# DOES CONTROLLING FOR NEIGHBOURHOOD QUALITY MATTER MORE FOR DIFFERENT TYPES OF HOUSE BUYER?

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**Abstract:**

The inclusion of neighbourhood quality variables has been recognised as reducing the bias in house price indices and increasing the explanatory power of regression based hedonic indices. The ability to identify the type of purchaser is used in this paper to test the importance of neighbourhood quality variables for a first-time or second-time buyer**.** This paper includes the physical location of the house and neighbourhood characteristics using small area population statistics from the 1996 Census of Population in Ireland. The results confirm for the Dublin market the experience of the US and UK literature that physical and neighbourhood location influence price. The paper also shows that neighbourhood quality is more important for the first time buyer. While some tentative explanations are offered as to why this is the case this finding is worthy of further investigation.

**Keywords:** house price indices, hedonic models, first-time buyers, second-time buyers, bias, neighbourhood quality

### *1. Introduction*

It is recognised that a change in the type of houses sold in a particular period will influence the mean and so this measure may reflect this change rather than an actual change in price. This has lead to a considerable literature on how better to measure changes in house prices. In recent times a number of alternative measures have emerged for the Irish market based on hedonic regression techniques, whereby the price of a commodity is the function of the commodity's characteristics. This methodology standardises for changes in the mix of properties and so should permit a more accurate record of how house prices have changed.

In considering the measurement of house price change the demand for a house can be viewed as derived i.e. it is the demand for the bundle of the attributes or characteristics that the particular house possesses. These characteristics include the structural features of the property but can also include the physical location of the house and the type of area in which the house is located. The idea of including location or neighbourhood variables while measuring changes in house prices is not new and has featured in both the US and UK literature. Both the Nationwide and Halifax house price indices for the UK, developed by Fleming and Nellis [9, 10, 11] include regional location variables. This paper examines the impact of including data from the Census of Population to measure neighbourhood characteristics.

The market for a particular house can be considered a local market. Once a potential house purchaser has made a decision about which price range is affordable the purchaser must then make a number of decisions regarding the property itself. These decisions include location, which particular neighbourhood or area, and then the specific house characteristics are being sought. So in the case of Dublin, the decision could be between North and South Dublin, then between Rathmines or Rathgar, Glasnevin or Drumcondra, and then what type of house i.e. a 3 bed semi-detached with en-suite, garden and garage. Fleming and Nellis [10] state that "unlike other consumer goods, houses are unique in occupying a fixed location and thus locational attributes must also play an important part in determining prospective purchasers' valuations".

The need to control or account for neighbourhood quality has been established in the international literature. The dataset available for this paper identifies if the purchaser of the property is a first-time buyer or a second-time buyer. Using this differentiation the analysis shows that inclusion of neighbourhood quality variables is more important for first-time buyers rather than second-time buyers. Zabel [21] examines the issues of controlling for quality in house price indices using a repeat-sales and a hedonic model. He decomposes the growth rate for house prices into three components – pure price change, the return due to structural characteristics, and the return due to neighbourhood characteristics. Using this decomposition, we assess the rate of return from the different factors depending on the type of buyer. Simple analysis indicates that the correlation between the rate of return on neighbourhood quality and structural characteristics is higher for first-time buyers than for either the total market or second-time buyers. Identification of buyer type means that this paper can determine the extent of bias for FTB and STB. In the case of FTB the bias that exists if neighbourhood variables are excluded is larger than for the total market or for STB, reflecting the importance attached to location by this group of buyers. Inclusion of neighbourhood quality variables results in a larger improvement in the explanatory power of regressions for first-time buyers. One possible explanation for this is that when purchasing FTB are making the decision about location but when "trading-up" as STB are more concerned about house size.

Section 1 of this paper outlines why it is necessary to take account of the mix of property transactions in a period when measuring the change in price. In section 2 an overview is given of different location variables in the US and UK literature, illustrating the importance of location variables, broadly defined, in explaining house price change. The next section of the paper outlines the details of the dataset employed in the analysis. Section 4 will apply alternative approaches to the use of location to the Irish data. A summary of findings will be presented in section 5. The final section will draw some conclusions as well as indicating some areas of further research.

***2. Why is there a need to mix-adjust***

For many years trends in house prices were measured by the Department of the Environment Housing Statistics Bulletin that presented an average new and second-hand house price for which

loans were approved in a particular quarter. This does have the advantage that it is the simplest measure to construct. However, no adjustment is made for any change in the mix of properties sold. This is acknowledged by the Department themselves who point out at the start of their Bulletin [8] "In comparing house price figures from one period to another, account should be taken of the fact that changes in the mix of houses and apartments to which the data relates affect the average figures". Fleming and Nellis [10] compare an index based on average house prices for the UK and standardised prices based on the hedonic approach and find that "standardisation does make a very substantial difference to the reported rate of house price inflation". A similar analysis in Fleming and Nellis [11] argue that use of an average to measure price change is misleading as standardised prices are shown to have risen somewhat less than simple average prices, the average price series is more volatile than the standardised series, and the simple average series shows reversals of trends not mirrored in the standardised series. They conclude that the differences are due to "variations in the underlying mix of traded properties from one period to the next."

Mark and Goldberg [17], referring to analysis of the mean price they undertook of US data, state "it is unclear whether the prices reflect differences in housing characteristics of traded housing units or whether prices actually increased". In general, the mean price is not used in the literature as a measure of house price change. The median price is given more prominence, although this measure is widely criticised for similar reasons (see for example, Case and Schiller, [5], Gatzlaff and Ling, [12], Wolverton and Senteza, [20]).

Using data for Dublin from the Irish Permanent plc[1] mortgage database it is evident that there has been a significant change in the price of properties sold over the time period. In the first quarter of 1996, only 9.4 per cent of properties had a price greater than £100,000. By the final quarter of 2000, this had more than reversed and 96.2 per cent of prices paid for houses were over £100,000, see Figure 1. A comparison of the structural characteristics in the first and last period under consideration indicates that there have been some changes in the mix of properties and their characteristics. The proportion of first-time buyers has declined from nearly 48 per cent of

[1] Irish Permanent plc was formerly a building society before converting to a public company. It is one of the largest mortgage providers in Ireland.

buyers to 42.5 per cent. The proportion of semi-detached and terraced houses has increased, while the proportion of apartments and bungalows has declined. The proportion of new houses has fallen from 47.7 per cent to 21.2 per cent. There have also been changes to the type of heating in housing. Houses with electric heating declined to 10.6 per cent of transactions compared to 15.4 per cent in quarter 1, 1996, those with solid heating also declined to 3 per cent from 8.1 per cent, while houses with gas heating or oil heating have increased as a proportion of transactions.

A substantial amount of literature has developed on the construction of alternative measures of price change in the housing market[2]. Within this, one of the main techniques is the use of the hedonic price index, based mainly on work by Griliches, who developed a hedonic price index for automobiles (see Griliches, [13]). Essentially the basic technique is that within each time period it is possible to observe different houses being sold with a different set of characteristics. For each time period, regression of price (or log price) on the set of variables measuring quality yields regression coefficients that can be taken as the implicit prices of the quality components. The index series is then produced by taking some standard set of frequencies of the characteristics (usually the base year) and applying the successive set of prices. Suppose the data extend over t time periods and that the regression in the kth time period is:

$$y_{kj} = b_{k0} + b_{k1}x_{1kj} + b_{k2}x_{2kj} + ... + b_{kp}x_{pkj} + e_{kj}, \qquad (1)$$

where the subscript j refers to houses within the time period k; $x_1, x_2, \ldots, x_p$ are the measured characteristics or attributes of the house; y is house price or its log and e represents the remaining 'random' variation affecting price. Then the set of coefficients $b_{k0}, b_{k1}, ..., b_{kp}$, can assign a price to any type of house, where 'type' is defined by the attributes. Thus a price can be assigned in all time periods corresponding to each house type that occurred in the base period.

The characteristics used can be quantitative, such as square footage, or qualitative, such as type of house or type of heating. One of the attributes of a house is its location, both its physical

location (i.e. postcode) but also its neighbourhood location (social class of neighbourhood, dominant occupation, level of educational attainment). Some of these neighbourhood characteristics can include proximity to parks or green areas, shopping or schools, and distance from the centre of the city. Neighbourhoods can also be classified using socio-economic data. While some of these are not strictly hedonic characteristics, it is generally accepted in much of the literature that the demand for a property is on the basis of a bundle of characteristics, both physical and location.

### *3. Literature Review*

Price indices constructed for the US tend to be of local markets, either a county or a metropolitan area. These US studies have the advantage that even at county level there is still a substantial number of transactions, an issue that will be returned to in the Irish context. In these studies details are collected reflecting the neighbourhood characteristics of the house location. Palmquist [19] compares alternative methodologies using data for King County in the State of Washington and includes variables for the distance to the nearest park, neighbourhood group sharing recreational facilities, and a variable if the house was located west of the highway, all of which were statistically significant. Crone and Voith [7] undertake a comparison using data for Montgomery County, Pennsylvania. The data on house price and attributes are merged with data at the census tract level that provide additional information on neighbourhood characteristics and accessibility to the business district. From this average household size, percentage of the population that is black, and percentage that are single family detached houses are included. Measures of accessibility to surrounding business districts such as highway travel time, average commuting time, and the availability of a commuter rail service are also included for each property. While the detailed results are not given the authors state that "the coefficients on the majority of housing and neighbourhood characteristics are highly significant and of the expected sign and magnitude".

