Modelling the Impact of Fundamentals on County Housing Markets in Ireland

Morgenroth, Edgar

Economic and Social Research Institute, Trinity College Dublin

30 July 2014

Modelling the Impact of Fundamentals on County Housing Markets in Ireland

Edgar Morgenroth*

Economic and Social Research Institute, Trinity College Dublin

Abstract: Ireland experienced a recent boom-bust cycle in the housing market. While the housing market in Ireland has been analysed at the national level there has been no research on the relationship between fundamentals and the housing market at the sub-national level. In this paper the spatial distribution of household changes is projected for the period 2011 to 2021 and this is used to consider the impact on housing demand, taking into account the significant overhang of vacant properties. Given the assumptions used the demographic projections indicate that the growth in number of households will be concentrate in and around the large cities and particularly Dublin. Given a smaller vacant stock and the projected growth in conjunction with small number of housing completions implies that the Greater Dublin Region will experience housing shortages. Formal modelling of the change in house prices, the stock of housing and the vacancy rate confirms that fundamental drivers are important in shaping these variables. Importantly, the estimated parameters confirm the emerging shortage of housing in Dublin and predict consequent strong growth in house prices.

JEL Code: R31, R32, R23

Key Words: Regional housing market, house prices, demographic change.

This Version: 30/07/2014

*Contact: Edgar Morgenroth, ESRI Whitaker Square, Sir John Rogerson's Quay, Dublin 2, Ireland edgar.morgenroth@esri.ie.

The research was produced as part of a research programme focussing on the residential property market in Ireland, jointly funded by the National Asset Management Agency (NAMA) and the and the Irish Banking Federation (IBF). The author would like to thank David Duffy, John Fitz Gerald, Killian O'Flynn and Anthony O'Brien for helpful comments. The views expressed are those of the author and do not represent the views of the funders.

1. Introduction

Starting in the late 1990's Ireland experienced a massive housing boom which ended when the housing bubble burst in 2007 and resulted in a severe economic crash and forced Ireland to seek a bailout from the EU/IMF/EZB troika (Conefrey and FitzGerald, 2010). While much of the debate and most of the analysis of housing in Ireland has been in the context of a national housing market, a wide range of variables, such as prices, new construction (completions), planning permissions, and vacancy rates vary considerably across the country, which implies that there is no homogenous national housing market but rather there are many local housing markets[1]. For example house prices have been three to four times higher in the county with the highest price compared to the county with the lowest price[2]. There are also significant differences across counties with respect to underlying fundamentals that affect the housing market such as income, unemployment, and population growth.

Given these differences in fundamentals and also their likely different future paths, one can expect the local housing markets to develop quite differently. Thus, while the housing market in some areas will recover more quickly, others areas may take very long or indeed may not recover at all, which has important policy implications. The spatial heterogeneity of the housing market also implies that analysis at the national level is likely to be biased, as has been found by Goodman (1998). It is therefore important to understand local housing markets and consider the drivers of change at the local level.

The lack of sub-national analysis of the housing market in Ireland is at least in part explained by the lack of consistent data over a sufficiently long time period, but may also be due to the relatively small size of Ireland which leads some to argue that analysis at the sub-national level is not important. This paper examines the Irish housing market using county level. Specifically, it constructs a projection of the number of households in each county for 2021 and analyses the consequences of the projected change on the required supply of housing. Using econometric analysis, that draws on the international literature, using a panel dataset changes in house prices, the stock of housing and the vacancy rate are also modelled in order to uncover the effect of different fundamental drivers of the housing market at the county level.

