The Implications of Housing Type/Size Mix and Density for the Affordability and Viability of New Housing Supply

NHPAU

Building Awareness For The Future

The Implications of Housing Type/Size Mix and Density for the Affordability and Viability of New Housing Supply

Professor Glen Bramley[1], Kathleen Dunmore[2], Dr Neil Dunse[1], Catherine Gilbert[2], Dr Sotirios Thanos[1] and David Watkins[1]

February 2010

NHPAU
Building Awareness For The Future

National Housing and Planning Advice Unit
CB04 Ground Floor of Clerical Block
Segensworth Road, Titchfield
Fareham PO15 5RR

T 023 9295 8152

www.communities.gov.uk/nhpau

[1] Heriot Watt University, Edinburgh
[2] Three Dragons

Contents

1. Executive Summary

Introduction

Densities of new residential development in England have risen sharply in the 2000s. This raises questions about what is driving this change, how far due to planning policy and how far to market forces; and how desirable it is in terms of consumer preferences, developer viability and affordability.

To answer these question, the study develops a model to understand how the price of a standard house is influenced by the mix of types of dwelling (e.g. flat, detached, semi detached, terraced) and densities (e.g. high medium and low) in the surrounding area. The model is then used to estimate the viability of different housing projects with different types and densities in selected local authority case study areas. Finally, the study reports on the impact of mix and density on affordability.

Research Method

1. A hedonic model has been constructed to study how the price of a house is influenced by different types of dwellings and housing densities in the surrounding area. Housing markets in the following case study areas (local authorities in brackets) are examined:

    - London South West (Hammersmith and Fulham, Hounslow and Richmond upon Thames)
    - London North East (Redbridge, Waltham Forest and Hackney)
    - Manchester (Manchester and Salford)
    - Leeds
    - Nottingham (Nottingham and Rushcliffe)
    - Southampton (Southampton, Eastleigh, Test Valley)

2. Using the output from the hedonic model, the report simulates the expected sale price of each housing unit under different scenarios of density and mix. With the information that has been collected on each site the research constructs hypothetical cost models of each scheme in the case study areas and draws conclusions about residual values.

3. Finally the house prices and development densities are analysed to evaluate the relative affordability of different mixes and densities. For affordability, two complementary measures are used:

    I. The *relative* price of the new housing product, compared with a representative *threshold* (entry-level) price for the local market area.

    II. The 'most affordable' prices from each scheme/density option/size category are converted into a weekly outgoings figure for a 95% repayment mortgage. A threshold weekly income is estimated to determine whether the property is affordable to buy.

Results

Mix, House Type and Density

Multiple regression analysis (MRA) is used to statistically determine the relationship between price and a series of explanatory variables which in this case includes a measure of mix and density, in each of the case study areas. The Regulated Mortgage Survey (RMS) house price dataset has been used, which covers the period between 2005 and 2007. This data has been matched to the Census data to obtain a series of socio-economic variables including among others house type mix, household and dwelling density. Using GIS software additional location and neighbourhood variables have been added to Census Output Area (COA) level.

- Generally speaking, high density neighbourhoods do not attract a premium, suggesting that consumers prefer lower density neighbourhoods.
- Consumers prefer houses over flats and detached properties over semi-detached and terraced (i.e lower density suburban areas).
- Both low density, detached-dominant areas and high density, flat-dominant areas attracted a premium over medium density semi-detached and terraced areas.
- The relative size of the these price premia or penalties for different type mix and density characteristics vary between different housing market areas. For example, the penalty from higher density was less marked in London and Manchester than in the other provincial cities examined.

Residual Land Values, Mix and Density

The analysis compared residual values for ten schemes in five urban locations, London, Southampton/Eastleigh, Manchester, Nottingham and Leeds. The analysis is based on actual schemes which are tested against three standard densities 30 dwellings per hectare, 50 dwellings per hectare and 120 dwellings per hectare. Scheme viability, as measured by residual value varies widely between cities and between locations within a city.

- Scheme viability (as measured by residual value) varied widely between cities and between locations within a city. However, it is interesting to note that, even in 2007, at the peak of the housing market 'boom', there were some locations where some types of housing development did not appear viable.
- In two cases, both in Leeds, the lowest density (30 dph) produced the highest residual value for the 100% market (no affordable housing) case. In six out of the ten locations, the highest density tested (120 dph) produced the highest residual value. In only one case, London North East, did the intermediate density mix (50 dph) produce the highest residual value.
- Actual schemes built where the model suggested 30dph produced the highest residual value were in some cases developed at considerably higher densities. (e.g. 71 and 282 dph).
- Affordable housing provision reduced residual value in all the cases.

Affordability Impacts, Mix and Density

Schemes with both two bed and three bed properties are used in the study. There are marked differences in the affordability of market housing products produced on new build sites in different market areas and, within those, between different neighbourhood locations.

- In general, the more affordable homes are generally within medium density schemes.
- Both the two London areas and Leeds offer examples of new build schemes being cheaper than the threshold level (see methodology section) in the existing market.
- For the properties with two beds in the study, in no case is low density the most affordable. In the majority of cases the medium density option offers a more affordable product than the high density option, even for two bed accommodation. However, the high density option is more affordable in the two Leeds cases and in the Southampton case.
- In most cases, new build schemes are not affordable by many under-forty families, assuming these are first-time buyers relying primarily upon income as rather than wealth or equity to buy.

Recommendations

The main policy recommendation for local authorities from this study is that they should monitor viability of housing development on a regular basis and consider the viability implications of the requirements they seek to impose on developers of larger housing sites, both in relation to mix and density and in relation to affordable housing. A further recommendation for local authorities is that they should monitor the relative prices of different sizes/types of housing provided on new build schemes compared with the local thresholds for affordability developed in their Strategic Housing Market Assessments (SHMAs). In the light of this, they should have regard to the relative affordability of the market offer on new housing schemes, as well as the effective affordability of the 'affordable housing' (particularly LCHO) likely to be provided on such schemes, in shaping their affordable housing requirements for different sites.

In general, this study provides a caution against 'one size fits all' planning policies. While it would be unfair to characterize the policies of the early 2000s as being only about building high density flats on brownfield urban sites, there was a perception that that was the main preference and this contributed to the marked shift in provision in this period. The evidence from this study suggests that such an exclusive emphasis would not serve well in meeting the preferences of a wide range of consumers, and neither would it necessarily promote affordability. The study suggests that policy guidance should recognise local variation, while encouraging the monitorng of viability and affordability.

For an affordability toolkit this study provides a pilot of a methodology to examine viability and affordability implications of housing mix and density. Resources for this study did not permit the development of this approach into a tool that could be easily used in any area to produce ready reckoners for local decision-making. However, that could be a logical next step; most of the ingredients are in place, from this study and some other research which the Unit has in hand, and it could be feasible to move on to provide a set of ready reckoners to make similar estimates for any area in the country rather than just for a limited set of case studies.

2. Introduction

Densities of new residential development in England have risen sharply in the 2000s. This raises questions about what is driving this change, how far due to planning policy and how far to market forces; and how desirable it is in terms of consumer preferences and affordability. This research aims to shed some light on these issues and intends to achieve three objectives.

1. Develop general models for house prices suitable for analysing values associated with house type, different mix and density across England.

2. Utilise those results to provide a modelling capability to estimate development costs and residual land values across England, for defined new product densities and mixes.

3. Analyse the house prices and development densities to evaluate the relative affordability of different mixes and densities.

The relative value of homes (Objective 1) in the market itself provides evidence of consumer evaluation of density, house type, mix and related attributes in different contexts. The relative profitability (Objective 2) of different types of housing development, defined by the difference between housing sales values and construction costs, provides a strong indicator of the likely choices of developers, were they not constrained by planning. House price levels and patterns are also relevant to another social policy concern, namely the concern about affordability (Objective 3). Affordability is a concern because it affects people's ability to access the mainstream tenure of homeownership, and may affect their ability to obtain or retain any adequate housing. The affordability criterion cuts across the 'evaluation of residential quality' and the 'commercial viability' criteria, because higher house prices are inherently less affordable. From this point of view house prices appear as a double-edged sword. Balancing these different criteria, one is perhaps seeking a 'happy medium' position where prices are high enough to promote viability and indicate satisfaction, without being excessively high to the detriment of affordability.

The report will begin with a brief historical overview of planning policy treatment of mix and density and recent trends in actual development. The report will proceed to present an analysis of house prices to provide evidence of consumer evaluation of density. This will be achieved through the application of hedonic pricing models. Next, the report will undertake an analysis of development costs and residual land values under different density and mix scenarios. Finally an analysis will be undertaken of these hypothetical developments to consider how affordable each density scenario is. Finally, we will draw some conclusions.

3. An Overview of British Planning Policy

British planning policy and practice has always had a significant impact on typical housing development densities. Planning policy through the 1990s took a progressively stronger stance in favour of 'sustainability', generally equated with more compact urban forms and also (in some versions) with mixed communities and mixed use. These themes were foreshadowed in the 1990 White Paper *This Common Inheritance*, whilst PPG3 (1992) introduced stronger policies on affordable housing and the re-use of brownfield land for housing, while still warning against 'town cramming'. PPG13 (1994) set out the role of planning in reducing CO2 emissions by managing travel demand, integrating land-use and planning and encouraging cycling, walking and public transport.

Meanwhile the JRF *Inquiry into Planning for Housing* (1994) recommended the re-use of urban land and increased urban densities, leading on to the Llewellyn Davies work on urban capacity. The Government's 'Sustainable Development Strategy' recommended more compact urban development. The 1995 Housing white paper *Our Future Homes: Opportunity, Choice, Responsibility* set out a target of 50% of new residential development on brownfield land, subsequently raised to 60% in the 1998 document *Planning for the Communities of the Future*.

The 1998 SEU Report *'Bringing Britain together'* foreshadowed a greater policy emphasis on regenerating poor and rundown urban areas, and taken together with the Rodgers Report (1999) *Towards an Urban Rennaissance* this signalled a further emphasis on urban (re-)development.

This was then reflected in PPG3 (2000), which introduced a 'new' approach to land allocation/ availability, based on urban capacity studies which (for a while) replaced traditional land availability studies. The emphasis was on the re-use of land in urban areas, using a sequential approach to identify potential sites assessed against a number of criteria. In addition to the 60% brownfield target (which included conversions, and could be varied regionally), this PPG set out an overall density target of 30-50 dwellings per hectare (dph) and a parking maximum of 1.5 spaces per dwelling. This PPG was accompanied by design guidance *'Better places to live by design'*.

However, from about 2003 the policy emphasis shifted again, paying more attention to housing supply and affordability issues, as encapsulated in the Barker (2003, 2004) Review. The ODPM (2003) *Sustainable Communities Plan* identified major growth areas and various funding mechanisms for land assembly and infrastructure. PPS3 (2006) replaces PPG3, and promotes housing development which provides: high quality housing; a mix of both market and affordable housing (tenure, price and type); housing in suitable locations; effective and efficient use of land, while maintaining the 60% target for brownfield land and the 30 dph national indicative minimum density.

3.1 Density Trends in New Development

Figure 1 and Table 1 describe recent trends in residential density, based on the Land Use Change Statistics (LUCS). This source enables previously used ('brownfield') land to be distinguished from land newly converted to urban use ('greenfield'), as in Figure 1.

Figure 1 shows a sharp increase from about 2001, tending to level off after 2004. It also shows that the density level tends to be higher on brownfield land and that this difference became more accentuated by 2004. Since, during this period, the share of brownfield land in overall housing supply also increased from 53% in 1997 to 59% in 2000 and 72% in 2006, then it is clear that part of the increase in densities reflects this shift in the location and type of land used for development. Nevertheless, Figure 1 also underlines that density increased markedly within both categories of land.

