Local Housing Markets and Urban Form

Colin Jones, Chris Leishman and Charlotte MacDonald

School of the Built Environment
Heriot-Watt University

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Address for correspondence:

Professor Colin Jones
School for Built Environment
Heriot-Watt University
Edinburgh
EH14 4AS

Email: C.A.Jones@sbe.hw.ac.uk

Abstract

Models of urban housing markets were originally developed with simplified assumptions. For example, urban form in these models is a single dimensional output in the shape of housing density. Subsequent empirical developments using hedonic price modelling and sub-market models have not attempted to link inputs or outputs to urban form. This paper explores the nature of urban form and the relationship between urban form and local housing markets. It first reviews the theoretical inter-relationships and develops a set of hypotheses. The hypotheses are then empirically tested on housing markets in three British cities – Leicester, Oxford and Sheffield. House price data from HM Land Registry are combined with information from the Census on the physical attributes of neighbourhoods as well as dwellings.

Introduction

The urban system in the UK in common with other western economies has exhibited decentralisation over the latter half of the twentieth century with the core cities in decline through a combination of de-industrialisation and decentralisation of industry together with residential suburbanisation. For much of this period the UK government has sought a stringent defence of 'green belts' of countryside surrounding cities. But these are now under threat with housing shortages, especially in the South East of England, that is partly a function of the pressure of land supply constraints. The Barker Review (2003, 2004), initiated by the government, identified housing supply constraints as a major influence on the housing market, and as a consequence UK real house prices have risen by 2% per year between 1971 and 2001 creating affordability problems (Barker, 2003). Its recommendations for change have focused on planning processes, for example taking a more regional perspective and more account of market signals (Barker, 2004). However, there is an apparent dilemma between the changes recommended by this review and the tight green belt policies aimed at compact cities.

Partly as a response to these urban pressures there has been a growing interest in urban form and its influence on sustainability over the last decade. The emphasis of this debate about the sustainability of urban forms has focused on increasing the density of development, ensuring a mix of uses, containing urban 'sprawl' and achieving social and economic diversity and vitality – characterised as the concept of a 'compact city' (Jenks *et al*, 1996). Much of the debate has been in normative terms and often on a purely environmental basis. Jones and MacDonald (2005) identify the importance of the role of real estate markets in determining urban form. The physical dimensions of urban form represent an amalgam of land use patterns, the transportation system and urban design features. This paper focuses on the relationship between urban form and local housing markets.

It begins by setting out the principal elements of urban form - land use patterns, position/ transport infrastructure, density, characteristics of the built environment, and layout. Next the paper examines access space models of urban housing markets and the relationship of their outcomes to urban form. The basic model of Muth (1969) is augmented to account for green belts and social housing provided by the state. These arguments are harnessed to develop a set of hypotheses on inter urban variations in house price gradients and attitudes toward urban form parameters, The subsequent section explains the study areas, research method and the data. This is followed by analysis and conclusions.

Elements of Urban Form

Urban form is taken here to be composed of four elements. These are land use, density, position/transport infrastructure and characteristics of the built environment. An additional micro-element is layout. The dominant land use is residential, but a functional urban area also requires industrial, retail, offices etc. Only residential use is considered here. Similarly while density has a number of sub-elements, gross population, net residential, commercial and industrial employment densities, only gross population density is included in the analysis.

Position/ transport infrastructure largely determines the ease by which people can reach buildings, spaces, and places. It provides a set of accessibility relationships within the urban area that can be seen in terms of the distances or travel costs. These relationships can be seen as a hierarchy, with at one level travel from residential areas to city centre, major retail locations, work and other services. At the other extreme there are accessibility relationships at the neighbourhood level, i.e. accessibility to local schools, medical centres and shops. This study focuses purely on distance to the city centre.

Characteristics of the built environment, is a concept encompassing various features of an urban area such as building type, building height and intensity of land use. This element encompasses building types, heights, and intensity of land use. Intensity is distinguished from density here because it refers just to the footprint of the building (s). For example, high rise flats would be considered high intensity even if they are surrounded by green space. The analysis here is concerned simply with the predominance of particular building types in a neighbourhood. The fifth element of urban form is layout. While certain types of layout may influence transport infrastructure provision and modal choice, and vice versa, the paper subsumes the issue of layout within building neighbourhood type.

The Local Housing Market and Urban Form

The starting point for the analysis is the comparative static access-space models of local markets. The logic of this approach stems from the seminal work on urban housing markets led by Kain (1961), Wingo (1961), and Alonso (1964), followed by Muth (1969) and Evans (1973) which emphasised travel to the city centre as a key determinant of residential location. In what has become known as the access space model households in these models trade off journey to work costs for housing expenditures.

