The Welfare Economics of Land Use Planning*

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Abstract

This paper presents an empirical methodology for the evaluation of the benefits and costs of land use planning. The technique is applied in the context of the Town and Country Planning System of the UK, and examines the gross and net benefits of land use regulation and their distribution across income groups. The results show that the welfare and distributional impacts can be large.

Proposed Running Head: Welfare Economics of Land Planning

1. Introduction

Economic research concerning land use planning has been focused primarily on the expected consequences determined within a theoretical model[1] or empirical evaluations of the costs[2] of these widely-used policies. In this paper we undertake to provide an analysis that quantifies some of the benefits of land use planning, which come in the form of environmental amenities provided to residents, and compares these with the costs of land use planning, which come in the form of increased land and housing costs from restrictions on the availability of developable land. Thus we provide estimates of the net benefits of land use planning in an urban area facing strong pressure for development. By examining how these benefits and costs are distributed over households, we are able to illusrtrate the distributional consequences of land use planning.

We find that land use planning produces benefits of considerable value. We also find that the cost of producing these benefits is high. In the context of an urban area facing a restrictive regulatory regime, the net

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[1] For example, see Sheppard [32], Fischel [23], Epple, Romer, and Filimon [20], and Brueckner [9], [10], and [11].

[2] For example, see Cheshire and Sheppard [14], Phillips and Goodstein [31], Bramley [6] and [5], Evans [21], Fischel [23], or Son and Kim [33]. For a survey see Evans [22].

effect is substantially negative, and it appears that welfare would be improved by permitting more development. We identify specific policy changes that could produce improvements in welfare, and examine how the costs and benefits are distributed across income groups.

While the application of modern land use planning in Britain developed at about the same time as in North America (the movement against 'ribbon development' in the UK had its first legislative success in 1932), the British laws had from the beginning the containment of 'sprawl' as a principal concern.[3] More recently, the movement against sprawl has spread to other countries, although the policies have been criticised (see, for example, Brueckner [8]) as a blunt instrument with which to tackle significant market failures.

Land use planning 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 (such as neighbourhood quality) and amenities (such as open space) by fiat rather than through taxes and direct public sector production. The absence of taxes, however, does not imply the absence of costs. The central question of this paper is: what are the magnitudes of the benefits and of the costs associated with these policies, and how are they distributed over different groups within an urban area?

1.1. Outline approach

The anlaysis proceeds through a series of steps:

1. Select an urban area with restrictive land use planning that otherwise approximates the assumptions of classic urban economic theory[4]

2. Collect sample housing market data in this urban area (price, structure characteristics, land, location, neighbourhood amenities, household composition and incomes)

3. Estimate the structure of hedonic prices for land and other attributes

[3]Indeed, as Evans [22] points out, Elizabethan London was subjected to a growth boundary – the city walls – enforced with draconian powers in 1580 when citizens were commanded to "desist and forebeare from any new building of any house or tenement within three miles (later extended to seven miles) of any of the gates" of the City of London "where no house hath been known." As might be expected, this Elizabethan Green Belt was unable to halt the demand for space and urban growth.

[4]While comparative static analysis of a monocentric urban model is a restrictive framework, useful insights can still be gained from the model and, indeed, the results we report here are consistent with its main properties. The analysis of course does not provide a description of the dynamic adjustment process; we compare one assumed equilibrium with an alternative which would exist once all adjustment had occurred. Adjustment of land prices and urban structure can occur relatively quickly through infill, subdivision, and extension of structures.

4. Using the implicit prices from the hedonic equation, household income and composition, estimate a household demand system that includes land and amenities produced by the planning sytem (as well as other structure and neighbourhood attributes)[5]

5. Use the demand system to determine a utility level for each household associated with the status quo

6. Use this initial utility level along with observed incomes, urban population, and the value of land at the urban periphery to estimate (using the standard urban equilibrium condition) the share of land made available for private residential consumption within the urban area

7. Use the initial utility level combined with the estimated demand and expenditure function as the basis for the welfare analysis

8. To measure gross benefits:

   a. For amenities generated by land use planning, use the demand system to calculate the reservation price (or the price that would obtain in the absence of land use planning)

   b. For each household, calculate the income compensation required to maintain status quo utility when the amenity price is raised to the reservation price (so household demand for the amenity is zero)

9. To measure net benefits:

   a. Estimate the change in land available for private residential consumption associated with land use planning

   b. Estimate the new urban land market equilibrium and household utility levels associated with changes in land use planning and the associated increase in private residential land consumption

   c. For each household, calculate the variation in income that would be equivalent to achieving the utility level associated with this new equilibrium, accounting for the reduced (or eliminated) availability of the regulation-produced amenity

In the analysis of both gross and net benefits, it is possible to consider a wide variety of possible alterations in the regulatory regime. Below we consider only a few specific alterations that indicate the likely range of benefits and net costs associated with feasible changes. Since we estimate a gross and net benefit for each household, we also present an evaluation of how these impacts vary with household income. This permits an

[5] The estimation draws on previous results that have estimated implicit prices (Cheshire and Sheppard [15]) and identified the structure of demand for land and planning benefits (Cheshire and Sheppard [17]).

analysis of the extent to which land use planning might be said to exacerbate or mitigate inequality in an economy.

