# THE USE OF LOCATION VARIABLES IN A MIX-ADJUSTED INDEX FOR DUBLIN HOUSE PRICES[1]

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*Introduction*

The rapid increase in house prices that has occurred in Ireland in recent years has focused attention on the methodology used to measure the change. Traditionally measurement of the change in Irish house prices has been based on an average price compiled by the Department of the Environment. While this is the simplest method it does suffer the drawback that a change in the type of houses sold in a particular period will influence the mean and so the measure may reflect this change rather than an actual change in price. Recognition of 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 (1984, 1985, 1992) include regional location variables. This paper examines the impact of including data from the census to measure neighbourhood characteristics.

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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 (1985) 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".

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.

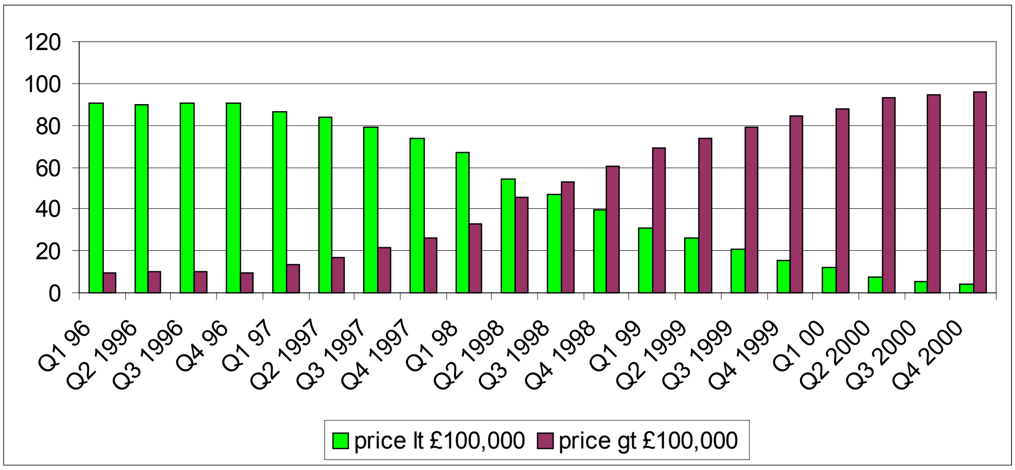
***Why is there a need to mix-adjust***

For many years trends in house prices were measured by the Department of the Environment Housing Statistics which 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 and so reported changes in house prices could be distorted by this. As the Department themselves point out at the start of their Bulletin "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 (1985, 1992) compare an index based on average house prices for the UK and standardised prices based on the hedonic approach and conclude that use of an average to measure price change is misleading. Mark and Goldberg

(1984) state, referring to analysis of the mean price they undertook of US data, "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, 1987, Gandzlaff and Ling, 1994, Wolverton and Senteza, 2000).

Using data for Dublin from the Irish Permanent 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, and 90.6 per cent had a price less 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.

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




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. The proportion of first-time buyers has declined from nearly 48 per cent of buyers to 42.5 per cent. The proportion of semi-detached and terraced houses has increased, while to proportion of apartments and bungalows has declined. The proportion of new houses has fallen from 34.4 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 7.8 per cent of transactions, those with solid heating also declined to 4.1 per cent, while houses with gas heating or oil heating have increased as a proportion of transactions. These figures point to changes in the quality of housing sold which needs to be accounted for in measuring price change.

A substantial amount of literature has developed on the construction of alternative measures of price change in the housing market[3]. 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, 1971). 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.

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. There has been some debate that, strictly, these are not hedonic characteristics. However, 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.

***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 (1980) 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 (1993) 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".

Hedonic house price indices have also been developed for the UK market. Fleming and Nellis (1984) compiled a mix-adjusted index for the Halifax Building Society in the UK. The authors were 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 (1985) 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,

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[3] A number of articles review the alternative measures. For example see Case, Pollakowski, and

modern family housing, higher incomes better-off council estates and multiracial areas[4]. 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).

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 (1980) 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 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".

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Wachter (1991) or Conniffe and Duffy (1999).

[4] 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 aggregate 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 estates; less well-off council estates; poorest council estates; multiracial areas; high status non-family areas; affluent suburban housing; and, better-off retirement areas.

Kiel and Zabel (1996) 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. Zabel (1999) 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 both structural characteristics and neighbourhood quality should be taken account of. 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, with the log of median income having the largest t-statistic.