It is instructive to examine the detail of the model developed by Muth (1969). The model makes a range of assumptions including a featureless plain, employment concentrated in the central business district, travel costs are the same in every direction, and spatially invariant prices and taxes. Households maximise utility subject to an income constraint. Households only have three choice variables,

housing, travel (distance) to the CBD, and all other goods where housing is of uniform quality. From this starting point it can be shown for spatial equilibrium the following condition holds;

$-qp_k = T_k$

where

q = quantity of housing consumed
p=price of housing
T = travel costs from the city centre
K= distance from the city centre
P_k and T_k are the rate of change in price and travel costs with distance from the city centre

P_k is the house price gradient from the city centre. Muth goes on to show that for the equilibrium to be stable that the house price gradient has to be a negative exponential function. Further perusal of the equation above also reveals that it is a function of travel costs. The lower the travel costs the flatter the house price gradient.

The implicit logic of these models is that the housing market is defined by the travel to work area (TTWA). Or more precisely the operation of the housing market determines the TTWA so for example lower transport costs leads not only to a flatter house price gradient but people living on average further from the city centre. Thus suburbanization can be explained by the model as a consequence of falling travel costs. Urban form is an implicit outcome of the model. In cities where there is a high income elasticity of demand for housing the model demonstrates that low incomes households consume small amounts of housing at high unit costs in inner high density locations and high incomes households consume the converse. Under a set of further assumptions Muth (1969) further illustrates that a negative exponential density function can be derived. Notwithstanding these additional assumptions the logic of the model is that other the elements of urban form, namely density, characteristics of the built environment and layout are endogenous outcomes to the model.

These conclusions are based on assumptions of a perfect market and represent long run equilibrium. Undoubtedly the output of this model provides valuable insights into the spatial structure of urban housing markets. The access space model can explain the long term suburbanization of the cities with growing household incomes and new transport technologies lowering transport costs. As household incomes have risen so have commuting distances. The model also emphasizes how the operation of local housing markets and urban form are set within a framework of transport costs (that determines accessibility relationships) which in turn is dependent on the transport infrastructure.

Further perspective on the determination of urban form can be drawn in the role of income. Income appears only formally in the model as an income constraint and as an influence on travel costs through the valuation of travel time but the high income elasticity of housing demand has a crucial role in explaining (changing) spatial structure. As the trade off between space and distance is crucially dependent on household income so the macro-urban form outcome for a particular city is also a function of the level of household incomes and the distribution of these incomes. Ceteris paribus cities with higher incomes have households who value travel time greater, have larger houses, and have a more dispersed urban form.

These conclusions are tempered by the role of planning through in particular the use of green belts, historic/existing housing development, the dynamic nature of the housing market and the trend toward decentralization of employment. The decentralisation of employment in a sense challenges the heart of the access space model, for example research in the USA finds that commuting distances remain constant despite continuing decentralisation because such trips are no longer necessarily only from suburbs to city centre (Gordon and Richardson, 1993). Nevertheless despite what might be described as the existence of polycentric development or city regions the city centre almost certainly remains the dominant point of accessibility for UK cities and the local housing market.

Planning in the UK is a combination form of individual development controls, indicative land use zoning and strategic planning that includes green belts. Green belts act as boundary constraint on the market restricting the urban land supply, and hence distorting the outcomes of the simple model. It is not simply a matter of creating a discontinuous price gradient as shown in Figure 1. Nor is it simply that demand is constrained by supply pushing up the housing price and residential densities uniformly across the city. Demand displaced from it 'natural' spatial equilibrium in the green belt is likely to seek close substitute locations. The lower density of development and scale of land availability in the suburbs also offers greater opportunities to the adaptation of the land use pattern. There is likely to be a piling up of demand either side of the green belt as shown in Figure 2. Such an effect may be exaggerated if there are household preferences to live near the green belt.

This last point highlights other simplifications in the model – the lack of locational or house type preferences. Both stem logically from the assumptions of constant housing quality and uniform plain. While such simplifications assist the power of the model to focus of the access-space trade off empirical analysis cannot so easily discount such factors. Thus there may be building type preferences, such as the desire of families with young children to occupy housing with gardens. There is a further limitation with regard to the UK in the form of tenure, especially social housing provided outside the market by public agencies. The existence of such housing does

not merely distort the model it challenges all the assumptions of the model because landlords do not maximise profits, rents are not set entirely on market criteria, and households are administratively allocated to housing.