The estimated land prices determined and analysed below may be interpreted as in a standard urban model. It is the price of land as pure space with accessibility to an employment centre. The market price of 'vacant' land within an urban area reflects the supply of amenities and local public goods available at each location in addition to the value of the land as pure space with accessibility. For this reason, the price of land as pure space can only be estimated within an hedonic framework. Land use planning determines the quantity of several amenities available at any location and also influences the overall supply of land as pure space.

The use of a housing market hedonic to estimate the underlying value of land is not entirely novel. Jackson, Johnson, and Kaserman [27], for example, utilise a polynomial that varies with location in a hedonic to estimate urban land values. The approach is justified by a simple observation about the hedonic price function: in equilibrium the hedonic price of an attribute is equal to both the marginal bid price for the attribute and the marginal cost of provision. Assuming adjustment to equilibrium, the marginal cost of providing additional land with a house is the value of land as pure space.

Alternative answers to measuring amenity value are available in simpler situations. Black [4], for example, whose focus is the value of education, uses a method based on generating 'comparables' of nearby properties located in different school catchment areas. This effectively standardises so far as possible for all individual characteristics except school quality. The present analysis requires valuations of several environmental and social amenities, and of land itself. Land values vary throughout the urban area and therefore require a comprehensive hedonic approach.

The estimation of both the gross and net benefits of land use planning 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 [3].

2. The Data

2.1. Observed Characteristics

The process that led to the choice of Reading as representing the extreme of planning constraint is explained more completely in Cheshire and Sheppard [14]. By a variety of measures Reading faces some of the most restrictive land use planning in Britain.

The sample was collected in the second and third quarters of 1984. The data are described in more detail in Cheshire and Sheppard [15]. 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. The 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 Small Area Statistics of the Census of Population and from local authorities. 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.[6]

While a variety of hedonic studies have been undertaken for UK cities, none have used data which included the amount of land 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.

3. Structure of Demand

The present analysis largely builds upon previous work (see Cheshire and Sheppard [15] and [17]) 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[7] 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:

$$\frac{p^{\psi}-1}{\psi} = K + \sum_{i \in D} \beta_i \cdot q_i + \sum_{j \in C} \beta_j \cdot \left(\frac{q_j^{\lambda}-1}{\lambda} \right) + r(x,\theta) \cdot \frac{L^{\xi}-1}{\xi} \tag{3.1}$$

where:

[6] It will be noted that the hedonic model was estimated on asking prices. This is discussed in more detail in Cheshire and Sheppard [15]. 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.

[7] 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, which is plausible given the modest rates of population growth.

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

Since land rents are critical in what follows, the land rent function warrants particular notice. The land rent function used here has the following form:

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

where:

x	$=$	distance from town centre,
θ	$=$	angle of deflection from East,
β_i	$=$	parameters to be estimated, and
n	$=$	an integer which determines the number of radial asymmetries

This possesses the advantage of considerable flexibility but requires the estimation of only five parameters. 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 [15]). 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.

Neighbourhood characteristics are formulated to include the main local amenity outputs produced by the planning system, specifically limitations on industrial land use and provision of open space. Clearly, the planning system provides a variety of other public goods such as coordination of infrastructure provision with urban development. Such services tend to accrue to the community as a whole rather than as local amenities, and are therefore not separately indentifiable in the hedonic function 3.1. Our analysis does not deal with the benefits and costs of these other activities, and focuses on the local amenities produced by land use planning.

Estimates of the rentalised hedonic price of structure and neighbourhood characteristics as well as land were obtained from these functions. The estimated structure price from the hedonic equation, $\widehat{P}$, 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 [18] is well suited as a tool for implementing step 4 of our methodology 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 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:[8]

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

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:

$$w_i = \overline{\alpha}_i + \upsilon_{a_i} A + \upsilon_{b_i} B + \overline{\gamma}_i \cdot \ln \widehat{P} + \delta_i \cdot \ln \left(\frac{M}{I^*} \right) + \sum_{j \in C} \gamma_{i,j} \cdot \ln p_j \tag{3.4}$$

[8] In the budget share equation we regard land as one of the continuously variable characteristics of a house, and its price $\widehat{r}$ would be one of the prices denoted p_j.

where:

$$\widehat{P} = \text{structure value predicted from the hedonic price function,}$$

$$\overline{\alpha}_i = (\alpha_i - \delta_i \alpha_0) + \sum_{k \in D} \gamma_{i,k} \cdot \ln \widehat{\beta}_k$$

$$\overline{\gamma}_i = \left(1 - \widehat{\psi}\right) \cdot \sum_{k \in D} \gamma_{i,k}$$

$$A = \text{the number of adults in the household}$$

$$B = \text{the number of children in the household}$$

$\widehat{\beta}_k, \widehat{\psi}$ are estimated parameters from the hedonic price function.