Figure 1: Trends in new housing density by whether land previously developed

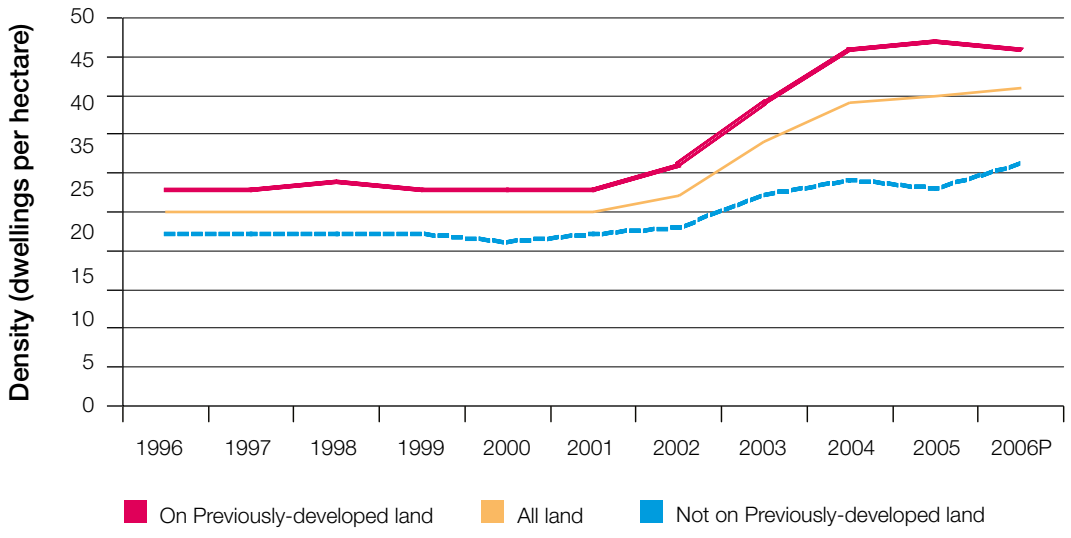

Table 1 shows the densities by region, before and after this recent upward shift. Up to the end of the 1990s densities had been remarkably stable at around 25 dwellings/ha and this level was found in most regions except London. Bramley & Watkins (1996) and Shepherd & Bibby (1994) discuss patterns in the preceding period, but broadly there was a stable picture going back into the 1980s. However, cross-sectionally, more urban areas, especially in London, built at higher densities, and higher densities were associated with a higher share of flats.

Table 1: Net Density of New Housing by Region 1996-2006 (dwellings per hectare)

Region	1996	2000	2004	2006
North East	27	24	32	43
North West	26	26	42	50
Yorks & Humber	24	22	32	41
East Midlands	22	21	35	34
West Midlands	27	24	36	43
South West	24	25	34	40
East of England	22	22	34	33
South East	23	24	37	38
London	56	56	97	84
England	25	25	39	41

Source: CLG Land Use Change Statistics

Table 2 presents a descriptive analysis of the patterns of density and the share of flats in new private housing developments, based on combining ward-level data from the Census, Land Registry and Emap-Glenigan housing sites database [based on Glenigan 2004 data]. Wards with no new private building and no sites data are omitted. The first column shows the rate of new private building, the second shows the net dwelling density of new private housing sites, which may be compared with existing gross density in the next column. The proportion of new flats is shown for two recent time periods and compared with the existing share of flats. Provision of more flats is clearly a key corollary of building at relatively high densities, as is confirmed by the data in this Table.

Table 2: Density and Share of Flats in New Private Development by Wards Types (wards in England with significant new private building)

	New Priv Build Rate % hhds	*Net New Priv Bldg Density*	*Existing Gross Density*	*Propn Flats % 2000-04*	*Propn Flats % 2005-06*	*Existing propn Flats %*
Urban-Rural Type						
Central London	0.47	152.0	79.2	92.1	95.0	82.9
Inner London	0.32	125.6	53.5	81.5	86.0	59.9
Outer London	0.25	93.6	32.4	66.6	72.6	33.6
South city centre	0.50	79.6	34.0	59.4	70.2	32.2
South other urban	0.50	64.8	21.0	41.1	50.0	17.0
South town fringe	0.56	39.9	11.4	21.1	24.1	9.7
South village isol	0.47	29.1	3.8	23.8	13.6	4.7
Mid-North City Centre	0.52	94.2	29.9	58.4	65.5	20.5
Mid-North other urban	0.44	57.5	20.2	29.6	38.3	9.4
Mid-north town fringe	0.64	38.7	10.7	15.7	15.7	5.2
Mid-north village isol	0.63	31.9	3.0	18.3	8.4	3.3
England	**0.46**	**69.0**	**23.8**	**41.1**	**48.1**	**18.5**

Note on Sources: Col. 1, 4, 5 Land Registry; Col 2 Emap-Glenigan housing sites database 2004; Col 6 2001 Census.

New private build densities average 69 dwellings per ha net, which is 2.9 times existing gross density. The relationship between new build net density and existing gross density applies in all categories, but to varying degrees; relative intensification appears to be greater in the least dense areas, but these are likely to be wards containing open land and other land uses. Densities obviously peak in central London and other city centres, but it is interesting to note that in urban fringe locations the new densities are just under 40 dwellings/ha, which is what current policy recommends. Only in village/isolated category is there an average as low as 30.

Nearly half (in percentage of units) of recent new private build has been of flats, and this has been on an increasing trend. Flats obviously take a higher share in denser and more urban locations, and the proportion of new flats exceeds the existing proportion of flats in all areas. Whether such a high proportion of flats is desirable or sustainable is one of the questions raised by recent trends.

Overall, linking trend data to the policy evolution, one can say that the policies of the late 1990s – brownfield and urban emphasis, and higher densities – have been successfully achieved. Indeed, it might be argued that they have been over-achieved.

4. Objective 1: House Prices, Mix and Density

4.1 Standard Urban Economic Theory

The theoretical relationship between land value, housing plot size (density) and distance to the central business district (CBD) is well established within conventional theory of urban economics (see Alonso, 1964, Muth, 1969 and Mills, 1972, for example). Within such theories the typical assumptions are:

1. Residents within a city face a trade-off between travel and commuting costs, and

2. Land developers choose the location and density of development to maximise profits.

Under these assumptions (and assuming a monocentric city located on a featureless plain) one would observe a declining rental gradient, increasing plot sizes (lower building density) and lower population densities with increasing distance from the CBD. These theories imply that building density should exhibit a geographic regularity with increase with distance from the CBD i.e. a mixture of different building densities at the same distance from the CBD should not occur.

Although such patterns are often broadly observed within large cities, building density does not vary uniformly throughout an urban area. This is due to market imperfections and the complexity of housing markets (heterogeneity, regulation and social welfare, for example). A method of unpicking and accounting for this complexity is the application of hedonic theory.

4.2 Literature Review: Hedonic Price Models

Hedonic price models have been widely used to test for the influence of external factors upon house prices. This is the research method adopted within this study to test and model the relationship between house prices, mix and density.

Hedonic models have found widespread application since the 1960s, particularly in terms of modelling housing prices. According to hedonic theory, an extension of consumer theory, the pricing of complex or multi-dimensional goods (of which housing is an example) should be derived from the implicit pricing of its component attributes, assuming an efficient market. Hedonic models, initially developed by Rosen (1974) following Lancaster (1966), may be used for the purpose of estimating these implicit or hedonic prices of individual attributes comprising that composite good.

There are numerous published hedonic models focused on the identification and estimation of positive and negative externality effects or our urban form. In this application of the hedonic model, externalities are conceptualised as housing attributes, whose (positive or negative) price can be estimated alongside the pricing of physical and location attributes. Typically, hedonic models constructed for this purpose include dummy variables denoting the presence or proximity of some amenity or disamenity effect. Model estimation then yields the price discount or premium associated with the externality. Alternatively, quantitative variables denoting the extent of some amenity or disamenity effect may be included. Such variables might include distance from the CBD, distance from a park or the quantity of traffic noise in a specific location. With regard to distance from the CBD results do not always accord with conventional urban economic theory as discussed in Sec 3.1.

Examining aspects of our urban environment, examples include the effects of airport noise (Mieszkowski and Saper, 1978, Damm et al, 1980, Uyeno et al 1993, Nelson, 2004), the influence of levels of air pollution (Ridker and Henning, 1968, Brookshire et al, 1982, Graves et al, 1988), proximity to parks and green space (Dehring and Dunse, 2006) and proximity to transport nodes (Gibbons and Machin, 2004).

Within the context of this study there have been a few recent studies which examine the impact on price of design, layout, land use mix and density. These studies are primarily centred around US case studies and examine aspects of New Urbanisn and Smart Growth. Criticising the dominant development form experienced within the US, New Urbanism presents several key propositions:

- unmixed homogenous aggregations of land uses create greater distances between houses and retail and other non-residential destinations encouraging car dependency and discouraging alternative forms of transport;
- low density large lot contemporary suburban development also encourages car dependence; and
- contemporary suburban developments contain too many winding streets and cul-de-sacs; they lack connectivity and easy movement (Song 2005).

Tu and Eppli (1999) compare a single housing development that embodies principles of New Urbanism to surrounding developments that do not. While they find that houses in the New Urbanism development sell at a significant premium, their approach does not yield much insight into how each of the New Urbanism neighbourhood characteristics—greater density, mixed uses, and street configuration—contribute to this price premium.

Song and Knaap (2003 and 2004) disaggregate the features of new urbanism and find that they are often capitalised into residential house prices. The study finds that residents in Portland, Oregon are willing to pay premiums for houses in neighbourhoods with more connective street networks; better pedestrian accessibility to commercial uses; more evenly distributed mixed land uses in the neighbourhood; and proximity to public transport . However, relevant to our research, they also find residents are willing to pay less for houses in neighbourhoods that are dense, contain more commercial uses and multifamily homes (flats).

Matthews and Turnbull (2007) also test features of the New Urbansim, specifically, neighbourhood composition and street layout and find that it does not necessarily have universal appeal to house purchasers. They find similar results to Song and Knaap (2003 and 2004) regarding density and mix.

Hedonic modelling is not the only source of evidence about people's evaluations of their residential experience and environment. Household survey questions about satisfaction with home and neighbourhood and concerns about neighbourhood problems provide another body of evidence (see for example Bramley & Power 2009, Bramley et al forthcoming).

4.3 Data

The data requirements of a hedonic model include a large and sufficiently diverse sample of housing transactions such that all attributes are observed and in different combinations and quantities. Such attributes would include physical, location, neighbourhood externalities and tenure as well as dwelling type, mix and density.

The Regulated Mortgage Survey (RMS) house price dataset has been used, which covers the period between 2005 and 2007. The Regulated Mortgage Survey (RMS) was launched in October 2005 and is a database of mortgage transactions. It relies upon lenders providing a copy of their statutory Product Sales Data submitted to the Financial Services Authority. Most lenders submit to RMS data on a monthly basis and it is a rich source of mortgage market information, including house price and basic housing characteristics. They claim to cover approximately 90% of housing market transactions.

To test the relationship between house price mix and density six city-regions were chosen in England. These were selected based on geographic location, economic diversity and size of metropolitan area. The six case studies (local authorities in brackets) are:

1. London North East (Redbridge, Waltham Forest and Hackney)
2. London South West (Hammersmith and Fulham, Hounslow and Richmond upon Thames)
3. Manchester (Manchester and Salford)
4. Leeds
5. Nottingham (Nottingham and Rushcliffe)
6. Southampton (Southampton, Eastleigh, Test Valley)

Figure 2: Case Study Areas

The housing data sample for the six case study areas is in total 90666 transactions. This sample size resulted after a data clearing exercises, in which 6666 transaction were dropped, 6.8% of the data. These transactions either have an unreasonably low selling price, below £20000, or refer to council tenants exercising their right to buy or there are missing data about the house type (e.g. detached, flat).

This data has been matched to the Census data to obtain a series of socio-economic including among other variables house type mix, household and dwelling density. Using GIS software additional location and neighbourhood variables have been added to Census Output Area (COA) level. All data have been carefully analysed to ensure consistency of variables and identification of data errors.

4.4 Estimation

To explore the effects of urban form on property values we use a standard hedonic price model. The basic model to be estimated for each of the six study areas is:

$$P = \propto + \beta_1 S + \beta_2 E + \beta_3 N + \beta_4 D + \beta_5 M + \varepsilon \quad (1)$$

where:

P sales price of house;

S structural attributes and market conditions;

E socio-economic characteristics;

L distance to CBD

N ethnic mix

D residential density of census area (incl distance to CBD);

M house type mix of census area;

As has been demonstrated in numerous hedonic studies to date, many factors influence house price other than density and mix, so the variable groups S, E, L and N are included to control for this[1]. A full description and definition of the variables included in the models is provided in Table A.1, Appendix A.

[1] In order to be able to examine the housing mix of each area, the available data on the percentage of each house type found in each of the census output areas (COAs) were converted. Dummy variables were created for COAs that are dominated (over 50%) by a specific house type. An additional dummy variable was created for a COAs that are not dominated by any house type. For density, the physical measure of dwelling per hectare (in a specific COA) was used, fitting better the data than other (highly correlated to this variable) density measures. The consistently negative coefficient of the density variable implied that any positive density effects might not be captured by this (or similar) variable. To this end a variable was created as the percentage of the land used for domestic purposes to the whole land area in a COA. This captures the increased residential use of an area and has a positive coefficient. Another variable was also created as the percentage of garden space to the whole domestically used land in a COA.

