The Welfare Economics of Land Use Planning*

Paul Cheshire† and Stephen Sheppard‡

January 2000

Abstract

Despite the pervasive nature of land use planning and land use regulation, evaluation of the costs and benefits of these policies has received only limited attention. This paper presents an empirical methodology, based on clear microeconomic foundations, for the evaluation of benefits and costs of land use planning. The technique is applied to the Town and Country Planning System of the UK. Evaluation is presented of gross benefits from several land use planning activities, the net costs of land use planning, and the distributional consequences of these policies. The results show that these welfare and distributional impacts can be very considerable.

1. Introduction

A central focus of economics is evaluation of the consequences of public policy. From the Corn Laws to control of environmental emissions, the tools of the profession have been applied to determine the costs and benefits of acts of government. This continues to the present, with examples such as the consideration of environmental regulation Hazilla and Kopp [1990], occupational safety regulation French [1988] and noise regulation Holland and Cross [1995]. Curiously, one of the most pervasive forms of government regulation, particularly strong in the UK, has received much less attention from economists: land use planning. While the theoretical properties of land use controls have received some attention¹, there are no studies which have estimated their net costs and distributional consequences. This lack of attention is particularly egregious in view of the fact that land use regulation affects the single most important item in consumers’ budgets, housing, and therefore has potentially greater consequences for welfare than regulation in any other context.

* We would like to thank the Editor and two anonymous referees for helpful comments on an earlier draft. This paper draws upon research funded by the Economic and Social Research Council under award No. D00 23 2044. This support is gratefully acknowledged.

† London School of Economics

‡ Oberlin College

¹ For example, see Sheppard [1988], Fischel [1990], Epple, Romer, and Filimon [1988], Brueckner [1990], Brueckner [1995], and Brueckner [1996].
Concern over the costs of land use regulation is of particular importance at present in England. A recent study (Department of Environment [1996]) predicted a large increase in the number of households to be accommodated in what is already one of the most densely settled countries in Europe. In response, a variety of groups and policy makers have called for even greater restrictions on land release for residential development to prevent further building in rural or ‘greenbelt’ areas.

More generally, virtually every urban area in the developed world exercises some control over the use of land and the type or extent of residential building. Such regulation serves a variety of purposes: control of the spatial structure of residential development can reduce the cost of providing some local public goods and serve to isolate land uses which are likely to generate costly external effects; regulation of building types can serve to limit the deadweight loss from property taxation; regulation of land use can be a method of providing valued public goods and amenities by fiat rather than through taxes and direct public sector production.

Those types of regulation which have been the subject of extensive analysis also serve a variety of goals and can reasonably be claimed to generate benefits as well as costs. The question of interest is not whether these public policies generate benefits, but rather what is the value of the benefits and how do these benefits compare with the costs associated with the policies. This paper develops and tests an approach for such an evaluation of land use planning. The method is applied to evaluate the most obvious benefits and a range of plausible net costs of land use planning, and the distributional incidence of these benefits and costs.

The British land use planning system constitutes the regulatory framework for this study and is the archetype for one of the three main types of planning system that operate around the world. The others are the ‘master planning’ system of continental Europe and the zoning system of the USA. In the British system every action that legally constitutes development requires individual consideration by the planning authority of the local community.

Several previous papers\(^2\) have shown that these systems of ‘development control’ act to restrict the supply of urban land by category of land use. The British and other land use planning systems generate benefits in the form of unpriced local public goods. These are not made available by imposing taxes on local residents and then using the proceeds to pay for production. Rather, they are produced by using the power of the state to require land to be used in particular ways, or neighbourhoods to be of a particular type. The absence of taxes, however, does not imply the absence of costs. These policies may result in significant changes in land prices. This in turn generates both welfare costs, measurable in terms of the equivalent variation associated with the price change, and distributional effects.

This paper draws on previous results obtained by its authors which have estimated implicit prices (Cheshire and Sheppard [1995]) and identified the structure of demand for land and planning benefits (Cheshire and Sheppard [1998]). Using this demand structure, we develop a methodology for quantifying

\(^2\)For example, see Mayo and Sheppard [1991], Cheshire and Sheppard [1989], Bramley [1993b], Evans [1988], Bramley [1993a], Gatzlaff and Smith [1993], Fischel [1990], or Son and Kim [1998]. For a survey see Evans [1999].
the net welfare and distributional impacts the system of land use planning can have. The focus is on a city selected, on the basis of indicators of its planning regime, to represent a tightly constrained case. The supply of land is estimated in a way which allows us to simulate any selected degree of relaxation. This permits us to calculate the equivalent variation in income associated with the alternative policies, and to assess the effective distributional consequences. While the sample is drawn from a single urban area: Reading in Southeast England, the area itself is reasonably representative of those markets subject to restrictive land use planning regimes. Furthermore, since there is a substantial degree of substitutability for housing across contiguous local markets, it is plausible to interpret the results as indicative of the effects of land use regulation in a wide range of communities in southern England.

The lack of explicit taxes and payments probably explains the absence of previous analyses of the welfare effects of land use regulation. This paper provides the first results of this sort for the British system, and we believe the methodology might be useful in assessing the impact of land use regulation on welfare and equity in other contexts. All planning systems work to some extent to provide local amenities without collecting taxes to pay for them. Thus, in principle, the techniques developed here should be applicable to the analysis of planning systems elsewhere.

1.1. Outline approach

The methodology proceeds through a series of straightforward steps. The first was to select an urban area that approximately conformed to the assumptions of classic urban economic theory but that was subject to the most restrictive regulatory regime and constraints on land availability. For this most constrained urban area, sample data concerning the housing market were collected, including price, land, location, neighbourhood amenities, and the incomes of households occupying the houses in the sample. These data allowed estimation of implicit prices (including that of land). With observed household incomes and composition, it is possible to estimate the demand system for households in the sample in a way that accounts for their demographic composition. This permits the construction of an expenditure function for any household type in the city. Using these we estimate the utility level experienced by a ‘typical’ household and for a range of possible household types.

Underlying this analysis is the standard monocentric urban model of economic theory (for an exposition see, for example, Straszheim [1987] and Brueckner [1987]) within which costs of commuting to a central employment district are traded off against costs of land for housing. In equilibrium no household can gain from moving and all land available for housing within the urban area is occupied. Each city is assumed to be economically independent of all others. Subject to these conditions utility maximisation determines a price of land at any location, usually expressed as an annualised rent, which falls with distance from the

---

3In other papers (Cheshire and Sheppard [1995] and Cheshire and Sheppard [1998]) the focus was on two cities, at the polar extremes of planning restrictiveness. Here the focus is only on the most restrictive city so as to avoid any problems arising from possible endogeneity of planning restrictiveness and preferences.
It should be noted that land, the price of which is determined within this framework, has a very special meaning. It is land as pure space with accessibility to the single employment centre. Any actual parcel of urban land is a heterogeneous good, however, since its location simultaneously determines the supply of amenities and local public goods its occupant consumes. The price of land as pure space therefore not only differs from the market price of land but it can only be estimated within an hedonic framework. Land use planning both determines the quantity of a range of amenities available at any location and influences the overall supply of land as pure space. Thus to estimate the economic impact of such planning it is necessary to estimate separately both the implicit prices attached to planning generated amenities and the effect on the price of land as pure space (and so housing) of any supply constraint that may be imposed. Only by combining these price effects with knowledge of the structure of demand can the welfare effects be estimated.

The utility level and characteristics of the household types identified above as representative of all households of their type in the urban area. The utility level and structure of demand are known and land market equilibrium requires all available land to be used; and we can directly observe the inner and outer limits of residential land use. With this information it is possible to estimate the proportion of the total urban land area that the planning authority makes available for residential use.

To estimate the gross benefits, we use the demand system to determine the ‘reservation price’ for each amenity attributable to the planning system by calculating the price at which demand for the good would be reduced to zero. The value of the gross benefit to each household is then estimated by calculating the variation in income that would be associated with increasing the price of each amenity to the reservation price.

Estimation of the net costs of land use planning is somewhat more complex since it is necessary to examine not only the change in benefits resulting from a change in planning regime (again using the demand system) but also the costs. The costs of land use planning come primarily in the form of increased prices for residential land and hence for housing (and by implication the density of development). The equilibrium land rents are estimated under alternative planning regimes involving alternative supplies of land and provision of amenities. The equivalent variation in income that would be associated with the reduction in residential land prices is then calculated, together with the effective increase in the price of

\footnote{It is recognised that the standard monocentric urban model and its use for comparative static analysis - given the durability of housing - is a restrictive framework for analysis. In answer it may be argued that despite such criticism useful insights can still be gained from the monocentric model and, indeed, the results we report here are consistent with its main properties. The comparative static analysis can be defended on two grounds: first that we offer no analysis of dynamic adjustment processes; we simply compare one assumed equilibrium with an alternative which would exist once all adjustment had occurred, given a constant structure of demand and income. The second is that adjustment of land prices and urban structure can occur quickly through infill, subdivision, and extension of these durable structures.}
planning generated amenities.