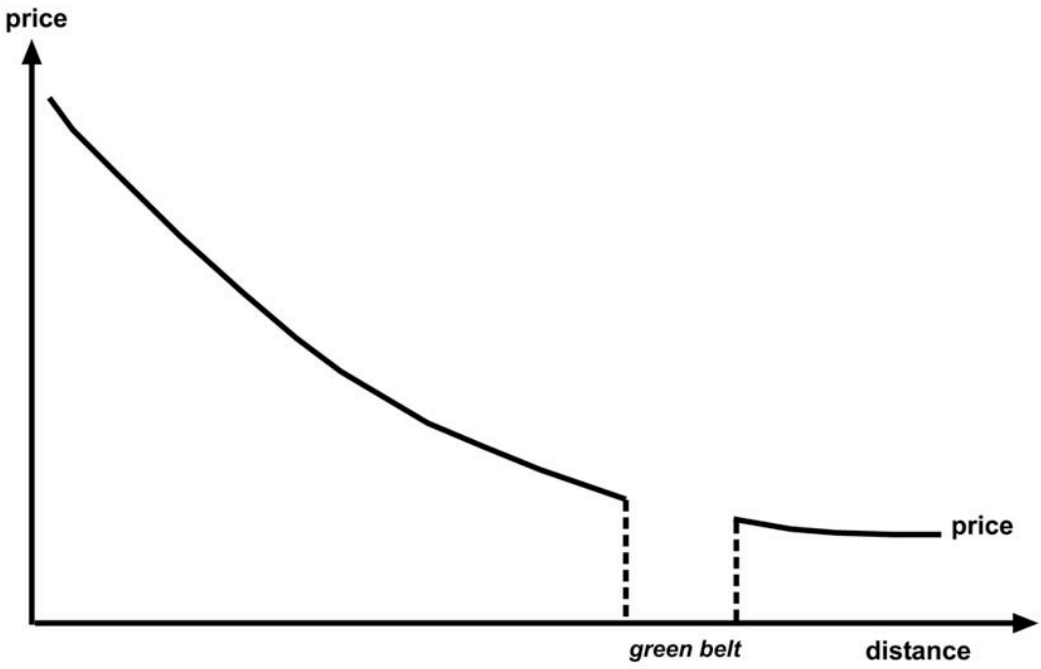

FIGURE 1 **Discontinuous House Price Gradient caused by Green Belt**

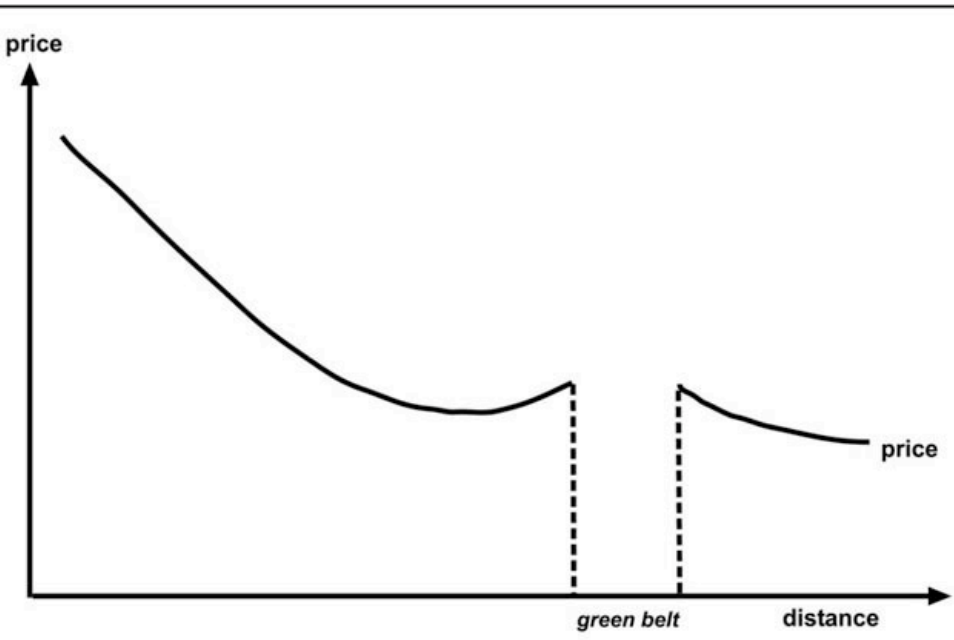

FIGURE 2 **Distorted House Price Gradient caused by Green Belt**

Social housing can be seen as discontinuities in the urban housing market space in the same way as a green belt. In many UK cities social housing was built in an inner ring around the city centre following slum clearance programmes of nineteenth century housing. The impact on the house price gradient of such a phenomenon is shown in Figure 3 which also assumes there are negative preferences to living near large social housing estates. The figure also illustrates how introducing just discontinuities of a green belt and a ring of social housing can distort substantially the negative exponential house price gradient. The real world is less straight forward and the discontinuities are amorphous spaces rather than rings and a city's house price surface can be viewed as an umbrella with 'holes'. The elements of the urban form – density, characteristics of the built environment, layout - within the areas of social housing are not determined by market forces.