Mix-adjusted price indices have also been developed for the UK market. Fleming and Nellis [9] compiled a mix-adjusted index for the Halifax Building Society in the UK. The authors were

[2] A number of articles review the alternative measures. For example see Case, Pollakowski, and Wachter [4] or Conniffe and Duffy [6].

keen to establish the influence of different characteristics at a regional, as well as at national level. In this case the price of a house was the function of various characteristics including location. Location is attributed by including the UK standard statistical region (formerly economic planning region) in which the house is located as an explanatory dummy variable, taking the value of 1 according to the region in which the property is located. The characteristics used by Fleming and Nellis are found to "generally explain around 70 per cent of variation in the UK and 55-80 per cent at the regional level, depending on the particular sub-grouping of houses". Fleming and Nellis [10] in a detailed paper about the Halifax index report that all the regional variables were found to statistically significant, indicated by very high t-statistic.

In a 1992 paper, Fleming and Nellis extend their previous analysis of the UK using the hedonic technique to take account of the specific influence of neighbourhood and surrounding area characteristics on house prices. The dataset that they access (the Nationwide Anglia Building Society) records the locality in which each property is situated in terms of post-codes, which define very small areas. This is then used in conjunction with a classification of residential neighbourhoods into, for example, modern family housing, higher incomes better-off council estates and multiracial areas[3]. Classification of the wider surrounding area based on parliamentary constituencies is also included. These include inner metropolitan area, better-off industrial areas and rural areas, resort and market towns. These groupings enable the classification of properties on the basis of their immediate neighbourhood and also on the basis of the wider surrounding area. Fleming and Nellis find that the inclusion of both these location variables improves the "overall explanatory power of the regression models compared to those obtained using only one of these". Furthermore, despite some concern, multicollinearity did not emerge as a significant problem using both the location variables and indeed, in general the use of the macro location variables (parliamentary constituency) is reported as reinforcing the micro variables (neighbourhood characteristics).

[3] This classification, called ACORN, applies census of population statistics to classify areas of about 150 households (census enumeration districts) into 38 different neighbourhood types. The ACORN classification takes into account 40 different variables encompassing demographic, housing and employment characteristics. The 38 neighbourhood types are aggregated up to 11 neighbourhood groups. These are: agricultural areas; modern family housing, higher incomes; older housing of intermediate status; poor quality, older terraced housing; better off council states; less well-off council estates; poorest council estates; multiracial areas; high status non-family areas; affluent suburban housing; and, better-off retirement areas.

While the papers cited above have included neighbourhood characteristics in their analysis of house price change a number of papers explicitly attempt to measure the specific impact of these characteristics on the change in house prices. Linneman [16] finds that between 15 and 50 per cent of price variation is explained by neighbourhood characteristics. He uses data from the Bureau of Census *Annual Housing Survey* to provide socio-economic information and information on the immediate neighbourhood. In general the signs of the regression coefficients for the variables used by Linneman are as expected. In a number of cases where this is not so he argues that the coefficient reflects the net impact of the measured variable and an omitted measure of airport accessibility. Thus, his results find that high levels of aeroplane noise are found to significantly increase Chicago property values. This somewhat counter-intuitive result reflects the fact that "since noise levels will be highest near the airport (and its expressway linkages) the variable reflects the net impact of the desirable trait of airport accessibility and the negative trait of aeroplane noise".

A theme in a number of papers authored, or co-authored, by Zabel is the impact of the surrounding neighbourhood on house prices. Kiel and Zabel [14] examine the impact of discrimination and prejudice in the US market on house prices. While the main focus of the article is on racial effects they also determine the effect when neighbourhood characteristics are added to the house price regression and find "these variables add significant explanatory power to the regressions" - evidenced by large increases in the adjusted $R^2$'s. Kiel and Zabel [15], evaluating the creation of indices using the American Housing Survey, find that neighbourhood characteristics are very important when estimating house price indices. Zabel [21] examines controlling for quality in house price indices. He maintains that while all significant determinants of house prices may not be included in the index ("accounted" for) as many as possible should be included in the regression ("controlled" for), so that unbiased estimates of the growth in house prices can be obtained. In a detailed example he argues that account should be taken of both structural characteristics and neighbourhood quality. Furthermore, this analysis allows the separation of the appreciation in house prices due to structural characteristics and due to neighbourhood quality. A number of neighbourhood quality variables are used. These include the median household income in the census tract, proportion non-white, proportion blue collar,

proportion over 25 who graduated from high school, proportion of houses that changed hands in the last five years, proportion of vacant housing units and the proportion of houses with less than one occupant per room in the census tract. As a group the neighbourhood quality variables are found to be highly significant.

### *4. The Data set*

The data set is taken from housing transactions on the Irish Permanent plc database that occurred in Dublin City and County. The Irish Permanent plc is one of the largest mortgage providers and accounts for approximately 23 per cent of the market. Between January 1996 and December 2000 this amounted to 17,977 transactions. Dublin City and County (hereafter referred to as Dublin) has, on average, accounted for 32 per cent of mortgages paid by the Irish Permanent database between quarter 1, 1996 and quarter 4, 2000. Since June 1998, Irish Permanent has published a monthly index of Irish house prices for Dublin, rest of country, and nationally, using data from 1996, constructed using a "hedonic" price methodology[4].

The existing dataset contains structural details of the property and if the purchaser is a first-buyer or not. Four address fields are available to record location – house name, street, town, and county or postcode. These address fields are used to allocate properties a location dummy variable depending on postcode or location in County Dublin. However, to date details have not been collected on the characteristics of the neighbourhood in which the property is located (see Table 1).

To assess the impact of the immediate neighbourhood quality on Dublin house prices, Small Area Population Statistics (SAPS) from the 1996 Census of Population is used. Small Area Population Statistics provide detailed information at the District Electoral Division (DED) level. DEDs are the smallest administrative area for which population statistics are published, of which there are 322 in Dublin City and County at the time of the 1996 Census of Population. Properties in the dataset are allocated a DED name via a coding system that matches addresses to their DED. This process resulted in a sample of 14,084 properties, over 77 per cent of the original dataset. The

[4] A detailed outline of the methodology underpinning the Irish Permanent Index is given in Baker and Duffy [2], and Conniffe and Duffy [6].

remaining properties could not be coded due to misspelling of their address or ambiguity as to the precise DED in which they are located.

If the sample is to reflect movements in house prices it is necessary that the mix of characteristics in the sample is reasonably representative of that for all the dwellings. Table 2 compares the characteristics of the properties in the sample with that of the population. It can be seen that apartments, new houses and houses heated by electricity are somewhat underrepresented, while semi-detached houses are over-represented. Dwellings in the sample sold for a lower average price than for the population as a whole. Geographically and in each time period the sample is similar to that of the overall population. Even though some differences do exist, the sample appears to be sufficiently comprehensive and representative to provide a suitable base to test the importance of location and neighbourhood characteristics in reflecting house price trends.

Unlike much of the US analysis Irish data does not provide details of the ethnic mix of different areas, a common variable in the international literature. However, a number of alternative measures of neighbourhood quality are available, some of which would be similar to those used in the international literature. One measure of neighbourhood quality is the proportion of retired or “empty-nest” households with no children. The higher the proportion here the more mature and established the neighbourhood. A measure of educational attainment within a neighbourhood is also included, the proportion of those aged over 21 when they had completed their education.

Irish census data defines social class group on the basis of occupation (see Table 3). According to the Central Statistics Office, the occupations included in each group have been selected in such a way to bring together people with similar occupational skill. In determining social class no account is taken of the differences between individuals on the basis of other characteristics, such as education. Social class ranks occupations by the level of skilled required on a social class scale ranging from 1 (highest) to 7 (lowest). A social class variable is also included based on the proportion in social class 1 and 2, a dummy variable taking the value of 1 if the proportion in social class 1 and 2 is less than 25 per cent.

***5. Alternative models for measuring house price change in Dublin***

Measure of house price change based purely on the structural characteristics is one possible approach. In this case no account is taken of physical location or neighbourhood quality effects.

$$P=B(\gamma) + \mu \qquad (2)$$

Where P is a matrix of the log of price and B is a matrix of structural characteristics. The base property against which differences in price is measured is an existing detached house (or bungalow), with a non-first time buyer, no garage, and gas, electricity or oil heating. Square footage is the most significant explanatory variable and in general the coefficients have the expected sign i.e. possession of a garage has a positive coefficient whereas use of solid fuel has a negative coefficient.

Following the methodology of Fleming and Nellis [9, 10] it was first decided to estimate the change in house price based on the structural characteristics of the house and an identification of the physical location of a property. In this approach no measure of neighbourhood characteristics are included. The physical location of the house is identified a number of dummy variable based on postcode or location in County Dublin. Model (3) is a hedonic regression including a measure of location.

$$P=B(\gamma) + L(\delta)+ \mu \qquad (3)$$

where L is a matrix of physical location variables and the other variables are as defined above. Location of the property, and as before, the square footage of the house, are important in explaining the change in the house price.

