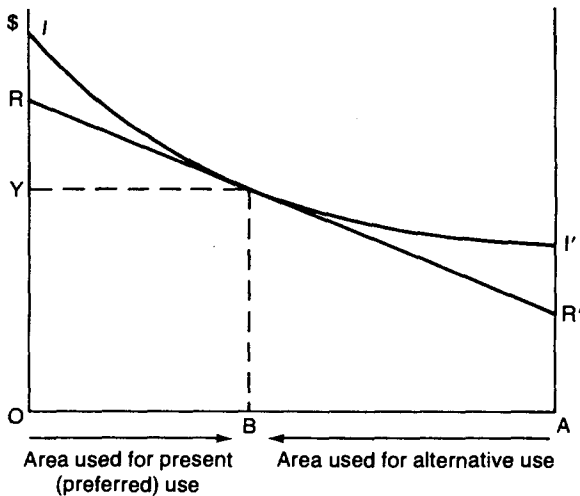


Fig. 2. Trade-off between two land uses.

move along the horizontal axis means that more land is in one use *and* less in the other. Whereas the slope of the indifference curve in Figure 1 represents the rate at which a person is willing to reduce hours of leisure if compensated by increasing income the slope of the corresponding curve in Figure 2 shows the rate at which he or she is willing to *switch* from a preferred to a less preferred use if compensated by an increase in rental income. In Figure 1 the slope shows the marginal utility of leisure; in Figure 2 it shows the *difference between* the marginal utilities derived from the two land uses: $MU_a - MU_p$ ($p =$ preferred, $a =$ alternative).

Income from all sources apart from property, plus the rental income from having all of the land in the preferred use, is shown by AR' . If the whole site was converted to the alternative use the total income would be OR . The slope of the line RR' is the difference in the rental yield of land in the two uses and RR' shows an income possibility frontier. Given the relative rents shown in the diagram and the indifference curve the owner will use OB of the land for the preferred use and BA for the alternative use and total income will be OY .

One implication of the difference between the two figures can be seen in the shape of the indifference curves. In the case of labour diminishing marginal utility of income and leisure will generally result in the indifference curves being convex downwards.¹

There can be no such presumption if we are studying the supply of land, or indeed labour, to a particular industry. A neutral assumption would be for them to be straight lines, and they could be concave downwards if an owner preferred to have all of his land in one use or the other rather than some in each. (In the most simple situation they would be horizontal straight lines if the owner was solely concerned to maximise rents and did not otherwise care about the use of his land). To see how this analysis can produce an upward sloping supply curve for land to an industry, we will assume straight line indifference curves and that five owners, each owns one hectare of farm land near an expanding urban area. Their indifference curves are shown in Figure 3a as $I_1, I_2 \dots I_5$. We assume no income from other sources and that each of them can earn AR rent from farming. As urban rents rise above AR to $OR_1, OR_2 \dots OR_5$ successive owners convert their land to urban use so that the supply curve will look like SS' in Figure 3b. With a larger number of owners it would be smoothed. This result is very similar to that of Evans (1983).

2. A Dynamic Theory

The important difference between dynamic and static theories of supply is that the former emphasise that the anticipation of future changes in conditions can have an important influence on both the current price and the current supply of land for a particular use. The models of this kind focus on the timing of a change in land use since the earlier a change occurs in response to an increase in price, the greater the supply response to the price increase. The following diagrammatic exposition of this model is derived very largely from the author's 1973 paper for OECD. Basically the same approach was used in an algebraic model by several writers who were interested in the impact of a tax on development gains on the supply and price of land for urban development (Rose, 1973; Foster and Glaister, 1975; Evans, 1982). The value of land for a particular purpose is the present value of the expected flow of net returns if it is used for that purpose. If there is to be a change in use the value of the site is the present value of the flow from the first use up to the time of the

¹ Another difference, argued by the classical economists but not central to this analysis, is that while a subsistence wage sets a minimum price at which labour will be supplied to an industry there is no such floor on the price of land.