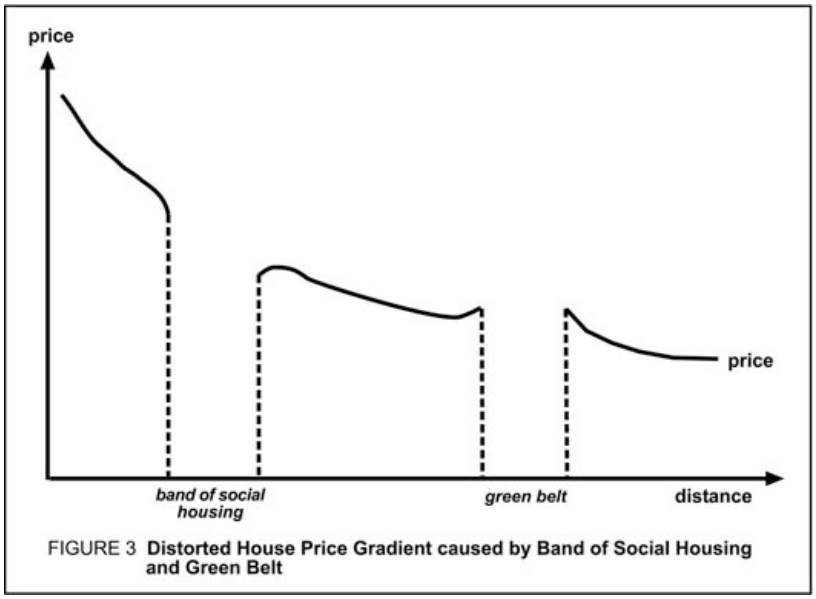

FIGURE 3 **Distorted House Price Gradient caused by Band of Social Housing and Green Belt**

Equilibrium in the access space model implicitly denies the occurrence of housing submarkets although their existence has gained general acceptance in the academic literature even though there are considerable differences of views of the underlying causes (Watkins, 2001). Jones et al (2003) demonstrates that submarkets are stable over time. This implies that spatial arbitrage processes do not work effectively and equilibrium is ultimately not restored across the urban housing market. As a consequence housing characteristics in submarkets tend to be stationary. Developers tend to build similar housing to that that already exists nearby and the planning system operates as an enabling mechanism. The corollary of this conclusion is that the major planning constraint on urban form and residential density is green belt policy. Nevertheless the fundamental access –space relationship should still remain within each private submarket.

Hypotheses

The discussion of the access space model highlights a number of issues about the spatial structure of housing markets. To summarise house price gradients are a function of urban travel costs, the level and distribution of incomes within a city, the spatial pattern of social housing and the effectiveness of planning constraints in the form of green belts. Nearness to social housing is likely to have a negative influence on house prices. In the UK the prices of former social housing bought by sitting tenants under the "Right to Buy" tend to be sold at a 'discount' compared with equivalent properties built by the private sector (Jones, 2003). These and other locational preferences may distort an underlying negative house price gradient from a city centre. These underlying forces also apply within submarkets as the UK planning system primarily constrains local housing markets through an overall land supply constraint enforced by the green belt.

Travel costs include travel time as a component and are dependent on the quality of local transport infrastructure. There is evidence in the UK that traffic speeds in urban areas are subject to some variation (Department of Transport, 2005). The average traffic speed across the major road network of large urban areas in 2004 was 21.0 mph during peak periods and 25.3 mph during the intervening off-peak periods. The range of values for the 18 areas surveyed was 33.5mph to 19.1 mph for average off peak speeds while peak averages varied from 31mph to 15.5mph. Thus congestion by slowing travel times pushing travel costs up and making house price gradients steeper. Thus in as much that travel costs differ with urban area then house price gradients will vary across different cities. Ceteris paribus the slower travel speeds the higher travel costs and the steeper the urban house price gradient.

The effectiveness of planning constraints vary by locality. For example Cheshire and Sheppard (1989) compare the consequences on house prices….. There are also variations in the level and distribution of local incomes between urban areas. Similarly the scale and spatial pattern of social housing development varies from one city to another. As a consequence house price gradients are likely to be different in each city and as corollary so will the nature of urban form.