While equation (3) includes a measure of physical location it does not measure the immediate neighbourhood characteristics that may influence the house price. In equation 4, the immediate neighbourhood characteristics used are a measure of social class, family life cycle, and age finishing education, while the physical location is as in equation (2).

$$P=B(\gamma) + L(\delta)+ N(\lambda)+\mu \qquad (4)$$

The inclusion of a matrix of neighbourhood quality measures, N, results in an improvement in the amount of house price variation explained. In general, the neighbourhood quality variables are significant and have the expected sign, with the social class variable being much more significant than the family variable. The location variable in general continues to be significant. Regression results are shown in Table 4**.** As part of the calculation of the bias that exists by not including measures of neighbourhood quality equation (4) is also be used to control for neighbourhood quality. In this case the neighbourhood variables are included in the regression but are not included in the calculation of the index.

***6. Summary of findings***

The database allows the identification of results for different types of buyer. As is shown in table 5, a larger proportion of first-time buyers buy a new house, have a lower average price and on average buy a smaller property than second-time buyers. Differences also emerge in the distribution of FTB and STB by location and neighbourhood quality. A slightly higher proportion of first-time buyers live in South County Dublin compared with second time buyers, while a slightly lower proportion of first time buyers live in North County Dublin. A higher proportion of second-time buyers live in neighbourhoods where more than 10 per cent are retired or empty-nest households and a lower proportion of STB live in neighbourhoods where the proportion in social class 1 and 2 is less than 25 per cent.

Results from the different equations show that inclusion of neighbourhood quality results in a higher adjusted R squared for the total market and for first-time buyers (FTB), Table 6, and second-time buyers (STB), Table 7, compared to equations where no account is taken of neighbourhood quality. For the total market, house size and social class are the two most significant variables, with square footage being the most important in 19 of the 20 quarters. In most cases the educational attainment of the neighbourhood is not significant. For first time buyers the social class variable is more significant in 11 quarters with square footage being the most significant in the remainder. For second time buyers house size, as measured by square footage, is the most significant variable in 18 quarters.

Inclusion of neighbourhood quality variables adds around 10 per cent to the adjusted R squared for the total market and for STB. For FTB the improvement is larger, with neighbourhood quality variables adding 13 per cent explanatory power. In some cases, the adjusted R squared value appears low, although this is typical of studies using cross-sectional data. The tables also report the standard error for each of the models. This shows that, once again in general, inclusion of neighbourhood quality variables results in a lower standard error. Possible explanations for greater improvement in explanatory power for FTB might be that, as entrants to the housing market, first time buyers are more concerned about the neighbourhood in which they purchase and so pay more attention to the neighbourhood quality. The fact that they are new to the process makes them more risk adverse. Alternatively, FTB make the decision about location but when "trading-up" as STB are more concerned about house size.

Not unexpectedly, the different approaches all agree in showing rapidly increasing house prices in Dublin since 1996. In the early period the indices remain close together, until quarter 3, 1998. Thereafter the average price index moves above and below the index that includes neighbourhood quality. The average price index shows a marginal decline in house price growth in Dublin in the first quarter of 2000 and a decline of over 2 per cent in the fourth quarter of 2000. The index that controls for neighbourhood quality shows the lowest rate of growth after quarter 3, 1998. In contrast to the average price index the mix-indices show continuing house price growth, rather than a decline in the final quarter. In the case of the index that only controls for neighbourhood quality growth in the final quarter is marginal. Annual quarter on quarter growth is shown in Figure 2.

Zabel [21] finds that "even if one does not want to account for neighbourhood quality in the house price index, it is necessary to include neighbourhood quality in the underlying model to obtain unbiased estimates of the resulting index". Calculating the change in house prices using separate models controlling for and excluding neighbourhood variables determine a measure of bias. As is evident from Table 8, the bias in the total market index that does not include neighbourhood variables is in some time periods quite large. Identification of buyer type means that this paper can take the above analysis a step further and determine the extent of bias for FTB and STB. In the case of FTB the bias that exists if neighbourhood variables are excluded is larger

than for the total market or for STB, reflecting the importance attached to location by this group of buyers.

Following the methodology in Zabel [21], the overall growth rate is broken down into its component parts. The three components are considered to be pure price change (both structural characteristics and neighbourhood quality accounted for), the return due to changes in structural characteristics (neighbourhood quality not accounted for), and the return due to changes in neighbourhood quality (average less change due to structural characteristics). Table 9 gives the growth rate based on the average house price and shows how this growth rate can be decomposed into the different components. In common with Zabel, who has access to a longer time series, in some cases the difference between the average price change and the pure price change can be quite large. But both measures agree that the peak for growth in the total market was reached in the third quarter of 1998. In many cases the rate of pure price change is higher than that of the average price but is reduced by the return on either or both sets of characteristics (structural or neighbourhood). In a number of quarters the return on changes in structural characteristics or neighbourhood quality is negative. However, some of the location and neighbourhood variables are very significant. A number of these variables measure lower quality i.e. one of the neighbourhood quality variables records if the percentage in the higher social classes (1 and 2) is less than 25 per cent. Thus an increase in these particular variables would represent a negative return.

The available database also allows examination of the results by buyer type. Once again, the indices show substantial appreciation in house prices for both first time buyers and second-time buyers, with both types of buyer showing significant differences between the average and the pure price change. Simple analysis indicates that the correlation between neighbourhood quality and structural characteristics is higher for first-time buyers than for either the total market or second-time buyers. In all cases, the correlation coefficient is negative.

### *7. Conclusions*

In setting out some conclusions from the analysis it must again be noted that the time period is relatively short, and over the past few years house prices have been climbing on an almost

continuous basis. A real test of the different indices will be their ability to identify turning points and to accurately track any downward trend in prices. On this basis, further exploration of how different variables may add to the explanation of house price variation for first-time and second-time buyers in Ireland is warranted.

The reliability of hedonic, or other, house price indices is partly dependent on their specification. This paper includes the physical location of the house and neighbourhood characteristics using small area population statistics from the 1996 Census of Population in Ireland. The results confirm for the Dublin market the experience of the US and UK literature that physical and neighbourhood location influence price. Decomposing the average growth rate into component parts indicates that there is quite a degree of fluctuation in the rate of return on neighbourhood quality and structural characteristics for the total market, first-time and second-time buyers. The paper also shows that neighbourhood quality is more important for the first time buyer, with neighbourhood quality variables having a substantial impact on bias. While some tentative explanations are offered as to why this is the case this finding is worthy of further investigation.

The paper outlines the impact of using location and census data on a stand-alone basis. Can and Megbolugbe [3] create a number of interactive terms, arguing that the physical characteristics of a house may have a different impact on price depending on location, for example “the addition of extra living space in a low-income area will not affect the price as in a high-income area”. Can and Megbolugbe therefore express the coefficient for living area and square footage as a function of their measure of the immediate neighbourhood characteristics. The introduction of interactions to the Irish data can be investigated.

The neighbourhood data has been assigned to each property by allocating different addresses or areas to relevant District Electoral Divisions (DED). The fact that a DED and postcode boundaries do not coincide, or that a DED can have streets as a boundary means that there may well be some misallocation. The use of a geo-mapping system would serve to overcome any inaccuracy and allow a more precise allocation of neighbourhood characteristics to a property. This could also be further explored to determine if it is more appropriate to use a wider area than

a single DED, i.e. the average social class of a group of DEDs. A larger sample would allow analysis of more local house markets, possibly by postcode.

If the coding of data could be improved the use of location and neighbourhood quality in the monthly index could to be examined. However, the number of transactions in some postcodes would be too small for use on a monthly basis, which would also have an impact on the social class variables. Some grouping of the postcodes into “local” house markets may provide a solution. This analysis should also be applied to the data for the rest of the country, a further area of research. The importance of physical location variables confirms the importance of local or regional indices that can then be weighted to produce a national index.

Reference:

1. M.J. Bailey, R. F. Muth and H. O. Nourse, A Regression Method for Real Estate Price Index Construction, *Journal of the American Statistical Association*, **58**, 933-942, (1963).

2. T. Baker and D. Duffy, *House Price Index: Methodology Explained*, Dublin; Irish Permanent (1998).

3. A. Can and I. Megbolugbe, Spatial Dependence and House Price Index Construction, *Journal of Real Estate Finance and Economics*, **14**, 203-222. (1997).

4. B. Case, H. O. Pollakowski and S. M. Wachter, On Choosing among House Price Index Methodologies, *American Real Estate and Urban Economics Association Journal*, **19**, 286-307, (1991).

5. E.K. Case, and R.J. Schiller, Prices of Single Family Homes since 1970: New Indexes for Four Cities, *New England Economic Review*, September-October, 45-56, (1987).

6. D. Conniffe and D. Duffy *Irish House Price Indices: Methodological Issues* Economic and Social Review, **30**, 403-423, (1999).

7. T.M. Crone, and R. P. Voith, "Estimating House Price Appreciation: A Comparison of Methods", *Journal of Housing Economics*, **2**, 324-338, (1992).

8. Department of the Environment and Local Government, *Annual Housing Statistics Bulletin*, Dublin, Stationary Office, (1999).