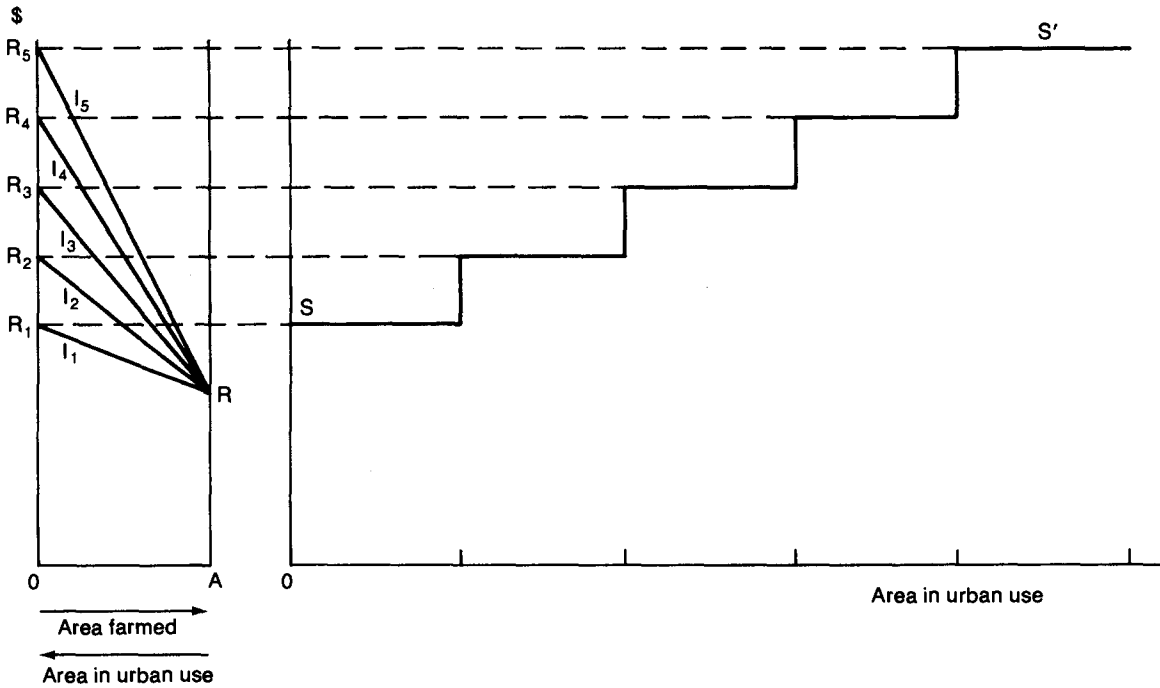


Fig. 3. Indifference curves and the land supply curve.

change and thereafter from the new use. The net returns from any particular use can also change over time. The value of land can, then, be defined as follows (Rose, 1973):

$$V_0 = \int_0^D f(t)e^{-rt}dt + \int_D^{\infty} h(t,D)e^{-r(t-D)}dt.e^{-rD} \quad (1)$$

where V_0 = value of the site at time 0;

$f(t)$ = net returns per period from the first use, a function of time;

r = the discount rate;

D = date of conversion from the first to the second use;

$h(t,D)$ = net returns from the second use.

The first part of the equation is the value at time 0 of the flow of returns from the predevelopment use up to the time of development (D). The second part is the value at time 0 of the returns after development. The level of those returns, $h(t,D)$, depend not only on the actual year when the returns occur (t) but also on when the development itself takes place (D).

Figure 4 represents a simplified version of the equation. It is assumed that the flow of returns from the predevelopment use, which might be farming, is

expected to be constant. Figure 4 does not permit any choice about the type or density of development so that h is a function of t but not of D . In this case rent from the developed use exceeds farm rent from t_d onwards.

The current value of the land for the particular post-development use, when development is assumed to occur at t_d , is shown in the V_u curve. The sum of the value of the interim and expected final use is shown as V_f . Expected returns after development increase the market value of land (V_f) above its value for farming (V_f) well before the time of actual development and before the higher post-development rents, R_u , can be obtained. Well before development (from t_u) the prospective urban value of the land (V_u) exceeds its value for its current farm use. Even in the absence of any land use controls the value of fringe land for urban purposes will commonly be well in excess of its farm value. The current value of the returns from the interim use for farming ($V_f - V_u$), starts off as OV_f when V_u is zero at a time when urban development is expected in the very remote future, and becomes smaller as the date of development approaches. That t_d is the optimum time for development, can be seen by differentiating V_0 with respect to D . Intuitively, the cost of