Although the prices of dichotomous variables are absorbed into the constant term, it is possible to estimate budget share equations for the dichotomous variables using the same functional structure as used for the continuous variables.

The addition of demographic effects is somewhat in the spirit of the specification adopted in Alessie and Kapteyn [1]. Intuitively, this approach makes the level of required 'subsistence' expenditure depend on the size and composition of the household, and the estimated parameters υ_{a_i} and υ_{b_i} determine the magnitude of this dependence. This differs from Alessie and Kapteyn [1], where 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 vary slightly from those reported in Cheshire and Sheppard [17] because of the incorporation of the demographic variables. While neither of these is statistically significant, both are correctly signed and produce reasonable results. 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.

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 variation 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[9] 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 [24], and subsequently by - amongst others - Brown [7], Murray [30], McConnell [29], Epple [19], and Bartik [2].

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 [30] makes a variety of interesting suggestions concerning possible instruments, one of which was employed in Cheshire and Sheppard [17]. 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 [25][10]. Based upon this test, the instruments were admissible and performed well in the case of the critical variables[11].

4. Planning Restrictiveness and Equilibrium Utilities

Land use planning produces a variety of local amenities. It regulates industrial land use and separates it from residential land uses. It 'produces' open space, by preserving or creating open spaces that are formally open to the public (such as public parks, school playing fields or neighbourhood commons) or by compelling land to be used in such a way that open spaces are preserved although public access may not be available (such as land in agricultural use within the suburbs or at the urban periphery, or green spaces surrounding office

[9] Not a true endogeneity, of course, but rather a correlation between the error with which the regressors are observed, and the unobserved model error.

[10] The test is developed and discussed in [25], chapter 18, 'General Asymptotic Tests', in section 18.2.3 as example (b) Test of Validity of Instrumental Variables: the Linear Case, on p. 157-159.

[11] The demand estimates and values of the test statistics are available from the authors.

developments). The demand system presented in the preceding section includes these three local amenities produced by the planning system: the control of industrial land use relative to residential use, the availability of open space accessible to the public (either through public ownership or extensive rights of public access), and the availability of open space which is inaccessible, but nevertheless valuable for visual amenity and for containing the spread of the built-up area.

We expect the value of the two types of open space to differ, since in addition to a visual amenity and reduced density, publicly accessible open space offers recreational opportunities. This expectation is validated by the estimated hedonic price functions. A further difference between the two types of open space arises in the possible means of provision. The planning system is central to the provision of both types of open space, although the proportion of locally available open space that is accessible to the public varies throughout the urban area. Thus at the urban periphery the predominant type of open space is inaccessible farmland or woodland. Such spaces are preserved almost exclusively via regulation of allowed land use rather than purchase of the land using tax revenues. Urban containment using growth boundaries can produce benefits by making the urban area more compact so that such amenitites are locally available to a larger number of residents.

To estimate the value of these benefits and the costs associated with the constraints we use the estimated demand system to parameterise and determine a status quo utility level for households in the existing equilibrium, and determine the prices that would be faced by households under alternative policies. This process also allows us to use the properties of land market equilibrium to characterise the extent of planning restrictiveness.

The demand system presented in section 3 above could in principle be used to investigate how the costs of land use planning would vary if the urban area were comprised of households having a variety of demographic structures. Preliminary analysis (reported more completely in Cheshire and Sheppard [16]) indicates that the impact of demographic structure on the costs and benefits is relatively modest, so the results below concentrate on urban equilibria for the sample mean household type, and cost and benefit measures for actual household demographic structure.

While the assumption that observed prices and consumption levels and choices are at equilibrium values may be standard, it may be cause difficulties if high transactions costs and durability of structures result in slow adjustment processes. An evaluation was undertaken to check the sample for apparent violations of optimising household behaviour by searching for violations of the Weak Axiom of Revealed Preference. This analysis revealed that the mean ‘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

For convenience we take land to be good 1, and represent its price as r. The prices of other goods are given by p_i ($i \geq 2$), and the utility level achieved is u. Then the expenditure function associated with the demand system used above is given by[12]

$$\ln c(u, r, p) = \ln I^* + A \sum_i \upsilon_{a_i} \ln p_i + B \sum_i \upsilon_{b_i} \ln p_i + u \cdot r^{\delta_1} \cdot \prod_{i \geq 2} p_i^{\delta_i} \tag{4.1}$$

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]:

$$\widehat{u} = \frac{\ln (M - t(x, \theta)) - \ln I^* - A \sum_i \upsilon_{a_i} \ln p_i - B \sum_i \upsilon_{b_i} \ln p_i}{r^{\delta_1} \cdot \prod_{i \geq 2} p_i^{\delta_i}} \tag{4.2}$$

To use this for estimating utility levels, we must determine the transport costs faced by a household at location (x, θ). Estimates of the land values obtained from the hedonic function discussed above indicated considerable radial asymmetries. These are not surprising given that roads and other components of transport infrastructure are not radially symmetric (see Cheshire and Sheppard [15]).