***The Data set***

The data set used in estimating the models in this paper is taken from housing transactions on the Irish Permanent database that occurred in Dublin City and County. 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. The results are based on separate regressions for each area (Dublin, rest of country, and national), buyer type (first-time buyer or second-time buyer), or house type (new or existing). The published index is a 3-month moving average. The indices are constructed using a "hedonic" price methodology[5].

The existing dataset contains structural details of the property and if the purchaser is a first-buyer or not. Location is recorded in four address fields. These address fields are used to allocate properties a location dummy variable equal to 1 if located in Central Dublin[6] and 0 otherwise.

However, to date details have not been collected on the characteristics of the neighbourhood in which the property is located. To assess the impact of the immediate neighbourhood quality on house prices in Dublin Small Area Population Statistics 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. Properties are allocated a DED via a coding system that matches addresses to their DED. This process resulted in a sample of 9,314 properties, nearly 52 per cent of the original dataset.

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 A1 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

[5] A detailed outline of the methodology underpinning the Irish Permanent Index is given in Baker and Duffy, 1998 and Conniffe and Duffy, 1999.

measures of neighbourhood quality are available, some of which would be similar to those used in the international literature. For the purposes of this article neighbourhood quality is measured by the proportion of households with no children that are retired or “empty-nests”. The higher the proportion here the more mature and established the neighbourhood.

Irish census data defines social class group on the basis of occupation (see Table 2). 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).

*Table 2: Social Class Occupations, 1996 Census of Population*

| | |
|---|---|
| 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

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.

***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.

$$\text{Log P} = a + b_1\text{FTBDV} + b_2\text{SDDV} + b_3\text{TCEDV} + b_4\text{APTDV} + b_5\text{NEWDV} + b_6\text{FOOTAGE} + b_7\text{GARDV} + b_8\text{SOLDV} \quad (1)$$

where FTBDV records if the purchaser is a first-time buyer; SDDV if the house is semi-detached; TCEDV if the house is terraced; APTDV if the property is an apartment; NEWDV if the house is

[6] Central Dublin is defined for this paper as the following postcodes: Dublin 1, Dublin 7, Dublin 8, Dublin 2, Dublin 4, and Dublin 6

new; FOOTAGE is the square footage of the property; GARDV if the property has a garage; SOLDV if the property uses solid fuel. On average, this model explains only 51 per cent of house price variation. 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. The base house is assumed to have no garage. Square footage is the most significant explanatory variable and in general the coefficients have the expected sign i.e. possession of a garage, GARDV, has a positive coefficient whereas use of solid fuel, SOLDV, has a negative coefficient (see Table A2).

Following the methodology of Fleming and Nellis (1984, 1985) 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 by including a dummy variable for Central Dublin. Model (2) is a hedonic regression including a measure of location.

$$\text{Log P} = a + b_1\text{FTBDV} + b_2\text{SDDV} + b_3\text{TCEDV} + b_4\text{APTDV} + b_5\text{NEWDV} + b_6\text{FOOTAGE} + b_7\text{GARDV} + b_8\text{SOLDV} + b_9\text{CENTRAL} \quad (2)$$

where CENTRAL is a dummy variable if the property is located in Central Dublin and the other variables are as defined above. As before, the square footage of the house, and now the location of the property are important in explaining the change in the house price. On average this equation explains 54 per cent of the variation in house price on a quarterly basis, ranging from 40 per cent to 65 per cent. A detailed table showing the results for the second quarter of each year is given in appendix Table A3.