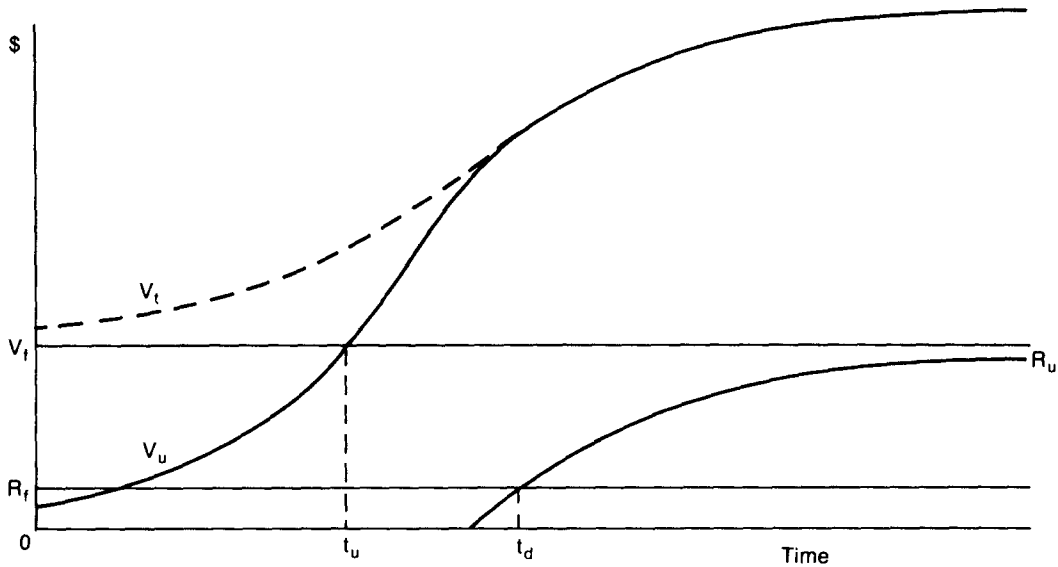


Fig. 4. Flow of returns.

deferring development is foregone post-development rent, R_u , and the returns from deferring development are continued farm rents, R_f . Development when R_u rises to equal R_f will maximise V_u . Note that the margin between urban and rural values occurs not only without any land use controls but also, in an important sense, without speculative withholding of land from development since it is assumed that the land is developed as soon as the net return from urban use exceeds the net return from farming.

Figure 4 abstracted from speculative land holding by assuming that there is only a single profitable urban use. The opportunity for speculative activity can be illustrated when we make the model a little more complex by recognising that different kinds of development of a site may be profitable at different stages in the urban development of a locality. One of the main reasons why the flow of returns from the post-development use varies with the time of development is that the most profitable kind or density of development will, itself, vary with the time of development. For example semi-rural subdivisions could be the most profitable kind or density of development when the particular site is beyond the fringe of an urban area, ordinary single family housing some years later and flats at an even later stage. In some circumstances these uses can follow one another but in other circumstances (discussed

below) the expected life of lower density urban uses will be so short that the different urban uses have to be seen as alternatives rather than members of a sequence. Speculative withholding of land under these latter circumstances occurs when continuing to farm is more profitable, even when low density development would return greater rents, because it keeps open the option for an even more profitable use in the future. This can be illustrated in Figure 5 which is derived from Figure 4. To simplify we limit our consideration to two possible levels or types of development, though the analysis would be essentially the same with more than two alternatives.

The rents from the two alternative urban uses are shown as R_u and R_u' respectively. The variation over time in the discounted values of the flow of returns from the interim use followed by each of the alternative urban developments at times t and t' would be V_t and V_t' respectively. In Figure 5 V_t and V_t' are both drawn on the assumption that the land is farmed up to time t and t' respectively and then developed. Considered at time 0 the value of the flow of returns from the earlier and less intense development is higher and the same is true at the time (t), which might be seen as a time of decision, when that development first becomes profitable. A landowner in these circumstances would be expected to choose the earlier development, notwithstanding the fact that at a later date his site would become