This approach permits examination of the distribution among households of costs and benefits, and provision of tentative answers concerning the efficiency of the land use planning system as implemented in Reading. We find that considerable value is attached to the amenities produced. These amenities, however, come at a very high cost, so that overall there are apparently considerable net costs associated with the restrictions imposed on land supply for a wide range of household types. The distributional consequences vary according to which aspects of planning are being considered.

The estimation of both the gross benefits and the net costs of land use regulation proceeds by using expenditure functions which would be associated with the household preferences if the household faced constant prices. In a housing market, this is an approximation since the prices of structure and neighbourhood characteristics depend on the quantity consumed. In principle, the accuracy of our approximation might be improved but only at the cost of greatly complicating an already difficult procedure. For further discussion, see Bartik [1988].

2. The Data

2.1. Planning restrictiveness

The process that led to the choice of Reading as representing the extreme of planning constraint was explained in Cheshire and Sheppard [1989]. A necessary condition to be included in the set of cities examined was that the city was relatively stable, of intermediate size (the housing market area of Reading that was identified contains 80000 households), with an essentially monocentric structure and therefore a plausible city to which to apply the standard urban economic location model. The indicators of planning restrictiveness used included acceptance and application rates per unit stock, appeal rates against refusal of permission and the price of greenfield sites on the fringe of existing development.

2.2. Observed Characteristics

The sample was collected in the second and third quarters of 1984. The data are described in more detail in Cheshire and Sheppard [1995]. Details of the house structures and asking price were obtained by taking a 15% sample of Estate Agents’ particulars of houses on sale. The data relate only to owner occupiers, therefore. This has implications for the interpretation of the estimates of the effects of land use planning on the distribution of real incomes and could qualify the estimates of benefits and costs. Precise location of each property was determined from large scale Ordnance Survey maps which also provided, in conjunction with aerial photographs, details of local land use. Neighbourhood characteristics were obtained from the

---

5 In selecting possible cities a requirement was set that no more than 15 percent of the employed labour force should work outside the city so that the self containment assumption should not be flouted too seriously.

6 The full data set can be downloaded on the internet on request.
Small Area Statistics of the Census of Population and from local authorities. Very considerable effort was invested in checking and cleaning the data set. After dropping observations where there were missing variables the hedonic model was estimated on 433 observations. Household income, demographic structure, transactions prices (where the property had recently sold) and other details of households were obtained from household surveys. There was a 48% return of the household survey after follow up. This meant the demand estimates could be estimated on a sample of 206 households.\(^7\)

While a variety of hedonic studies have been undertaken for UK cities, none have used data which included the amount of land included with each structure and its precise location. Without such information it is impossible to obtain estimates of land values or land rent gradients in the sense embodied in standard economic theory: that is land as pure space with accessibility. As was shown in Cheshire and Sheppard [1995], since the value of neighbourhood amenities is largely capitalised into land values, the market price of cleared sites does not reflect this price as defined in theory - the appropriate concept for our purposes. The effects of land use planning on overall land supply are reflected in changes in the equilibrium price of land as pure space with consequent implications for house prices. It is these, and their implications for welfare, which are of interest as well as the amenity values created which are capitalised into the market price of land.

3. Structure of Demand

The present analysis largely builds upon previous work (see Cheshire and Sheppard [1995] and Cheshire and Sheppard [1998]) which obtained estimates of hedonic prices and the structure of demand for housing and neighbourhood characteristics. These results are briefly summarised here.

3.1. Hedonic price function and land rents

With the data described above, the implicit prices of characteristics are obtained\(^8\) using the estimated coefficients of a ‘Box-Cox’ hedonic price function. There are three different ‘transformation parameters’: one for the structure price, one for land area, and one for all other non-dichotomous variables. The final hedonic price function to be estimated is given by:

\[
p^\psi - 1 = K + \sum_{i \in D} \beta_i \cdot q_i + \sum_{j \in C} \beta_j \cdot \left( \frac{q_j^\lambda - 1}{\lambda} \right) + r(x, \theta) \cdot \frac{L^\xi - 1}{\xi}
\]

\(^7\)It will be noted that the hedonic model was estimated on asking prices. This is justified at more length in Cheshire and Sheppard [1995]. Alternative estimates were made using transactions prices from the smaller sample obtained from the household survey. Generally the results were little different but those obtained on asking prices from the larger samples were preferred.

\(^8\)All prices were expressed as annualised rents using the then effective mortgage rate of 8.5%. Capitalisation rates were assumed not to vary over the urban area (see below).
where:

\[ p = \text{rentalised price of structure} \]
\[ q_i, q_j = \text{structure or location specific characteristics} \]
\[ K, \beta_i, \beta_j, \psi, \lambda, \xi = \text{parameters to be estimated} \]
\[ L = \text{quantity of land included with structure} \]
\[ D = \text{set of indices of characteristics which are dichotomous} \]
\[ C = \text{set of indices of characteristics which are continuously variable} \]
\[ r(x, \theta) = \text{land rent function defined below} \]
\[ \psi, \lambda, \xi = \text{are the standard parameters of the Box-Cox functional form.} \]

Since land rents are critical in what follows, the land rent function warrants particular comment. Because much of the data used in hedonic analyses lacks land and location information, the form of the ‘land value’ component of a hedonic function has not received much attention. Perhaps the most obvious exception is Jackson, Johnson, and Kaserman [1984] who use a third degree polynomial in two dimensions to model land prices. The land rent function used here has the following form:

\[ r(x, \theta) = \beta_1 \cdot e^{x \cdot (\beta_2 + \beta_3 \sin(n \theta - \beta_4))} \]  (3.2)

where:

\[ x = \text{distance from town centre}, \]
\[ \theta = \text{angle of deflection from East}, \]
\[ \beta_i = \text{parameters to be estimated, and} \]
\[ n = \text{an integer which determines the number of radial asymmetries} \]

This rent function possesses the advantage of considerable flexibility but requires the estimation of fewer than half the ten parameters used in Jackson, et al. The function also allows estimation of asymmetries in the land rent surface due to transport networks or topography. Multiple asymmetries are possible (and were tested for) although multiple asymmetries are constrained to be radially symmetric. As fitted, however, the asymmetries closely tracked the main access routes (see Cheshire and Sheppard [1995]). The form does not require that land rents decrease from the urban centre. It is ‘monocentric’ only in the sense that along any linear path from the city centre land rents will increase or decrease at a constant rate.

Estimates of the rentalised hedonic price of structure and neighbourhood characteristics as well as land were obtained from these functions. Note that neighbourhood characteristics, as discussed in more detail in section 5 below, are formulated to include the main amenity outputs produced by the planning system. The estimated structure price from the hedonic equation, \( \hat{P} \), is a function of the vector of observed characteristics and location.
3.2. Almost Ideal Demand System

The Almost Ideal Demand System developed by Deaton and Muellbauer [1980] is well suited for our purposes for two reasons. First, it provides a flexible and theoretically well-grounded framework within which to analyse individual demand data. Second, because it is derived explicitly from a particular expenditure function whose parameters are estimated (or approximated) as part of the estimation of the demand system, it provides for simple implementation of the welfare analysis. Once the demand system is estimated, an expenditure function is obtained that can be used to determine the equivalent variation in income associated with changes in land prices.

Making use of the linear approximation of the budget share equations suggested by Deaton and Muellbauer, their model can be adapted to the present circumstances and a budget share equation derived of the form:

$$w_i = (\alpha_i - \delta_i \alpha_0) + \sum_{j \in C} \gamma_{i,j} \cdot \ln p_j + \sum_{k \in D} \gamma_{i,k} \cdot \ln p_k + \delta_i \cdot \ln \left( \frac{M}{I^*} \right)$$  (3.3)

where:

- $w_i$ = expenditure share on characteristic $i$,
- $p_j, p_k$ = prices of characteristics,
- $D$ = set of indices of dichotomous characteristics,
- $C$ = set of indices of continuous characteristics,
- $M$ = income,
- $I^*$ = Stone’s price index, defined by $\ln I^* = \sum_i w_i \ln p_i$
- $\alpha_i, \alpha_0, \delta_i, \gamma_{i,j}, \gamma_{i,k}$ = parameters to be estimated.

This basic demand system is modified in two further ways: first, to account for the fact that there is no within-sample variation in the implicit prices of dichotomous characteristics, so that all such prices must be absorbed into the constant term; and second, to provide for the estimation of the impacts of household structure (the number of adults and the number of children in the household) on the demand for structure attributes and neighbourhood characteristics.

Using the hedonic prices obtained by differentiating 3.1, equation 3.3 is adapted to:

$$w_i = \bar{\sigma}_i + \nu_A A + \nu_B B + \tilde{\gamma}_i \cdot \ln \tilde{P} + \delta_i \cdot \ln \left( \frac{M}{I^*} \right) + \sum_{j \in C} \gamma_{i,j} \cdot \ln p_j$$  (3.4)

\footnote{In the budget share equation we regard land as one of the continuously variable characteristics of a house, and its price $\tilde{r}$ would be one of the prices denoted $p_j$.}
where:

\[ \hat{P} = \text{structure value predicted from the hedonic price function}, \]
\[ \alpha_i = (\alpha_i - \delta_i \alpha_0) + \sum_{k \in D} \gamma_{i,k} \cdot \ln \hat{\beta}_k \]
\[ \tau_i = \left(1 - \hat{\psi}\right) \cdot \sum_{k \in D} \gamma_{i,k} \]

\( A = \text{the number of adults in the household} \)
\( B = \text{the number of children in the household} \)
\( \hat{\beta}_k, \hat{\psi} \text{ are estimated parameters from the hedonic price function.} \)

The prices of dichotomous variables are not used in the demand system since they are constant across the sample. It is possible to estimate budget share equations for the dichotomous variables, however, using the same functional structure as used for the continuous variables.