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

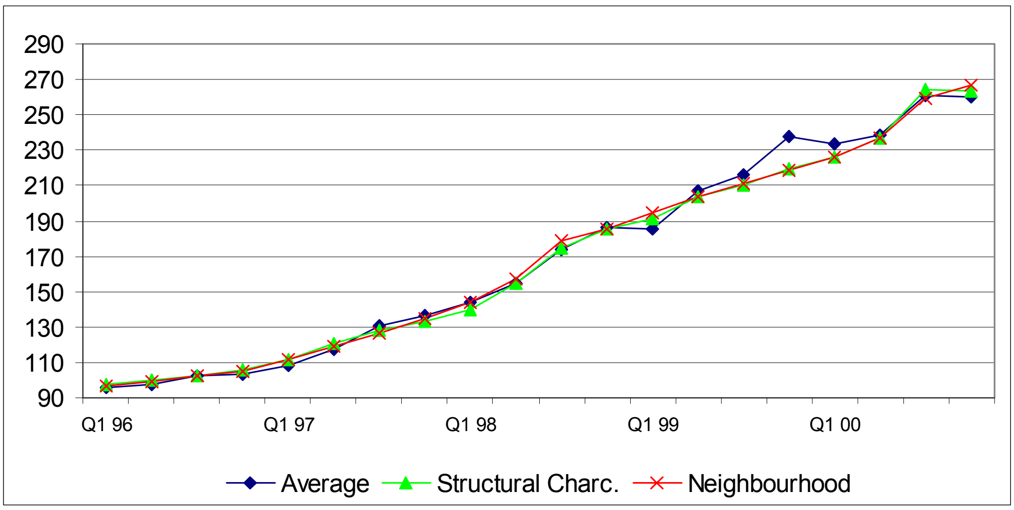
$$\text{Log P} = a + b_1\text{FTBDV} + b_2\text{SDDV} + b_3\text{TCEDV} + b_4\text{APTDV} + b_5\text{NEWDV} + b_6\text{FOOTAGE} + b_7\text{GARDV} + b_8\text{SOLDV} + b_9\text{CENTRAL} + b_{10}\text{SC} + b_{11}\text{FAMILY} \quad (3)$$

The inclusion of neighbourhood quality measures results in an improvement in the amount of house price variation explained. Use of structural, location and neighbourhood quality explains an average of 63 per cent, ranging from 50 per cent to 71 per cent. Coefficients and t statistics are given in appendix table A4. In general both 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.

***Summary of findings***

Not unexpectedly, the different approaches outlined in this paper all agree in showing rapidly increasing house prices in Dublin since 1996, and the indices are shown in Figure 4.Until the fourth quarter 1998, the three different measures move closely together, but thereafter the measures show diverging trends. For much of the period from quarter 1, 1999 to quarter 4, 2000, the index based on average price shows stronger growth than either of the mix-adjusted indices, while the index based on structural characteristics shows the lowest appreciation. In common with the average price, the model using structural characteristics shows a marginal decline in house price growth in Dublin in the latter half of 2000. In contrast, when neighbourhood quality is included there is no evidence as yet of an easing in house price growth.

***Figure 4: House Price Indices for Dublin, 1996=100***



Results from the different models show that, generally, inclusion of neighbourhood quality results in a higher adjusted R squared. In some cases, the adjusted R squared value may appear low, although this is typical of studies using cross-sectional data. Table A5 also reports 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.

Zabel (1999) suggests that the calculation of indices based initially on structural characteristics and then on both structural characteristics and neighbourhood quality allows the decomposition of the growth rate in house prices into its component parts – 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). The first column in Table 3 gives the growth rate based on the average house price and shows how this growth rate can be decomposed into the different components. The pure price change takes account of both structural and neighbourhood quality. In some cases the difference between the average price change and the pure price change can be quite large.

*Table 3: Dublin City and County House Price Change, Q2 1996 to Q4 2000*

| | Average | Pure price change | Due to Neighbourhood quality | Due to Structural Characteristics |
|---|---|---|---|---|
| Q2 1996 | 1.7 | 3.0 | -0.6 | -0.8 |
| Q3 1996 | 4.4 | 3.3 | -0.9 | 2.0 |
| Q4 96 | 0.9 | 2.4 | 0.6 | -2.1 |
| Q1 97 | 5.0 | 6.3 | -0.9 | -0.5 |
| Q2 1997 | 8.6 | 6.8 | 1.9 | -0.1 |
| Q3 1997 | 11.6 | 6.1 | -0.5 | 6.0 |
| Q4 1997 | 4.4 | 6.6 | -2.5 | 0.3 |
| Q1 98 | 5.1 | 6.8 | -1.7 | 0.0 |
| Q2 1998 | 7.6 | 9.3 | 1.0 | -2.7 |
| Q3 1998 | 12.2 | 13.5 | -0.2 | -1.2 |
| Q4 1998 | 7.2 | 3.7 | 2.5 | 0.9 |
| Q1 99 | -0.2 | 4.9 | -2.0 | -3.2 |
| Q2 1999 | 11.8 | 4.5 | 1.9 | 5.4 |
| Q3 1999 | 4.1 | 3.6 | -0.2 | 0.6 |
| Q4 1999 | 9.9 | 3.7 | 0.4 | 5.8 |
| Q1 00 | -1.4 | 3.6 | -0.3 | -4.7 |
| Q2 2000 | 2.1 | 4.6 | 0.0 | -2.5 |
| Q3 2000 | 9.2 | 9.7 | 2.1 | -2.6 |
| Q4 2000 | -0.2 | 2.8 | -3.1 | 0.2 |

### *Conclusions*

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 SAPS data from the 1996 Census. The results confirm for the Dublin market the experience of the US and UK literature that physical and neighbourhood location influence price. However, once again it must 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.