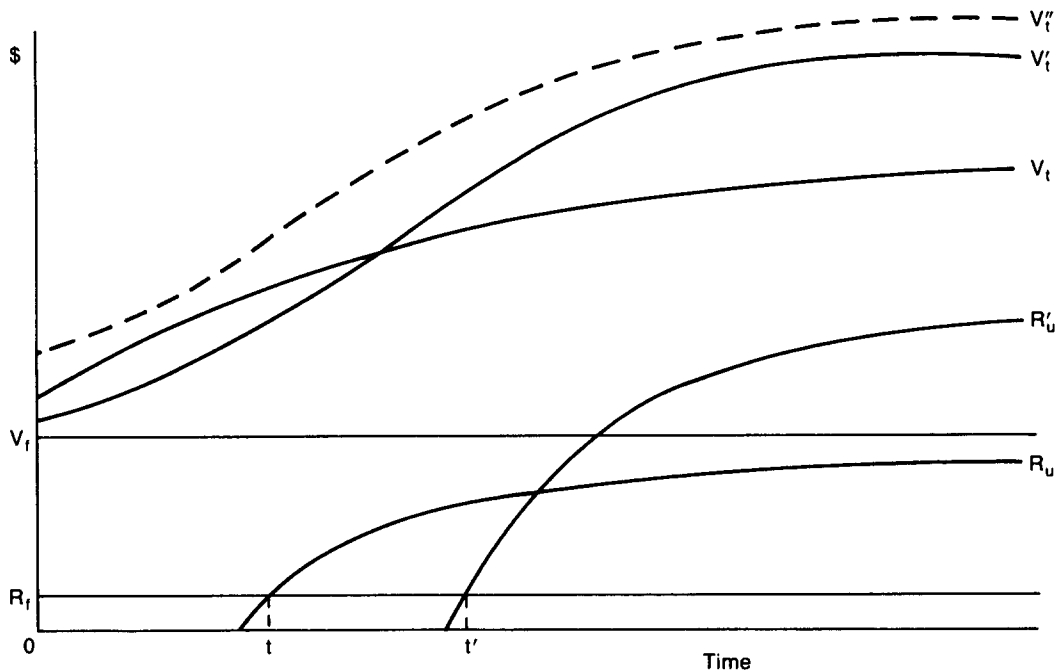


Fig. 5. Alternative land uses.

more valuable if it was still vacant and available for use for the more intensive development represented by R_u' .

If, of course, the total discounted value of the expected flow of returns from the more intensive form of development were to be as shown by V_t' instead of V_t it would be more profitable for the owner to keep the land vacant until the higher density use became profitable: the present value at time 0 and time t of the loss of revenue from continuing farming between t and t' would be more than offset by the present value of higher revenue after t' . In this case, between t and t' the owner would be deferring development even though there was an urban use which would return more in rent than farming.

Under what circumstances are land uses alternatives rather than potential members of a sequence? Figures 4 and 5 are not suitable for examination of this question because they assume that net rents from a land use change fairly smoothly over time if they change at all. The typical time pattern of net rents from urban development, however, is for net rents to be large and negative in the first year or two when the site is being prepared and construction costs are incurred, and much smaller and positive in following years when returns

are being received. Such sequences come in bundles: the positive returns come only after the costs. The present value of such a flow of returns will depend crucially on how long the flow of positive returns is expected to continue. When considering whether or not an interim low-density urban use is a worthwhile part of a sequence, a land owner will compare the discounted value of the flow of returns from continuing the current use. The shorter the expected duration of the interim use, *ceteris paribus*, the less likely it is to form part of an optimal sequence.

Once land has been committed to a use by the construction of durable structures a change in use is desirable if, after paying the cost of demolition, the site is worth more in the new use than the site and buildings are worth in the current use. One could argue that the value of a vacant site is greater than the value of a site with buildings because a vacant site can be committed to its most profitable use with less sacrifice of returns from alternative production. It is more correct, though, to define site value as its value if it was vacant and to regard the value of buildings as the residual. The buildings on a site which could be much more profitably used for another purpose have little economic value.

It is easy to distinguish, then, between existing

uses, whether farming or housing, which require little or no new investment, and new uses which require a lot. In Figure 5 V_t and V_t' can be regarded as valuations of alternative sequences of land use. The fact that they cross does not reduce the superiority of V_t at time 0 and up to time t when the first decision must be made. It shows that, even though the flow of returns from R_u' is worth more from the time V_t and V_t' cross, that gain is worth less at time 0 than the sacrifice from the loss of R_u between t and t' . The greater value of V_t' at later dates reflects the financial advantage of keeping options open by deferring development. The V_t s are not site values but the value at different times of alternative flows of net returns. The true site value is the highest V_t at any one time, reflecting the most profitable sequence of uses if the site was vacant at that time.

The analysis of urban land when there are alternative sequences of development shows that it is sometimes worth holding land vacant, in an existing use, even when it could bring higher net returns in another use. This occurs because committing it to the second use may be less valuable than holding it vacant in order to be able to commit it later to an even more profitable use. It follows that urban and rural values will diverge even further than would be expected from the analysis in Figure 4.

Does the model help explain scattered development? It does so in two ways. First, some land is more suitable for future higher density use and will be more likely to be held out of development. Second, property owners have varying discount rates. Those with higher discount rates will choose to develop earlier, and owners' discount rates are not likely to be closely related to the closeness of a property to the established urban (or commercial) area.

3. Uncertainty

Analysing alternative sequences of future returns as though they were known with certainty omits a major determinant of land use. Uncertainty influences the results of the analyses in Section 2 in two ways.