We construct a transport cost function t for a household at (x, θ) that exhibits equivalent asymmetries in directions determined by the estimated land rent surface. In this sense the asymmetries in transport costs are determined by the estimated land values from the hedonic price function 3.1.

Transport costs per mile per annum are taken to be:

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

where $n = 2 \quad \tau = 403.49 \quad \upsilon = 0.46156 \quad \pi = 3.1415...$

The parameters β_4 and υ are derived from the estimated land rent function. The parameter τ determines the overall level of transport costs, and is chosen so that the mean travel cost per mile traveled matches the

[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 $\alpha_0 + \sum \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_l \gamma_{k,l} \ln p_k \ln p_l$. 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. Note also that we use the prices and demand system parameters of all attributes, whether they are dichotomous or continuous. In contrast to the budget share equation 3.4 for empirical estimation, where all dichotomous attribute prices were collected under the 'umbrella' of the estimated structure price $\widehat{P}$, here we need to take account of the separate impact on required expenditure of changes in each of these attribute prices.

[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.

estimated vehicle running costs[14] plus time costs[15] for the urban area. The parameter values shown match (via parameters n and υ and β_4) the asymmetries observed in the estimated land rent surface.

Given these transport costs a vector of utility levels[16] $\mathbf{u_1}$ 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.

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:

$$\ln(M - t(x,\theta)) = \ln I^* + A\sum_i \upsilon_{a_i} \ln p_i + B\sum_i \upsilon_{b_i} \ln p_i + u \cdot r^{\delta_1} \cdot \prod_{i\geq 2} p_i^{\delta_i} \tag{4.4}$$

Solving for land rent gives:

$$r(u,x,\theta,p,M) = \left(\frac{\ln(M - t(x,\theta)) - \ln I^* - A\sum_i \upsilon_{a_i} \ln p_i - B\sum_i \upsilon_{b_i} \ln p_i}{u \cdot \prod_{i\geq 2} p_i^{\delta_i}} \right)^{\frac{1}{\delta_1}} \tag{4.5}$$

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 monocentric urban model to estimate the proportion of available land, $\widehat{\omega}$, made available for development.[17] 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. Then equilibrium in the land market would require:

$$N = \int_0^{2\pi} \int_{\chi_1}^{\chi_2(\theta)} \frac{\omega \cdot x}{h(u, r(u,x,\theta,p,M), p)} \, dx \, d\theta \tag{4.6}$$

where:

N is the total number of households to be accommodated within the urban area

ω is the share of space internal to the urban area made available for residential use;

χ_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 θ

[14] As reported by the Automobile Association for 1984.

[15] Based on estimated mean travel speeds and sample mean incomes within the 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 $\overline{\mathbf{u}}_1$ denotes the mean of the corresponding vector.

[17] In principle, it might be possible to estimate the value of $\widehat{\omega}$ directly from maps, but the method applied here guarantees that the value of $\widehat{\omega}$ is consistent with the estimated prices, structure of demand and income.

The use of a closed urban model is central to the procedure we follow, and more generally for analysis of land use regulatory policies. In an 'open' urban system with exogenous welfare levels, land use planning may affect urban growth and size, but not welfare. A model such as that used here would be appropriate for evaluating policy changes which occurred more or less simultaneously in all cities in an economy, as would happen, for example, with reform of a national land use planning system. It is also consistent with individuals devoting significant resources to promote or oppose land use planning, since these actions are difficult to explain if the regulations generate no welfare consequences.

The parameters ω, χ_1, and $\chi_2(\theta)$ represent the planning policy, and are of central interest in the evaluations below. The value for χ_1 is estimated from the data, but turns out to be relatively unimportant since proportionately so little land is in the central business district. The status quo values of ω and $\chi_2(\theta)$ are also inferred from the data, and are the variables that together determine the availability of open space, with open space within the built up area determined by ω and the boundary of the urban area determined by $\chi_2(\theta)$.

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

$$\chi_2(\theta) = \frac{M - c(u,R,p)}{t(x,\theta)}. \tag{4.7}$$

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. Given the asymmetry in the land value function, this implies that the planning authority imposes an asymmetric, rather than circular, constraint on urban expansion. Whether this is by conscious design or emerges as the outcome of a pattern of greater challenge to planning decisions in those areas where the value of residential land is greatest is interesting, but does not affect our analysis. In the analysis below we use alternative boundary prices for land to characterise alternative levels of constraint imposed by the land use planning authority.

Using the estimates for the residential boundaries, the parameter ω is estimated by adapting equation 4.6 to obtain:

$$\hat{\omega} = \frac{N}{\int_0^{2\pi}\int_{\chi_1}^{\chi_2(\theta)} \frac{x}{h(\bar{u}, r(\bar{u}, x, \theta, \bar{p}, \overline{M}), \bar{p})}\, dx\, d\theta} \tag{4.8}$$

and evaluating at sample mean levels of utility, income, and non-land prices: $\bar{u}$, $\overline{M}$, 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 the sample mean income, face identical non-land prices, and achieve sample mean utility levels.