The addition of demographic effects in this way is somewhat in the spirit of the specification adopted in Alessie and Kapteyn [1991]. Intuitively, this approach makes the level of required ‘subsistence’ expenditure depend on the size and composition of the household, and the estimated parameters \( \nu_a \) and \( \nu_b \) determine the magnitude of this dependence. This differs from Alessie and Kapteyn [1991], where the family size alone is used, and required subsistence expenditures increase by the same amount for an additional adult or an additional child. In the context of modeling expenditure on housing and neighbourhood quality, it seems sensible to allow for the impact of adults and children to be unequal.

The estimated budget share equations used here thus vary slightly from those reported in Cheshire and Sheppard [1998] because of the incorporation of these variables to capture the impact of the number of adults and the number of children present in each household. While neither of these is statistically significant, both are correctly signed and produce reasonable results. The estimated budget share equations can be obtained from the authors.

Overall, the estimated budget share equations perform well. While some individual parameters are estimated with high standard errors (and are not statistically significant) this is at least in part due to collinearity between characteristics’ prices. Furthermore, it is to be expected that not all prices will affect demand for a particular characteristic in a significant way. Price elasticities (reported in Cheshire and Sheppard [1998]) in Reading ranged from -1.1 to -1.5 and income elasticities varied around 1.6.

### 3.3. Estimation of the Demand System and Price Endogeneity

Estimation of the demand for structure attributes and neighbourhood amenities begins with estimation of the hedonic price function 3.1. This determines the implicit prices of the attributes, which are then taken as (stochastic) regressors in the second step. In the second step attribute demand is estimated as a function of income, the attribute prices, and household structure.
The estimation is only possible, of course, if there is some variance in the prices which confront the households. This variance arises naturally because the data determine a nonlinear hedonic price function. This helpful nonlinearity, however, creates another potential problem: errors in the quantity of attributes (whether they arise as part of the household’s choice or the analyst’s measurement) will generate variations in the measured hedonic prices. This ‘endogeneity’ of attribute prices\(^{10}\) destroys the independence from the model error term which the prices (as regressors) must exhibit for attribute demand to be consistently estimated. The endogeneity problem was first discussed by Freeman [1979], and has been discussed in, \textit{inter alia} Brown and Rosen [1982], Murray [1983], McConnell and Phipps [1987], Epple [1987], and Bartik [1987].

The appropriate response to such price endogeneity is to find or construct other variables which are correlated with the hedonic prices faced by the household but not correlated with the error terms of the demand functions. It is useful to note that the problem is not one of a truly simultaneous equation system. Each household is a small part of the overall market, and reasonably takes the structure of the hedonic price function as exogenous.

Murray [1983] makes a variety of interesting suggestions concerning possible instruments, one of which was employed in Cheshire and Sheppard [1998]. The estimates used in this paper are based on a similar procedure: use as instruments the attribute prices estimated for the two houses that are located nearest each observation in geographic space, or that are ‘most similar’ to the observation (using a measure of similarity that considers both the geographic distance and the difference in measured structure and neighbourhood attributes).

Since our results depend particularly upon the estimated demand for residential land and for open space, the validity of the constructed instruments for estimating these demands was verified using a test proposed by Gourieroux and Monfort [1995]\(^{11}\). Based upon this test, the instruments were admissable and performed well in the case of the critical variables. (The demand estimates and values of the test statistics are available from the authors.)

4. Equilibrium Utilities and Planning Restrictiveness

The demand system presented in the preceding section includes three neighbourhood characteristics which can be regarded as amenities generated by land use regulation: the availability of open space accessible to the public (either through public ownership or extensive rights of public access); the availability of open space which is inaccessible, but nevertheless valuable for visual amenity and for containing the spread of the built-up area; and the limitation of the extent of industrial land use relative to residential use within

\(^{10}\)Not a true endogeneity, of course, but rather a correlation between the error with which the regressors are observed, and the unobserved model error.

\(^{11}\)The test is developed and discussed in Gourieroux and Monfort [1995], chapter 18, ‘General Asymptotic Tests’, in section 18.2.3 as example (b) \textit{Test of Validity of Instrumental Variables: the Linear Case}, on p. 157-159.
The first step in estimating the value of these benefits and the costs associated with the constraints is to parameterise and determine a utility level for households in the existing equilibrium, and determine the prices which would be faced by households under alternative policies. Following this the properties of land market equilibrium are used to characterise the extent of planning restrictiveness.

In order to incorporate the possibility that preferences for land and other attributes may vary with household composition, these estimates were undertaken for four different household types. These were the sample mean household, one and two adult households, and households with two adults and two children. In each case the existing equilibrium was calculated for a hypothetical city consisting only of households of the type whose utility levels were being estimated. In practice, variation in household composition made little difference to the results, and only those relating to the mean household and the smallest and largest considered are reported below.

While the assumption that observed prices and consumption levels are at equilibrium values may be standard, in the context of housing markets it may be thought particularly strong because high transactions costs and durability of structures might suggest very slow adjustment processes. A separate evaluation (not fully reported here) was undertaken to check the sample for apparent violations of optimising household behaviour by searching for violations of the Weak Axiom of Revealed Preference using techniques adapted from those presented in Varian [1985]; Varian [1990]. Such violations might reflect failures of households to choose the most preferred consumption but they may also arise if the market is in disequilibrium. This analysis revealed that within the sample more than 60% of households exhibited behaviour fully consistent with maximisation of a common utility function. Given the confidence intervals attached to the measure, the choices of only a small minority could be judged to be inconsistent with preference maximisation. On average the ‘efficiency’ of household expenditures was 97.7%, suggesting that even if households could costlessly adjust to new residential locations the savings would average only 2.3% of income, a deviation well within normal margins of error.

4.1. Utility level

Taking land area as the good whose index is 1, and representing its price \( r \) separately from the vector of other prices \( p \), the expenditure function associated with the demand system used above is given by

\[
\ln c(u, r, p) = \ln I^* + A \sum_i v_{ai} \ln p_i + B \sum_i v_{bi} \ln p_i + u \cdot r^* + \prod_{i \geq 2} p_i^\delta
\]  

(4.1)

\[12\] In this equation and those that follow, we use \( I^* \) to denote the price index. In the original presentation of Deaton and Muellbauer, this index was given by \( \alpha_0 + \sum \alpha_k \ln p_k + \frac{1}{2} \sum \gamma_{k,i} \ln p_k \ln p_i \). In the calculations here a standard simplification is used, with Stone’s price index employed as an approximation, calculated using estimated land rents and hedonic prices of attributes.
Households have a given after tax income $M$, and spend part of this income on transport costs $t(x, \theta)$, leaving $M - t(x, \theta)$ available for expenditures on goods and services from which utility is derived. This implies an indirect utility function for each household having the form\(^{13}\):

$$
\hat{u} = \frac{\ln (M - t(x, \theta)) - \ln I^* - A \sum_i u_{ai} \ln p_i - B \sum_i u_{bi} \ln p_i}{\prod_{i \geq 2} p_i^{b_i}} \tag{4.2}
$$

To use this for estimating utility levels, we must determine the transport costs faced by a household at location $(x, \theta)$. The first thing to note is that estimates of the land values obtained from the hedonic function discussed above indicated considerable radial asymmetries. These are to be expected given the fact that roads and other components of transport infrastructure are not radially symmetric, and it was shown in Cheshire and Sheppard [1995] that these asymmetries faithfully reflected those of the transport system. In determining the transport cost function for a household at $(x, \theta)$, therefore, we would expect that the function $t$ would exhibit equivalent asymmetries with a directional orientation reflecting that estimated for the land rent surface.

Transport costs per mile per annum are taken to be:

$$
t(x, \theta) = \tau x (1 + v \sin (n \theta - \beta_4 - \pi)) \tag{4.3}
$$

where $n = 2$, $\tau = 403.49$, $v = 0.46156$

and the parameter $\beta_4$ is taken from the estimated land rent function. The parameter values shown capture (via parameters $n$ and $v$ and $\beta_4$) the asymmetries observed in the estimated land rent surface. Given the structural asymmetries, the overall level of transport costs is determined by two factors: actual operating costs (or fares if using public transport) and the time costs of travel. The parameter $\tau$ determines the overall level of transport costs, and is chosen so that the average transport cost per mile equals the amount expected from available estimates of vehicle running costs\(^{14}\) plus time costs.\(^{15}\)

Given these transport costs a vector of utility levels\(^{16}\) $u_1$ can be calculated whose components give the estimated utility level for each household as determined by equation 4.2. These are shown in table 4.1 below.