First, owners' assessments of likely future prices,

costs and other conditions vary. Owners who are optimistic about the value of future development opportunities will tend to keep their land vacant in order to be able to take full advantage of them. Owners of adjacent sites may make very different predictions. As with discount rates, there is no reason why owners who are more or less optimistic should be clustered together so scattered development is likely.

Second, individual owners are likely to be uncertain about the future. This could be illustrated by introducing different R_u' curves, each of which may occur. In this context, as Titman (1985) shows, vacant land can be likened to an option to develop in the way which emerges in the course of time as being most profitable. His example is land in commercial areas which is held for many years in a low intensity use such as surface car parking:

"... a vacant lot can be viewed as an option to purchase one of a number of different possible buildings at exercise prices that are equal to their respective construction costs. This approach provides a valuation formula that is a function of observable variables and is independent of the investor's preferences." (pp. 505-6)

The value of the vacant site is then the value of the option to choose the future level of development in the light of those future conditions. Using the valuation of options from the theory of finance, Titman shows how this can be expressed as a function of the alternative levels of profitability of building condominiums at the future date, annual rentals, the risk free interest rate and the value of the site for current construction.² If its option value for future construction exceeds its value for current construction it will pay the owner to keep it vacant.

An important result of this analysis is that it can formally demonstrate that the greater the level of uncertainty about future market conditions the greater the value of the option to decide the level and type of development in the light of those conditions as they emerge rather than determine them immediately in order to build forthwith. With a high level of uncertainty a decision to develop immediately is relatively unattractive. It follows that the higher the level of uncertainty the higher the

² Brown and Achour (1984) have shown in a more conventional analysis how the value of options can be adapted to the property market.

value of vacant land relative to developed land and the smaller the supply of such land to (for) development. The level of uncertainty about future opportunities itself then contributes to the margin between value of property in its existing use and its value for a new expanding use.

An important policy implication follows. Planning of land use, and land use controls that are adopted to implement plans, to the extent that they reduce the level of uncertainty about the form and level of development that will be appropriate and permissible, can actually hasten development. The result would be to *increase* the supply and *reduce* the price of land for development and redevelopment. This implication is directly contrary to the general conclusion about the impact of land use planning on prices of land for urban use: namely that it restricts the supply and therefore causes prices to be higher (Hall *et al* 1973; Neutze, 1973).

Land use controls are often seen as a source of uncertainty about future returns rather than as a means of reducing uncertainty since the authority administering the controls has discretion about whether or not certain kinds of developments will be permitted (Wiltshaw, 1986). Such uncertainty would not, however, increase the option value of vacant land. Nor does it counter the major increase in certainty about future patterns of land use provided by land use planning. In general, planning makes the whole context within which development takes place less uncertain, though it is possible for plans to be changed so frequently that they, themselves, cause increased uncertainty about the future pattern of development. It may be, of course, that the effect of uncertainty is small relative to the direct effect of supply restrictions on prices.

4. Discussion

This paper has analysed three explanations for the features of the urban land market that seem inconsistent with a straightforward static theory. They are: (1) the non-financial direct utility which is obtained from occupation and ownership of land varies with its use and between owners, (2) land use decisions and land values depend on expectations about the future as well as on present conditions in the market, and (3) uncertainty about future

conditions results in owners' expectations varying and the greater the uncertainty the greater the gains from deferring development. These explanations are additive rather than alternatives. An owner who enjoys his land being farmed will be even more likely to refrain from development if he believes that it will continue to appreciate with expanding urban development opportunities. Furthermore, his decision will be reinforced if it seems possible that even more profitable development possibilities could emerge in the future. For many land owners the relevant aspect of future expectations is their impact on the future market value. The second and third explanations are specially closely related since future expectations are always uncertain. The degree of uncertainty, however, varies greatly.

In particular circumstances one or other of the explanations is likely to be of greater importance. Titman was correct in focussing on the high degree of uncertainty attached to the profitability of high density redevelopment. Direct utility is an important factor inhibiting the sale of attractive rural properties for urban use but it is unimportant in areas where rural land is unused and gathers rubbish and weeds or in the case of derelict land in old industrial areas. The relative importance could be investigated in two ways. The first is to ask property owners about the reason for their decisions about the timing of development. Such questions would need to be very carefully framed and to recognise that decisions by owners to develop may be taken in very different contexts (Goodchild and Munton, 1985). The second is to formulate hypotheses about observable features of the market that would occur if one or other of the explanations was the most important.

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