Multiple regression analysis (MRA) is used to statistically determine the relationship between price and a series of explanatory variables which in this case includes a measure of mix and density. A series of statistical tests are carried out to ensure statistical significance and robustness of the model. However, at the most basic level attention is given to three outputs which are;

1. the adjusted r-square which measures the explanatory power of the equation.

2. the regression co-efficients which measure the relationship between the independent variables (including mix and density) and the dependent variable (sale price).

3. the constant which within a hedonic model is a measure of the value of basic accommodation.

Many of the independent variables are coded in binary form (Table A.1, Appendix A) as dummy variables which are interpreted as the additional value added with respect to the constant. Within this model the constant represents a second-hand, three-bedroomed, semi-detached house (no garage) sold during Quarter 3 and 4 of 2007. The property is located within a census output area (COA) dominated by semi-detached properties.

Semi-log[2] is a common form of hedonic model and in this study we specify the dependent variable as the log of sale price. STATA 9.2 was used for the model estimation (see StataCorp, 2007).

4.5 Results of Hedonic Analysis

The models produce an adjusted r-square ranging between 0.53 and 0.70 and the full results are provided in Appendix B. The control variables generally fall within a priori expectations and will be discussed in more detail below.

4.5.1 Structural Attributes and Market Conditions

The results indicate that prices have risen between 2005 and 2007, detached properties sell for a premium and larger properties (as proxied by the number of bedrooms) achieve a higher sale price, all things equal. Newly built properties and those with garages also attract a premium.

4.5.2 Socio-economic Characteristics

As would be expected, areas dominated by wealthy households (proxied by social grouping and car ownership) attract a premium whereas areas with high unemployment do not. Where significant (Southampton, Leeds and Manchester), areas with large student populations also attract a price premium, although this will often be due to demand from investors within the buy to let market.

[2] When a semi-logarithmic functional form is applied the relative effect of the dummy variable on the dependent variable is not its coefficient β, as with continuous variables, but ($e^{\beta} - 1$) (Halvorsen and Palmquist, 1980). The modelling results were corrected for this.

4.5.3 Distance to CBD

Given conventional urban economic theory (section 3.1), it would be expected that the co-efficient measuring the distance from the CBD would be significant and negative (i.e a declining price gradient). However, the results within the case studies are mixed. Manchester, Nottingham and London indicate a significant negative relationship, whereas Leeds and Southampton indicate a significant positive relationship. In fact, a review of hedonic house price models indicates this to be a typical result, due to the complexity of urban areas. Where the gradient is positive or negative, the price gradient is very shallow.

4.5.4 Ethnic Mix

Results regarding ethnic dominance are generally inconclusive. Ethnic mix is only statistically significant within NE London which is most likely due to the scale of the metropolitan area.

4.5.5 Density, House Type and Mix

Table 3 and 4 below focuses on the relationship between house price density and mix for each of the case study areas. For all case studies, except London, the results in Table 3 suggest that new built properties attract a premium. Bungalows and detached properties sell for more than semi-detached (as indicated by positive coefficients) and terraced and flats sell for less (as indicated by negative coefficients). This accords with a priori expectations and is consistent with other hedonic house price studies.

Table 3: Regression Coefficients: House Type

	Southampton	Nottingham	Leeds	Manchester	London SW	London NE
Newbuilt	0.073***	0.176***	0.122***	0.190***	–0.036	0.022
Bungalow	0.122***	0.131***	0.072***	0.055*	–0.168***	–0.032
Detached	0.212***	0.233***	0.198***	0.127***	–0.044**	–0.013
Terached	–0.063***	–0.102***	–0.069***	–0.099***	–0.010	–0.031***
Flat_con	–0.258***	–0.167***	–0.150***	–0.110***	–0.374***	–0.293***
Flat_pp	–0.157***	–0.101***	–0.052***	–0.041***	–0.280***	–0.254***

***= coef. significant at $p < 0.01$; ** = significant at $p < 0.05$; *=significant at $p < 0.10$

Table 4 presents the coefficients that measure mix and density. High density is viewed negatively. The more densely populated the area, the lower the value, all things being equal. The variables measuring dominance produce mixed results. With the exception of Leeds and Manchester, areas dominated by detached properties attract a premium. With the exception of SW London terraced areas do not when compared to semi-detached dominant areas. Flat dominated areas (with the exception of Manchester) also attract a premium. This is perhaps counterintuitive but this variable is not simply measuring dominance but there is likely to be an interaction with distance. Detached dominant areas tend to be located within the suburbs and flat dominant areas within city centres (see Section 3.1). Both are attractive to different households depending on their lifestyle preferences.

As the ratio of domestic[3] land to non domestic[4] land increases (Domest100) we witness positive coefficients (where statistically significant) across each case study. Increasing the ratio of garden space to domestic land (Garden 100) sees a negative price premium (where statistically significant).

Table 4: Regression Coefficients: Mix and Density

Coefficients/ Areas	Detached house dominated area	Terraced house dominated area	Flat dominated area	Areas not dominated by a house type	Dwelling Density	Domestic to non-domestic space	"Garden" to "built" domestic space
Southampton	0.059***	–0.025*	0.065***	0.015	–0.003***	0.001	–0.001*
Nottingham	0.081***	–0.050*	0.172***	0.055***	–0.003***	0.001**	–0.002*
Leeds	–0.010	–0.035***	0.128***	0.021***	–0.004***	0.002***	–0.002***
Manchester	–0.022	–0.052**	0.052	–0.024	–0.001**	0.001*	0.001
London SW	0.384***	–0.036	0.134***	0.043*	0.000	0.002***	–0.007***
London NE	0.266***	–0.045**	0.074***	0.029	–0.001***	0.001***	–0.003***

***= coef. significant at $p < 0.01$; ** = significant at $p < 0.05$; *=significant at $p < 0.10$

Table 5 attaches monetary values to the mix and density variables. For example adding one more dwelling per hectare reduces house values by £745 in Leeds whereas properties in a Southampton detached dominant area attract a premium of £12496 by comparison to those in a semi-detached dominant area.

[3] Domestic Land – land used for residential and recreational purposes i.e housing and adjoining gardens and public open space

[4] Non-Domestic Land – land used for industrial and commercial purposes

Table 5: Implicit Price of Mix and Density Attributes in £

Case Study	Value for one more dwelling per hectare	Value for 1% more domestic to non-domestic space	Value for 1% more "garden" to "built" domestic space	Value for Detached house dominated area	Value for Terraced house dominated area	Value for Flat dominated area	Value for areas not dominated by a house type
Southampton	–577.3***	104.5	–259.5*	12496.6***	–4999.2*	13857.3***	3140.6
Nottingham	–442.1***	152.5**	–320.3*	12723.6***	–7350.2*	28458.8***	8571.8***
Leeds	–745.5***	311.2***	–326.94***	–1760.3	–5948.9***	23543.9***	3685.2***
Manchester	–198.6**	128.3*	127.4	–3053.4	–7064.73**	7417.7	–3380.7
London SW	–26.9	554.9***	–2366.4***	169134.3***	–12821.5	51970.6***	15909.0 *
London NE	–354.9***	376.3***	–866.9***	76974.6***	–11168.4**	19333.3***	7385.8

***= coef. significant at $p < 0.01$; ** = significant at $p < 0.05$; *=significant at $p < 0.10$

The analysis highlights the relative value of homes in the market and provides evidence of consumer evaluation of density, house type and related attributes in different contexts. The analysis feeds directly into stages 2 and 3 of the research. For the analysis of residual land values, the results provide the estimated house values for houses in different mix and density developments. For stage 3, these house price estimates will be analysed in the context of affordability.

5. Objective 2: Residual Land Values, Mix and Density

5.1 Introduction

The Emap-Glenigan database has been examined in significant detail to identify actual completed development sites within our case study areas. Sites between 100 and 200 households have been selected (to match broadly with census output areas). A detailed analysis of each site was undertaken. Knowing the details of each development we were able to use the output of the hedonic models to estimate the sale price of each housing unit. In addition, using the Land Registry data we have been able to determine the actual sale price achieved for each unit. Therefore, we have been able to compare the actual and hedonic prices to determine the predictive accuracy of the hedonic pricing models.

Using the output of Stage 1 we have been able to simulate the expected sale price of each housing unit under different scenarios of density. With the information that has been collected on each site we are able to construct hypothetical cost models of each scheme and draw conclusions about residual land values.

5.2 Viability Appraisal

The analysis compared residual values for 10 schemes in six urban locations, London South West, London North East, Manchester/Salford , Nottingham, Leeds and Southampton/Eastleigh. The analysis was based on actual schemes (sites) which were tested against 3 hypothetical standard densities 30 dph, 50 dph and 120 dph. Information on actual density for each scheme is supplied as a comparator, where known. 8 of the 10 schemes were in suburban locations, while 2 were in town centres. Actual schemes were all over 100 units and therefore could be expected to provide a proportion of affordable housing. No information on actual affordable housing provision is available.

The site mixes generating the three standard densities were

- 30 DPH: 10% 2 bed terrace; 15% 3 bed terrace; 25% 3 bed semi; 15% 3 bed detached; 25% 4 bed detached; 10% 5 bed detached
- 50 DPH: 10% 2 bed flat; 20% 2 bed terrace; 30% 3 bed terrace; 30% 3 bed semi; 10% 3 bed detached
- 120 DPH: 20% 1 bed flat; 60% 2 bed flat; 20% 3 bed flat.

Viability is measured by the 'residual value' of the site; that is, the difference between the revenue from selling the completed homes and the costs incurred in building them including overheads and normal profit margins (but not including land). Residual development values, calculated in essentially the same way, form the main basis of developers' judgements of how much to bid for land when negotiating with landowners. We show this 'bottom line' figure on a £ per hectare basis, to facilitate comparison.

Density affects residual value in various ways. On the one hand, higher density means more homes can be provided on the site so you get more revenue. But revenue per unit is likely to be lower both because the units are likely to be smaller and because as we have shown earlier, the values of homes at higher densities are generally likely to be lower than if the same unit was part of a lower density development. Smaller units also cost more per square metre to build than do larger units. Thus, it is not clear-cut, in advance of doing the calculation in particular cases, which density and mix will be most profitable.

The analysis was undertaken at 2007 build costs and house prices[5]. Two scenarios were modelled: a scheme with 100% market housing and one with 70% market housing and 30% affordable housing (the affordable housing comprising 20% social rent and 10% new build homebuy at a 50% share purchase)[6]. It was assumed that no grant was available for the affordable housing. In this instance, clearly, affordable housing will reduce the revenue to the developer. The RSLs taking the affordable housing will only pay as much as they can afford to, allowing for their future rents and sales, and this will be markedly less than market prices.

Table 6: Density and Viability

Case	Location	Urban Type	Site Area hectares	No of Units	Density dwg/ha *(Actual)*	Residual £ /ha 0% A H	Value £ /ha 30% A H
1	London SW	Centre	0.6	18	30	£3,455,000	£2,348,000
1				30	50	£4,823,000	£3,218,000
1				72	120	**£9,817,000**	**£6,255,000**
					(170)		
2	London SW	Suburban	0.63	19	30	£4,906,000	£3,487,000
2				32	50	£6,829,000	£4,783,000
2				76	120	**£12,679,000**	**£8,494,000**
					(302)		
3	London NE	Suburban	1	30	30	£2,415,000	£1,483,000
3				50	50	£2,900,000	£1,628,000
3				120	120	£2,429,000	£268,000
				180	180	**£3,643,000**	**£402,000**
					(180)		
4	Manchester/	Suburban	2.83	86	30	£3,105,000	£2,018,000
4	Salford			142	50	£3,849,000	£2,376,000
4				339	120	**£8,589,000**	**£5,179,000**
					(65)		

[5] Build costs were annual averages taken from the BCIS Housing Tender Price Index adjusted by location factor. House prices were derived from the HW hedonic price model

[6] Social rents were set at borough based target rents for 2007 (Source Dataspring). Home Buy rent on the unsold share was set at 2.75%

Case	Location	Urban Type	Site Area hectares	No of Units	Density dwg/ha *(Actual)*	Residual £ /ha 0% A H	Value £ /ha 30% A H
5	Manchester/	Suburban	3.84	114	30	£879,000	**£281,000**
5	Salford			192	50	£609,000	–£164,000
5				460	120	**£1,536,000**	–£357,000
					(42)		
7	Leeds	Suburban	0.68	20	30	**£1,251,000**	**£593,000**
7				34	50	£490,000	–£226,000
7				82	120	£321,000	–£1,262,000
					(282)		
8	Leeds	Suburban	1.66	50	30	**£803,000**	**£231,000**
8				83	50	–£137,000	–£718,000
8				200	120	–£1,083,000	–£2,363,000
					(71)		
9	Nottingham	Centre	1	30	30	£1,485,000	£795,000
9				50	50	£1,514,000	£606,000
9				120	120	**£3,724,000**	**£1,496,000**
11	Nottingham	Suburban	2.57	78	30	£3,645,000	£2,486,000
11				128	50	£4,094,000	£2,632,000
11				309	120	**£8,897,000**	**£5,553,000**
					(44)		
12	Southampton	Suburban	1.93	58	30	£2,932,000	£1,937,000
12	Eastleigh			96	50	£3,050,000	£1,838,000
12				232	120	**£4,496,000**	**£2,096,000**
					(52)		

Two further qualifications should be made in relation to the viability calculations, or rather their implications. Firstly, we only estimate the residual values for housing development on the case study sites. We do not consider whether these sites might have significant positive alternative use values, for example for industry or business use. Where this was the case, a positive value for housing would not necessarily be higher than the alternative use value, and would not necessarily lead to housing being developed. Secondly, we do not investigate the relationship between residual value and the willingness of landowners and/or developers to proceed with development. It is reasonable to presume that negative values would seriously deter activity. It may also be argued that a relatively low value would deter development, (a) because putting any reasonable risk margin around that value would indicate a potential risk of the development making a loss, while (b) the owner might consider it better to wait until such time as a higher value can be realised, whether through improved market conditions or a more flexible planning authority.