\(^{13}\)Clearly, any monotonic transformation of the right hand side of 4.2 would serve as well. In these calculations this particular representation is employed.

\(^{14}\)As reported by the Automobile Association for 1984.

\(^{15}\)Based on estimated mean travel speeds and sample mean incomes within each city.

\(^{16}\)Bold face is used to denote vectors or matrices with each row corresponding to an observation in our sample. A bar over the variable such as $\bar{u}_1$ denotes the mean of the corresponding vector.
4.2. Levels of planning restriction

The expenditure function given in equation 4.1 can also be used to derive the general form of the equilibrium land rent. An optimising consumer makes a choice which satisfies:

\[
\ln (M - t(x, \theta)) = \ln I^* + A \sum_i v_{ai} \ln p_i + B \sum_i v_{bi} \ln p_i u \cdot r^b_i \cdot \prod_{i \geq 2} p_i^b \tag{4.4}
\]

Solving for land rent gives:

\[
r(u, x, \theta, p, M) = \left( \frac{\ln (M - t(x, \theta)) - \ln I^* - A \sum_i v_{ai} \ln p_i - B \sum_i v_{bi} \ln p_i}{u \cdot \prod_{i \geq 2} p_i^b} \right)^\frac{1}{b} \tag{4.5}
\]

Estimated parameters for the demand system, and a utility level, can be used to calculate bid-rents for each household type considered at any location.

It is then possible to make use of this land rent within the equilibrium conditions of a standard monocentric urban model\(^{17}\) to estimate the proportion of available land, \(\tilde{\omega}\), made available for development.\(^{18}\) Let \(h(u, r, p)\) be the compensated demand for land for a consumer whose preferences generate an expenditure function of the form 4.1, where \(r\) is land rent and \(p\) is the vector of all prices. If the city were occupied by a single class of identical individuals, then equilibrium in the land market would require:

\[
N = \int_0^{\chi_2(\theta)} \int_{\chi_1}^{\omega \cdot x} \frac{\omega \cdot x}{h(u, r(u, x, \theta, p, M), p)} \, dx \, d\theta \tag{4.6}
\]

where:

- \(N\) is the total number of households to be accommodated within the urban area
- \(\omega\) is the share of space internal to the urban area made available for residential use;
- \(\chi_1\) is the inner boundary of allowed residential development;
- \(\chi_2(\theta)\) is the outer boundary of residential development, which may depend on the direction \(\theta\)

This formulation of equilibrium is often characterised as a ‘closed’ urban system because population \(N\) is given exogenously, and the welfare level is determined by the model. Such an approach is central to the procedure we follow, and is critical to analysis of land use regulatory policies. In an ‘open’ urban system the welfare level is set exogenously and migration in or out of the urban area occurs to determine equilibrium. In such a system, no land use policy generates welfare costs (or benefits) for the residents.

A model such as that used here is appropriate for evaluation of policy changes which occur more or less

\(^{17}\)This equilibrium condition is directly adapted from Muth [1969] and Mills [1972] where consumption choices not only accommodate all households on available land but determine varying densities of occupation at each location.

\(^{18}\)It might be thought that the value of \(\tilde{\omega}\) could be estimated directly from maps. This is not practicable for two reasons. Residential development requires a complementary supply of land for infrastructure but what that area is cannot be determined \(a\ priori\); more important for present purposes is that the value of \(\tilde{\omega}\) has to be consistent with the estimated prices, structure of demand and income.
simultaneously in all cities in an economy, as would occur, for example, with reform of a national land use planning system.

Note that if the outer boundary of residential land use is determined by a constant price of land $R$, we can characterise the function $\chi_2(\theta)$ in terms of income $M$, transport costs $t(x, \theta)$, and the expenditure function $c(u, R, p)$ as follows:

$$\chi_2(\theta) = \frac{M - c(u, R, p)}{t(x, \theta)}.$$ 

(4.7)

For a given transport cost function, prices of other goods $p$, and income level, this permits us to specify the outer boundary of residential development as deriving from the boundary price $R$. In the analysis below we use alternative boundary prices for land to characterise alternative levels of constraint imposed by the land use planning authority.

The parameters $\omega$, $\chi_1$, and $\chi_2(\theta)$ (or $R$) are determined by planning policy, and are of central interest in the evaluations below. $\chi_1$ and $\chi_2$ are estimated from the observed structure of the urban area, and are determined by the actual location of observations within our samples. The value estimated for $\chi_1$ is not critical since proportionately so little land is in the central business district compared to land made available for residential purposes. Given these estimates for the residential boundaries, the parameter $\omega$ is estimated by adapting equation 4.6 to obtain:

$$\hat{\omega} = \frac{N}{\int \int \left[ \frac{x}{h(\bar{u}, r(\bar{u}, x, \theta, p, M), \bar{p})} \right] dx d\theta}$$ 

(4.8)

and evaluating at sample mean levels of utility, income, and non-land prices: $\bar{u}$, $\bar{M}$, and $\bar{p}$. That is, we estimate the implicit level of planning restrictiveness by solving for the equilibrium of a land market accommodating $N$ households who have identical incomes, face identical non-land prices, and achieve identical utility levels - with each of these represented by the sample mean. This is done for three household compositions: a single adult household, a sample mean composition and a household with two adults and two children\(^{19}\). In each case, as was noted above, for logical consistency the estimation is done for a hypothetical city composed only of the household type in question. The purpose is to reveal the sensitivity of the resulting estimated planning benefits and costs to possible variations in the demographic composition of households.

The parameter $\omega$ represents the proportion of the available land area internal to the city made available for residential development. In any city, this parameter will always be considerably less than one, since some land will be bid away by other uses or allocated for transport infrastructure. Local land use policy

\(^{19}\)In order to offset the substantial impact of income on land consumption and focus on the effects of household composition alone, the estimation for all household types was done at a constant sample mean income. There is some variation in mean income by household size, however.
concerning the provision of internal open space - whether accessible in the form of parkland or inaccessible, ‘visual amenity’ open space like farmland - will be the major determinant of differences in \( \omega \) between topographically similar cities.

\[
\begin{array}{|c|c|c|}
\hline
\text{Household Type} & \hat{\omega} & \bar{U} \\
\hline
\text{Mean} & 0.3795 & 21.394 \\
\text{One adult} & 0.3893 & 21.546 \\
\text{Two adults} & 0.3720 & 21.354 \\
\text{Two adult plus two children} & 0.3647 & 21.351 \\
\hline
\end{array}
\]

Table 4.1: Estimated utility and level of planning restriction by household type

Table 4.1 presents the estimates of \( \hat{\omega} \) together with the parameter \( \bar{\pi} \), the mean utility levels for the four household types. It may be noted that the inclusion of a demographic composition shifter in the estimation of the structure of demand increases slightly the estimated value of \( \hat{\omega} \) compared with that reported in Cheshire and Sheppard [1997]. Independently, values of \( \hat{\omega} \) have now been estimated for several samples drawn from English cities at different dates. All except the present one excluded demographic composition of households. The values of \( \hat{\omega} \) have ranged from 0.32 to 0.44. In what follows the utility levels and measures of planning policy reported in Table 4.1 are taken as the basis from which possible changes in planning policy will be evaluated.

5. Benefits of Planning Amenities

5.1. Gross value of benefits

To obtain an estimated value of the ‘gross benefits’ of planning amenities, a comparison is undertaken between the status quo consumption of those amenities attributable to the land use planning system and the consumption that would be available in the absence of land use regulation. For each household the variation in income that would be equivalent to this change is determined. In the section below the mean value of these benefits and the distribution of the benefits among income groups of the sample are reported.

What quantity of amenities would be available in the absence of land use regulation? Table 5.1 lists the assumptions that are maintained for the calculations that follow.

\[
\begin{array}{|c|c|}
\hline
\text{Amenity} & \text{Amount available in absence of planning} \\
\hline
\text{Accessible open space} & \text{Zero accessible open space} \\
\text{Inaccessible open space} & \text{Zero inaccessible open space} \\
\text{Industrial land use quantity} & \text{47 percent of all land in industrial use throughout urban area} \\
\hline
\end{array}
\]

Table 5.1: Amenities available in the absence of land use regulation

The idea behind these comparisons is to identify a reasonable, if extreme, picture of what the urban
structure would be in the absence of any land use regulation. For both publicly accessible and inaccessible open space, the evaluations presented compare the *status quo* to a situation where incomes, population, and preferences remain unchanged but the quantity of both types of open space is reduced to zero. In the case of accessible open space, it may be conjectured that none of the amenity would be provided in the absence of the sort of collective, public action that land use planning exemplifies. Although some inaccessible open space may be available to the few residents at the urban periphery in the absence of planning, it is unlikely to be available in the exurban ‘village’ settings that characterise much of the enjoyment of such amenities under the present planning regime.

The case of industrial land use is less straightforward, since one might characterise the planning system as both constraining the overall quantity of industrial land use as well as its distribution within the urban area. Much of the distribution within the urban area, and among income classes, is properly thought of as endogenously determined by political and economic forces. The analysis below instead concentrates on what might be characterised as the benefit from control of the overall level of industrial land use. A comparison is offered between the *status quo* and a scenario where every part of the urban area has industrial land use equal to the maximum observed in the data collected. This may reasonably represent a situation where there is no collective regulation of either the placement of industry, nor the overall level of industrial land use.