With green belts constraining urban development this creates higher residential densities and more scope for household preferences toward density and the built form of neighbourhoods as represented by market prices. Attitudes to these characteristics may also vary by city density and size but are not considered here.

Study Areas

The three English cities used as study areas in this paper are Leicester, Oxford and Sheffield. Their location within England can be seen on the map to the right (Figure 4). In order to provide a context for the empirical work that follows, this section of the paper seeks to provide a general background to the housing market and urban form characteristics and a brief socioeconomic background for each of the three cities. The boundary for each city is the Local or Unitary Authority boundary, as defined by the 2001 UK Census.
The data used in this section come from the 2001 UK Census and HM Land Registry residential transactions for 2002. These are the same sources that have been used in the subsequent empirical work below.

Leicester

Leicester is located in the East Midlands and has a population of 279,921 and an area of 73.32 km^2. The market comprised the sale of 5,767 dwellings with an average property price of £83,520 in 2002. The housing stock encompassing all tenures is composed of 10.2% detached, 37.1% semi-detached, 35.4% terraced and 17.2% flats. Table 1 provides a breakdown of average property prices by property type.

Table 1 – Average property prices in three cities in 2002 by house type

Mean Price (£)	Leicester	Oxford	Sheffield
All property types	83 520	214 823	87 618
Detached	157 467	384 731	156 892
Semi-detached	84 587	202 068	78 672
Terraced	67 847	208 768	60 299
Flat	72 971	166 474	84 230

Some 57.9% of households in Leicester are owner occupiers, which is relatively low compared to 68.7% for England as a whole. The remaining rented households are split 14.1% private renters and the remaining 28% renting from the council or other social landlords. The spatial pattern of social housing given in Figure 5 reveals a concentration within 4km of the city centre.

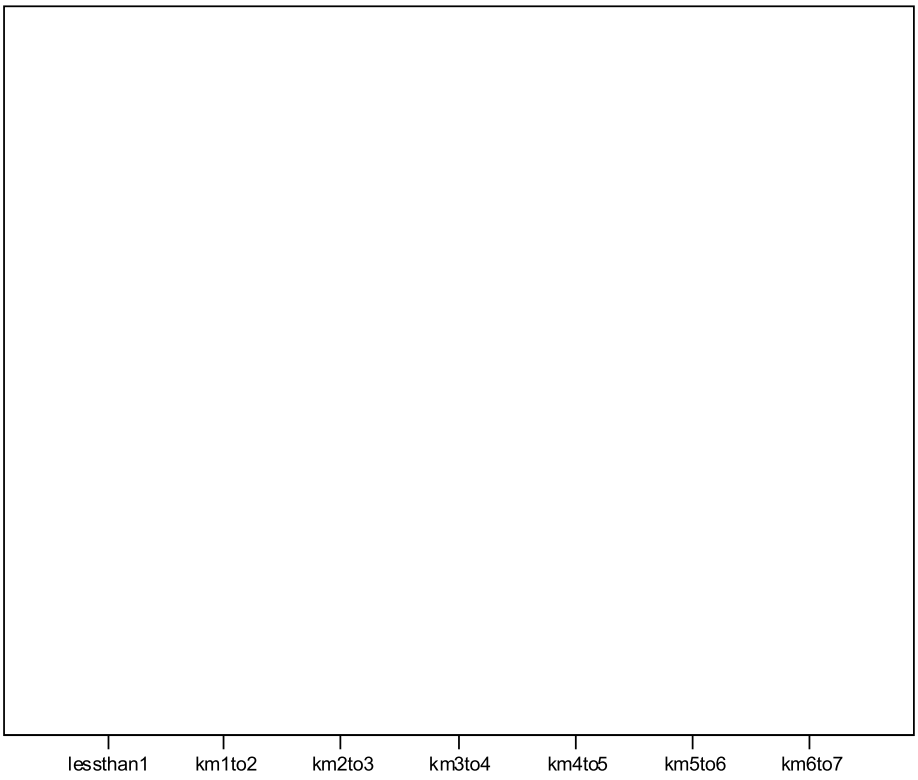

Figure 5 The Spatial Pattern of Social Housing in Leicester

Leicester has a relatively high density compared to Oxford and Sheffield, with an average of 38.2 persons per hectare and 15.95 dwellings per hectare. The mean distance to city centre is 3.1 km and the furthest distance to city centre (based on census output area centroids) is 6.49 km. These distances are similar to those of Oxford, which suggests that Leicester is a more constrained city than Oxford given that Leicester has both a larger population and is higher density. The city also has the slowest traffic speeds in the cities of England (Department of Transport, 2005).