5.3 Key findings

As indicated in Table 6, scheme viability (as measured by residual value) varied widely between cities and between locations within a city. That is to be expected, given the wide regional and local variations in house prices. However, it is interesting to note that, even in 2007, at the peak of the housing market 'boom', there were some locations where some types of housing development did not appear viable.

We are particularly interested in the effects of different mixes and densities, so the table is set out to enable easy comparisons for each case. Figures in bold show the highest residual value option in each case. Negative figures are shown in red. In two cases, both in Leeds, the lowest density (30 dph) produced the highest residual value, as shown in the penultimate column for the 100% market (no affordable housing) case. The pattern is similar when affordable housing is included, except that in one more case (case 5, Manchester) the low density option is most viable. In six out of the ten locations, the highest density tested (120 dph) produced the highest residual value. This is a wholly flatted scheme. In only one case, London North East, did the intermediate density mix (50 dph) produce the highest residual value[7].

It is of some interest to compare the actual densities of the real life schemes, although there are some difficulties of measurement in a couple of cases, and it may be that the measurements are not fully consistent in terms of where the boundaries lie relative to access roads and so forth. However it appears that in 3 or 4 instances (mainly in London) actual densities were much higher than 120 dph.

All 3 schemes where 30 dph produced the highest RV were in 'suburban' locations but so were 4 of the 6 schemes where 120 dph produced the highest modelled RV. Actual schemes built where the model suggested 30dph produced the highest RV were in some cases developed at considerably higher densities. (e.g. 71 and 282 dph).

[7] In this case the team thought that a higher density would have been sought and allowed, and this would have been more viable if wholly market housing but not if requiring 30% affordable.

2 of the 3 instances where 30 dph produced the highest RV were in Leeds, the third was in Manchester (and that was only when affordable housing was included, which made the other options non-viable).

Leeds was the only location where 100% market housing produced a negative RV: In one location in Leeds the 120 dph scheme produced a negative RV with 100% market housing. On that same scheme the 50 dph scenario also produced a negative RV. Leeds was the only location where 30 dph produced the best value for both cases modelled.

The main conclusion from this comparison is that, in the conditions of 2007, high density housing was very often the most viable/profitable option. In those cases where it was not, low density was preferred from an economic point of view. In only one instance was the medium density mix most viable, and then only clearly so with affordable housing included. These general findings are consistent with the observed tendency to concentrate on building high density flatted schemes during this recent period. The findings are partially consistent with earlier work by Bramley and Brown (2008), looking at earlier figures using a different (cruder) modelling approach, particularly in suggesting that viability tends to favour either high or low density, but rarely the intermediate mixes.

5.4 Affordable housing provision

Affordable housing provision reduced residual value (RV) in all cases, as expected. RVs moved from positive to negative at 50 and 120 dph for one scheme in Manchester and one in Leeds (the other location in Leeds was already producing negative RVs at 120 dph and 50 dph with 100% market housing). No 30 dph schemes produced a negative RV with 100% affordable housing.

There was one instance (in Manchester) where the highest RV with affordable housing (30 dph) was different from the highest RV with market housing (120 dph). This situation can arise where a high density scheme is producing a marginal increase in RV for each additional unit with 100% market housing. The introduction of affordable housing reduces revenue per unit and scheme economics change from positive to negative with increased density. In this example the actual density of the completed scheme was 42 dph. In all other cases the density with the highest RV was unchanged.

5.5 Relationship with recorded land value

It is possible to compare the highest modelled RV with 100% market housing and with 30% affordable housing with actual RVs for the area as recorded by the Valuation Office[8].

[8] Property Market Report July 2007

Table 7: Residual Land Values, Density and Affordable Housing

Location	Density with highest modelled RV	Highest Modelled RV per hectare no AH £m	Highest Modelled RV per hectare 30% AH £m	Recorded RV per hectare £m PMR	PMR location
Hounslow	120	£9.8m	£6.2m	£7.5-9m	Outer London
Hounslow	120	£12.7m	£8.5m	£7.5-9m	Outer London
Waltham Forest	50	£2.9m	£1.6m	£7.5-9m	Outer London
Manchester	120	£8.5m	£5.2m	£5.75m	Manchester
Manchester (1)	120/30	£1.5m	£0.3m	£5.75m	Manchester
Leeds	30	£1.2m	£0.6m	£3.5 -4m	Leeds
Leeds	30	£0.8m	£0.2m	£3.5 -4m	Leeds
Nottingham	120	£3.7m	£1.5m	£2.5-3m	Nottingham
Nottingham (2)	120	£8.9m	£5.5m	£2.5-3m	Nottingham
Eastleigh	120	£4.5m	£2m	£4-4.2m	Southampton

Notes:

1. In this example the introduction of affordable housing changed the mix with the highest RV. It was 120 dph for 100% market housing and 30 dph with 30% affordable housing.

2. It is not known whether planning policy would have permitted a 120 dph scheme in this location. Actual density was 44 dph and 2nd highest modelled RV was 50 dph producing an RV of £4.0m for 100% market housing and £2.6m for 30% affordable housing.

Too much should not be read into these comparators. As our examples demonstrate there is wide variation between RVs for individual schemes in the same city-region. The Valuation Office values are themselves averages for a set date across a range of sites and the location (e.g. Outer London) may be so wide as to be of limited value for comparison with individual schemes. We know that individual schemes were completed over several years (typically 18-24 months), which would suggest that land purchase for a scheme completing in 2007 would have taken place no later than 2005. Nationally residential land values as recorded by Property Market Report rose by 11% between July 2005 and 2007.

Modelled RVs are of the same order of magnitude as recorded RVs in Hounslow, Nottingham and Eastleigh and for one of the Manchester examples. In Leeds, Waltham Forest and the second Manchester example, recorded RVs are considerably higher than our modelled ones This may simply reflect the particular choice of sites we used as case studies.

6. Objective 3: Affordability Impacts, Mix and Density

6.1 Introduction

The determination of what type of housing is built, in terms of the mixture of types, sizes, tenures and densities of housing within new housing schemes, results from an interaction between local planning authorities and developers. Planning sets general policy parameters within Local Development Documents, reflecting national policy such as PPS3, and may set more particular requirements for certain sites or locations through action area plans or development briefs. Developers may be expected to try to design developments which are most viable/profitable, but within the parameters of what they expect to be acceptable to the planning authorities. Developers have no particular brief to produce affordable housing, unless they are an RSL, but local authorities will be concerned about this as part of their strategic housing role, reinforced by recent planning guidance which requires them to consider affordability.

Different types of new housing scheme, in terms of their mix and density characteristics, may impact on affordability within a local housing market in at least two ways.

1. The particular products included and the overall scheme characteristics will affect the market price levels at which the homes are sold, which in turn affects whether they materially add to the supply and choice of relatively affordable housing within the local market.

2. Typically schemes are expected to include some proportion of 'affordable' housing (i.e. subsidized, sub-market social or intermediate rent or LCHO), generally secured through a s.106 agreement.

While a higher proportion of affordable requirement through s.106 does on the face of it increase affordable supply and choice, if this threatens scheme viability it may not be achieved and thus be counterproductive. Furthermore, unrealistic (non-viable) s.106 requirements may reduce the overall supply from this and similar sites, so worsening market affordability outcomes in the longer term. Alternatively, they might lead to developers changing the mix on the market part of the development to reduce the effective contribution of Type 1 above.

This section of the report provides evidence primarily relevant to 1) above, i.e. the affordability or otherwise of market products from different mix/density options. It uses the same case studies as other parts of the research, but draws on information from another parallel NHPAU RIF project on local income patterns and threshold house prices. The affordability impacts via 2) above have to be assessed in the context of the wider viability assessment.

6.2 Affordability Measures

Two complementary affordability measures are used for this part of the work.

a) The *relative price* of the new housing product, compared with a representative *threshold* (entry-level) price for the local market area.

b) The *proportion* of local households in relevant groups who have *enough income* to be able to afford to buy this product under normal mortgage availability conditions.

Threshold entry-level prices are intended to provide a robust measure of the kind of price at which a household (requiring a given size of dwelling) would have to pay to enter the market, based on the distributional pattern of prices in the overall market (existing secondhand and new build sales). Based on the parallel NHPAU RIF research project by Wilcox and Bramley, it may be argued that lower decile prices would be a better representative of this threshold than the conventionally recommended lower quartile prices. For the purposes of this project we work with a compromise measure based on the mid-point between lower decile and lower quartile.

These price estimates are based on RMS data for mortgaged sales by bedroom size for our target year of 2007, at Local Authority (District) level.

The analysis focuses in particular on two size categories, 2-bedroom and 3-bedroom. As Wilcox & Bramley show, apart from in London most first time purchaser activity is in these size categories. Experience with 'affordable' LCHO products shows that most potential buyers want to have at least 2 bedrooms if they are going to make the major commitment of house purchase. At the same time, the recent apparent glut of supply of new 2-bedroom flats is arguably not contributing to the requirements of families and other larger households. Therefore it is important to repeat the analysis for the 3-bedroom category. In terms of the case study model schemes, this refers to 3-bedroom houses (terraced, semi or detached), not flats[9].

For type a) measures, we look at each scheme mix/density option in turn and identify the 'most affordable' (i.e. cheapest) type of unit in the relevant size category, and mark that as the relevant price for that new scheme. We then calculate the ratio of this price to the local threshold price for that size (2B or 3B). This measure is very simple to interpret. If the ratio is (much) greater than 1.00, this scheme in this locality does not offer new housing choices which are more affordable than the existing market. If the ratio is less than 1.00, then it does offer such relatively affordable choices within the market.

For type b) measures, we take the 'most affordable' prices from each scheme/density option/size category and convert these into a weekly outgoings figure for a 95% repayment mortgage. We divide this figure by 0.25 (i.e. multiply by 4) to get a threshold weekly income to be able to afford to buy this property, based on the SHMA Guidance recommended affordability ratio (25% of gross income). This threshold is then compared with estimated local income distributions derived from the research of Wilcox & Bramley for NHPAU in the parallel RIF project.

The local income distributions from the parallel research are derived by a multi-stage process, essentially using the Family Resources Survey (FRS) to calibrate relationships between income measures (e.g. proportion below £400 pw) and a range of proxy or predictor variables, including household composition, economic activity, occupational groups, tenure, local earnings, and other factors. Local data sources for equivalent measures (e.g. Annual Population Survey, ASHE) are used to drive income predictions for local authority districts in England. These include estimates of median income and proportions below £100pw bands up to £800pw. Similar estimates are made for the full household income of all households of all ages, and of 'first benefit unit' income

[9] The RMS price data used to generate the thresholds based on quantiles refers to all 3-bedroom homes, not distinguishing flats and houses; the vast majority of 3-bedroom salese will normally be houses.

excluding income-related benefits for three other groups: all under-40 households; under-40 working households; under-40 families. Linear interpolation between the bands is used to find the proportion below any particular threshold.

For both types of measure we are interested primarily in comparing different density/mix options for each site/location. These are the same sites/locations as used in the viability work, based on the detailed house price modelling described in section 2 and the selection of typical recent developments described in section 3.

It should be noted that both threshold entry prices and income distributions are calculated at local authority district level. Hence, the resulting indicators of affordability of new schemes can also be calculated at this level. However, most of our case study areas actually comprise multi-authority zones (conceived as representative of city regions). Therefore we present the results averaging the scores across the constituent authorities (weighted by number of households).