9. M.C. Fleming and J. G. Nellis, *The Halifax House Price Index - Technical Details*, Halifax: Halifax Building Society, (1984).

10. M.C. Fleming and J. G. Nellis, The Application of Hedonic Indexing Methods: A Study of House Prices in the United Kingdom, *Statistical Journal of the United Nations*, ECE 3, 249-270, (1985).

11. M.C. Fleming and J. G. Nellis, Development of Standardised Indices for Measuring House Price Inflation Indexing Methods Incorporating Physical and Locational Characteristics, *Applied Economics*, **24**, 1067-1085, (1992).

12. D.H. Gatzlaff and D. C. Ling, Measuring Changes in Local House Prices: An Empirical Investigation of Alternative Methodologies, *Journal of Urban Economics*, **40**, 221-244, (1994).

13. Z. Griliches, Hedonic Price Indices for Automobiles, in Z. Griliches (ed.), "Price Indices and Quality Change: Studies in New Methods of Measurement", Cambridge: Harvard University Press, (1971).

14. K.A. Kiel and J.E. Zabel, House Price Differentials in U.S. Cities: Household and Neighbourhood Racial Effects *Journal of Housing Economics*, **5**, 143-165, (1996).

15. K.A. Kiel and J.E. Zabel, Evaluating the Usefulness of the American Housing Survey for Creating House Price Indices, *Journal of Real Estate Finance and Economics*, **14**, 189-202. (1997).

16. P. Linneman, Some Empirical Results on the Nature of the Hedonic Price Function for the Urban Housing Market *Journal of Urban Economics*, **8**, 47-68, (1980).

17. J.H. Mark and M.A. Goldberg, Alternative Housing Price Indices: An Evaluation, *American Real Estate and Urban Economics Association Journal*, **12**, 30-49, (1984).

18. E.S. Mills and R. Simenauer, New Hedonic Estimates of Regional Constant Quality House Prices, *Journal of Urban Economics*, **39**, 209-215, (1996).

19. R.B. Palmquist, Alternative Techniques for Developing Real Estate Price Indexes, *The Review of Economics and Statistics*, **3**, 442-448, (1980).

20. M.L. Wolverton and J. Senteza, Hedonic Estimates of Regional Constant Quality House Prices, *Journal of Real Estate Research*, **19,** 235-253, (2000).

21. J.E. Zabel, Controlling for Quality in House Price Indices, *Journal of Real Estate Finance and Economics*, **19**, 223-241, (1999).

Figure 1: Dublin City and County, Proportion of Transactions by Price Band

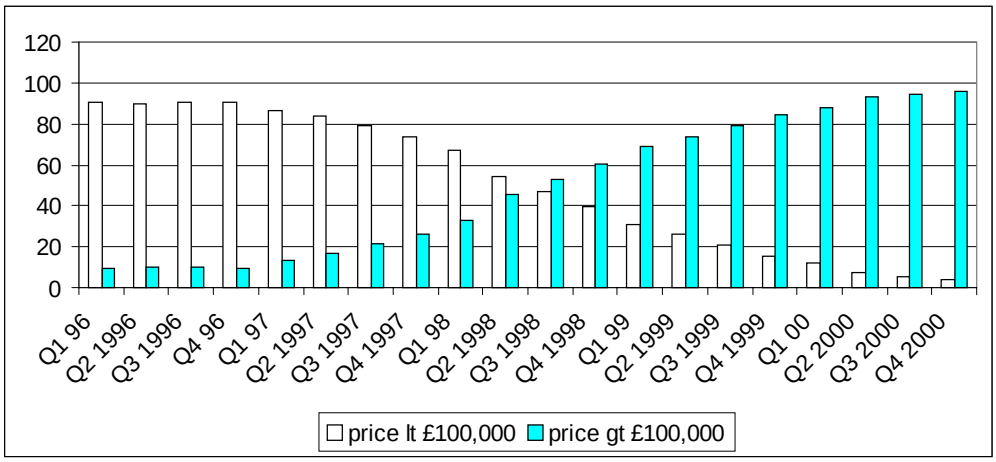

Table 1: Variables in the Database

| | |
|---|---|
| Addr1 | House name/number and street name |
| Addr2 | Street name |
| Addr3 | Town or city suburb |
| Addr4 | County name or post-code |
| Price | Price paid for the property |
| FTB | Records if the purchaser is a first-time buyer or not |
| Type | Type of house: Detached, Semi-Det.,Bungalow, Terraced, or Apartment |
| New | Records if the property is new or existing |
| RIPS | Records if the property is an investment property or not |
| Create | Date file created |
| Loanno | A unique reference number for each property |
| Funding | Date funding was drawn down by the purchaser |
| Loan Type | Identifies funding product for the Irish Permanent |
| Rooms | The number of living rooms |
| Beds | The number of bedrooms |
| Garage | Records if the property has a garage or not |
| Footage | The square footage of the dwelling |
| Heat | The type of heating in the property: Electricity, Gas, Oil, Solid, or None |
| Central | A dummy variable if the property is located in Dublin 1, Dublin 4, Dublin 2, Dublin 8, or Dublin 7 |
| CITYN | A dummy variable if the property is located in North Dublin City, outside of Central. |
| CITYS | A dummy variable if the property is located in South Dublin City, outside of Central. |
| COUNTYN | A dummy variable if the property is located in North Dublin County |
| COUNTYS | A dummy variable if the property is located in South Dublin County |
| SC | A social class dummy variable, taking the value of 1 if the proportion in social class 1 and 2 is less than 25 per cent. |
| Family | A dummy variable taking the value of 1 if the proportion of retired or “empty-nest” households with no children is greater than 20 per cent. |
| Ed21 | A dummy variable taking the value of 1 if over 50 per cent finished education aged over 21 years. |

Table 2: How Representative is the Sample

| | Sample | Total | | Sample | Total |
|---|---|---|---|---|---|
| *Characteristics* | % | % | *Period* | % | % |
| FTB | 33.7 | 35.8 | Q1 96 | 3.2 | 3.0 |
| New | 17.6 | 23.2 | Q2 1996 | 4.8 | 4.4 |
| Detached | 7.0 | 7.6 | Q3 1996 | 4.6 | 4.3 |
| Semi-Detached | 55.5 | 50.1 | Q4 96 | 3.3 | 3.1 |
| Bungalow | 2.6 | 2.9 | Q1 97 | 2.7 | 2.6 |
| Apt | 4.5 | 10.0 | Q2 1997 | 4.1 | 3.6 |
| Terraced | 30.3 | 29.4 | Q3 1997 | 4.2 | 4.1 |
| Garage | 11.7 | 13.5 | Q4 1997 | 2.4 | 2.5 |
| Oil | 18.4 | 17.0 | Q1 98 | 4.0 | 4.2 |
| Gas | 64.4 | 62.4 | Q2 1998 | 5.5 | 5.4 |
| Electricity | 11.1 | 14.5 | Q3 1998 | 6.8 | 6.4 |
| Solid fuel | 6.1 | 6.0 | Q4 1998 | 6.4 | 6.9 |
| *Average* | | | Q1 99 | 6.2 | 6.0 |
| Sq.footage | 1,054 | 1,045 | Q2 1999 | 7.0 | 6.8 |
| Price | 122,683 | 127,623 | Q3 1999 | 7.4 | 7.2 |
| | | | Q4 1999 | 7.0 | 7.0 |
| *Location* | % | % | Q1 00 | 4.6 | 4.7 |
| Central | 10.8 | 12.3 | Q2 2000 | 5.1 | 5.5 |
| CityN | 32.3 | 29.6 | Q3 2000 | 5.6 | 6.3 |
| CityS | 34.3 | 32.3 | Q4 2000 | 5.2 | 6.1 |
| CountyN | 10.6 | 11.8 | | | |
| CountyS | 11.6 | 12.6 | | | |

Table 3: Social Class Occupations, 1996 Census of Population, Ireland

| | |
|---|---|
| 1 | Professional Workers |
| 2 | Managerial and technical |
| 3 | Non-Manual |
| 4 | Skilled manual |
| 5 | Semi-skilled |
| 6 | Unskilled |
| 7 | All others gainfully occupied and unknown |