Other possible SAPS data that could be used includes type of household, employment status, employment sector, socio-economic group or level of education. The use of these is worth further exploration. As outlined above, some of the US literature uses a number of alternative census variables to explain neighbourhood characteristics.

The neighbourhood data has been assigned to each property by allocating different addresses or areas to relevant DEDs. The fact that DED and postcode boundaries do not coincide, or that DEDs can have streets as their boundaries 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. The above analysis is based on a sample. More accurate assignment to DED would improve the size of the sample and allow more detailed analysis. The location variable used is of necessity quite broad. A larger sample would allow analysis of more local house markets, possibly by postcode.

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.

The paper outlines the impact of using location and census data on a stand-alone basis. Can and Megbolugbe (1997) 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 real test of the different indices will be their ability to identify turning points. On this basis, further exploration of how different variables may add to the explanation of house price variation, along the lines suggest above, is warranted.

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*Table A1: A Comparison of the coded sample to the total dataset*

| | Sample | Total |
|---|---|---|
| *Characteristics* | % | % |
| FTB | 33.7 | 35.8 |
| New | 17.6 | 23.2 |
| Detached | 7.0 | 7.6 |
| Semi-Detached | 55.5 | 50.1 |
| Bungalow | 2.6 | 2.9 |
| Apt | 4.5 | 10.0 |
| Terraced | 30.3 | 29.4 |
| Garage | 11.7 | 13.5 |
| Oil | 18.4 | 17.0 |
| Gas | 64.4 | 62.4 |
| Electricity | 11.1 | 14.5 |
| Solid fuel | 6.1 | 6.0 |
| | | |
| *Average* | | |
| Sq.footage | 1,054 | 1,045 |
| Price | 122,683 | 127,623 |
| | | |
| *Location* | % | % |
| CENTRAL | 16.5 | 16.5 |
| | | |
| *Period* | | |
| Q1 96 | 3.2 | 3.0 |
| Q2 1996 | 4.8 | 4.4 |
| Q3 1996 | 4.6 | 4.3 |
| Q4 96 | 3.3 | 3.1 |
| Q1 97 | 2.7 | 2.6 |
| Q2 1997 | 4.1 | 3.6 |
| Q3 1997 | 4.2 | 4.1 |
| Q4 1997 | 2.4 | 2.5 |
| Q1 98 | 4.0 | 4.2 |
| Q2 1998 | 5.5 | 5.4 |
| Q3 1998 | 6.8 | 6.4 |
| Q4 1998 | 6.4 | 6.9 |
| Q1 99 | 6.2 | 6.0 |
| Q2 1999 | 7.0 | 6.8 |
| Q3 1999 | 7.4 | 7.2 |
| Q4 1999 | 7.0 | 7.0 |
| Q1 00 | 4.6 | 4.7 |
| Q2 2000 | 5.1 | 5.5 |
| Q3 2000 | 5.6 | 6.3 |
| Q4 2000 | 5.2 | 6.1 |

Table A2: *Selected Regression Results, Quarter 2 1996-00, Regression based on structural characteristics, (Dependent variable = log house price)*