The analysis is presented for 2007, the last year for which we have income data and robust price data. It should of course be remembered that 2007 was the year at the peak of the long housing market upswing, so measures of affordability tend to look worse for that year than for other years.

6.3 Relative Prices

We first present results in terms of relative prices (new schemes relative to threshold entry). Table 8 presents the ratios for 2-bed homes, while 8 looks at 3-Bed houses. Essentially these ratios address the question of whether these schemes would be ‘cheap’ relative to the entry level of the existing market.

It might be thought that new homes would always be more expensive than secondhand, but this is not the case as a generalisation which applies across the country. New homes command some premium in some areas but little or no premium in other areas.

Table 8: Relative Price of Cheapest Type within New Scheme over Local Threshold Entry Price by Case Study, Two-Bedroom Homes, 2007

2 Bed Home	1st Site			2nd Site		
	Low Dens	Med Dens	High Dens	Low Dens	Med Dens	High Dens
Mean Mixarea	2 Bed	2 Bed	2 Bed	2 Bed	2 Bed	2 Bed
Leeds (7&8)	1.22	0.97	0.91	1.00	0.80	0.76
Nottingham (10&11)	1.33	1.21	1.27	2.13	1.98	2.02
Manchester (4&5)	2.12	1.93	1.93	1.14	1.04	1.13
Southampton (12)	1.37	1.11	1.04			
London NE (3)	0.96	0.61	0.67			
London SW (1&2)	0.89	0.62	0.87	1.08	0.75	0.99
Ave Case Studies	1.32	1.08	1.11	1.24	1.05	1.13

Note: lighter shaded cases are more affordable in relative but not absolute terms; darker shaded cases are more affordable options in both absolute and relative terms.

Table 8 suggests that in Nottingham, Manchester and Southampton, none of the schemes or options would be cheaper than the existing market threshold for two bed homes. However, in the two London areas and also in Leeds, it appears that a number of the options on the schemes illustrated could come in cheaper than the threshold (LQ-LD price). This illustrates the point just made about local variation in the existence or extent of any 'new build premium'. It would be consistent with previous experience and logic that the new-secondhand gap in prices would be more noticeable in urban areas of the north which have experienced relatively lower demand in the recent past; and less apparent in generally pressurised markets, particularly London, where house types like older terraces are sought after eagerly by many buyers.

Table 8 says that low density schemes (30 DPH) do not offer relatively cheap 2-bed housing options in any of these cases (10 schemes in 6 areas). It might be thought that high density (120 DPH)would obviously relatively cheaper ('pile them high, sell them cheap') but this was not apparently the case in 2007. Only in a minority of cases (3 out of 10) was high density clearly cheaper than medium density, and even then the difference was not great. In the majority of cases (6 out of 10), medium density (60 DPH) offered cheaper 2- bed options than higher density.

Table 9 also acts as a reminder that differences between local neighbourhoods within the same market area may be greater than differences between density/mix options or indeed between market areas. This is particularly apparent in Nottingham and Manchester.

Table 9 provides the same kind of analysis for 3-bed houses. However, in this case only two density bands are compared, because the high density option does not provide any 3-bed houses suitable for families, only flats.

Table 9: Relative Price of Cheapest Type within New Scheme over Local Threshold Entry Price by Case Study, Two-Bedroom Homes, 2007

3 Bed Family Home	1st Site		2nd Site	
	Low Dens	Med Dens	Low Dens	Med Dens
Mean mixarea	3 Bed	3 Bed	3 Bed	3 Bed
Leeds (7&8)	1.11	0.89	0.94	0.75
Nottingham (10&11)	1.31	1.19	2.10	1.95
Manchester (4&5)	2.14	1.96	1.21	1.11
Southampton (12)	1.16	1.03		
London NE (3)	0.84	0.79		
London SW (1&2)	0.76	0.78	0.92	0.93
Ave Case Studies	1.23	1.11	1.20	1.09

Note: shading indicates relative or absolute affordability.

In general the three-bed evidence reinforces the story about medium density being more affordable. In five out of six areas the more affordable option is generally within medium density (typically the 3-bed terrace). Curiously, in London SW, 3-bed detached within the low density scheme is marginally cheaper. It is not quite clear why this should be so but the negative effect of density in the hedonic model for London SW is very weak, while perhaps detached houses represented in the London SW sample are modern examples on small plots (whereas typical semis in this area would be high quality on large plots).

Again, as with 2-bed, the two London areas and Leeds offer examples of new build schemes being cheaper than the threshold level in the existing market, whereas the other areas do not.

6.4 How many could afford them?

Table 9 presents results for the second measure of affordability, the percentage of households aged under 40 who could afford to buy a two –bedroom home. While again comparing schemes and density levels, we also add in the first column the proportion able to afford to buy at the local market threshold (mid point of lower quartile and decile). Again, shading indicates relative and absolute affordability of options.

Table 10: Proportions of Under-40 Households able to afford 2 Bed homes on Case Study Schemes and in Wider Market, 2007

Any <40 HHld	Local	1st Site			2nd Site		
afford 2 B home	thresh	Low Dens	Med Dens	High Dens	Low Dens	Med Dens	High Dens
Mean Mixarea	%	%	%	%	%	%	%
Leeds (7&8)	38.5	28.3	39.9	43.6	38.7	50.3	53.5
Nottingham (10&11)	40.0	31.6	35.4	33.7	16.9	19.4	18.7
Manchester (4&5)	37.1	11.5	15.1	15.0	32.6	35.3	32.9
Southampton (12)	29.4	20.7	26.9	28.5			
London NE (3)	23.9	25.9	39.5	36.1			
London SW (1&2)	30.5	34.8	44.3	35.8	28.4	39.9	31.4
Ave Case Studies	33.2	25.1	33.5	32.3	30.9	38.4	36.5

Note: shading indicates relative or absolute affordability.

The first column provides an overall market context picture of general affordability conditions in each locality. These differences are less dramatic than might be expected; however, those shown below in Table 10 for families are sharper. Nottingham is the most affordable area, at 40%, followed by Leeds then Manchester, although these are all fairly similar. Southampton is similar to London SW with around 30% affording to access the market (on income). London NE has the lowest affordability at 24% on average.

Although the metric is different, and provides additional information, the pattern in terms of density is similar. In no case is low density more affordable. In the majority of cases the medium density option offers a more affordable product than the high density option, even for 2-bed accommodation. However, the high density option is more affordable in the two Leeds cases and in the Southampton case.

Table 11 provides a similar analysis for 3-bed houses and families. In general, the ability of under-40 families to afford 3-bed houses is quite a lot lower than the 2-bed proportions just considered, and this is particularly so in London. As before, the new build schemes in the locations considered would offer enhanced absolute affordability in three areas, Leeds and the two London sectors.

Table 11: Proportions of Under-40 Families able to afford 3 Bed houses on Case Study Schemes and in Wider Market, 2007

<40 Family	Local	1st Site		2nd Site	
afford 3 B house	thresh	Low Dens	Med Dens	Low Dens	Med Dens
Mean Mixarea	%	%	%	%	%
Leeds (7&8)	23.3	19.2	30.2	27.1	38.7
Nottingham (10&11)	30.2	22.3	25.6	11.1	13.3
Manchester (4&5)	24.8	6.5	9.0	20.5	22.6
Southampton (12)	20.5	16.6	19.9		
London NE (3)	9.4	13.4	15.4		
London SW (1&2)	10.5	13.8	13.6	11.8	11.6
Ave Case Studies	19.3	14.7	18.7	18.9	23.3

Note: shading indicates relative or absolute affordability.

As before, we find that for most schemes (8 out of 10) it is the medium density option which provides more affordable product. The exception is London SW where the low density scheme is marginally more affordable.

Perhaps the more striking conclusion from Table 11 is that in most cases (except perhaps Leeds), new build schemes are not affordable by many under-40 families, assuming these are first time buyers relying primarily upon income as rather than wealth or equity to buy.

6.5 Benchmarking

It is perhaps useful to place these case studies in their wider context. This may be desirable to forestall any potential criticism that these areas are not typical. At the same time we can shed some light on how these affordability measures compare with some other measures used in this field.

Table 12 compares the proportions of all under-40 households able to afford to buy (2- bed, threshold price) with the proportion of working under-40s and the proportion of families (3-bed), using the methodology of the two NHPAU studies, with earlier estimates by Bramley using a different model methodology, and with the widely-used 'affordability ratio' based on lower quartile prices and earnings.

In terms of levels, the first measure is very similar to the most relevant one derived from Bramley's earlier work (pctbinc – % of under-35 households able to buy based on income), 37.7% vs 38.3%. Both models suggest higher absolute affordability rates for working households, although the level is higher in the second case. The new model underlines the much poorer affordability for families, notably in London. The ranking of CS areas is rather different here, with Manchester more affordable than Leeds while Southampton is more affordable than London SW, for families. There is also some difference in ranking with the earlier Bramley method, which takes account of different size requirements. The lower quartile ratio has a similar ranking in general, but with the notable exception of the London areas, where the order is reversed (all the other measures suggest London NE is worse than London SW, but this ratio suggests it is better).

This discussion underlines a point which is of wider relevance for NHPAU, which is that different measures of affordability, although they are correlated, do have some differences in relative incidence and ranking when looked at across localities.

Table 12: Affordability Measures Comparison with Bramley model and lower quartile price: earnings ratio, by case study area and region, 2007

Area	<40 afford 2B	<40 wkg afford 2B	<40 fam afford 3B	Bramley <35 afford inc %	Bramley Wlth-adj aff %	Bramley all wkg aff %	Lwr Qtl Price: Earnings
Mean	%	%	%				
	pctbnm	pctbnmw	pctbnmf	pctbinc	pbwadj	PCTBW	lqhper06
CS Area							
Leeds	38.5	42.6	23.3	41.4	45.5	53.2	7.1
Nottingham	40.0	46.7	30.2	44.2	48.4	59.8	6.1
Manchester	37.1	41.0	24.8	34.6	38.9	49.8	6.4
Southampton	29.4	32.1	20.5	35.5	41.9	45.6	8.7
London NE	23.9	28.0	9.4	19.5	24.7	28.0	9.6
London SW	30.5	35.1	10.5	25.7	33.0	34.2	10.4
England	37.7	42.2	23.5	38.3	44.0	49.8	8.2
Region							
Nth East	47.9	56.4	31.7	45.4	48.2	60.1	6.1
Yorks & Humb	44.7	50.8	30.0	45.0	48.7	57.9	6.7
Nth West	44.3	50.7	29.6	44.2	48.6	58.2	6.6
E Mids	42.9	48.4	30.4	47.2	51.7	59.8	7.0
W Mids	40.9	46.3	27.0	42.0	46.9	54.9	7.5
Sth West	30.4	32.1	19.6	35.5	42.3	45.9	9.2
East Eng	36.6	38.7	24.7	38.7	45.5	49.3	8.6
Sth East	34.9	38.0	21.8	36.5	44.5	46.4	9.4
Gtr London	27.0	31.2	8.4	22.6	28.6	31.3	10.0
England	37.7	42.2	23.5	38.3	44.0	49.8	8.2

6.6 Affordability of LCHO

Within the viability modelling we have considered the option of including 30% affordable housing within each scheme, of which one third (10% of all units) would be intermediate LCHO in the form of New Build Homebuy. It is assumed that this would be available on the basis of people buying a 50% share and paying a rental charge of 2.75% of the remaining equity on the balance. Tables 11 and 12 show the 'incremental affordability' associated with this LCHO provision compared with the market. The upper part of the table shows the extra percent of households able to afford the New Build Homebuy but not market provision of the particular new build product. The lower part of the table shows the extra percent able to afford the Homebuy product compared with the local threshold entry level to the market. Table 11 refers to all under 40 households and 2-bed homes, while Table 14 refers to families buying 3-bed.

Table 13 suggests that LCHO widens accessibility to home ownership quite a bit, but more so in northern areas especially Leeds, and less so in London. The lower part of the table suggests that there is wide variation between schemes/locations in the value of LCHO in terms of improving access/affordability relative to the market threshold. For the second Nottingham scheme and the first Manchester scheme, LCHO is still less affordable than the local market threshold, suggesting this would not be a good use of s.106 in these instances. By contrast, in London NE and Leeds, schemes could offer 20-30% more households access compared with the local market.

In general, this analysis tends to support the contention in that in most areas low density is less affordable, while in quite a few cases medium density is more affordable than high density (while also being necessary to provide family housing).