Since the parameter ω represents the proportion of the available land area internal to the city made available for private residential consumption, ω 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 concerning the provision of internal open space - whether accessible or inaccessible - will be the major determinant of differences in ω between topographically similar cities.

$\widehat{\omega}$	$\overline{u}$	R
0.3795	21.394	41870 $\frac{\$}{acre}$

Table 4.1: Estimated utility and level of planning restriction

Table 4.1 presents the estimate of $\hat{\omega}$ together with the parameter $\overline{u}$, the mean utility level, and R, the land value that prevails at the urban periphery in the status quo from which the effects of 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 amenities attributable to the land use planning system and the consumption that would be available in the absence of land use planning. For each household the variation in income that would be equivalent to this change is determined.

Table 5.1 lists the comparisons undertaken to measure the value of planning amenities.

Amenity	Amount available in absence of planning
Accessible open space	Zero accessible open space
Inaccessible open space	Zero inaccessible open space
Industrial land use quantity	47 percent of all land in industrial use throughout urban area

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

The idea behind these comparisons is to identify a feasible though extreme characterisation of what the urban structure would be in the absence of any land use planning. 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 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 represent an extreme situation where there is no regulation of either the placement of industry, or 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 amenity, the following procedure was used: let p_1 denote the vector of prices in which all characteristics including land and amenities have prices equal to the hedonic prices observed in the sample. 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 planning outlined in table 5.1. Then for each household, the gross benefit from the given amenity is:

$$c(u_1, r_1, p_2) - c(u_1, r_1, p_1) \tag{5.1}$$

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[18] for each amenity, followed by the standard deviation (over all households in the sample). The final column provides the concentration coefficient[19] with respect to household income, to measure the distributional incidence of the benefits.

[18] These and all monetary figures given below are in 1984 pounds per annum unless otherwise noted.

[19] The 'concentration coefficient' is the analog of the Gini coefficient for the distribution of one variable, with households ranked according to another (often income). In this case, the distribution of gross benefits among households ranked by income. For further details on concentration coefficients and concentration curves, see Lambert [28].

Amenity	Mean £s		σ	C
Accessible Space	£	2424.45	1745.05	0.1269
Inaccessible Space	£	1029.65	1223.90	0.2312
Industrial Land Quantity	£	1092.00	600.96	0.2171

Table 5.2: Value of Benefits from Planning Amenities

Overall, the estimated values of gross benefits are sensible. Accessible open space provides a variety of recreational amenities not provided by inaccessible open space, and therefore we would expect the value of the benefits to be higher. The value of benefits of limiting industrial land use are also plausible, although the value of this amenity may be sensitive to the type of industries active in the urban area and the magnitude of disamenities they might be allowed to generate. The value of gross benefits is large relative to household income. This, however, is not surprising given that the value measures the amount of additional income a household would require to maintain its utility level after removal of the amenity. For important amenities, this value can indeed be large relative to income. We turn next to consider the way these benefits are distributed over households.

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. 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.

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 [12] and [13]). The difference may be attributed to two factors: the sample is of owner-occupiers only, which (to an approximation) represents 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 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, we are able to reach an important conclusion: 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.

Figure 5.1 shows how the benefits from the amenities are distributed between income quintiles within the sample (with quintiles defined on income after taxes but exclusive of any imputed planning benefit). The bars indicate the distribution of income, showing the percentage that accrues to each quintile within the sample. The lines indicate the distribution of gross benefits from accessible open space (thick solid line), inaccessible open space (dashed line), and control of industrial land use (thin solid line). Thus, for example, benefits from accessible open space go disproportionately to the poorest quintile, with this ‘transfer’ being paid for by the fourth and fifth quintiles getting less than their income share. For control of industrial land use, figure 5.1 reveals that the poorest and the wealthiest quintiles receive benefit shares larger than their income shares.