Source: Central Statistics Office

Table 4: *Regression Results, Regression based on Structural Characteristics, Postcode Location and Neighbourhood Quality (Dependent variable = log house price)*

| | **Q1 1996** | **Q2 1996** | **Q3 1996** | **Q4 1996** | **Q1 1997** | **Q2 1997** | **Q3 1997** | **Q4 1997** | **Q1 1998** | **Q2 1998** | **Q3 1998** | **Q4 1998** | **Q1 1999** | **Q2 1999** | **Q3 1999** | **Q4 1999** | **Q1 2000** | **Q2 2000** | **Q3 2000** | **Q4 2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 10.829 | 10.671 | 10.661 | 11.321 | 10.868 | 11.001 | 11.085 | 11.156 | 11.468 | 11.375 | 11.543 | 11.668 | 11.278 | 11.400 | 11.568 | 11.576 | 11.575 | 11.738 | 11.691 | 11.993 |
| FTBDV | -0.0942 | -0.103 | -0.0846 | -0.170 | -0.0913 | -0.0591 | -0.0626 | -0.0523 * | -0.0855 | -0.0945 | -0.100 | -0.117 | -0.0583 | -0.0435 | -0.0679 | -0.0541 | -0.0797 | -0.0453 | -0.0389 | -0.0458 |
| SDDV | -0.140 | -0.0829 | -0.0383 | -0.193 | -0.0558 * | -0.140 | -0.171 | -0.148 | -0.254 | -0.0755 | -0.174 | -0.203 | -0.1022 | -0.1500 | -0.1612 | -0.1657 | -0.1159 | -0.1954 | -0.1519 | -0.2117 |
| TCEDV | -0.239 | -0.158 | -0.135 * | -0.294 | -0.175 | -0.195 | -0.322 | -0.278 | -0.392 | -0.1485 | -0.260 | -0.255 | -0.1614 | -0.2066 | -0.1980 | -0.2121 | -0.1819 | -0.1695 | -0.1556 | -0.2762 |
| APTDV | -0.0302 * | 0.0486 * | 0.180 | -0.0557 * | 0.157 | 0.0112 * | 0.0062 * | -0.0487 * | -0.0361 * | 0.1975 | 0.0211 * | -0.137 | 0.2278 | 0.0699 * | 0.0901 | 0.0234 * | 0.1075 * | 0.0293 * | 0.1061 * | -0.1309 |
| NEWDV | 0.0485 | 0.0523 | 0.0483 | 0.101 | 0.0100 * | -0.0016 * | -0.0311 * | 0.0571 * | 0.0191 * | 0.0216 * | -0.0127 * | 0.0201 * | 0.0294 * | -0.0591 | 0.0214 * | 0.0103 * | -0.0483 * | -0.0183 * | 0.0082 * | 0.0244 * |
| FOOTAGE ('000) | 0.6105 | 0.6570 | 0.6465 | 0.1403 | 0.5512 | 0.5642 | 0.6200 | 0.6141 | 0.4395 | 0.4339 | 0.4993 | 0.4272 | 0.7199 | 0.6708 | 0.5818 | 0.5948 | 0.6681 | 0.5682 | 0.7004 | 0.4960 |
| GARDV | 0.0705 | 0.0945 | 0.0637 | 0.198 | 0.0254 * | 0.1004 | 0.0647 | 0.124 | 0.0354 * | 0.0323 * | 0.0514 | 0.0770 | 0.0185 * | 0.0344 * | 0.1207 | 0.1191 | 0.0647 | 0.1293 | 0.0179 * | 0.0588 |
| SOLDV | -0.115 | -0.102 | -0.0536 * | -0.117 | -0.0593 * | -0.0127 * | -0.151 | -0.158 | -0.1657 | -0.0661 * | -0.0572 * | -0.0863 | -0.0734 * | -0.0444 * | -0.1101 | 0.0014 * | -0.0544 * | -0.0757 | -0.0704 * | -0.106 |
| CITYN | -0.137 | -0.0249 * | -0.0596 * | -0.0285 * | -0.0547 * | -0.0928 | -0.0806 | -0.120 | -0.0324 * | -0.0565 * | -0.0981 | -0.0751 | -0.0885 | -0.0798 | -0.0910 | -0.0634 | -0.100 | -0.151 | -0.155 | -0.152 |
| CITYS | -0.159 | -0.0544 * | -0.129 | -0.0862 | -0.135 | -0.136 | -0.166 | -0.135 | -0.109 | -0.124 | -0.124 | -0.118 | -0.119 | -0.138 | -0.124 | -0.130 | -0.151 | -0.168 | -0.186 | -0.183 |
| COUNTYN | -0.182 | -0.126 | -0.151 | -0.108 | -0.116 | -0.224 | -0.263 | -0.317 | -0.186 | -0.177 | -0.207 | -0.236 | -0.189 | -0.209 | -0.191 | -0.220 | -0.243 | -0.263 | -0.296 | -0.301 |
| COUNTYS | -0.112 | -0.0785 * | -0.106 | -0.119 | -0.169 | -0.220 | -0.212 | -0.199 | -0.132 | -0.181 | -0.152 | -0.191 | -0.228 | -0.159 | -0.156 | -0.168 | -0.188 | -0.189 | -0.175 | -0.241 |
| FAMILY | 0.159 | 0.115 | 0.238 | 0.219 | 0.247 | 0.212 | 0.209 | 0.148 | 0.196 | 0.153 | 0.152 | 0.158 | 0.171 | 0.194 | 0.127 | 0.183 | 0.110 | 0.136 | 0.122 | 0.205 |
| SC | -0.297 | -0.277 | -0.297 | -0.260 | -0.231 | -0.250 | -0.253 | -0.293 | -0.288 | -0.302 | -0.301 | -0.291 | -0.249 | -0.240 | -0.266 | -0.274 | -0.286 | -0.227 | -0.259 | -0.229 |
| ED21 | -0.0133 * | -0.0016 * | 0.0461 | 0.0494 * | 0.0357 * | 0.0336 * | 0.0575 | 0.0246 * | -0.0116 * | 0.0357 * | 0.0392 | 0.0400 | 0.0377 | 0.0536 | 0.0183 * | 0.0231 * | 0.0217 * | 0.0422 | 0.0021 * | 0.0277 * |
| Adj. R squared | 0.685 | 0.656 | 0.653 | 0.521 | 0.551 | 0.589 | 0.661 | 0.602 | 0.618 | 0.489 | 0.588 | 0.564 | 0.608 | 0.66 | 0.653 | 0.667 | 0.604 | 0.577 | 0.665 | 0.595 |
| Std Error of the Estimate | 0.2204 | 0.2205 | 0.2355 | 0.2393 | 0.2343 | 0.2174 | 0.2243 | 0.2424 | 0.2234 | 0.2523 | 0.2453 | 0.2355 | 0.2164 | 0.2183 | 0.2196 | 0.2274 | 0.2353 | 0.214 | 0.2225 | 0.2124 |
| No. of cases | 450 | 637 | 641 | 460 | 362 | 520 | 584 | 338 | 588 | 763 | 888 | 935 | 834 | 954 | 1012 | 960 | 637 | 756 | 815 | 787 |

* indicates not significant at a 5% level

Table 5. Comparison of First-Time Buyers and Second-Time Buyers

| | First-Time Buyer % | Second-Time Buyer % |
|---|---|---|
| *Characteristics* | | |
| New | 34.9 | 13.5 |
| Detached | 3.6 | 8.1 |
| Semi-Detached | 53.4 | 54.3 |
| Bungalow | 2.0 | 2.4 |
| Apt | 6.8 | 6.5 |
| Terraced | 34.2 | 28.8 |
| Garage | 7.9 | 14.2 |
| Oil | 12.0 | 19.8 |
| Gas | 66.9 | 63.2 |
| Electricity | 13.5 | 11.6 |
| Solid fuel | 7.7 | 5.4 |
| | | |
| *Location* | | |
| Central | 10.8 | 10.8 |
| CityN | 33.5 | 32.0 |
| CityS | 32.8 | 34.8 |
| CountyN | 9.8 | 11.1 |
| CountyS | 12.9 | 10.9 |
| | | |
| *Average* | | |
| Sq.footage | 969 | 1,081 |
| Price (£) | 99,579 | 135,140 |

Table 6: *Regression Results for First-Time Buyers, Regression based on Structural Characteristics, Postcode Location and Neighbourhood Quality (Dependent variable = log house price)*