Table 13: Incremental Affordability associated with LCHO Provision on Case Study Sites – 2 Bedroom

	1st Site			2nd Site		
Increment from Base	Low Dens	Med Dens	High Dens	Low Dens	Med Dens	High Dens
	%	%	%	%	%	%
Leeds	19.9	20.0	19.3	19.9	18.0	17.1
Nottingham	15.8	16.6	16.0	10.9	11.3	11.1
Manchester	12.7	11.9	11.9	15.5	16.1	15.5
Southampton	10.1	17.3	19.7			
London NE	11.0	17.4	16.4			
London SW	9.9	13.0	9.6	11.9	8.7	10.9
Total	13.4	16.0	15.4	15.2	14.1	14.2
Increment over market threshold						
Leeds	9.7	21.4	24.4	20.1	29.8	32.0
Nottingham	7.4	12.0	9.7	0.0	0.0	0.0
Manchester	0.0	0.0	0.0	10.9	14.3	11.3
Southampton	1.4	14.8	18.8			
London NE	13.0	33.0	28.7			
London SW	14.1	26.8	14.8	9.7	18.1	11.8
Total	5.3	16.4	14.5	12.9	19.3	17.5

Table 14: Incremental Affordability associated with LCHO Provision on Case Study Sites – 3 Bedroom

	1st Site		2nd Site	
Increment from Base	Low Dens %	Med Dens %	Low Dens %	Med Dens %
Leeds	18.8	19.3	19.2	19.5
Nottingham	15.1	15.8	9.3	8.7
Manchester	9.7	8.9	12.3	14.7
Southampton	9.3	9.2	0.0	0.0
London NE	12.0	11.3	0.0	0.0
London SW	15.2	14.6	9.6	9.0
Total	13.5	13.3	13.2	13.8
Increment over market threshold				
Leeds	14.7	26.3	23.0	34.9
Nottingham	7.2	11.2	0.0	0.0
Manchester	0.0	0.0	7.9	12.4
Southampton	5.4	8.6		
London NE	15.9	17.3		
London SW	18.5	17.7	10.8	10.0
Total	9.0	12.7	12.8	17.8

6.7 Changes over Time

We are in a position to repeat this analysis for 2005, but we do not believe this would add much to the evidence presented, because the basic price structure would be the same (implicit in our approach to hedonic modelling). Income estimates for 2005 are slightly different, but again this would be unlikely to be sufficiently different to make much difference to the overall results.

Estimates for 2008 might be made on the basis of assumptions about changes in prices for given types of accommodation, based on simple descriptive data on changes in medians by type. There is some evidence for the alleged greater fall in the price of flats. This might have the effect of tilting the advantage for 2-bed homes slightly in favour of higher density flatted schemes. For example, it appears that across the 6 case study areas flat prices have fallen by 4% points more than terraced house prices between 2007 and 2008. This difference is 11% in the case of Nottingham,

7% in Leeds and 6% in Manchester, but only 3% in London SW, 0% in Southampton, with a relative increase in flat prices in London NE. This is consistent with a story of particular falls in northern central cities.

The magnitude of the differences in some cases between medium and high density options, in terms of price ratios, is quite small. In some instances it could be overturned by a relative price change of 4% or more. Therefore, the conclusion that medium density is the most affordable in the majority of cases might be slightly modified.

7. Conclusions and Implications

This report set out to achieve three objectives:

1. Develop general models for house prices suitable for analysing values associated with different mix and density across England.

2. Utilise those results to provide a modelling capability to estimate development costs and residual land values across England, for defined new product densities and mixes.

3. Analyse the house prices and development densities to evaluate the relative affordability of different mixes and densities.

The model of house prices revealed some interesting results, consistent with some of the existing literature although contrary to those of some similar recent US studies. Generally speaking, high density neighbourhoods do not attract a premium, suggesting that consumers prefer lower density neighbourhoods. Consumers prefer houses over flats and detached properties over semi-detached and terraced (i.e lower density suburban areas). Interestingly, both low density, detached-dominant areas and high density, flat-dominant areas attracted a premium over medium density semi-detached and terraced areas.

As is expected on the basis of urban economic and hedonic pricing theory, the relative size of the these price premia or penalties for different type mix and density characteristics vary between different housing market areas. For example, the penalty from higher density was less marked in London and Manchester than in the other provincial cities examined. These patterns reflect relative supply and demand conditions in the period of the study. Sustained changes in housing supply mix in an area might change these relativities in the medium term. There is some evidence from the end of our study period that the sustained increase in the supply of higher density flatted developments was pushing their relative prices down somewhat by 2008.

Viability varied widely across the case study cities and between locations within each city. High and low density developments tended to produce the highest residual value. Only in one case did a medium density development indicate the greatest potential viability.

There are marked differences in the affordability of market housing products produced on new build sites in different market areas and, within those, between different neighbourhood locations. In some instances (more true away from London), new build schemes are generally less affordable than the existing markets. In other instances (including London), new build can offer products which are more affordable than what is generally available in the local market.

In general, low density schemes rarely offer products for sale at market levels which are relatively affordable. By contrast, medium density schemes are the ones which most often do this, certainly for families and very often also for the general buyer seeking 2-bed accommodation. In only a minority of cases, in 2007, were high density flatted schemes more affordable for 2-bed homes. With recent price changes this might become more common again, but the differences will not be large. This finding poses something of a dilemma for planners considering the guidance in PPS3, which encourages the provision of a range of house types and the facilitation of affordability in the market sector as well as through direct provision of affordable housing. Planning authorities might wish to encourage the provision of medium density mixed schemes, but these will often be less

viable/profitable than either high or low density options. This may lead to difficult negotiations with developers, and with lower prices following the Credit Crunch more of the resulting schemes might drop below the viability threshold.

Tradeoffs with s.106 policies may vary in different circumstances, although it is clearly necessary to consider viability and needs at the same time. It might be argued that, where particular schemes offer significant enhancements to market affordability, as in the medium or higher density Leeds and London cases, there would be less case for imposing high s.106 requirements. Conversely, where the new housing products remain less affordable than the general market threshold, the case for s.106 may be stronger, although needs and/or viability arguments might modify this. In cases like 11 (Nottingham) and 4 (Manchester) it would appear to be inappropriate to use s.106 for LCHO since this would not be more affordable than the market threshold.

In this study we have not attempted to model other aspects of the outcomes produced by different housing mixes and densities, for example those relating to social sustainability of neighbourhoods, environmental quality and quality of life, or transport accessibility and car dependence. Other evidence may be drawn on to inform planning policies for housing mix on these matters (see for example Bramley & Power 2009, Bramley et al 2009). These wider considerations are likely to influence planning policies and decisions on mix and density matters, alongside the issues of viability and affordability which were the focus of this study.

The main policy recommendation for local authorities from this study is that they should monitor viability of housing development on a regular basis and consider the viability implications of the requirements they seek to impose on developers of larger housing sites, both in relation to mix and density and in relation to affordable housing. A further recommendation for local authorities is that they should monitor the relative prices of different sizes/types of housing provided on new build schemes compared with the local thresholds for affordability developed in their Strategic Housing Market Assessments (SHMAs). In the light of this, they should have regard to the relative affordability of the market offer on new housing schemes, as well as the effective affordability of the 'affordable housing' (particularly LCHO) likely to be provided on such schemes, in shaping their affordable housing requirements for different sites.

In general, this study provides a caution against 'one size fits all' planning policies. While it would be unfair to characterize the policies of the early 2000s as being only about building high density flats on brownfield urban sites, there was a perception that that was the main preference and this contributed to the marked shift in provision in this period. The evidence from this study suggests that such an exclusive emphasis would not serve well in meeting the preferences of a wide range of consumers, and neither would it necessarily promote affordability. The study suggests that policy guidance should recognise local variation, while encouraging the monitorng of viability and affordability.

For an affordability toolkit, this study provides a pilot of a methodology to examine viability and affordability implications of housing mix and density. Resources for this study did not permit the development of this approach into a tool that could be easily used in any area to produce ready reckoners for local decision-making. However, that could be a logical next step; most of the ingredients are in place, from this study and some other research which the Unit has in hand, and it could be feasible to move on to provide a set of ready reckoners to make similar estimates for any area in the country rather than just for a limited set of case studies.

8. References

Alonso, W (1964) Location and land use: toward a general theory of land rent, Harvard University Press, Boston.

Barker, K. (2003) Review of Housing Supply: Interim Report—Analysis (London: HMSO).

Barker, K. (2004) Review of Housing Supply: Final Report—Recommendations (London: HMSO).

Bramley, G. & Power, S. (2009) 'Urban form and social sustainability: the role of density and housing type', *Environment & Planning B*.

Bramley, G. & Watkins, D. (2009) 'Affordability and supply: the rural dimension', *Planning Practice and Research*.

Bramley, G., Brown, C., Dempsey, N. & Power, S. (2009 forthcoming) 'Social Sustainability and and Urban Form: evidence from English cities', *Environment & Planning A*.

Bramley, G., Leishman, C., Karley, N.K., Morgan, J. & Watkins, D. (2007) *Transforming Places: Housing Investment and Neighbourhood Market Change*. York: Joseph Rowntree Foundation.

Bramley, G. & Watkins, C. (1996) *Steering the Housing Market: New Building and the Changing Planning System*. Bristol: Policy Press.

Brookshire, D.S., Thayer, M.A., Schulze, W.D., and D'Arge, R.C. (1982) Valuing public goods – A comparison of survey and hedonic approaches, *American Economic Review*, Vol.72, No.1, 165-177.

Breusch, T., Pagan, A. (1979); A simple test for heteroscedasticity and random coefficient variation; *Econometrica*, 47: 1287 – 1294.

Chatterjee, S., Hadi, A.S., Price, B. (2000); *Regression Analysis by Example*; New York, John Wiley & Sons.

Communities and Local Government (CLG) (2006) *Planning Policy Statement 3: Housing*. London: CLG.

CLG (2006) *Better places to live by design* London: CLG.

Damm, D., Lerman, S.R., Lerner-Lam, E. and Young, J. (1980) The response of urban real estate values in anticipation of the Washington Metro, *Journal of Transport Economics and Policy*, September 1980.

DETR (1998) *Planning for the Communities of the Future*. Planning Policy Document.

DETR (1999a) *Towards an Urban Renaissance – Final Report of the Urban Task Force*, London, E and FN Spon.

DETR (1999b) *A Better Quality of Life*, London, DETR.

DETR (2000) *Planning Policy Guidance Note 3: Housing* (PPG3) London: DETR.

DoE (1992) Planning Policy Guidance Note 3: Housing (PPG3) London: DOE.

DOE and DTp (1994) *Planning Policy Guidance Note 13: Transport* (PPG13).

DOE (1995) Our Future Homes: Opportunity, Choice, Responsibility Housing white paper.

Gibbons, S. and Machin, S. (2004) Valuing rail access using transport innovations, Centre for Economic Performance, London School of Economics and Political Science.

Graves, P., Murdoch, J.C., Thayer, M.A., and Waldman, D. (1988) The robustness of hedonic price estimation: urban air quality, *Land Economics*, Vol.64, No.3, 220-233.

Gujarati, D. N. (2003); Basic Econometrics; Fourth Edition, McGraw-Hill Eds, New York, USA.

Halvorsen, R. and Paimquist, R. (1980) The interpretation of dummy variables in semilogarithmic equations. *American Economic Review* **70**, pp. 474-475.

H M Government (1990) *This Common Inheritance*, White Paper.

H M Government (2005) *Securing the Future*, Cm 6467. London: TSO.

Joseph Rowntree Foundation (JRF) (1994) *Inquiry into Planning for Housing* JRF, York.

Lancaster, K. (1966) A new approach to consumer theory, *Journal of Political Economy*, 74, 132-157.

Matthews, J and Turnbull, G (2007) Neighbourhood street layout and property value: The interaction of accessibility and land use mix, Journal of Real Estate Finance and Economics, 35, 111-141.

Mieszkowski, P. and Saper, A.M. (1978) An Estimate of the Effects of Airport Noise on Property Values, *Journal of Urban Economics*, Vol.5, No.4, 425-440.

Mills, E (1972) Studies in the structure of the Urban Economy, The John Hopkins Press, Baltimore.

Muth, R (1969) Cities and Housing, University of Chicago Press, Chicago.

Nelson, J.P (2004) Meta analysis of airport noise and hedonic property values: problems and prospects, *Journal of Transport Economics and Policy*, Vol. 38, No. 1, 1-27.

Office of the Deputy Prime Minister (ODPM) (2003) *Sustainable communities: building for the future*. HMSO, London.

Ridker, R. and Henning, J. (1968) The determinants of residential property values with special reference to air pollution, *Review of Economics and Statistics*, Vol.46, 246-257.

