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An economic theory for industrial land policy

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ABSTRACT

When a land-use plan is made which includes land for industrial uses, the amount of land reserved is usually based on an implicit theory about how firms demand land. As a result, it is not clear what the effects would be if the reservation turns out to be incorrect. Here, a theory is made explicit, by focussing on the technical possibilities which a firm has for substituting between land and all other factors of production. Where that substitution is easy – such as for office-using firms – the practical consequences of reserving too little land are not likely to be great. Where that substitution is difficult – such as for many factory-using firms – the practical consequences could be serious. It follows that it is important to reserve such land generously.

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Introduction

Land use plans often include the reservation of land for the production of goods and services – called here, industrial land. This policy is pursued not because the amount of land used for production is big and for that reason needs to be controlled: in the Netherlands, for example in 2006 only 2.5% of the land area was occupied by production firms and commercial services including shops (Statistics Netherlands http://statline.cbs.nl). Nor is this issue important because land costs are a large part of the total expenditure of firms, for they are marginal: again using the Netherlands as an example, even though the density of economic activities is high, land costs are only around 1.5% of total fixed capital investments of firms.[1] The policy concern is that difficulties in obtaining land will restrict production and thus employment, or push up costs. So land-use planning should reserve sufficient land and in the right locations.

For their industrial land policy, planners have to estimate how much land will be needed for industrial uses in a particular location over the plan period. There are several ways of making that estimate (see e.g. Louw et al., 2009, pp. 46–51), but the most common seems to start from forecasts of employment changes in that location, translating this into changes in the demand for land. This translation requires knowledge of the intensity of employment (number of workplaces per hectare) for the different industrial sectors, also forecasts of how that might change. The advantage of this method is that it is quick and easy. The disadvantage is that it is not based on any theory about how firms use land. Instead, the assumption is made that the way in which firms use land is determined only by the number of workplaces, according to a fixed ratio. As a result, little is known about the effects of making a faulty estimate. If more industrial land is reserved than comes to be demanded, this land will be used inefficiently: it will stand empty, or firms will use it wastefully. If too little land is reserved, firms might be hindered in their production, might have unnecessarily high production costs, or might locate elsewhere. It is the purpose of this article to put forward a theory about how firms use land as a factor of production, a theory which should help those responsible for industrial land policy to avoid such disadvantages.

The argument is developed in the following way. Of the various ways in which land can contribute to production, only one is considered, namely that land provides a place with a particular extent on which production can take place. However, attention for this has more or less disappeared from current mainstream economic theory: land is no longer regarded as a separate factor of production. There are micro-economic theories about land and about the possibility of substituting between land and all other production factors, but they take no account of the possible limits to that. We need a theory which takes into account two characteristics of land – that it is indispensable and immobile – and what this means for how a firm demands land as extent. This theory is developed by investigating two extremes – substitution is difficult and substitution is easy – and by exploring what that means for a firm deciding how much land to take on a new site, and for a firm deciding whether to

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[1] This share varies between sectors, but even for firms in the service sector which often want expensive locations, it is not above 2%. There is a rule of thumb that when a firm invests in a new factory, the land costs 1% of the total, the building 9%, and whatever is put inside the building costs 90%: the Dutch data on investments in land and buildings are consistent with this (average values for the period 2000–2006, Statistics Netherlands http://statline.cbs.nl).

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relocate when production grows. Those theoretical deductions are compared against empirical data about industrial land use in the Netherlands. Finally conclusions for practice are drawn.

Land as a factor of production

Land has three characteristics which are important for production: land gives access to natural resources such as fertility and raw materials; it provides a (point) location relative to other firms, to labour, to markets, to infrastructure; it provides a place on the ground with extent (area) where production can take place. This article should increase our understanding of the amount of land which a firm needs for production (the third characteristic). What we mean here by land is: a piece of ground with a certain extent. We are not concerned here with natural resources in and under the ground. Nor are we interested in the location of that land, so we are not talking about how a firm chooses a location for its production. And we are talking only about land used for production, not land used for consumption, such as a garden or a park (although the theoretical discussion below is partly applicable to land as a consumption good also).