| | **Q2 1996** | **t-statistic** | **Q2 1997** | **t-statistic** | **Q2 1998** | **t-statistic** | **Q2 1999** | **t-statistic** | **Q2 2000** | **t-statistic** |
|---|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 10.275 | 165.70 | 10.575 | 165.00 | 11.0323 | 139.52 | 11.1157 | 180.92 | 11.3756 | 152.67 |
| FTBDV | -0.076 | -2.80 | -0.032 | -1.31 | -0.115 | -4.23 | -0.040 | -1.78 | -0.079 | -2.88 |
| SDDV | -0.129 | -3.65 | -0.116 | -2.74 | -0.065 | -1.36 | -0.146 | -4.08 | -0.212 | -4.84 |
| TCEDV | -0.209 | -5.24 | -0.171 | -3.69 | -0.160 | -2.91 | -0.175 | -4.30 | -0.191 | -4.02 |
| APTDV | 0.051 | 0.88 | 0.068 | 0.92 | 0.268 | 3.30 | 0.221 | 3.48 | 0.154 | 1.62 |
| NEWDV | 0.058 | 1.93 | -0.024 | -0.84 | -0.035 | -1.09 | -0.072 | -2.59 | -0.101 | -1.78 |
| FOOTAGE ('000) | 0.876 | 19.34 | 0.728 | 17.25 | 0.565 | 11.87 | 0.759 | 21.31 | 0.705 | 14.70 |
| GARDV | 0.148 | 3.77 | 0.146 | 3.76 | -0.036 | -1.03 | 0.047 | 1.46 | 0.145 | 3.69 |
| SOLDV | -0.104 | -2.83 | 0.082 | 1.87 | -0.092 | -1.37 | -0.077 | -1.85 | -0.032 | -0.57 |
| | | | | | | | | | | |
| Adj R squared | 0.603 | | 0.555 | | 0.351 | | 0.568 | | 0.510 | |
| Std. Error of Estimate | 0.247 | | 0.220 | | 0.275 | | 0.239 | | 0.243 | |
| No. of observations | 439 | | 373 | | 493 | | 636 | | 472 | |

Table A3 *Selected Regression Results, Quarter 2 1996-00, Regression based on Structural Characteristics and Location (Dependent variable = log house price)*

| | *Q2 1996* | *t-statistic* | *Q2 1997* | *t-statistic* | *Q2 1998* | *t-statistic* | *Q2 1999* | *t-statistic* | *Q2 2000* | *t-statistic* |
|---|---|---|---|---|---|---|---|---|---|---|
| C | 10.278 | 166.97 | 10.552 | 160.50 | 11.023 | 146.74 | 11.138 | 183.38 | 11.325 | 157.47 |
| FTBDV | -0.078 | -2.88 | -0.033 | -1.30 | -0.109 | -4.22 | -0.047 | -2.07 | -0.089 | -3.33 |
| SDDV | -0.127 | -3.61 | -0.114 | -2.64 | -0.069 | -1.50 | -0.142 | -3.90 | -0.216 | -5.09 |
| TCEDV | -0.222 | -5.58 | -0.195 | -4.04 | -0.267 | -4.96 | -0.213 | -5.13 | -0.226 | -4.86 |
| APTDV | 0.013 | 0.20 | -0.036 | -0.44 | 0.045 | 0.54 | 0.033 | 0.47 | -0.025 | -0.26 |
| NEWDV | 0.053 | 1.76 | -0.018 | -0.62 | -0.019 | -0.63 | -0.068 | -2.40 | -0.125 | -2.19 |
| FOOTAGE ('000) | 0.871 | 19.40 | 0.741 | 17.10 | 0.561 | 12.42 | 0.731 | 21.26 | 0.752 | 16.32 |
| GARDV | 0.148 | 3.81 | 0.163 | 4.14 | -0.004 | -0.13 | 0.037 | 1.12 | 0.139 | 3.67 |
| SOLDV | -0.103 | -2.82 | 0.061 | 1.34 | -0.108 | -1.69 | -0.096 | -2.30 | -0.078 | -1.43 |
| CENTRAL | 0.050 | 1.23 | 0.138 | 3.34 | 0.314 | 7.58 | 0.233 | 6.69 | 0.298 | 7.52 |
| Adjusted R squared | 0.608 | | 0.553 | | 0.420 | | 0.582 | | 0.558 | |
| Std.Error of the Estimate | 0.245 | | 0.225 | | 0.262 | | 0.243 | | 0.236 | |
| No. of observations | 438 | | 373 | | 491 | | 643 | | 474 | |

Table A4 *Selected Regression Results, Quarter 2 1996-00, Regression based on Structural Characteristics, Location and Neighbourhood Quality (Dependent variable = log house price)*