| | Q1 1996 | Q2 1996 | Q3 1996 | Q4 1996 | Q1 1997 | Q2 1997 | Q3 1997 | Q4 1997 | Q1 1998 | Q2 1998 | Q3 1998 | Q4 1998 | Q1 1999 | Q2 1999 | Q3 1999 | Q4 1999 | Q1 2000 | Q2 2000 | Q3 2000 | Q4 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 10.865 | 10.659 | 10.698 | 11.186 | 10.974 | 11.142 | 11.268 | 10.988 | 11.406 | 11.444 | 11.811 | 11.519 | 11.109 | 11.586 | 11.618 | 11.580 | 11.735 | 11.929 | 11.839 | 12.161 |
| SDDV | -0.1077 * | -0.0543 * | -0.0548 * | -0.2132 | 0.0838 * | -0.1706 | -0.2575 | -0.0156 * | -0.0718 * | -0.1646 | 0.0156 * | 0.0010 * | 0.0369 * | -0.1736 | -0.1183 * | -0.1858 | -0.1559 * | -0.1315 * | -0.1174 | -0.2020 |
| TCEDV | -0.2332 | -0.1607 | -0.1792 | -0.3425 | -0.1096 * | -0.2014 | -0.3994 | -0.1032 * | -0.2426 | -0.2905 | -0.1814 | -0.0859 * | -0.0234 * | -0.2596 | -0.2154 | -0.2241 | -0.3163 | -0.1790 | -0.1852 | -0.2755 |
| APTDV | -0.1211 * | -0.0363 * | 0.0580 * | -0.1115 * | 0.1142 * | -0.1335 * | -0.1738 * | 0.0835 * | 0.0520 * | 0.0561 * | -0.0533 * | 0.0101 * | 0.4180 | -0.0088 * | -0.0050 * | 0.0361 * | -0.1479 * | 0.0101 * | 0.0555 * | -0.2116 |
| NEWDV | 0.0500 * | 0.0546 * | 0.0942 | 0.1071 | 0.0552 * | 0.0544 * | 0.0070 * | 0.1136 | 0.0166 * | 0.0418 * | 0.0165 * | 0.0122 * | 0.0166 * | -0.0360 * | 0.0065 * | 0.0200 * | -0.0162 * | -0.0166 * | -0.0050 * | 0.0401 * |
| FOOTAGE (000) | 0.5000 | 0.5327 | 0.5458 | -0.0027 | 0.2539 | 0.3104 | 0.3686 | 0.4829 | 0.3207 | 0.3315 | 0.0026 | 0.2440 | 0.7274 | 0.4199 | 0.3756 | 0.5215 | 0.4065 | 0.2365 | 0.4160 | 0.3187 |
| GARDV | 0.0851 * | 0.1566 | 0.1051 | 0.1869 | -0.0350 * | 0.1193 * | 0.1855 | 0.1805 | 0.0838 | -0.0167 * | 0.1234 | 0.0420 * | 0.0642 * | 0.0475 * | 0.0914 * | 0.0585 * | 0.0757 * | 0.2109 | -0.0297 * | 0.1203 |
| SOLDV | -0.0954 | -0.0621 * | -0.0392 * | -0.1286 | -0.0659 * | 0.0608 * | -0.0506 * | -0.2525 | -0.2373 | -0.0326 * | -0.0901 * | -0.0905 | -0.0614 * | -0.1487 | -0.1694 | -0.0114 * | -0.1482 * | -0.1418 | -0.2112 | -0.0619 * |
| CITYN | -0.1050 * | 0.0340 * | -0.0780 * | 0.0822 * | -0.0648 * | -0.0494 * | -0.0628 * | -0.0891 * | -0.1296 | -0.1369 | -0.2557 | -0.1000 | -0.1393 | -0.0455 * | -0.0349 * | -0.0388 * | -0.1851 | -0.1650 | -0.1369 | -0.2417 |
| CITYS | -0.1900 | -0.0666 * | -0.1464 | -0.0031 * | -0.1481 | -0.1450 | -0.1053 | -0.1462 | -0.1843 | -0.1812 | -0.2310 | -0.1651 | -0.1576 | -0.1498 | -0.1042 | -0.0937 * | -0.2519 | -0.2028 | -0.1496 | -0.2575 |
| COUNTYN | -0.2142 | -0.0564 * | -0.1463 | 0.0504 * | -0.1564 * | -0.1946 | -0.2003 | -0.1763 * | -0.2443 | -0.1569 | -0.3722 | -0.1887 | -0.2200 | -0.0947 * | -0.0798 * | -0.1994 | -0.1654 * | -0.2280 | -0.2393 | -0.4025 |
| COUNTYS | -0.1470 | -0.0941 * | -0.1249 * | -0.0729 * | -0.2451 | -0.2092 | -0.2622 | -0.2282 | -0.2766 | -0.1616 | -0.3526 | -0.2785 | -0.2839 | -0.1802 | -0.1401 | -0.2941 | -0.2544 | -0.2217 | -0.2309 | -0.3549 |
| FAMILY | 0.0082 * | 0.1471 | 0.2388 | 0.2244 | 0.2728 | 0.2856 | 0.2177 | 0.1219 * | 0.1492 * | 0.2190 | 0.2447 | 0.2186 | 0.2907 | 0.1769 | 0.1898 | 0.2270 | 0.2417 | 0.0899 * | 0.1818 | 0.2342 |
| SC | -0.3166 | -0.2790 | -0.2750 | -0.1962 | -0.2445 | -0.2258 | -0.2245 | -0.2150 | -0.2606 | -0.2453 | -0.2363 | -0.2354 | -0.2768 | -0.1986 | -0.2229 | -0.2848 | -0.1204 | -0.1551 | -0.1967 | -0.2121 |
| ED21 | -0.0341 * | -0.0098 * | 0.0161 * | 0.0931 | 0.0466 * | 0.0527 * | 0.0887 | 0.0392 * | -0.0052 * | 0.1060 | 0.1052 | 0.0982 | 0.0799 | 0.0569 | 0.0388 * | 0.0728 * | 0.1211 | 0.0750 | 0.0574 | 0.0448 * |
| Adj. R squared | 0.5680 | 0.5350 | 0.5380 | 0.4300 | 0.3590 | 0.4250 | 0.5050 | 0.5080 | 0.4880 | 0.4390 | 0.3930 | 0.4330 | 0.5660 | 0.4510 | 0.4430 | 0.4790 | 0.3740 | 0.3610 | 0.4520 | 0.4630 |
| Std Error of the Estimate | 0.2180 | 0.2208 | 0.2404 | 0.2335 | 0.2372 | 0.2196 | 0.2041 | 0.2176 | 0.1916 | 0.2151 | 0.2302 | 0.2144 | 0.2076 | 0.2224 | 0.2115 | 0.2244 | 0.2480 | 0.1959 | 0.1800 | 0.1946 |
| No. of cases | 224 | 306 | 289 | 237 | 167 | 201 | 247 | 140 | 219 | 273 | 317 | 318 | 294 | 278 | 253 | 245 | 164 | 217 | 278 | 328 |

* indicates not significant at a 5% level

Table 7: *Regression Results for Second-Time Buyers, Regression based on Structural Characteristics, Postcode Location and Neighbourhood Quality (Dependent variable = log house price)*

| | **Q1 1996** | **Q2 1996** | **Q3 1996** | **Q4 1996** | **Q1 1997** | **Q2 1997** | **Q3 1997** | **Q4 1997** | **Q1 1998** | **Q2 1998** | **Q3 1998** | **Q4 1998** | **Q1 1999** | **Q2 1999** | **Q3 1999** | **Q4 1999** | **Q1 2000** | **Q2 2000** | **Q3 2000** | **Q4 2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 10.783 | 10.628 | 10.583 | 11.245 | 10.937 | 10.977 | 11.105 | 11.259 | 11.382 | 11.367 | 11.434 | 11.684 | 11.310 | 11.369 | 11.515 | 11.554 | 11.511 | 11.642 | 11.657 | 11.922 |
| SDDV | -0.1503 | -0.0822 | -0.0168 * | -0.1854 | -0.1387 | -0.1158 | -0.1541 | -0.1618 | -0.2489 | -0.0572 * | -0.1635 | -0.2568 | -0.1427 | -0.1373 | -0.1458 | -0.1562 | -0.1024 | -0.2146 | -0.1462 | -0.2239 |
| TCEDV | -0.2293 | -0.1137 | -0.0983 | -0.2585 | -0.2160 | -0.1927 | -0.3444 | -0.3424 | -0.3525 | -0.1091 | -0.2104 | -0.3032 | -0.2034 | -0.1911 | -0.1712 | -0.2062 | -0.1407 | -0.1548 | -0.1453 | -0.2962 |
| APTDV | 0.0347 * | 0.1507 | 0.2565 | 0.0278 * | 0.1049 * | 0.0667 * | 0.0020 * | -0.1239 * | 0.0101 * | 0.2269 | 0.0888 * | -0.1897 | 0.1660 | 0.0864 * | 0.1406 | 0.0325 * | 0.1885 | 0.0524 * | 0.1466 | -0.1299 * |
| NEWDV | 0.0208 * | 0.0889 | 0.0012 * | 0.0725 * | -0.0369 * | -0.0207 * | -0.0272 * | 0.0363 * | 0.0263 * | 0.0071 * | -0.0067 * | 0.0303 * | 0.0625 | -0.0810 | 0.0134 * | 0.0113 * | -0.0454 * | 0.0227 * | -0.0164 * | 0.0352 * |
| FOOTAGE ('000) | 0.6745 | 0.6878 | 0.6881 | 0.3268 | 0.5818 | 0.5876 | 0.6361 | 0.6454 | 0.4701 | 0.4337 | 0.5777 | 0.4742 | 0.7203 | 0.6908 | 0.6098 | 0.6090 | 0.7020 | 0.6835 | 0.7343 | 0.5072 |
| GARDV | 0.0807 | 0.1085 | 0.0478 * | 0.1901 | 0.0423 * | 0.0988 | 0.0349 * | 0.0861 * | 0.0122 * | 0.0496 * | 0.0284 * | 0.0719 | 0.0154 * | 0.0254 * | 0.1263 | 0.1236 | 0.0512 * | 0.1278 | 0.0409 * | 0.0486 * |
| SOLDV | -0.1253 | -0.1474 | -0.0654 | -0.0753 * | -0.0575 * | -0.0403 * | -0.1778 | -0.1599 | -0.1353 | -0.0694 * | -0.0361 * | -0.0814 * | -0.0927 * | 0.0040 * | -0.0471 * | 0.0051 * | -0.0048 * | -0.0179 * | 0.0484 * | -0.2014 |
| CITYN | -0.2244 | -0.0789 | -0.0381 * | -0.1005 * | -0.0824 * | -0.1022 | -0.0906 * | -0.1879 | 0.0027 * | -0.0243 * | -0.0492 * | -0.0674 * | -0.0674 * | -0.0790 | -0.0949 | -0.0690 | -0.0648 * | -0.1433 | -0.1403 | -0.0591 * |
| CITYS | -0.1935 | -0.0659 * | -0.1099 | -0.1753 | -0.1760 | -0.1244 | -0.2157 | -0.1716 | -0.0842 * | -0.1046 | -0.0859 | -0.0905 | -0.0976 | -0.1173 | -0.1189 | -0.1338 | -0.1062 | -0.1589 | -0.1723 | -0.1006 |
| COUNTYN | -0.2317 | -0.2152 | -0.1437 | -0.2554 | -0.1260 * | -0.2370 | -0.3081 | -0.4561 | -0.1550 | -0.1852 | -0.1609 | -0.2621 | -0.1815 | -0.2277 | -0.2136 | -0.2287 | -0.2305 | -0.2634 | -0.2972 | -0.2024 |
| COUNTYS | -0.1573 | -0.0164 * | -0.0804 * | -0.1481 | -0.1794 | -0.2085 | -0.1884 | -0.2604 | -0.0256 * | -0.2076 | -0.1004 | -0.1718 | -0.2170 | -0.1352 | -0.1260 | -0.1124 | -0.1449 | -0.1794 | -0.1398 | -0.1104 |
| FAMILY | 0.2283 | 0.1022 | 0.2315 | 0.1801 | 0.2119 | 0.1789 | 0.2177 | 0.1383 * | 0.2281 | 0.1250 | 0.1223 | 0.1459 | 0.1165 | 0.2047 | 0.1197 | 0.1754 | 0.0928 | 0.0966 | 0.0899 | 0.2103 |
| SC | -0.3041 | -0.2746 | -0.3147 | -0.3354 | -0.2281 | -0.2731 | -0.2695 | -0.3586 | -0.3039 | -0.3262 | -0.3241 | -0.3168 | -0.2369 | -0.2624 | -0.2736 | -0.2717 | -0.3228 | -0.2506 | -0.2874 | -0.2537 |
| ED21 | 0.0234 * | 0.0291 * | 0.0669 | -0.0103 * | 0.0304 * | 0.0327 * | 0.0479 * | 0.0220 * | 0.0110 * | 0.0096 * | 0.0108 * | 0.0122 * | 0.0128 * | 0.0542 | 0.0232 * | 0.0165 * | 0.0025 * | 0.0256 * | -0.0179 * | 0.0262 * |
| Adj. R squared | 0.7110 | 0.7120 | 0.6840 | 0.5900 | 0.6030 | 0.6120 | 0.7000 | 0.6260 | 0.6260 | 0.4770 | 0.6210 | 0.5760 | 0.6050 | 0.6980 | 0.6620 | 0.6860 | 0.6350 | 0.6270 | 0.6910 | 0.6230 |
| Std Error of the Estimate | 0.2258 | 0.2091 | 0.2327 | 0.2400 | 0.2349 | 0.2237 | 0.2342 | 0.2556 | 0.2410 | 0.2566 | 0.2447 | 0.2429 | 0.2185 | 0.2175 | 0.2239 | 0.2296 | 0.2296 | 0.2175 | 0.2352 | 0.2190 |
| No. of cases | 227 | 330 | 352 | 225 | 196 | 321 | 338 | 198 | 370 | 492 | 570 | 619 | 540 | 678 | 761 | 716 | 474 | 540 | 537 | 459 |