A theory about the demand for (production) land as extent must take account of the contribution which land makes to production, and the degree to which that particular contribution could possibly be made by other factors of production. Land contributes to production by giving a place on the ground without which no production is possible: land is indispensable for production. However, production can take place more on less intensively on land. So although it is indispensable, some of its contribution can be replaced by the input of other production factors. This focuses attention on the technical possibilities for substituting between area of land and other factors of production. For example, a firm which wants to produce a certain amount of goods and services can do that in a one storey building on a plot of land with stores and parking on the surface in the open air, or in a multi-storey building with everything under cover and on a smaller plot of land. In that second case, capital has been substituted for land. If that requires also more labour input, labour too has been substituted for land.

It is curious that current mainstream economics cannot help us in the search for theories about this. When economics as a science started to develop, attention for the contribution of land to production was central, as the following quotation shows:

> "The land is the source or matter from whence all wealth is produced. The labour of man is the form which produces it: and wealth itself is nothing but the maintenance, conveniences, and superfluities of life." (Cantillon, 1755)

Yet 150 years later we read:

> "It will be well at this point to note how very unsatisfactory, from the theoretic point of view, is the popular division or classification of the factors of production as land, labour, and capital. The distinction between land and capital is obviously arbitrary. . . . . Land, therefore, even as economically defined, cannot be considered in isolation from capital." (Wicksteed, 1910, bk I, ch 9, par 11)

And today, most modern textbooks only mention labour and capital (such as machines, buildings or monetary funds) as production factors and make no reference to land (Hubacek and van den Bergh, 2006). Land, as the provider of location, interests regional scientists but not many mainstream economists. 'Hundreds of books on economics are published with 'land' absent from the index' (Gaffney, 2004, p. 3). There is no attention for the substitutability between land and capital, and it is assumed implicitly that land can be completely replaced by capital.

Micro-economic theories of land as extent

Even if macro-economics does not find land relevant for economic growth, and textbooks on general economic theory pay no attention to it, the obvious importance of land (as extent) for everyday life has led to its treatment in more specialist economic literature. These are micro-economic theories about the demand for land as area, and some of them are applicable to both land when used for production and when used for consumption.

The analytical tools of neo-classical economics have been applied to land by Barlowe (1958), Harvey (1987) and more recently by Hubacek and Vazquez (2002). The question of the amount of land demanded was raised by Alonso (1964, p. 5), who at the same time remarked how strange it was that others ignored it.

> "...it would seem that later theorists have not studied Marshall's analysis with care, for the question of size of the site is almost universally ignored. . . ..The matter can be made very clear at the level of the firm. If two firms realize the same location advantages with respect to a location, but one requires a site only half the size of that required by the other, the former will be able to bid a price per square foot of land at that location twice as large as the latter."

The economists who followed in Alonso's footsteps (such as Muth, 1969 and Fujita, 1989) applied his ideas about land use to residential land (land as a consumption good) and not to land for production. Moreover, the applicability of Alonso's ideas is limited because they consider two questions – the choice of quantity and the choice of location – in one integrated – and therefore very complex – theory.

Another approach is to investigate the price elasticity of demand for land for production. A theoretical approach to this is offered by Marshall (1890) with his four rules of derived demand. According to these rules, the forces influencing the elasticity of demand for a productive factor are the elasticity of demand for the final product, the elasticity of supply of the other necessary production factors, the ease of substitution in production, and the relative importance of the factor. Marshall argued that the greater any one of these, the greater the elasticity of derived factor demand.

However, most work which takes this approach is empirical, and is applied to residential land (Muth, 1971; Sirmans and Redman, 1979; Sirmans and Kau, 1981; Needham, 2000). These studies suggest that the elasticity of demand for land for housing is quite low and averages around −0.5. The same method could be applied to land for production, but to our knowledge this has not been done. The elasticity of demand for industrial land has been estimated in a different way by the Centraal Planbureau (1999): for the Netherlands the result was between −0.1 and −0.2. This is even less than for housing: the reason might be that, in comparison with housing, land costs relative to the costs of other production factors are low (for industry around 1.5% – see above; for housing, land is 20–30% of the price of a new house – van der Heijden et al., 2005).

Substitution between land and one particular factor of production – buildings – is studied in real estate economics. This has, for example, theories about how the optimal height of an office block or an apartment building can be determined by considering the substitution between land and capital (construction costs – see e.g. Harvey, 1987, pp. 91–96; Evans, 2004, pp. 36–37).[2] However, this approach when applied to land for production purposes, is limited

[2] The relevance of these real estate theories has become much less as a result of developments in construction economics, by which the costs of constructing one extra storey (putting more capital onto the same land) do not increase (or hardly) with the number of storeys, as a result of which there is no longer an optimum number of storeys.

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