Shepherd, J. & Bibby, P. (1994) The Analysis of Land Use Change Survey Data. Report to Department of the Environment. South East Regional Research Laboratory. London: Birkbeck College.

Social Exclusion Unit (1998) *Bringing Britain together: development of a national strategy for neighbourhood renewal*. London: SEU.

Song, Y. (2005). Smart growth and urban development pattern: A comparative study. International Regional Science Review, 28, 239–265.

Song, Y., & Knapp, G.-J. (2003).New urbanism and housing values: a dissagregate assessment, Journal of Urban Economics, 54, pp 218-238.

Song, Y., & Knapp, G.-J. (2004). Measuring the effects of mixed land uses on housing values. Regional Science and Urban Economics, 34, 663–680.

StataCorp. (2005); *Stata Base Reference Manual R-Z for Stata Statistical Software: Release* 9. College Station, TX: StataCorp LP. Data Control, Texas, US.

StataCorp. (2007); *Stata Statistical Software: Release 9.2* College Station, TX: StataCorp LP. Data Control, Texas, US.

Tu, C. C., & Eppli, M. J. (1999). Valuing new urbanism: The case of the Kentlands. Real Estate Economics, 27, 425–451.

Uyeno, D., Hamilton, S.W. and Biggs, A.J.G. (1993) The density of residential land use and the impact of airport noise, *Journal of Transport Economics and Policy*, Jan. 1993, Vol.XXVII, No.1.

White, H. (1980); A heteroscedasticity consistent covariance matrix estimator and a direct test of heteroscedasticity; *Econometrica*, 48: 817 – 818.

9. Appendix A

Table A.1: Variable Description

Variable	Label
LOGPRICE	The natural logarithm of the house selling price
NEWBUILT	1 for new-built house, 0 otherwise
BUNGALOW	1 for bungalows, 0 otherwise
DETACHED	1 for detached houses, 0 otherwise
TERACHED	1 for Terraced houses, 0 otherwise
FLAT_CON	1 for converted flats, 0 otherwise
FLAT_PP	1 for purpose built flats, 0 otherwise
BEDROOM1	1 for houses with 1 bedrooms, 0 otherwise
BEDS2	1 for houses with 2 bedrooms, 0 otherwise
BEDS4	1 for houses with 4 bedrooms, 0 otherwise
BEDS5	1 for houses with 5 bedrooms, 0 otherwise
BEDSOVER	1 for houses with 6 or more bedrooms, 0 otherwise
BEDS_NO	1 for missing bedroom number, 0 otherwise
GARAGE	1 for a house with garage(s), 0 otherwise
VILLAGE	1 for a house located in a village, 0 otherwise
TOWN_FRI	1 for town-fridge house location, 0 otherwise
DETACH_D	1 for COAs with more than 50% detached houses, 0 otherwise
TERRA_D	1 for COAs with more than 50% terraced houses, 0 otherwise
FLAT_DOM	1 for COAs with more than 50% flats, 0 otherwise
NO_DOMIN	1 for COAs that are not dominated from a specifc house type, 0 otherwise
DDWELL	Dwelling density – dwellings per hectare
DIST_KM	distance (km) to nearest town centre
Domest100	The percentage of residential land use area to the total Census Output Area
Garden100	The percentage of garden to the total residential area in COAs
SOCIALRD	1 for COAs with more than 50% of houses in social rent, 0 otherwise
PRIVR0_4	1 for COAs with more than 40% of houses privately rented, 0 otherwise
OLD0_3	1 for COAs with more than 30% of the population over 60, 0 otherwise
HH1_0_5	1 for COAs with more than 50% of one person households, 0 otherwise

Variable	Label
ASIAN0_4	1 for COAs with more than 40% of asian ethnic group, 0 otherwise
BLACK0_2	1 for COAs with more than 20% of black ethnic group, 0 otherwise
CHIN0_2	1 for COAs with more than 20% of Chinese or other ethnic group, 0 otherwise
SOCAB0_4	1 for COAs with more than 40% in Social Classes A&B, 0 otherwise
SOCC1_0_4	1 for COAs with more than 40% in Social Classe C1, 0 otherwise
SOCE0_35	1 for COAs with more than 35% in Social Classe E, 0 otherwise
ILL0_3	COAs with more than 30% reporting themselves having long term limiting illness
Unemp100	The percentage of all 16-74 who are ea and unemployed in COA
NOCARD	1 for COAs with 50% or more of the households not owning a car, 0 otherwise
CAR2D	1 for COAs with 50% or more of the households owning 2 or more cars, 0 otherwise
Studen100	The percentage of all student households in COA
BUYER1ST	1 for first time buyer, 0 otherwise
SOLEMORG	1 for mortgage taken by a single individual, 0 otherwise
Q2_05	1 for the given quarter and year, 0 otherwise
Q3_05	1 for the given quarter and year, 0 otherwise
Q4_05	1 for the given quarter and year, 0 otherwise
Q1_06	1 for the given quarter and year, 0 otherwise
Q2_06	1 for the given quarter and year, 0 otherwise
Q3_06	1 for the given quarter and year, 0 otherwise
Q4_06	1 for the given quarter and year, 0 otherwise
Q1_07	1 for the given quarter and year, 0 otherwise
Q2_07	1 for the given quarter and year, 0 otherwise

10. Appendix B: Regression Output

Southampton

Linear regression		Number of obs		14549
		F(46, 14502)		630.02
		Prob > F		0
		R-squared		0.6746
Number of clusters (COA) = 1432 clusters (COA) = 1432		Root MSE		0.2496

LOGPRICE	Coefficient	Robust Std. Err.	t	P>t
NEWBUILT	0.0734	0.0197	3.73	0.00
BUNGALOW	0.1222	0.0145	8.45	0.00
DETACHED	0.212	0.0106	19.96	0.00
TERACHED	–0.0631	0.008	–7.85	0.00
FLAT_CON	–0.2582	0.0142	–18.17	0.00
FLAT_PP	–0.157	0.015	–10.48	0.00
BEDROOM1	–0.2816	0.0131	–21.43	0.00
BEDS2	–0.071	0.0076	–9.37	0.00
BEDS4	0.1839	0.0088	20.85	0.00
BEDS5	0.4389	0.0243	18.1	0.00
BEDSOVER	0.7041	0.0734	9.59	0.00
BEDS_NO	0.0017	0.0072	0.23	0.82
GARAGE	0.0312	0.0055	5.68	0.00
VILLAGE	0.3078	0.0387	7.96	0.00
TOWN_FRI	0.0539	0.0194	2.78	0.01
DETACH_D	0.0592	0.0166	3.56	0.00
TERRA_D	–0.0247	0.0142	–1.73	0.08
FLAT_DOM	0.0655	0.0247	2.65	0.01
NO_DOMIN	0.0152	0.0114	1.34	0.18
DDWELL	–0.0028	0.0006	–4.87	0.00
DIST_KM	0.0101	0.002	4.92	0.00
Domest100	0.0005	0.0004	1.45	0.15

Garden100	–0.0013	0.0008	–1.68	0.09
SOCIALRD	–0.1305	0.016	–8.17	0.00
PRIVR0_4	0.0867	0.0337	2.57	0.01
OLD0_3	0.0613	0.0162	3.78	0.00
HH1_0_5	–0.0073	0.0311	–0.23	0.82
ASIAN0_4	–0.0296	0.0591	–0.5	0.62
SOCAB0_4	0.1143	0.0272	4.2	0.00
SOCC1_0	–0.0073	0.0403	–0.18	0.86
SOCE0_35	–0.0234	0.0402	–0.58	0.56
ILL0_3	0.0156	0.0292	0.53	0.59
Unemp100	–0.0155	0.0037	–4.17	0.00
NOCARD	–0.0001	0.0308	0	1.00
CAR2D	0.0574	0.0148	3.87	0.00
Studen100	0.0069	0.0019	3.72	0.00
BUYER1ST	–0.1176	0.0064	–18.48	0.00
SOLEMORG	–0.0394	0.0053	–7.45	0.00
Q2_05	–0.1312	0.0105	–12.51	0.00
Q3_05	–0.13	0.0105	–12.4	0.00
Q4_05	–0.1206	0.0104	–11.65	0.00
Q1_06	–0.1239	0.0109	–11.42	0.00
Q2_06	–0.0984	0.0098	–10.04	0.00
Q3_06	–0.0928	0.0099	–9.39	0.00
Q4_06	–0.0757	0.0104	–7.29	0.00
Q1_07	–0.0587	0.0108	–5.42	0.00
Q2_07	–0.0343	0.011	–3.12	0.00
Constant	12.3111	0.0601	204.83	0.00

Nottingham

Linear	regression	Number of obs		8661
		F(46, 8614)		440
		Prob > F		0
		R-squared		0.6986
		Root MSE		0.28034
Number of clusters (COA) = 1222				
LOGPRICE	Coeficient (B)	Robust Std. Err.	t	P>t
NEWBUILT	0.1756	0.0284	6.18	0.00
BUNGALOW	0.1309	0.0233	5.62	0.00
DETACHED	0.2328	0.0142	16.36	0.00
TERACHED	–0.1017	0.0115	–8.86	0.00
FLAT_CON	–0.1665	0.0408	–4.08	0.00
FLAT_PP	–0.1013	0.0287	–3.53	0.00
BEDROOM1	–0.2742	0.0258	–10.65	0.00
BEDS2	–0.0921	0.0105	–8.74	0.00
BEDS4	0.2416	0.0134	18.01	0.00
BEDS5	0.4872	0.0268	18.21	0.00
BEDSOVER	0.6602	0.0869	7.6	0.00
BEDS_NO	0.015	0.0093	1.62	0.11
GARAGE	0.0417	0.0086	4.87	0.00
VILLAGE	0.501	0.0611	8.2	0.00
TOWN_FRI	0.2098	0.0326	6.43	0.00
DETACH_D	0.0807	0.0223	3.62	0.00
TERRA_D	–0.0497	0.0279	–1.78	0.08
FLAT_DOM	0.1722	0.0442	3.9	0.00
NO_DOMIN	0.055	0.0214	2.57	0.01
DDWELL	–0.0029	0.0009	–3.34	0.00
DIST_KM	–0.0299	0.0040	–7.42	0.00

Domest100	0.001	0.0005	1.96	0.05
Garden100	–0.0021	0.0012	–1.79	0.07
SOCIALRD	–0.0566	0.0296	–1.92	0.06
PRIVR0_4	0.0532	0.0425	1.25	0.21
OLD0_3	0.0141	0.0236	0.6	0.55
HH1_0_5	–0.0152	0.0315	–0.48	0.63
ASIAN0_4	–0.0701	0.0548	–1.28	0.20
SOCAB0_4	0.2109	0.0324	6.51	0.00
SOCE0_35	–0.0699	0.0327	–2.14	0.03
ILL0_3	–0.0293	0.0344	–0.85	0.39
Unemp100	–0.0272	0.0051	–5.39	0.00
NOCARD	–0.1052	0.0208	–5.05	0.00
CAR2D	0.0737	0.0349	2.11	0.04
Studen100	0.0012	0.0021	0.61	0.54
BUYER1ST	–0.1647	0.0085	–19.46	0.00
SOLEMORG	–0.0583	0.0067	–8.75	0.00
Q2_05	–0.0699	0.0126	–5.56	0.00
Q3_05	–0.0618	0.0126	–4.91	0.00
Q4_05	–0.0664	0.0131	–5.06	0.00
Q1_06	–0.0477	0.0131	–3.64	0.00
Q2_06	–0.053	0.0134	–3.95	0.00
Q3_06	–0.0377	0.0135	–2.8	0.01
Q4_06	–0.0206	0.0124	–1.66	0.10
Q1_07	–0.0037	0.0126	–0.3	0.76
Q2_07	–0.005	0.0117	–0.43	0.67
Constant	12.267	0.0948	129.37	0.00

Leeds

Linear regression		Number of obs		18061
		F(46, 2282)		238.3
		Prob > F		0
		R-squared		0.6658
Number of clusters (COA):	2283	Root MSE		0.26829