- indicates not significant at a 5% level

Figure 2: Annual Quarter on Quarter Growth Rate

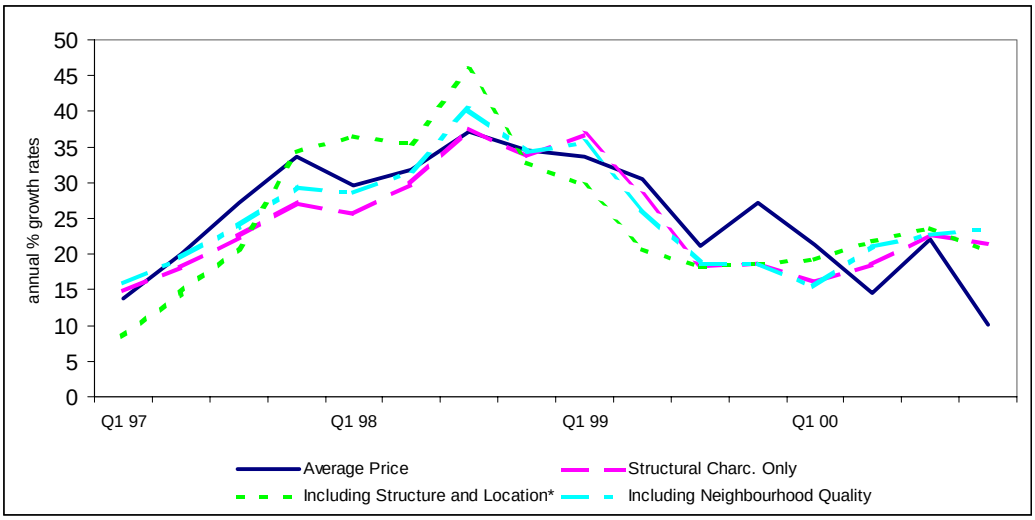

Table 8: Measurement of Bias by Type of Buyer

| **Total Market** | **Q2 1996** | **Q3 1996** | **Q4 1996** | **Q1 1997** | **Q2 1997** | **Q3 1997** | **Q4 1997** | **Q1 1998** | **Q2 1998** | **Q3 1998** | **Q4 1998** | **Q1 1999** | **Q2 1999** | **Q3 1999** | **Q4 1999** | **Q1 2000** | **Q2 2000** | **Q3 2000** | **Q4 2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change in average price | 1.8 | 2.7 | 0.2 | 8.6 | 7.5 | 8.8 | 5.1 | 5.4 | 9.3 | 13.3 | 3.1 | 4.7 | 6.7 | 5.2 | 8.2 | -0.2 | 0.7 | 12.1 | -2.3 |
| Pure Price change | 4.2 | 1.7 | 3.1 | 6.1 | 7.3 | 5.5 | 7.7 | 5.4 | 9.8 | 12.4 | 3.3 | 6.4 | 2.2 | 5.7 | 3.3 | 3.5 | 7.3 | 7.2 | 3.9 |
| Change due to NQ | -1.3 | -2.9 | -1.9 | -0.8 | 1.5 | -1.3 | 4.8 | 1.6 | -1.9 | -0.3 | -0.6 | -2.1 | -1.6 | 4.2 | -0.4 | 1.3 | -4.5 | 4.4 | -3.7 |
| Change due to SC | -1.1 | 3.8 | -1.0 | 3.4 | -1.3 | 4.6 | -7.4 | -1.6 | 1.3 | 1.2 | 0.5 | 0.5 | 6.0 | -4.7 | 5.3 | -5.0 | -2.0 | 0.6 | -2.5 |
| SC, NQ$^{na}$ | 2.9 | -1.1 | 1.2 | 5.3 | 8.8 | 4.2 | 12.6 | 7.0 | 7.9 | 12.2 | 2.6 | 4.3 | 0.7 | 9.9 | 2.9 | 4.8 | 2.8 | 11.6 | 0.2 |
| SC | 5.3 | 1.9 | 2.0 | 4.4 | 8.9 | 4.2 | 7.8 | 3.3 | 12.4 | 11.4 | 3.3 | 5.9 | 4.4 | 4.5 | 3.4 | 2.6 | 8.3 | 7.4 | 2.4 |
| Bias (SC-SC, NQ$^{na}$) | 2.4 | 3.0 | 0.8 | -0.8 | 0.1 | 0.0 | -4.8 | -3.7 | 4.4 | -0.8 | 0.7 | 1.7 | 3.7 | -5.5 | 0.4 | -2.2 | 5.5 | -4.2 | 2.1 |
| **FTB Market** | **Q2 1996** | **Q3 1996** | **Q4 1996** | **Q1 1997** | **Q2 1997** | **Q3 1997** | **Q4 1997** | **Q1 1998** | **Q2 1998** | **Q3 1998** | **Q4 1998** | **Q1 1999** | **Q2 1999** | **Q3 1999** | **Q4 1999** | **Q1 2000** | **Q2 2000** | **Q3 2000** | **Q4 2000** |
| Change in average price | 2.4 | 3.7 | 1.7 | 8.1 | 10.9 | 3.2 | 8.1 | 1.7 | 14.0 | 3.3 | 6.0 | 10.4 | 2.8 | 2.0 | 8.4 | -0.3 | 3.5 | 8.2 | 5.6 |
| Pure Price change | 4.3 | 2.6 | 2.2 | 6.3 | 9.9 | 5.8 | 4.1 | 5.6 | 13.4 | 6.3 | 5.1 | 10.5 | -0.1 | 5.4 | 5.8 | 0.6 | 8.2 | 6.7 | 7.7 |
| Change due to NQ | -4.4 | -2.3 | -8.2 | 5.3 | -1.5 | -1.7 | 3.1 | 5.1 | -8.3 | -0.6 | 0.6 | 3.0 | -2.0 | 2.4 | 1.1 | -10.9 | 6.1 | 2.8 | 1.3 |
| Change due to SC | 2.5 | 3.5 | 7.6 | -3.5 | 2.5 | -0.9 | 0.9 | -9.1 | 8.9 | -2.4 | 0.4 | -3.2 | 4.9 | -5.7 | 1.5 | 9.9 | -10.8 | -1.3 | -3.4 |
| SC, NQ$^{na}$ | -0.1 | 0.3 | -6.0 | 11.5 | 8.3 | 4.1 | 7.2 | 10.7 | 5.1 | 5.7 | 5.6 | 13.6 | -2.1 | 7.7 | 7.0 | -10.2 | 14.2 | 9.5 | 9.0 |
| SC | 4.0 | 1.9 | 2.8 | 5.0 | 13.1 | 1.9 | 5.6 | 2.7 | 15.4 | 5.7 | 4.0 | 10.6 | 3.9 | 2.7 | 3.0 | 2.7 | 9.5 | 6.4 | 5.6 |
| Bias (SC-SC, NQ$^{na}$) | 4.1 | 1.7 | 8.8 | -6.5 | 4.8 | -2.2 | -1.6 | -8.0 | 10.3 | 0.0 | -1.6 | -2.9 | 6.0 | -5.1 | -4.0 | 12.9 | -4.7 | -3.1 | -3.4 |
| **STB Market** | **Q2 1996** | **Q3 1996** | **Q4 1996** | **Q1 1997** | **Q2 1997** | **Q3 1997** | **Q4 1997** | **Q1 1998** | **Q2 1998** | **Q3 1998** | **Q4 1998** | **Q1 1999** | **Q2 1999** | **Q3 1999** | **Q4 1999** | **Q1 2000** | **Q2 2000** | **Q3 2000** | **Q4 2000** |
| Change in average price | 0.1 | 1.1 | 3.9 | 3.6 | 4.4 | 12.7 | 4.1 | 6.0 | 6.3 | 16.3 | 3.2 | 2.3 | 6.4 | 5.3 | 7.6 | 0.5 | 0.7 | 15.2 | -3.6 |
| Pure Price change | 6.2 | 0.0 | 4.2 | 5.8 | 1.7 | 6.6 | 7.6 | 6.4 | 8.1 | 15.2 | 3.6 | 3.4 | 2.8 | 5.9 | 2.5 | 6.1 | 6.3 | 5.5 | 1.5 |
| Change due to NQ | -0.5 | -1.7 | 6.6 | -7.7 | 2.3 | -1.5 | 7.0 | -2.8 | 2.3 | -0.2 | -0.7 | -3.4 | -2.3 | 3.4 | -0.2 | 4.3 | -4.9 | 4.7 | -5.3 |
| Change due to SC | -5.6 | 2.8 | -6.9 | 5.5 | -3.2 | 7.6 | -10.5 | 2.4 | -4.0 | 1.3 | 0.3 | 2.3 | 5.9 | -4.0 | 5.3 | -9.9 | -0.7 | 5.1 | 0.1 |
| SC, NQ$^{na}$ | 5.7 | -1.7 | 10.8 | -2.0 | 7.6 | 5.1 | 14.6 | 3.6 | 10.4 | 15.1 | 2.9 | 0.0 | 0.6 | 9.4 | 2.3 | 10.4 | 1.4 | 10.2 | -3.8 |
| SC | 7.3 | 1.2 | 1.9 | 3.3 | 5.7 | 8.0 | 0.0 | 11.0 | 10.9 | 14.8 | 3.6 | 3.2 | 3.4 | 5.9 | 2.6 | 5.0 | 7.2 | 5.1 | 2.0 |
| Bias (SC-SC, NQ$^{na}$) | 1.6 | 2.9 | -8.8 | 5.2 | -2.0 | 2.9 | -14.6 | 7.4 | 0.6 | -0.2 | 0.7 | 3.2 | 2.8 | -3.5 | 0.3 | -5.4 | 5.7 | -5.1 | 5.7 |