| | *Q2 1996* | *t-statistic* | *Q2 1997* | *t-statistic* | *Q2 1998* | *t-statistic* | *Q2 1999* | *t-statistic* | *Q2 2000* | *t-statistic* |
|---|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 10.532 | 183.296 | 10.764 | 163.813 | 11.290 | 159.526 | 11.339 | 203.312 | 11.458 | 161.836 |
| FTBDV | -0.074 | -3.146 | -0.049 | -1.946 | -0.097 | -4.046 | -0.054 | -2.661 | -0.076 | -3.006 |
| SDDV | -0.101 | -3.304 | -0.110 | -2.633 | -0.089 | -2.104 | -0.138 | -4.233 | -0.183 | -4.492 |
| TCEDV | -0.163 | -4.641 | -0.166 | -3.531 | -0.220 | -4.427 | -0.176 | -4.708 | -0.156 | -3.466 |
| APTDV | 0.016 | 0.277 | -0.063 | -0.792 | -0.027 | -0.350 | 0.024 | 0.391 | -0.031 | -0.339 |
| NEWDV | 0.044 | 1.687 | -0.013 | -0.445 | 0.016 | 0.562 | -0.039 | -1.537 | -0.115 | -2.173 |
| FOOTAGE ('000) | 0.705 | 17.173 | 0.606 | 14.623 | 0.420 | 10.162 | 0.619 | 19.640 | 0.673 | 14.916 |
| GARDV | 0.114 | 3.358 | 0.129 | 3.326 | 0.019 | 0.594 | 0.010 | 0.339 | 0.112 | 3.079 |
| SOLDV | -0.114 | -3.613 | 0.003 | 0.070 | -0.117 | -1.975 | -0.090 | -2.438 | -0.062 | -1.189 |
| CENTRAL | 0.058 | 1.634 | 0.147 | 3.681 | 0.262 | 6.877 | 0.186 | 5.945 | 0.244 | 6.357 |
| SC | -0.257 | -11.374 | -0.184 | -7.660 | -0.255 | -11.061 | -0.223 | -12.096 | -0.194 | -8.539 |
| FAMILY | 0.168 | 4.147 | 0.196 | 4.066 | 0.278 | 5.060 | 0.246 | 7.173 | 0.136 | 3.381 |
| | | | | | | | | | | |
| Adj R squared | 0.709 | | 0.600 | | 0.528 | | 0.668 | | 0.611 | |
| Std. Error of Estimate | 0.212 | | 0.222 | | 0.243 | | 0.217 | | 0.225 | |
| No. of observations | 438 | | 380 | | 498 | | 644 | | 477 | |

Table A5: *Adjusted R squared and Standard Error results*

| | 96Q1 | Q2 | Q3 | Q4 | 97Q1 | Q2 | Q3 | Q4 | 98Q1 | Q2 | Q3 | Q4 | 99Q1 | Q2 | Q3 | Q4 | 00Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Adj.R squared* | | | | | | | | | | | | | | | | | | | | |
| Structural | 0.55 | 0.60 | 0.55 | 0.37 | 0.39 | 0.56 | 0.64 | 0.55 | 0.51 | 0.35 | 0.49 | 0.41 | 0.49 | 0.57 | 0.54 | 0.57 | 0.53 | 0.51 | 0.56 | 0.51 |
| Location | 0.59 | 0.61 | 0.57 | 0.40 | 0.42 | 0.55 | 0.65 | 0.57 | 0.53 | 0.42 | 0.52 | 0.45 | 0.51 | 0.58 | 0.55 | 0.59 | 0.54 | 0.56 | 0.62 | 0.56 |
| Neighbourhood | 0.71 | 0.71 | 0.66 | 0.51 | 0.50 | 0.60 | 0.69 | 0.63 | 0.66 | 0.53 | 0.66 | 0.58 | 0.61 | 0.67 | 0.64 | 0.67 | 0.63 | 0.61 | 0.68 | 0.63 |
| *Std.error* | | | | | | | | | | | | | | | | | | | | |
| Structural | 0.258 | 0.247 | 0.279 | 0.266 | 0.253 | 0.220 | 0.232 | 0.255 | 0.265 | 0.275 | 0.260 | 0.274 | 0.231 | 0.239 | 0.248 | 0.256 | 0.251 | 0.243 | 0.254 | 0.241 |
| Location | 0.253 | 0.245 | 0.271 | 0.261 | 0.246 | 0.225 | 0.231 | 0.2485 | 0.266 | 0.262 | 0.258 | 0.272 | 0.233 | 0.243 | 0.250 | 0.252 | 0.257 | 0.236 | 0.241 | 0.236 |
| Neighbourhood | 0.215 | 0.212 | 0.243 | 0.244 | 0.229 | 0.222 | 0.219 | 0.235 | 0.226 | 0.243 | 0.239 | 0.240 | 0.209 | 0.217 | 0.223 | 0.232 | 0.232 | 0.225 | 0.222 | 0.216 |
| *No. of observations* | 294 | 439 | 419 | 303 | 248 | 373 | 380 | 217 | 356 | 493 | 607 | 583 | 573 | 636 | 682 | 640 | 412 | 472 | 512 | 479 |