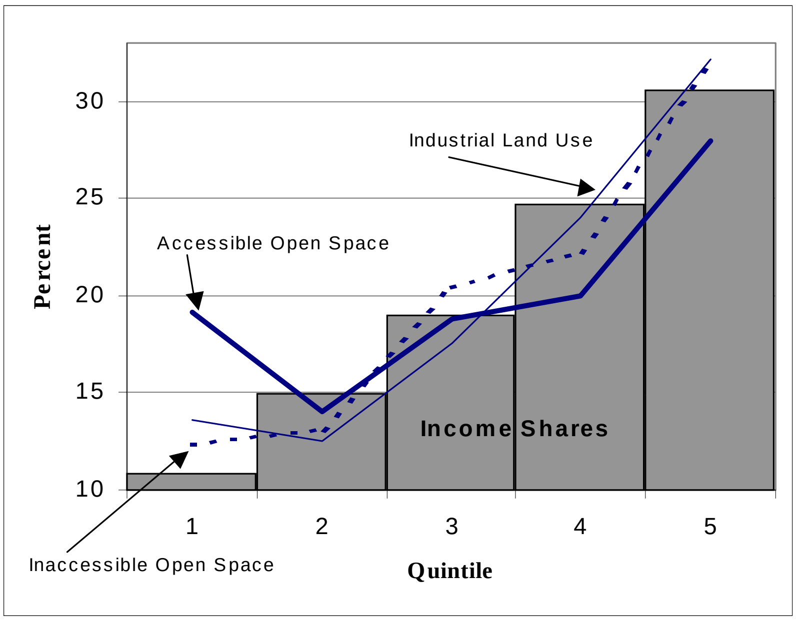

Figure 5.1: Distribution of benefits from land use planning

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 CSO [12] and [13], 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. The calculations indicate that although different amenities vary in their distributional impact, the combined effect of providing amenities through land use planning is regressive. There is a 3.1 percent increase in the Gini resulting from all amenities combined.[20]

Planning Amenity	% Change in Gini
Accessible open space	-4.29
Inaccessible open space	+3.54
Control of industrial land	+0.92
All open space	+1.39
All planning amenities	+3.10

Table 5.3: Percent change in Gini from planning amenities

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. Since planning amenities are capitalised into the price of houses, a reduction in amenities caused by relaxing land use planning would produce a capital loss for *existing* house owners[21] (even if it would be consistent with increasing overall community welfare). The estimates further 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

The analysis presented in section 5 provided estimates of the value of amenities produced by the planning system. We have not yet considered the value of these amenities relative to the costs, which is central to the question of the efficiency of the amount of amenities provided. The costs arise because of restrictions on the amount of land available for residential development. This increases equilibrium land values and increases the cost of housing. These distortions must be estimated and their impact on welfare compared with the value of the amenities provided. In this section we provide estimates of the *net costs* of land use planning, taking into account both the value of benefits provided and the increased land costs resulting from regulation.

Estimates of the net costs of the *status quo* are provided for three alternative regulatory scenarios. The

[20] Note that the changes in the Gini coefficient are not cumulative, so that the change resulting from all amenities is not the sum of the impacts from individual amenities. This is due to the non-additive nature of the Gini index of inequality combined with the way in which the benefits are distributed over space and household classes.

[21] 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.'

first estimates the net impact on welfare of a plausible relaxation of the constraint on available internal land supply. The second adds the impact of a modest relaxation in 'containment policy' (which limits the boundary of urban growth). Finally, a comparison is made with a regulatory regime that allows both a plausible internal relaxation and a substantial extension of the urban growth boundary.

6.1. Reduced provision of internal open space

The estimated values of ω (the proportion of urban land made available for residential use) presented above was 0.3795. Application of this methodology to other time periods and urban areas has produced values of ω ranging from 0.32 to 0.44 with the highest of these estimates being for an area that, according to other indicators, had one of the least restrictive land use planning regimes in England (Cheshire and Sheppard [14]).

We consider then the adoption of a more relaxed regime of internal open space availability, with ω 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, with an associated increase in average utility levels. Such a policy change would also reduce the benefits derived from local amenities since it would imply a 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 within the urban area. The increase in land for private residential consumption in this scenario would be approximately 1839.05 acres in total or about 1001.36 square feet per household. To release this much land for 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 p_2 represent, for each household, the prices of housing and neighbourhood characteristics with the price of open space increased by these amounts. Let $\overline{\mathsf{p}}_2$ 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 p_1 and $\overline{\mathsf{p}}_1$.

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:

$$N = \int_{0}^{2\pi} \int_{\chi_1}^{\chi_2(\theta)} \frac{\omega_2 \cdot x}{h(u_2, r(u_2, x, \theta, \overline{\mathsf{p}}_2, \overline{\mathsf{M}}), \overline{\mathsf{p}}_2)} \, dx \, d\theta \tag{6.1}$$

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 $r(u_2, x, \theta, \overline{\mathsf{p}}_2, \overline{\mathsf{M}})$, 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:

$$\frac{\partial u}{\partial p_i} = -\frac{\frac{\partial c(u,r,p)}{\partial p_i}}{\frac{\partial c(u,r,p)}{\partial u}} = -\frac{h_i(u, r, p)}{\lambda} \tag{6.2}$$

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. Let φ be a factor of proportionality that represents a sample mean value for $-\frac{1}{\lambda}$. Then we determine a vector of utilities u_2 by solving for the value of φ that satisfies:

$$\mathsf{u}_2 = \mathsf{u}_1 + \varphi \left(\mathsf{L} \Delta \mathsf{r} + \mathsf{q}_a \Delta \mathsf{p}_a + \mathsf{q}_i \Delta \mathsf{p}_i \right) \tag{6.3}$$
$$\overline{\mathsf{u}}_2 = u_2$$

where:

$\overline{\mathsf{u}}_2$ = mean of vector u_2

L = quantity of land consumed by an individual household

$\Delta \mathsf{r}$ = change in land rent at the household's location

q_a = quantity of accessible open space consumed by the household

$\Delta \mathsf{p}_a$ = change in price of accessible open space at the household's location

q_i = quantity of inaccessible open space consumed by the household

$\Delta \mathsf{p}_i$ = change in price of inaccessible open space at the household's location