The largest employment sector is manufacturing followed closely by wholesale and retail trade, with 23.4% and 18.7% of employment in these sectors

Figure 4 **Location of Cities**

respectively. Overall employment in Leicester is around 53%, with 4.9% unemployed. 39.5% of people in Leicester are grouped as social class AB or C1, which is lower than the other two cities.

Oxford

Oxford is directly south of Leicester. It has a population of 134,248 and an area of 45.6 km^2. It is the smallest of the three cities both in terms of area and population. The housing market is just under half the size of Leicester's with 2,579 transactions in 2002. Oxford has by far the highest average property prices of all the three cities, with the average price of all property types standing at £214,823 in 2002. Table 1 provides details of average prices by property type.

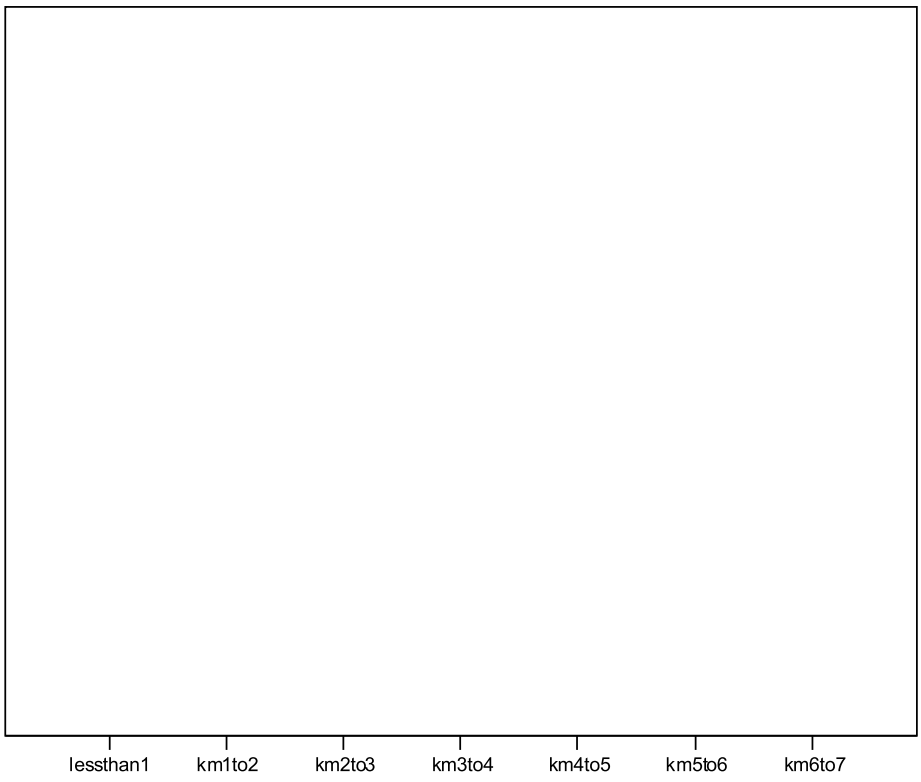

Figure 6 The Spatial Pattern of Social Housing in Oxford

There are 29.4 persons per hectare and some 11.79 households per hectare in Oxford (or 11.43 dwellings per hectare). In all there are 52,836 dwellings and of these dwellings, 9.8% are detached, 31.6% are semi-detached, 30.1% are terraced and 28.2% are flats.

Some 54.9% of households are owner occupiers, 21.2% rent from the council or other social landlords, and 23.9% are private renters. This is by far the largest proportion of private renters of the three cities. This is a reflection of the large influence the universities have on the city in terms of student numbers. The spatial pattern of council housing shown in Figure 6 demonstrates that council housing is generally located further out from the city centre than Leicester.

Interestingly, Oxford has a large number of people that travel to work by bicycle (14.9%). It also has the lowest percentage of people driving a car or van to work (See Table 2). Average traffic speeds are the fastest of the three cities (Department of Transport, 2005) and despite the bicycle usage do not show any distinctive differences between peak and off peak travel times.