The price at which demand for each amenity would be reduced to zero (or any other level) can be determined using the demand system evaluated for the household. For each of these amenities, the following procedure was used: let \( p_1 \) denote the vector of prices in which all characteristics take prices obtained by differentiating equation 3.1, using the land rent function 3.2 and the parameters of the estimated structure of demand. Let \( p_2 \) denote the vector of prices in which all prices remain the same except that the price of the amenity in question is adjusted for each household to achieve the quantity assumed to prevail in the absence of land use regulation outlined in table 5.1 above. Then for each household, the gross benefit from the given amenity is:

\[
c(u_1, r_1, p_2) - c(u_1, r_1, p_1)
\]

(5.1)

where the utility level \( u_1 \) is obtained for each household via equation 4.2. The estimates adjust for actual household size and structure in two ways: first, the effective amenity price that is associated with the absence of planning amenities is determined by the household demand structure and is therefore sensitive to the actual number of adults and children present in the household. Second, the calculation of the gross benefits themselves uses the expenditure function that, as shown in equation 4.1, depends on the demographic structure of the household.

Table 5.2 presents the results for each planning amenity averaged over all households. The second column of the table lists the mean value of estimated gross benefits\(^{20}\) for each amenity, followed by the

\(^{20}\) These and all monetary figures given below are in 1984 pounds per annum unless otherwise noted.
standard deviation, correlation with household income, correlation with plot size, and correlation with the price of the house. The final column provides the concentration coefficient with respect to household income, to measure the distributional incidence of the benefits.

<table>
<thead>
<tr>
<th>Amenity</th>
<th>Mean £s</th>
<th>$\sigma$</th>
<th>$r_Y$</th>
<th>$r_{\text{area}}$</th>
<th>$r_{\text{value}}$</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessible Space</td>
<td>£ 2424.45</td>
<td>1745.05</td>
<td>0.1827</td>
<td>0.7975</td>
<td>0.8860</td>
<td>0.1269</td>
</tr>
<tr>
<td>Inaccessible Space</td>
<td>£ 1029.65</td>
<td>1233.90</td>
<td>0.2472</td>
<td>0.5611</td>
<td>0.6641</td>
<td>0.2312</td>
</tr>
<tr>
<td>Industrial Land Quantity</td>
<td>£ 1092.00</td>
<td>600.96</td>
<td>0.6139</td>
<td>0.6913</td>
<td>0.8318</td>
<td>0.2171</td>
</tr>
</tbody>
</table>

Table 5.2: Value of Benefits from Planning Amenities

5.2. Distributional consequences

We focus on two separate issues regarding the distributional consequences of land use planning. The first concerns the equity with which the benefits (and, in section 6, the net costs) are distributed. The second concerns the impacts of planning policies on the distribution of welfare in society. The natural way to approach these questions is to consider the distribution of the estimated benefits over households in the sample. Some caution is warranted. The measured benefits (and later net costs) are money metric measures of the changes in household welfare estimated to result from activities carried out within the land use planning system. While this approach provides an exact representation of household preferences, Blackorby and Donaldson [1988] have pointed out that the representation may not be concave. This can be problematic if one wishes to rely upon a Bergson-Samuelson social welfare function to justify redistributive policies.

Despite these caveats, we proceed to examine the distribution of these costs and benefits because:

- the money metric measures have a clear link to and comparability with household income, which enables one to consider the ‘effective income’ obtained by combining the costs and benefits which result from the planning system with household income;

- there may be interest in how benefits and costs are distributed amongst the homeowners represented by the sample without reference to implications for redistributive policies;

- policies which achieve reduced inequity in the distribution of income (or ‘effective income’) might be judged desirable and justified using a social welfare function which is not of the Bergson-Samuelson type.

The widespread use of the ‘money metric’ for evaluation of public policies might provide sufficient justification for the use of such an approach in the present study to facilitate comparison of land use planning benefits and their distribution with such public sector activities as education, transport, and health care.
The level of income inequality in the sample is less than that observed in the entire UK population. The Gini coefficient for after tax income in the Reading sample is 0.205. For this time period the index for after tax income for the entire UK was approximately 0.381 (see Central Statistical Office [1985] and Central Statistical Office [1986]). The difference may be attributed to two factors: the sample is of owner-occupiers only, which (to an approximation) represent the upper two-thirds of the income distribution. Second, the measure of income derives from a survey in which households reported the range which contained their after-tax income. This has the effect of reducing the measured income inequality in the sample.

The last column of table 5.2 presents the concentration coefficient\(^{21}\) for the distribution of the gross benefit with respect to after tax household income. Since for this sample the Gini coefficient of income after tax is 20.52, limitations on industrial land use and provision of inaccessible open space tend to increase inequality while provision of accessible open space tends to reduce inequality.

The distributional impacts of open space provision are seen in more detail in figure 5.1, which shows concentration curves across households of gross benefits from accessible open space (in the left panel) and inaccessible open space (in the right panel) with respect to household income. The concentration curves suggest, and the concentration coefficients presented in table 5.2 reinforce the observation that provision of accessible open space tends to reduce inequality in the distribution of effective income (inclusive of the benefits of amenities) while provision of inaccessible open space tends to increase inequality.

![Lorenz curve for after-tax income](image1)

![Concentration curve for accessible open space](image2)

![Concentration curve for inaccessible open space](image3)

**Figure 5.1:** Concentration curves for open space

Figure 5.2 shows how the benefits from these open space amenities are distributed between income quintiles within the sample (with quintiles defined on income after taxes but exclusive of any imputed planning benefit). The line superimposed over the bars shows the actual distribution of post tax income going to each quintile. Thus for accessible open space, the change in effective income distribution arises primarily from the poorest quintile getting a share of benefits larger than their corresponding income share, and ‘paying’ for this by the fourth and fifth quintiles getting less than their income share. The distribution of benefits associated with inaccessible open space is shown in the right hand panel of figure 5.2. For this

---

\(^{21}\)For details on and properties of concentration coefficients and concentration curves, see Lambert [1993].
amenity, the lowest income quintile receive a share of benefits that is slightly larger than their income share, as do the highest income and third quintiles.

Figure 5.2: Distribution of benefits from open space

Figure 5.3 provides both the concentration curve and the distribution across sample income quintiles of the benefits from limiting industrial land use. The poorest and the wealthiest quintiles receive benefit shares larger than their income shares. Overall, as suggested by the concentration coefficient in 5.2, limits on industrial land use tend to increase inequality.

Figure 5.3: Distribution of benefits from limiting industrial land use

It is of interest to compare the distributional consequences of amenities produced by the planning system with other benefits produced by the public sector in Britain. Analysis of some of these other benefits is reported in Central Statistical Office [1985] and Central Statistical Office [1986], which covers a variety of benefits, including state education, the national health service and transport subsidies. Collectively, these lower the Gini coefficient of income after direct and indirect taxes by about 10.11 percent. A different picture emerges from an evaluation of the distributional impacts of planning amenities, as indicated in table 5.3, which presents the percentage change in the sample Gini that occurs when the monetary value
of different planning amenities is added to household income.

<table>
<thead>
<tr>
<th>Planning Amenity</th>
<th>% Change in Gini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessible open space</td>
<td>-4.29</td>
</tr>
<tr>
<td>Inaccessible open space</td>
<td>+3.54</td>
</tr>
<tr>
<td>Control of industrial land</td>
<td>+0.92</td>
</tr>
<tr>
<td>All open space</td>
<td>+1.39</td>
</tr>
<tr>
<td>All planning amenities</td>
<td>+3.10</td>
</tr>
</tbody>
</table>

Table 5.3: Percent change in Gini from planning amenities

The calculations indicate that the combined consequences of planning amenities is regressive, with a 3.1 percent increase in the Gini resulting from all amenities combined. Individual amenities do not necessarily increase inequality, however. The provision of publicly accessible open space provides a relatively large reduction in inequality, and the control of industrial land is almost distributionally neutral.

The gross benefit estimates for the planning amenities are large and from a political economic perspective help to explain the widespread support given to the constraints imposed by land use planning. Such regulation produces amenities highly valued by a large number of residents. A further point is that households are financially locked into the system. Since planning amenities are capitalised into the price of the ‘house-land bundle’, a reduction in amenities by, say, permitting development on inaccessible open land would produce a capital loss for existing house owners (although, as can be seen below, it would be consistent with increasing overall community welfare). The estimates show that planning benefits are not distributed equally, and taken together increase inequality in the distribution of effective income.

6. Net Costs of Land Use Planning

That the amenities produced by the planning system are valuable does not establish that the quantity provided is efficient. Application of benefit-cost tests, as noted above, is made more difficult by the fact that the amenities are provided through regulation rather than through market transactions. With land use planning the costs come in the form of distortions in land and housing prices, and these must be estimated and then their impact on welfare compared with the value of the consequent change in amenity provided.