φ = factor of proportionality to determine change in utility level

Using equation 6.3 we solve for the factor of proportionality φ, 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:

$$c \left(\mathsf{u}_2, r \left(u_1, \mathsf{x}, \boldsymbol{\theta}, \overline{\mathsf{p}}_1, \overline{\mathsf{M}} \right), \mathsf{p}_1 \right) - c \left(\mathsf{u}_2, r \left(u_2, \mathsf{x}, \boldsymbol{\theta}, \overline{\mathsf{p}}_2, \overline{\mathsf{M}} \right), \mathsf{p}_2 \right) \tag{6.4}$$

Evaluating the difference presented in equation 6.4 gives a measure of the change in required expenditure to achieve welfare level u_2 under the status quo and under the relaxed policy. If this difference is positive, then larger expenditure is required under the status quo, and the difference would measure the improvement in welfare that would occur if the alternative policy were adopted. It is this equivalent variation in income which is taken as the measure of the net costs of land use planning. Naturally, the impact varies across households and depends on both private land consumption and local availability of open space. Table 6.1 provides a summary of the calculations, which were undertaken for all households in the sample.

Average net cost - £ per annum	45.55
Standard deviation of net cost	61.20
Net cost as a percent of income	0.43

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.

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. The distributional impacts of these changes are discussed in greater detail below. We note here that all income groups experience positive net costs and would benefit from the adoption of the more permissive planning regime.

Although moderate for individual households the net costs of the more restrictive status quo planning regime, which provides a higher level of internal open space, aggregated over the entire urban area, are about £3.644 million per annum and therefore substantial in absolute terms. This approximates an increase in income tax of about 0.43 pence in the pound, with proceeds providing the existing level of internal open space.

6.2. Containment of the urbanised area

Next we address the effects of containment policies designed to limit the 'sprawl' or maximum extent of residential land consumption. So called 'greenbelts' or urban growth boundaries represent the best known of these types of policies. We consider replacing the status quo regulatory regime with one in which the internal open space parameter ω 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 price of £30000 per acre or a boundary price of £25000 per acre. This compares with the estimated price of land at the existing boundary of the urban area estimated from the rent function to be £41870 per acre[22].

It may appear curious to characterise containment policies in terms of the price of land at the boundary of urban development. As implied in footnote 21 above, proper issues for land use planning are generally taken to include environmental issues, physical structures and arrangements of structures, and the particular uses of land. In practice regulatory constraints that block development will be challenged through a variety of means if the incentive is sufficiently large. Then the regulatory constraint may be accepted by the owners of land whose value is below a certain threshold, but fought by landowners whose land is above this threshold. The result is that regulations appear as if the authority were imposing a constraint that implemented a constant land value at the urban periphery.

In addition to the reduction in open space from a relaxed constraint within the built up area, in this second simulation exercise there will be a reduction in open space at the urban periphery caused by the expansion of residential land use into the peripheral land that was previously protected from development. Again, we use the estimated demand system to calculate the increase in the price of open space that would be required to reduce household demand for this amenity to an amount consistent with the increased provision of land for private consumption.

Let the matrix p_3 provide a price vector for each household which reflects these higher prices for open space, and $\overline{\mathsf{p}}_3$ represent the associated vector of sample mean prices. If R is the price of land at the boundary of development, for a utility level experienced within the urban area of u_3, the extent of residential development will be:

$$\chi_2(\theta) = r^{-1}\left(u_3, R, \theta, \overline{\mathsf{p}}_3, \overline{\mathsf{M}}\right) = \left\{x \,\middle|\, r\left(u_3, x, \theta, \overline{\mathsf{p}}_3, \overline{\mathsf{M}}\right) = R\right\} \tag{6.5}$$

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

$$N = \int_0^{2\pi} \int_{\chi_1}^{r^{-1}\left(u_3, R, \theta, \overline{\mathsf{p}}_3, \overline{\mathsf{M}}\right)} \frac{\omega_2 \cdot x}{h(u_3, r(u_3, x, \theta, \overline{\mathsf{p}}_3, \overline{\mathsf{M}}), \overline{\mathsf{p}}_3)} \, dx \, d\theta \tag{6.6}$$

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:

$$c\left(\mathsf{u}_3, r\left(u_1, \mathsf{x}, \boldsymbol{\theta}, \overline{\mathsf{p}}_1, \overline{\mathsf{M}}\right), \mathsf{p}_1\right) - c\left(\mathsf{u}_3, r\left(u_3, \mathsf{x}, \boldsymbol{\theta}, \overline{\mathsf{p}}_3, \overline{\mathsf{M}}\right), \mathsf{p}_3\right) \tag{6.7}$$

[22] In each case the price of land is the estimated price of land as pure space at a given location, exclusive of the value of local amenities and public goods.