Table 2 – Travel to work mode in three cities

Travel mode (% of people aged 16-74 in employment)	Leicester	Oxford	Sheffield
Underground metro, light rail or tram	0.09	0.19	2.79
Train	0.81	1.8	0.74
Bus, minibus or coach	15.23	16.33	17.76
Motorcycle, scooter, moped	0.69	1.06	0.7
Driving a car or van	47.47	37.67	52.36
Passenger in a car or van	7.59	4.22	6.45
Taxi	0.4	0.35	0.33
Bicycle	4	14.86	1.08
On foot	15.83	14.69	10.42
Other	0.38	0.41	0.35

Oxford has the smallest mean distance to city centre of the three cities at 2.99 km, but this would seem logical given that it is the smallest city. Oxford is perhaps not quite as ‘compact’ as Leicester, but is most definitely more compact than Sheffield.

The largest employment sector in Oxford is unsurprisingly education (19.7%), but this is closely followed by real estate, renting and business activities (16.4%). The city has the lowest unemployment figure of the three at 2.3%. 53.3% of the population are employed. Together with the highest house prices these statistics suggest that Oxford is the wealthiest of the three cities.

Sheffield

Sheffield is the most northerly, and the largest of the cities. It has a population of 513,234, with 224,655 dwellings. Its area is 367.94 km^2. The average house price for all property types is slightly higher than Leicester, but much lower than Oxford at £87,618 in 2002. It has by far the largest housing market with 10359 sales in 2002. Although the average house price for all property types is higher for Sheffield than Leicester, there are some notable differences between the average prices for individual property types. The average prices for semi-detached and terraced properties is around £6,000 higher in Leicester for both types, whilst the average price for a flat in Sheffield is nearly £12 000 more (see Table 1).

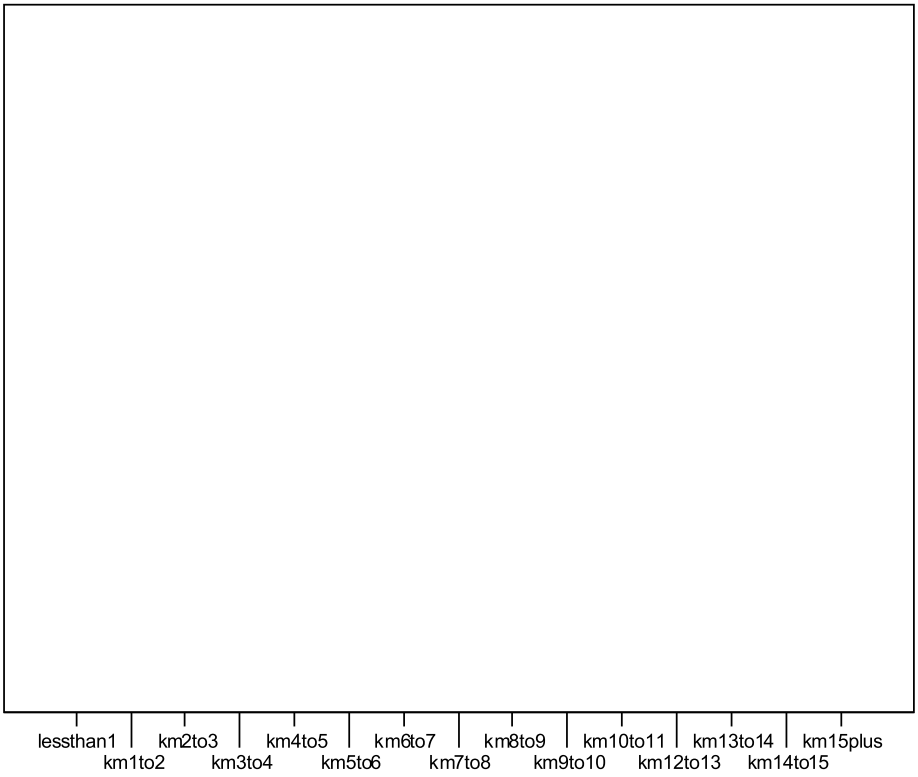

Figure 7 Spatial Pattern of Social Housing in Sheffield

The differences in average prices are made more interesting by the proportion of property types in Sheffield. The proportion of flats is much higher in Sheffield than

Leicester, at 35.6%. The percentage of semi-detached and terraced properties in Sheffield is also much smaller than those in Leicester (see Table 3).

Table 3 – Property type mix of three cities

Property type (%)	Leicester	Oxford	Sheffield
Detached	10.2	9.8	20.4
Semi-detached	37.1	31.6	23.5
Terraced	35.4	30.1	20.3
Flat	17.2	28.2	35.6

Sheffield has the highest proportion of owner occupiers, at 60.2%, as well as the lowest proportion of private renters (9.6%). It has by far the highest proportion of social renters at 30.3%, which is much higher than the national figure for England of 19.26%. Figure 7 shows that the spatial pattern of social housing in the city conforms more closely to the classic inner city ring location of English cities than Leicester and Oxford.