A difficulty which confronts this approach is to decide the extent to which distortions in land prices might actually be attributable to the policy. The approach used provides a lower bound estimate of the

---

22 This may underlie the advice given in the Financial Times Property section (27/28 March 1999) to prospective opponents of new development: ‘However angry you are at the prospect of losing your view, or at the impact on the value of your property, do not cite that in evidence. Talk instead in terms of loss of habitat, densities and roof lines, which are genuine planning matters.’
net costs of land use planning in a highly constrained community: it is thus a conservative estimate of the maximum cost in the economy under investigation. It is lower bound for at least two reasons. As was suggested in the previous section benefits are likely to be over rather than under estimated; and more importantly the assumption adopted with respect to the extension of the built area if containment policies were relaxed is likely to be on the conservative side. The sensitivity of this estimate to variations in household composition is accounted for by utilising an estimated demand system that accounts for the dependency of expenditure on family structure.

Estimates of the net costs of the status quo are provided for three alternative regulatory scenarios. The first estimates the net impact on welfare of a plausible upper limit relaxation on the constraint of available internal land supply. The second adds the impact of a modest relaxation in ‘containment policy’ (which limits the maximum extent of urban development). Finally, a comparison is made with a regulatory regime that allows a substantial relaxation of urban containment.

6.1. Alternative provision of internal open space

Estimated values of $\omega$ (the proportion of available urban land made available for residential use) were presented in Table 4.1. For the sample mean household this was 0.3795. As was noted above there could be no city in which the value of $\omega$ approached 1, its upper limit, since some land must always be used for purposes other than private residences. A methodology similar to that employed in this paper applied in the context of this and other urban areas has produced estimates of $\omega$ ranging from 0.32 to 0.44. The upper bound of these estimates was obtained for an area that, according to other indicators, had one of the least restrictive land use regulation regimes in Britain (Cheshire and Sheppard [1989]), so comparing the existing situation in the sample with one in which the availability of development land is increased so that $\omega$ rises to 0.425 provides a measure of what is both a plausible and feasible relaxation in land use planning constraints.²³

Consider then the adoption in Reading of this more relaxed regime of internal open space availability, with $\omega$ increasing from $\omega_1 = 0.3795$ to $\omega_2 = 0.425$. Two major consequences would follow from such a change in policy: first there would be an increase in the availability of residential land. Competitive equilibrium in the urban land market will then require a reduction in land rents for the mean household, with an associated increase in average utility levels. Such a policy change would also entail a cost, however, since it would imply a simultaneous reduction in open space. The reduction in open space is assumed to come from both accessible and inaccessible open space so that the ratio of the two remains constant.

²³Of course each urban setting is different, and the public amenities demanded by the residents may vary due to Tiebout sorting or other processes. The analysis does not assert a priori that this relaxation would be desired by households in the sample. Rather, it starts with a particular relaxation and asks: given the structure of demand for land and other amenities estimated for the community concerned, what will be the impact on household welfare and what is the income-equivalent measure of this impact. One could use this method to evaluate any proposed impact without regard to its empirical plausibility or political feasibility.
increase in the supply of private residential land resulting from the implementation of $\omega_2$ in place of $\omega_1$ over the allowed range of residential construction would be approximately 1839.05 acres in total or about 1001.36 square feet per household. To release this much land to private consumption would require a 17.23 percent reduction in internal open space.

The estimated demand system is then used to determine the increase in the implicit price that would be required to achieve this reduction in demand for open space. The implicit price of accessible open space would, on average, increase by 18.96 percent, and that of inaccessible open space by 18.23 percent. Let the price vector $\mathbf{p}_2$ represent, for each household, the prices of housing and neighbourhood characteristics with the price of open space increased by these amounts. Let $\bar{\mathbf{p}}_2$ be the vector of mean prices for the sample, reflecting the increased price for open space. The associated price vectors before any change (representing the status quo) are $\mathbf{p}_1$ and $\bar{\mathbf{p}}_1$.

If the level of planning restrictiveness were reduced, and the price of internal open space were increased to release the associated amount of land for private consumption, a new equilibrium would be reached with utility level $u_2$. This utility level can be determined by solving:

$$ N = \int_0^{2\pi} \int_{\chi_1} \frac{\omega_2 \cdot x}{h(u_2, r(u_2, x, \theta, \bar{\mathbf{p}}_2, \bar{\mathbf{M}}), \bar{\mathbf{p}}_2)} \, dx \, d\theta $$

for utility level $u_2$. Expression 6.1 defines the utility level that would be achieved, on average, for households in the sample. The utility levels can be used to provide an estimate of the new level of land rent at each location $r(u_2, x, \theta, \bar{\mathbf{p}}_2, \bar{\mathbf{M}})$, so that for each household, there can be an estimate of the change in the price of land as well as the change in the price of open space.

Since post-tax income remains constant implicit differentiation of the expenditure function allows us to determine the marginal indirect utility of a change in price:

$$ \frac{\partial u}{\partial p_i} = \frac{\frac{\partial c(u, r, p)}{\partial p_i}}{\frac{\partial c(u, r, p)}{\partial u}} = - \frac{h_i(u, r, p)}{\lambda} $$

Thus the marginal indirect utility of a change in price is proportional to consumption of the good, with the factor of proportionality $-\frac{1}{\lambda}$ equal to minus the reciprocal of the ‘marginal cost of utility’. This observation suggests the following approach for estimating the change in utility for each individual household. Determine a vector of utilities $\mathbf{u}_2$ by solving for $\varphi$ to satisfy:

$$ \mathbf{u}_2 = \mathbf{u}_1 + \varphi (L \Delta r + \mathbf{q}_a \Delta \mathbf{p}_a + \mathbf{q}_i \Delta \mathbf{p}_i) $$

$$ \bar{\mathbf{u}}_2 = \mathbf{u}_2 $$

where:
\[ \mu_2 = \text{mean of vector } u_2 \]
\[ L = \text{quantity of land consumed by an individual household} \]
\[ \Delta r = \text{change in land rent at the household’s location} \]
\[ q_a = \text{quantity of accessible open space consumed by the household} \]
\[ \Delta p_a = \text{change in price of accessible open space at the household’s location} \]
\[ q_i = \text{quantity of inaccessible open space consumed by the household} \]
\[ \Delta p_i = \text{change in price of inaccessible open space at the household’s location} \]
\[ \varphi = \text{factor of proportionality to determine change in utility level} \]

Using equation 6.3 we solve for the factor of proportionality \( \varphi \), and obtain an estimated vector of new utilities for each household \( u_2 \). This can be used to calculate a vector of net costs of planning for the sample:

\[
c(u_2, r(u_1, x, \theta, p_1, M), p_1) - c(u_2, r(u_2, x, \theta, p_2, M), p_2)
\]  \hspace{1cm} (6.4)

In equation 6.4 a vector of rents is generated by evaluating \( r(\cdot) \) at every location given by the vectors \( x \) and \( \theta \). This yields vectors of utilities \( u_2 \) and rents, and a matrix of prices \( p_i \) with one row for each observation.

Evaluating the expenditure function for each household then gives the expenditure, or income net of transport costs, required to achieve the utility level associated with the more permissive planning regime under the two alternative sets of land and amenity prices. Evaluating the difference in these two real income levels, indicated in equation 6.4, provides the equivalent variation associated with the change in planning policy. It is this equivalent variation in income which is taken as the measure of the net costs of land use regulation. The change in planning policy will affect each household differently, altering both the price it must pay for private land consumption and the open space that is available to it. A positive number indicates that greater expenditures would be required under the restrictive planning policies to achieve utility level \( u_2 \) — that is the increased cost of private land consumption resulting from a more restrictive planning regime imposes a cost which is not fully compensated by the increased availability of open space. Table 6.1 provides a summary of the calculations, which were undertaken for all households in the sample.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average net cost - £ per annum</td>
<td>45.55</td>
</tr>
<tr>
<td>Standard deviation of net cost</td>
<td>61.20</td>
</tr>
<tr>
<td>Net cost as a percent of income</td>
<td>0.43</td>
</tr>
<tr>
<td>Correlation between net cost and income</td>
<td>0.4864</td>
</tr>
<tr>
<td>Correlation between net cost and land area</td>
<td>0.3752</td>
</tr>
<tr>
<td>Correlation between net cost and house value</td>
<td>0.4623</td>
</tr>
</tbody>
</table>

Table 6.1: Net Costs of Internal Land Availability Policies
The results presented in table 6.1 make specific adjustment for the actual composition of each household in the sample (number of adults and number of children), utilising the household’s composition explicitly in the expenditure function to evaluate equation 6.4, and the actual household location to determine the land price that is an argument to the expenditure function. Additionally, the household composition and the location are utilised to determine the matrix of prices \( p_i \) that enter into the calculations. Thus the net cost, while an average over all households, explicitly takes account of the demographic structure and location of each observation.

On average, a relaxation of the internal space constraint policy would be equivalent to an increase in income of nearly £45.55 per annum. There is considerable variation in the levels of net costs experienced by different households. Table 6.1 includes simple bivariate correlations between the net cost of providing the greater supply of internal open space and household income, land consumption, and house value for the mean household composition.