LOGPRICE	Coefficient (B)	Robust Std. Err.	t	P>t
NEWBUILT	0.1216	0.0099	12.32	0.00
BUNGALOW	0.0719	0.0129	5.58	0.00
DETACHED	0.1977	0.0085	23.26	0.00
TERACHED	–0.0688	0.0055	–12.46	0.00
FLAT_CON	–0.1497	0.0126	–11.91	0.00
FLAT_PP	–0.0522	0.0127	–4.11	0.00
BEDROOM1	–0.2990	0.0131	–22.9	0.00
BEDS2	–0.1056	0.0055	–19.17	0.00
BEDS4	0.2337	0.0077	30.28	0.00
BEDS5	0.5241	0.0196	26.73	0.00
BEDSOVER	0.7439	0.0491	15.16	0.00
BEDS_NO	–0.0062	0.0054	–1.16	0.25
GARAGE	0.0482	0.0048	10.04	0.00
VILLAGE	0.0700	0.0132	5.31	0.00
TOWN_FRI	0.0189	0.0146	1.29	0.20
DETACH_D	–0.0103	0.0098	–1.05	0.30
TERRA_D	–0.0352	0.0072	–4.86	0.00
FLAT_DOM	0.1282	0.0160	8.01	0.00
NO_DOMIN	0.0212	0.0058	3.68	0.00
DDWELL	–0.0043	0.0002	–18.53	0.00
DIST_KM	0.0269	0.0010	27.5	0.00

Domest100	0.0018	0.0002	11.78	0.00
Garden100	–0.0019	0.0003	–5.95	0.00
SOCIALRD	–0.1225	0.0095	–12.86	0.00
PRIVR0_4	0.1138	0.0225	5.05	0.00
OLD0_3	0.0649	0.0081	8	0.00
HH1_0_5	0.0202	0.0119	1.7	0.09
ASIAN0_4	0.0115	0.0286	0.4	0.69
SOCAB0_4	0.2199	0.0105	20.87	0.00
SOCE0_35	0.0311	0.0157	1.98	0.05
ILL0_3	–0.0362	0.0132	–2.75	0.01
Unemp100	–0.0254	0.0013	–18.94	0.00
NOCARD	–0.0725	0.0087	–8.32	0.00
CAR2D	0.1554	0.0110	14.15	0.00
Studen100	0.0114	0.0011	10.13	0.00
BUYER1ST	–0.1413	0.0045	–31.33	0.00
SOLEMORG	–0.0534	0.0043	–12.54	0.00
Q2_05	–0.1405	0.0082	–17.12	0.00
Q3_05	–0.1129	0.0086	–13.16	0.00
Q4_05	–0.1098	0.0091	–12.1	0.00
Q1_06	–0.1137	0.0088	–12.94	0.00
Q2_06	–0.0889	0.0076	–11.64	0.00
Q3_06	–0.0604	0.0080	–7.52	0.00
Q4_06	–0.0367	0.0080	–4.58	0.00
Q1_07	–0.0377	0.0084	–4.5	0.00
Q2_07	–0.0143	0.0077	–1.86	0.06
Constant	12.0868	0.0251	480.94	0.00

Manchester

Linear regression		Number of obs		15562
		F(49, 15512)		406.12
		Prob > F		0
		R-squared		0.5704
		Root MSE		0.29839
Number of clusters (COA) = 1938				
LOGPRICE	Coefficient (B)	Robust Std. Err.	t	P>t
NEWBUILT	0.1904	0.0154	12.37	0.00
BUNGALOW	0.0548	0.0317	1.73	0.08
DETACHED	0.1274	0.0137	9.32	0.00
TERACHED	–0.0995	0.0106	–9.37	0.00
FLAT_CON	–0.1097	0.0197	–5.56	0.00
FLAT_PP	–0.0408	0.0181	–2.25	0.02
BEDROOM1	–0.3185	0.0211	–15.11	0.00
BEDS2	–0.0883	0.0104	–8.53	0.00
BEDS4	0.2765	0.0140	19.79	0.00
BEDS5	0.5182	0.0301	17.2	0.00
BEDSOVER	0.7605	0.0622	12.23	0.00
BEDS_NO	–0.0428	0.0082	–5.22	0.00
GARAGE	0.0636	0.0081	7.89	0.00
VILLAGE	0.6014	0.2946	2.04	0.04
TOWN_FRI	0.1209	0.0392	3.08	0.00
DETACH_D	–0.0221	0.0415	–0.53	0.60
TERRA_D	–0.0518	0.0248	–2.09	0.04
FLAT_DOM	0.0517	0.0357	1.45	0.15
NO_DOMIN	–0.0245	0.0162	–1.51	0.13
DDWELL	–0.0014	0.0006	–2.2	0.03
DIST_KM	–0.0656	0.0048	–13.53	0.00

Domest100	0.0009	0.0005	1.75	0.08
Garden100	0.0009	0.0007	1.35	0.18
SOCIALRD	–0.0943	0.0204	–4.61	0.00
PRIVR0_4	0.1285	0.0338	3.8	0.00
OLD0_3	0.0251	0.0272	0.92	0.36
HH1_0_5	0.0437	0.0282	1.55	0.12
ASIAN0_4	0.0931	0.0262	3.56	0.00
BLACK0_2	0.0128	0.0315	0.41	0.69
CHIN0_2	–0.0581	0.0777	–0.75	0.46
SOCAB0_4	0.2215	0.0304	7.28	0.00
SOCC1_0_4	0.0918	0.0565	1.62	0.11
SOCE0_35	0.0036	0.0303	0.12	0.91
ILL0_3	–0.0410	0.0271	–1.51	0.13
Unemp100	–0.0160	0.0034	–4.68	0.00
NOCARD	–0.0829	0.0176	–4.72	0.00
CAR2D	0.3065	0.0385	7.96	0.00
Studen100	0.0073	0.0026	2.86	0.00
BUYER1ST	–0.1718	0.0064	–26.9	0.00
SOLEMORG	–0.0788	0.0052	–15.19	0.00
Q2_05	–0.1886	0.0122	–15.47	0.00
Q3_05	–0.1485	0.0111	–13.41	0.00
Q4_05	–0.1455	0.0115	–12.61	0.00
Q1_06	–0.1236	0.0124	–9.99	0.00
Q2_06	–0.1049	0.0106	–9.91	0.00
Q3_06	–0.0758	0.0101	–7.51	0.00
Q4_06	–0.0543	0.0112	–4.85	0.00
Q1_07	–0.0328	0.0111	–2.96	0.00
Q2_07	–0.0162	0.0092	–1.76	0.08
Constant	12.2731	0.0506	242.32	0.00

London SW

Linear	regression	Number of obs		17045
		F(45, 16999)		580.68
		Prob > F		0
		R-squared		0.6073
		Root MSE		0.35742
Number of clusters (COA) = 1834				
LOGPRICE	Coefficient (B)	Robust Std. Err.	t	P>t
NEWBUILT	–0.0360	0.0413	–0.87	0.38
BUNGALOW	–0.1679	0.0436	–3.85	0.00
DETACHED	–0.0442	0.0212	–2.08	0.04
TERACHED	–0.0095	0.0125	–0.76	0.45
FLAT_CON	–0.3742	0.0167	–22.4	0.00
FLAT_PP	–0.2800	0.0171	–16.35	0.00
BEDROOM1	–0.3469	0.0144	–24.09	0.00
BEDS2	–0.1367	0.0119	–11.48	0.00
BEDS4	0.3198	0.0129	24.8	0.00
BEDS5	0.6618	0.0251	26.34	0.00
BEDSOVER	0.9353	0.0523	17.87	0.00
BEDS_NO	0.0355	0.0115	3.07	0.00
GARAGE	–0.0086	0.0112	–0.77	0.44
DETACH_D	0.3839	0.0718	5.35	0.00
TERRA_D	–0.0361	0.0269	–1.34	0.18
FLAT_DOM	0.1344	0.0276	4.87	0.00
NO_DOMIN	0.0431	0.0248	1.74	0.08
DDWELL	–0.0001	0.0001	–1.1	0.27
DIST_KM	–0.0905	0.0068	–13.34	0.00
Domest100	0.0015	0.0004	3.85	0.00
Garden100	–0.0065	0.0006	–10.37	0.00
SOCIALRD	–0.2180	0.0351	–6.2	0.00

PRIVR0_4	–0.0077	0.0277	–0.28	0.78
OLD0_3	0.0432	0.0367	1.18	0.24
HH1_0_5	–0.0486	0.0230	–2.11	0.04
ASIAN0_4	0.0130	0.0282	0.46	0.65
BLACK0_2	–0.0196	0.0643	–0.31	0.76
SOCAB0_4	0.2912	0.0168	17.35	0.00
SOCC1_0	–0.0105	0.0327	–0.32	0.75
ILL0_3	–0.0919	0.0822	–1.12	0.26
Unemp100	0.0073	0.0048	1.51	0.13
NOCARD	0.0297	0.0235	1.27	0.21
CAR2D	0.2137	0.0469	4.56	0.00
Studen100	–0.0089	0.0048	–1.84	0.07
BUYER1ST	–0.1747	0.0076	–23.07	0.00
SOLEMORG	–0.0473	0.0061	–7.78	0.00
Q2_05	–0.2165	0.0150	–14.48	0.00
Q3_05	–0.2295	0.0143	–16	0.00
Q4_05	–0.2342	0.0164	–14.26	0.00
Q1_06	–0.1891	0.0156	–12.12	0.00
Q2_06	–0.1585	0.0147	–10.75	0.00
Q3_06	–0.1391	0.0151	–9.19	0.00
Q4_06	–0.1269	0.0168	–7.55	0.00
Q1_07	–0.0784	0.0166	–4.71	0.00
Q2_07	–0.0202	0.0152	–1.33	0.18
Constant	13.4892	0.0582	231.8	0.00

London NE

Linear regression		Number of obs		16239
		F(46, 16192)		421.87
		Prob > F		0
		R-squared		0.5375
Number of clusters (COA):	2036	Root MSE		0.26615
LOGPRICE	Coefficient	Robust Std. Err.	t	P>t
NEWBUILT	0.0218	0.0264	0.82	0.41
BUNGALOW	–0.032	0.0249	–1.29	0.20
DETACHED	–0.0135	0.0193	–0.7	0.48
TERACHED	–0.0314	0.009	–3.49	0.00
FLAT_CON	–0.2927	0.0142	–20.64	0.00
FLAT_PP	–0.2543	0.0144	–17.64	0.00
BEDROOM1	–0.2475	0.011	–22.43	0.00
BEDS2	–0.0881	0.0081	–10.81	0.00
BEDS4	0.2221	0.0099	22.47	0.00
BEDS5	0.3715	0.0175	21.26	0.00
BEDSOVER	0.6241	0.0452	13.79	0.00
BEDS_NO	–0.0103	0.0073	–1.41	0.16
GARAGE	0.0518	0.0071	7.28	0.00
DETACH_D	0.266	0.0642	4.14	0.00
TERRA_D	–0.0452	0.0169	–2.68	0.01
FLAT_DOM	0.0738	0.021	3.52	0.00
NO_DOMIN	0.0288	0.0196	1.47	0.14
DDWELL	–0.0014	0.0003	–4.17	0.00
DIST_KM	–0.0373	0.0032	–11.74	0.00
Domest100	0.0015	0.0003	4.53	0.00
Garden100	–0.0034	0.0008	–4.2	0.00
SOCIALRD	–0.0197	0.0234	–0.84	0.40
PRIVR0_4	–0.0751	0.0404	–1.86	0.06

OLD0_3	0.0369	0.0264	1.4	0.16
HH1_0_5	–0.0105	0.0211	–0.5	0.62
ASIAN0_4	–0.1341	0.0156	–8.58	0.00
BLACK0_2	–0.0753	0.0152	–4.95	0.00
SOCAB0_4	0.3081	0.0528	5.83	0.00
SOCC1_0	–0.0406	0.0255	–1.59	0.11
SOCE0_35	–0.0414	0.038	–1.09	0.28
ILL0_3	–0.1132	0.0315	–3.6	0.00
Unemp100	–0.0101	0.0024	–4.17	0.00
NOCARD	0.0532	0.0198	2.69	0.01
CAR2D	0.2482	0.0466	5.33	0.00
Studen100	0.0012	0.0057	0.22	0.83
BUYER1ST	–0.1278	0.0056	–22.93	0.00
SOLEMORG	–0.0681	0.0048	–14.22	0.00
Q2_05	–0.2103	0.0104	–20.16	0.00
Q3_05	–0.194	0.0098	–19.85	0.00
Q4_05	–0.2022	0.0112	–18.12	0.00
Q1_06	–0.1903	0.0116	–16.46	0.00
Q2_06	–0.1667	0.0105	–15.87	0.00
Q3_06	–0.1295	0.0102	–12.7	0.00
Q4_06	–0.0986	0.0109	–9.02	0.00
Q1_07	–0.0829	0.011	–7.56	0.00
Q2_07	–0.0309	0.0105	–2.95	0.00
Constant	13.1279	0.0651	201.57	0.00

National Housing and Planning Advice Unit
CB04, Ground Floor of Clerical Block
Segensworth Road, Titchfield
Fareham PO15 5RR

Printed in the UK on material containing no less that 75% post-consumer waste.
February 2010