SC = Structural Characteristics, NQ= Neighbourhood quality, na indicates variables has been controlled for but not accounted for

Table 9: Change in Return on Property Characteristics by Different Buyer

| Total | Pure price change | Due to Neighbourhood quality | Due to Structural Characteristics | Overall Growth Rate |
|---|---|---|---|---|
| Q2 1996 | 4.2 | -1.3 | -1.1 | 1.8 |
| Q3 1996 | 1.7 | -2.9 | 3.8 | 2.7 |
| Q4 96 | 3.1 | -1.9 | -1.0 | 0.2 |
| Q1 97 | 6.1 | -0.8 | 3.4 | 8.6 |
| Q2 1997 | 7.3 | 1.5 | -1.3 | 7.5 |
| Q3 1997 | 5.5 | -1.3 | 4.6 | 8.8 |
| Q4 1997 | 7.7 | 4.8 | -7.4 | 5.1 |
| Q1 98 | 5.4 | 1.6 | -1.6 | 5.4 |
| Q2 1998 | 9.8 | -1.9 | 1.3 | 9.3 |
| Q3 1998 | 12.4 | -0.3 | 1.2 | 13.3 |
| Q4 1998 | 3.3 | -0.6 | 0.5 | 3.1 |
| Q1 99 | 6.4 | -2.1 | 0.5 | 4.7 |
| Q2 1999 | 2.2 | -1.6 | 6.0 | 6.7 |
| Q3 1999 | 5.7 | 4.2 | -4.7 | 5.2 |
| Q4 1999 | 3.3 | -0.4 | 5.3 | 8.2 |
| Q1 00 | 3.5 | 1.3 | -5.0 | -0.2 |
| Q2 2000 | 7.3 | -4.5 | -2.0 | 0.7 |
| Q3 2000 | 7.2 | 4.4 | 0.6 | 12.1 |
| Q4 2000 | 3.9 | -3.7 | -2.5 | -2.3 |

| First time Buyer | Pure price change | Due to Neighbourhood quality | Due to Structural Characteristics | Overall Growth Rate |
|---|---|---|---|---|
| Q2 1996 | 4.3 | -4.4 | 2.5 | 2.4 |
| Q3 1996 | 2.6 | -2.3 | 3.5 | 3.7 |
| Q4 96 | 2.2 | -8.2 | 7.6 | 1.7 |
| Q1 97 | 6.3 | 5.3 | -3.5 | 8.1 |
| Q2 1997 | 9.9 | -1.5 | 2.5 | 10.9 |
| Q3 1997 | 5.8 | -1.7 | -0.9 | 3.2 |
| Q4 1997 | 4.1 | 3.1 | 0.9 | 8.1 |
| Q1 98 | 5.6 | 5.1 | -9.1 | 1.7 |
| Q2 1998 | 13.4 | -8.3 | 8.9 | 14.0 |
| Q3 1998 | 6.3 | -0.6 | -2.4 | 3.3 |
| Q4 1998 | 5.1 | 0.6 | 0.4 | 6.0 |
| Q1 99 | 10.5 | 3.0 | -3.2 | 10.4 |
| Q2 1999 | -0.1 | -2.0 | 4.9 | 2.8 |
| Q3 1999 | 5.4 | 2.4 | -5.7 | 2.0 |
| Q4 1999 | 5.8 | 1.1 | 1.5 | 8.4 |
| Q1 00 | 0.6 | -10.9 | 9.9 | -0.3 |
| Q2 2000 | 8.2 | 6.1 | -10.8 | 3.5 |
| Q3 2000 | 6.7 | 2.8 | -1.3 | 8.2 |
| Q4 2000 | 7.7 | 1.3 | -3.4 | 5.6 |

| Second time Buyer | Pure price change | Due to Neighbourhood quality | Due to Structural Characteristics | Overall Growth Rate |
|---|---|---|---|---|
| Q2 1996 | 6.2 | -0.5 | -5.6 | 0.1 |
| Q3 1996 | 0.0 | -1.7 | 2.8 | 1.1 |
| Q4 96 | 4.2 | 6.6 | -6.9 | 3.9 |
| Q1 97 | 5.8 | -7.7 | 5.5 | 3.6 |
| Q2 1997 | 5.3 | 2.3 | -3.2 | 4.4 |
| Q3 1997 | 6.6 | -1.5 | 7.6 | 12.7 |
| Q4 1997 | 7.6 | 7.0 | -10.5 | 4.1 |
| Q1 98 | 6.4 | -2.8 | 2.4 | 6.0 |
| Q2 1998 | 8.1 | 2.3 | -4.0 | 6.3 |
| Q3 1998 | 15.2 | -0.2 | 1.3 | 16.3 |
| Q4 1998 | 3.6 | -0.7 | 0.3 | 3.2 |
| Q1 99 | 3.4 | -3.4 | 2.3 | 2.3 |
| Q2 1999 | 2.8 | -2.3 | 5.9 | 6.4 |
| Q3 1999 | 5.9 | 3.4 | -4.0 | 5.3 |
| Q4 1999 | 2.5 | -0.2 | 5.3 | 7.6 |
| Q1 00 | 6.1 | 4.3 | -9.9 | 0.5 |
| Q2 2000 | 6.3 | -4.9 | -0.7 | 0.7 |
| Q3 2000 | 5.5 | 4.7 | 5.1 | 15.2 |
| Q4 2000 | 1.5 | -5.3 | 0.1 | -3.6 |