Figure 6.1 shows, in the left panel, the concentration curve of these costs with respect to after tax income. The right panel shows the distribution of net costs by income quintiles, along with income shares received by each quintile. In contrast to the discussion of gross benefits this represents costs net of benefits so if upper income groups bear a greater share of cost than their income share, the policy may be viewed as generally redistributive.

![Lorenz curve for after-tax income](image1)

**Figure 6.1: Distribution of net benefits from relaxing land supply constraint**

Figure 6.1 shows internal open space policies to be mildly progressive. The first quintile comes out about even. The second and third quintiles gain at the expense of the fourth and fifth quintile. This is an observation about relative position only. All income groups experience positive net costs and, the evidence suggests, would benefit from the adoption of the more permissive planning regime.

Although moderate for individual households the net costs of the more restrictive planning regime, which provides a higher level of internal open space, aggregated over the entire urban area, are, at about £3.644 million per annum, substantial in absolute terms. This may be thought of as equivalent to an
increase in income tax of about 0.43 pence in the pound.

6.2. Containment of the urbanised area

Having considered the welfare effects of the provision of amenities requiring the restriction of land supply internal to the urban area it is now necessary to address the effects of a more significant feature of English land use regulation: the ‘containment’ policies that seek to contain development within the existing boundaries of the built-up area and prevent urbanisation spreading to agricultural land. So called ‘greenbelts’ represent the best known but most expensive instrument of this policy. We consider replacing the status quo regulatory regime with one in which the internal open space parameter $\omega$ is raised from $\omega_1 = 0.3795$ to $\omega_2 = 0.425$, and the maximum extent of residential development is not constrained at $\chi_2(\theta)$ but is allowed to expand to a level associated with either a boundary rent equivalent to a value of £30000 per acre or a boundary rent of £25000 per acre.

The first scenario is designed to provide an evaluation of a modest relaxation of containment and allow expansion that does not extrapolate too far beyond the state of the world that generated the data used to estimate the structure of demand. The second is designed to provide an estimate of the impact of a more substantial relaxation of constraints. Each of these extensions of $\chi_2(\theta)$ is modelled by means of setting the price of land at the boundary of urban development to a constant value lower than that estimated to be consistent with the observed boundary $\chi_2(\theta)$. Each of the value identified above implies an expansion in the total physical area of the built-up area whose magnitude relative to the existing area is shown in table 6.2. As before the estimates account for actual household composition and location using an estimated demand system that is sensitive to these variables.

It would appear curious to a planner to characterise containment policies in terms of the price of land at the boundary of urban development, especially bearing in mind this is the price of land as pure space with accessibility not that observed in land markets. As noted in footnote 22 above, proper issues for land use regulation are generally taken to include environmental issues, physical structures and arrangements of structures, and the particular uses of land.24 In practice, however, regulatory constraints that declare land as unsuitable for development will be challenged through a variety of means if the incentive is sufficiently great. The implication is that the regulatory constraint is accepted by the owners of land whose value is below a certain threshold, and fought by landowners whose land is above this threshold. As a result, the economic outcome is as if the regulatory authority were imposing a constraint that implemented a constant land value at the urban periphery.

As in the previous case, evaluation of alternative regulatory regimes necessitates determination of a change in land rents and a change in the effective price of open space. This latter price will increase more than in the previous case because of the reduction in internal open space and also because the increase

24Indeed, the focus on these physical and environmental issues may have contributed to the economists neglect of this economically important type of regulatory activity.
in the spatial extent of the urban area implies that fewer households will live within a kilometre of the boundary of development. These households will therefore experience reduced access to open countryside.

The reduction in open space from changing internal land supply was discussed above. To capture the effect of the second factor, all open space consumption is assumed to be reduced by a proportion which reflects the additional consumption of open space of households living within one kilometre of the urban periphery compared to those that do not. This results in a total 39.06 percent reduction in both accessible and inaccessible open space for the urban area. The larger reduction in inaccessible open space is to be expected, since much of the open land beyond the urban periphery is not open to the general public. Let the matrix $\mathbf{p}_3$ provide a price vector for each household which reflects these higher prices for open space, and $\mathbf{\bar{p}}_3$ represent the associated vector of sample mean prices.

The estimates presented below are comparisons with a status quo regulatory regime having internal land supply given by $\omega_1 = 0.3795$ and land value at the periphery of £41870 per acre, based upon the estimated values in the sample at the edge of the built-up urban area. Against this we compare an increase in internal land supply and a relaxation of urban containment to a capitalised rental value for vacant land of £30000 or £25000 per acre. If $R$ is the price of land at the boundary of development, for a mean utility level experienced within the urban area of $u_3$, the extent of residential development will be:

$$\chi_2(\theta) = r^{-1}(u_3, R, \theta, \mathbf{\bar{p}}_3, \mathbf{\bar{M}}) = \{ x \mid r(u_3, x, \theta, \mathbf{\bar{p}}_3, \mathbf{\bar{M}}) = R \} \quad (6.5)$$

The utility level which equilibrates the urban land market in this case can be determined by solving for $u_3$ in the equation:

$$N = \int_{0}^{2\pi} r^{-1}(u_3, R, \theta, \mathbf{\bar{p}}_3, \mathbf{\bar{M}}) \int_{\chi_1}^{\omega_2 \cdot x} \frac{\omega_2 \cdot x}{h(u_3, r(u_3, x, \theta, \mathbf{\bar{p}}_3, \mathbf{\bar{M}}), \mathbf{\bar{p}}_3)} \, dx \, d\theta \quad (6.6)$$

It has been elegantly argued by Capozza and Helsley [1990] that since expected future population growth in a city will mean that savings in commuting costs at any given location compared to a location on the boundary will grow over time and be proportionately greatest nearest to the current boundary of development, capitalisation rates may vary with location. They would be expected to be lower nearer the periphery since future commuting cost savings would rise towards the urban boundary with future urban growth. Any such effect producing spatial variation in capitalisation rates has been ignored in this analysis (a constant rate equal to the current after-tax mortgage rate has been used) for two reasons. The first is that given actual population growth in the Reading region was only $4.4\%$ for the decade 1971-81, such variation, if it existed, would have been very small. It might not have existed at all if expectations were that the planning system would operate to retain the existing boundary. Secondly, even if such variation existed there was no way it could be estimated. However, it may be worth noting that £25000 per acre, which represents nearly a tenfold markup on ambient agricultural land values, could more than have contained any realistic premium for residential land caused by the modest growth exerting a downward influence on rates of capitalisation at the urban boundary.
<table>
<thead>
<tr>
<th></th>
<th>Modest relaxation</th>
<th>Significant relaxation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average net cost of land use regulation - £ per annum</td>
<td>210.94</td>
<td>407.44</td>
</tr>
<tr>
<td>Standard deviation of net cost of land use regulation</td>
<td>376.68</td>
<td>335.40</td>
</tr>
<tr>
<td>Net cost as a percent of income</td>
<td>2.01</td>
<td>3.89</td>
</tr>
<tr>
<td>Capitalised land value at urban periphery - £ per acre</td>
<td>30000</td>
<td>25000</td>
</tr>
<tr>
<td>Percent increase in urbanised land area</td>
<td>46.9</td>
<td>70.7</td>
</tr>
<tr>
<td>Correlation between net cost and household income</td>
<td>0.142</td>
<td>0.377</td>
</tr>
<tr>
<td>Correlation between net cost and land consumption</td>
<td>0.832</td>
<td>0.915</td>
</tr>
<tr>
<td>Correlation between net cost and house value</td>
<td>0.451</td>
<td>0.668</td>
</tr>
</tbody>
</table>

Table 6.2: Net Costs of Open Space and Containment Policies

After solving for the mean utility level $u_3$ for each of the values of $R$, we obtain a vector of estimated utilities $u_3$ using a procedure similar to that outlined in equation 6.3. We then estimate the net cost of the combined land use planning policies by:

$$c(u_3, r(u_1, x, \theta, p_1, M), p_1) - c(u_3, r(u_3, x, \theta, p_3, M), p_3)$$

(6.7)

Table 6.2 presents a summary of these calculations. The net cost per household is larger now that the effects of containment are considered together with the internal space availability constraint. The total estimated net costs range from 210.94 to 407.44 percent of household income, depending on the direction from the city centre. It must be stressed that these are estimated net costs of the restriction on land supply imposed by the planning system, taking into account the loss of open space which households would experience. While this amenity is valuable to households, the reduction in available residential land and the resulting increase in housing costs overwhelms the attractiveness of more plentiful open space.

The large net costs associated with the existing planning regime do not necessarily imply that households would be better off with no land use regulation whatsoever. Rather, the costs suggest that households would experience an improvement in welfare if planning constraints were relaxed somewhat, to permit greater private consumption of land even if this came at the expense of open space. Note that the correlation between net costs and income is weaker than the correlation between land consumption or overall house value, confirming the intuitive expectation that these costs are being generated via land market distortions. Relative to the contemplated alternative land use planning policies, the status quo might be viewed as analogous to taxes imposed at various rates on each household, with the average tax payments as indicated in tables 6.1 and 6.2 by the entry of net cost as a percent of income.