As well as the largest area, Sheffield also has the largest mean distance to city centre, at 5.22 km. The city also has the lowest density figures, with 13.9 persons per hectare and 6.17 dwellings per hectare. Together, these figures tentatively suggest that Sheffield is not a particularly compact city, especially when compared to Leicester, and probably the least constrained by planning.

Wholesale and retail and manufacturing are Sheffield's biggest employment sectors at 16.92% and 15.6% respectively. Sheffield has the highest employment of the three cities at 55.7% of the population, with unemployment at 4.2%.

Research Method and Data

The empirical analysis utilizes multiple regression analysis based on a hedonic housing model. There is now an extensive house price literature that has applied this approach, see for example Cheshire and Sheppard (2004). It enables housing to be viewed as a composite good and prices to be ascribed to the individual attributes (Rosen, 2004). There are a number of implicit assumptions that the model presumes not least equilibrium in the housing market but also independence between the variables. The research here is based on housing transactions in a single year, 2002. Although there was rapid house price inflation in 2002 it is our contention that the

driving force was macro-economic trends not localized factors that had a differential impact within local housing markets.

The variables included in the analysis are set out in Table 4. The characteristics of the property are simply the house type expressed as a series of dummy variables. House price and house type are derived from land registry data. Distance to the city centre is calculated from the centre of the Census output area in which the property is located. Census output areas are broadly equivalent to 140 households. The other variables are linked to the urban form characteristics of the neighbourhood, defined as a Census super output area accounting for approximately 600 households.

Neighbourhood variables are defined in physical terms and incorporate measures of residential density and characteristics of the built environment. These are the percentage of households with first floor as lowest floor level, average number of rooms per dwelling, dwellings per hectare, and the percentages of detached houses, terraced houses and flats. In addition to account for the role of social housing the percentage of social housing in the super output area is included.

Table 4 Definition of Variables

Variable name	Description	Source
Price	Market property price	HMLR 2002 house price data
Det	Dummy variable for individual property type	Derived from HMLR 2002 house price data
Terrace	Dummy variable for individual property type	Derived from HMLR 2002 house price data
Flat	Dummy variable for individual property type	Derived from HMLR 2002 house price data
Distance	Distance to city centre from centroid of output area in km	Calculated using coordinates of central points of output area
pn_firstfl	% of households with first floor as lowest floor level in super output area	2001 UK Census
N_averms	Average number of rooms per dwelling in super output area	2001 UK Census
N_dwphec	Dwellings per hectare in super output area	2001 UK Census
pn_detach	% of detached properties in super output area	2001 UK Census
pn_terr	% of terraced properties in super output area	2001 UK Census

pn_socrent	% of social housing in super output area	2001 UK Census

Results

The analysis is initially presented as a regression for each city with the dependent price variable expressed as a natural logarithm and distance as a dependent variable. The results, presented in Table 5, reveal that the coefficient for the distance variable has the expected negative coefficient for all three cities

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The housing characteristics variables consistently have the right signs and the density variables are normally significant. However, while the average number of rooms variable is consistently significant with the right sign the number of dwellings per hectare proves to be less robust.

The Leicester regression explains 40% of the variance, Oxford a similar percentage, 44%, and Sheffield 54%. However, there is limited evidence of multi-collinearity judged by the VIF statistics principally in the neighbourhood built environment variables that limits the efficiency.

Table 5 Regressions results for three cities with natural logarithm of house price the dependent variable

Variable	Leicester	Oxford	Sheffield
Constant	10.63**	11.37**	8.51**
Det	0.51**	0.37**	0.55**
Terrace	-0.17**	-0.04*	-0.25**
Flat	-0.42**	-0.42**	-0.18**
Distance	-0.02**	-0.08**	0.01**
Pn first fl	0.04**	-0.05**	0.06**
N averms	0.14**	0.18**	0.49**
N dwphec	0.00	-0.003**	0.005**
Pn detach	0.00	0.003**	-0.001
Pn terr	-0.002**	0.000	-0.003**
Pn socrent	-0.01**	-0.01**	-0.01**

** significant at 99% level, * significant at 95% level

Conclusions

There is a growing interest in the nature of sustainable urban form although most of the arguments are in normative terms. This paper has examined the theoretical links between the housing market and urban form. It notes that the spatial price structures of housing markets can be modified by green belts and develops some theoretical links between urban form and housing market outcomes. However, the empirical analysis of three cities in England is far from conclusive and probably suffers from missing variable specification. To a degree this is intentional in order to focus on urban form variables. Further work is needed to refine the variables.

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