	Modest relaxation	Significant relaxation
Average net cost of land use planning - £ per annum	210.94	407.44
Standard deviation of net cost of land use planning	376.68	335.40
Net cost as a percent of income	2.01	3.89
Capitalised land value at urban periphery - £ per acre	30000	25000
Percent increase in urbanised land area	46.9	70.7

Table 6.2: Net Costs of Open Space and Containment Policies

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 .[23]

We emphasize 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 and the price of private open space overwhelms the attractiveness of more plentiful publicly provided open space.

Relaxing the urban growth boundary does result in an expansion of the urbanised land area. In this part of Britain, approximately 15% of the land is in urban use. Significant relaxation of the urban growth boundary could increase this percentage to approximately 26%.

The large net costs associated with the existing planning regime do not necessarily imply that households would be better off with no land use planning whatsoever. Rather, the costs suggest that households would experience an improvement in welfare if planning constraints were relaxed, to permit greater private consumption of land even if this came at the expense of publicly provided open space.

6.3. Distributional impacts

Each of the changes in regulatory constraints presented above would generate net benefits (or the removal of net costs) for all income quintiles. Figure 6.1 shows the distribution between income quintiles of the net benefits (reduction in net costs) associated with a relaxed internal constraint (solid thin line), modest relaxation of the urban growth boundary (dashed line) and significant relaxation of the urban growth boundary (solid thick

[23]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.

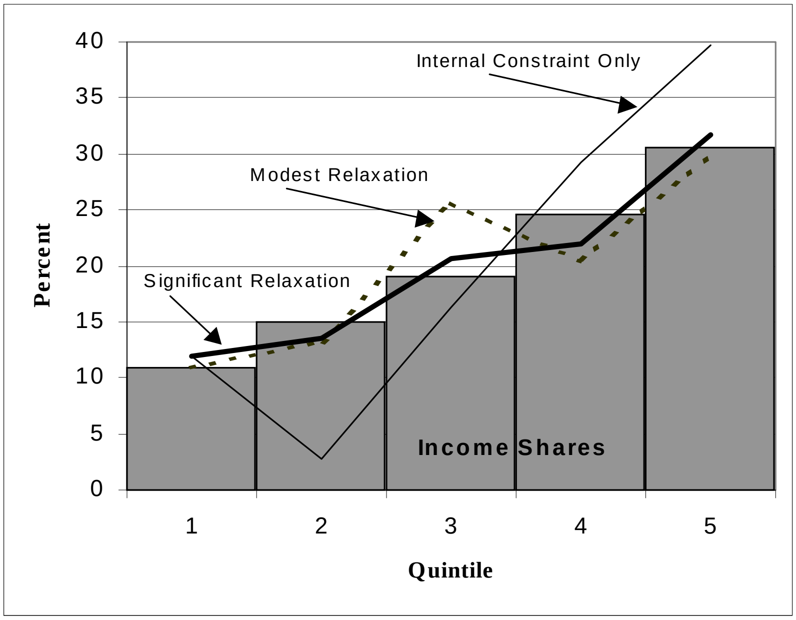

Figure 6.1: Net distributional impacts of changes in land use policies

line). Each of these is plotted above bars that indicate the share of after-tax income received by each quintile in the sample.

While each quintile gains from each of the changes in planning constraints considered, in general the gains resulting from relaxing the urban growth boundary are distributed roughly in proportion to income. Such reforms therefore increase aggregate welfare and have only minimal impact on the overall distribution of welfare. The reform of internal space constraints generates benefits that are less equally distributed, with disproportionately large shares going to the fourth and fifth quintiles.

A central question in the analysis of these policies can be simply put: overall, is land use planning progressive? Table 6.3 presents an analysis of the distributional impacts along the lines discussed in Lambert [28]. The column labeled C_{X-T} presents the concentration coefficient for after-tax income net of the costs of land use planning. 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 planning including the burden of the land value distortions associated with providing the amenities reveals a pattern that is almost distributionally neutral, at least within the class of owner occupiers. Overall the process of land use planning generates very slight

Scenario	C_{X-T}	G_{X-T}	G_X	C_T	$G_X - G_{X-T}$
Relax internal space constraint, full containment	0.2060	0.2063	0.2052	0.3914	−0.00108
Relax internal space constraint, modest containment	0.2049	0.2058	0.2052	0.1899	−0.00062
Relax internal space constraint, minimal containment	0.2053	0.2058	0.2052	0.2081	−0.00064

Table 6.3: Components of Distributional Impact

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 planning 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 two thirds 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 that 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 might take a considerable time, although some adjustments can be made in a relatively short period by reconverting houses that have been subdivided, extending existing structures and by amalgamation.

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 use planning. Determination of how the land price function changes 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. Our demand system estimates make 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.

The estimates obtained in this study are likely to be indicative of the situation in many cities in southern England. The net costs are apparently significant, as much as 3.9 percent of annual household incomes. Furthermore, the analysis suggests interesting differences between the various components of land use 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 relative to incomes some of the most expensive in the world. 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 [26]. 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 planning 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 who seek to measure the benefits and costs of land use planning or other 'smart growth' policies. Smart growth over 50 years of British experience appears to have imposed substantial net costs.

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