25 It should be borne in mind that the equivalent variation measure which this represents approximates that measured as the change in consumer surplus. Viewed this way it will be readily seen that such a measure may be large even though the expenditure share is small. If the price were high enough the expenditure share might be near zero; but the loss of consumer surplus would be even larger than that implied here.

26 Since we have accounted for the value of benefits received.
6.3. Distributional impacts

Both the ‘modest’ and the more ‘significant’ relaxation in regulatory constraints would generate net benefits (or the removal of net costs) for all income quintiles. Figure 6.2 shows the concentration curve of the impacts from a modest relaxation of planning constraints with respect to income, and the distribution of net costs between income quintiles. The households in the first, third, and fifth quintiles bear a disproportionate share of the costs of planning, with the second and fourth quintiles being relatively favoured. As before, all income groups experience net costs and would appear to benefit from a regime of land use regulation that while producing fewer amenity benefits was substantially less restrictive on urban land supply.

Figure 6.3 shows the concentration curve of the impacts from a more significant relaxation in land use regulation, along with the distribution of the net costs across income quintiles in the sample. While the average reduction in costs per household is nearly doubled, the impact on final income distribution is modest because the distribution of these costs is similar to the distribution of income.

If we regard land use planning policies as, in some sense, equivalent to taxes then a central question
is surely ‘are these taxes progressive’? Subject again to the caveats concerning use of ‘money metric’
measures of net costs, table 6.3 presents an analysis of the distributional impacts along the lines discussed
in Lambert [1993]. The column labeled $C_{X-T}$ presents the concentration coefficient for after-tax income net
of the costs of land use regulation. The next column presents the Gini coefficient for such ‘after-regulation’
income. The column $G_X$ is the Gini coefficient for household income after tax but before the regulatory
burden is considered, while $C_T$ gives the concentration coefficient of the net cost itself. The final column
indicates the impact on income inequality.

While the distribution of the planning benefits discussed in section 5.2 is ‘regressive’ in the sense that
it increases inequality, evaluation of the net costs of land use regulation including the burden of the land
value distortions associated with providing the amenities reveals a pattern that is almost distributionally
neutral. Overall the process of land use regulation generates very slight reductions in inequality. For
example the significant relaxation of the planning constraint would increase the effective Gini coefficient in
the fourth decimal place, or less than three tenths of one percent. Unfortunately, this small reduction in
inequality is purchased at a very considerable cost. Relative to the least constrained scenario, the status
quo generates £32,595,000 annual net costs, equivalent to a tax on incomes of 3.9 percent.

7. Conclusions

The estimates of the welfare effects of land use regulation presented in this paper have obvious limitations.
They relate to only one urban area and are based on the characteristics, behaviour and preferences of owner
occupiers in that city. Since owner occupiers made up approximately three quarters of all households this
may not be critical but it certainly restricts the generality of the analysis of the distributional impacts. The
estimates also depend on a monocentric urban model and involve the comparison of alternative equilibria.
One of these is observed; the others are those which are estimated would apply once the effects of the
hypothesised policy changes had fully worked themselves through. In the context of durable structures
such as housing this may take a considerable time. No analysis of the dynamics of the adjustment process
is offered although two points can be made. The equilibrium which it is assumed is being observed is
that which reflected the operation of the system of land use planning for about a generation. The second
point is that even though housing is durable, adjustments can be made in a relatively short period by
reconverting houses that have been subdivided, extending existing structures and by amalgamation.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$C_{X-T}$</th>
<th>$G_{X-T}$</th>
<th>$G_X$</th>
<th>$C_T$</th>
<th>$G_X - G_{X-T}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relax internal space constraint, full containment</td>
<td>0.2060</td>
<td>0.2063</td>
<td>0.2052</td>
<td>0.3914</td>
<td>-0.00108</td>
</tr>
<tr>
<td>Relax internal space constraint, modest containment</td>
<td>0.2049</td>
<td>0.2058</td>
<td>0.2052</td>
<td>0.1899</td>
<td>-0.00062</td>
</tr>
<tr>
<td>Relax internal space constraint, minimal containment</td>
<td>0.2053</td>
<td>0.2058</td>
<td>0.2052</td>
<td>0.2081</td>
<td>-0.00064</td>
</tr>
</tbody>
</table>

Table 6.3: Components of Distributional Impact
Despite the limitations of the monocentric urban model the results embodied in these estimates suggest that it has considerable strengths. When land rents are defined in the sense implied in the model, that is as land as pure space with accessibility, fitted values fully conform to the predictions of the model including faithfully reflecting transport routes. The model also has the great virtue of relative simplicity.

Such ‘simplicity’ is, however, clearly relative. The methodology employed here involves several complex steps in which utility levels are determined for both an average household and for individual households, demands are used to calculate changes in attribute prices, and equivalent variations in income are calculated. The complexity of the procedure is primarily due to the complexity of the urban land market. It is not possible simply to estimate changes in consumer surplus from land demand by considering how the price of land changes in response to land market regulation. Equilibrium in an urban land market determines not a single land price, but rather a land price function. Determination of how this land price function changes in response to land market regulation is the primary source of the complexity in the analysis above. Once the impacts on equilibrium land prices are calculated, it would be possible to use an approximation of the welfare costs but such an approach would provide little simplification. Since we have an explicit expenditure function available, and since determination of the impacts on equilibrium land prices has provided other required information, it seems more appropriate to provide direct calculations of benefits and costs.

How does the methodology developed in this paper compare with others that might be available? Horowitz [1984], for example, presents a method for calculating equivalent variations in income directly from estimated hedonic price functions. One difference which characterises the approach of this paper is the use of equilibrium in the urban land market. Since changes in planning regimes are ‘system wide’ phenomena, they will certainly result in significant changes in the overall structure of land market equilibrium in the city. Such changes cannot be observed in the estimation of a hedonic price function. While Horowitz’s approach may be useful for the measurement of the gross benefits from planning amenities, evaluation of the costs requires estimation and evaluation of the new equilibrium.

The methodology for evaluation of some of the economic consequences of land use planning presented here pays particular attention to the income-equivalent costs of restricting land availability with the consequent increase in land and housing prices that implies. Not only do these estimates provide a test for the methodology but they are likely to be indicative of the situation in a range of other cities in southern England. The net costs are apparently significant, as much as 3.9 percent of annual household incomes. We should be concerned but not surprised by the size of this figure. As was remarked in the introduction, the lack of attention that has been paid to the economic impacts of land use regulation is particularly egregious since its effects are felt on the single most important element of household budgets.

Are the estimated net costs presented here plausible? A simple calculation provides an alternative check, and suggests the potential effect of constraining the supply of urban land is likely to be substantial. In 1984 the price of land for urban development on the outskirts of Reading was approximately £480000.
per hectare. At the ruling densities for greenfield new housing of 22 per hectare that implied the land cost alone associated with a new house was about £22000. Given an agricultural land price of £5000, and given the price of agricultural land relative to vacant residential land observed in relatively unconstrained land markets, it is unlikely that the unconstrained price per hectare would have exceeded £55000. This would imply a price per plot of £2500. Given that the net mortgage rate was 8.5 percent and that sample mean household income was £13694, the annualised difference in plot values would be £1658, or 12.1 percent of mean household income. Our estimates indicate a more modest impact, but then we do not consider a completely unconstrained land market; and it is net of reduced benefits.

The analysis suggests interesting differences between the various components of land use regulation and planning. Provision of open space that is generally accessible to the public generates benefits that are significant and tend to reduce inequality. Provision of open space that is inaccessible to the public (largely located at the urban periphery) generates benefits that are very unequally distributed, and tend to increase inequality.

Overall, the benefits produced by the planning system appear to be distributed in a way that favors those who are already favored with higher incomes, so that including the value of the benefits in a measure of income increases measured inequality. These benefits are not produced at zero cost. They are effectively paid for through the distortions in land prices that make housing in Britain some of the most expensive in the world. These burdens are also not equally distributed, falling more heavily on those with higher incomes. The net effect is a system of valuable benefits, and very high costs, that combines for a net effect that is almost distributionally neutral.

A variety of extensions to the research might be pursued. It would be useful to verify that there are not other benefits produced by land use planning which have not been measured in this study and which might alter the estimated net costs. It would be of further interest to embed the analysis within a more comprehensive general equilibrium model, as done by Hazilla and Kopp [1990]. This might identify additional economic costs of planning27 which should be considered. The analysis presented here concentrates on the costs that arise through operation of the market for residential land which comes as part of owner-occupied properties. Land use regulation obviously affects other sectors of the economy as well.

The methods developed are computationally feasible and could be widely applied. They do, however, require data which provide information on residential structure values and characteristics, including land and location as well as the incomes of the households occupying the sample of houses. Given such data, the analysis could be of benefit to planners and policy makers. The results also reinforce the often repeated advice of economists that the provision of public goods by regulation has the additional disadvantage from a liberal viewpoint: the real costs are not directly visible, but require some effort and ingenuity even to approximate. That they are not visible, however, does not mean that they are not real nor, in the case at least of British land use planning, that they cannot be substantial.

27 Such as price distortions resulting from higher land prices or suboptimal location of production.
References