In the long run the housing market is shaped by key demand fundamentals such as demography (size of the population, household size, and migration) and income (which in turn is a function of employment and unemployment) and supply fundamentals such as the housing stock and construction costs. In the short run, price expectations play an important role and these are also an important source of housing market fluctuations. A study of local US housing markets found that changes in regional economic conditions, income, and employment had a significant impact on local housing markets (Hwang and Quigley, 2006). In their study the demand for owner occupier housing is a function of the price, user cost, the cost of renting and population and income, which they refer

[1] An exception is the paper by Lyons (2014) which considers rents and house prices as a function of property characteristics and location for 1100 zones for the period 2007 to 2012 in a hedonic pricing model. He did not consider the effect of fundamentals which is the focus of this paper.

[2] Based on data from the ESRI/PTSB House Price index (https://www.permanenttsb.ie/about-us/house-price-index/archive/) and asking prices published by Daft.ie (http://www.daft.ie/report/).

to as demand shifters and the supply of housing depends on house prices and construction costs. Other models also include zoned land as a determinant of supply.

A number of relevant papers on the national housing market in Ireland have been published. For example Kenny (1999) conducted a cointegration analysis, focusing on the long-run relationship between house prices, housing stock, income and mortgage interest rate. He found that constraints on the supply side imply that prices can overshoot if demand increases. In the short-run a slow speed of adjustment was found. Roche (1999) tests for a housing bubble using a regime switching model and also estimated a simple model of price determination. Using the latter model he estimated an income elasticity between 0.58 and 1.24 and an interest rate elasticity of -0.013 and -0.04.

This paper is organised as follows. Section 2 outlines the methodology used to generate demographic projections for counties, which are used to identify the demographically driven housing demand, which is estimated accounting for the overhang of vacant dwellings identified in Census 2011. In Section 3 the changes in house prices, housing stock and the vacant stock are modelled using panel date econometric methods in order to identify the effect of a number of fundamental variables that are thought to influence the housing market. Section 4 summarises the results and offers some conclusions.

2. Demographic Projections and Excess Housing Stock

The housing market interacts significantly with demographic change. Thus, an increase in the population resulting in an increase in households raises the demand for housing. Likewise, holding the population constant, an increase in household formation raises the demand for housing. Of course high house prices or constrained supply of housing may also impact on household formation. Here the implications of some plausible demographic projections on the stock of vacant housing and the demand for new housing construction are considered.

2.1 Demographic Projection Model

The county level population is projected for single year age cohorts by gender using data taken from the 2011 Census of Population and applying a cohort component model. This method is based on the so called balancing equation where the population at a point in time is equal to the population at some previous point in time plus births, plus net in-migration minus deaths over the period between the two points in time. More formally this equation is written as:

$$P_1 = P_0 + B_{0-1} - D_{0-1} + NM_{0-1}$$

where the subscripts refer to the time periods, P refers to the population, B refers to births, D refers to deaths and NM refers to net in-migration. This relationship can be used for forecasting proposes if the starting population is known (see Morgenroth, 2002, 2008).

Taking the starting population births are estimated by applying age specific fertility rates to the relevant cohorts of woman. Fertility varies significantly across counties, with the total fertility rate (TFR) ranging from 1.91 (Dublin) to 2.41 (Cavan). The assumption applied here is that the TFR is not going to change, which is a reasonable assumption, given the relatively short period considered here

(to 2021). A declining fertility rate would obviously result in a lower population but as those persons born between 2011 and 2021 will be too young to form a new household the assumption does not affect the overall result. Mortality rates for each single year of age cohort are assumed to be the same throughout the country and are those applied by the CSO in the production of their population projections (CSO, 2013). They imply a continuing improvement in life expectancy.

There have been substantial change in relation to both international and internal migration patterns over the last decade and assumptions for migration have a significant effect on the size of the population, particularly over the relatively short period considered. In particular while Ireland recorded a net international immigration of almost 105,000 (2.3% of the population) in 2007, net international emigration has averaged just over 31,000 for the years 2009 to 2013.

International migration estimates for the country as a whole are available from the CSO for the period to 2013, which are incorporated here[3]. For the period 2014 to 2021 the migration estimates produced by the ESRI macroeconomic HERMES model (Fitz Gerald and Kearney, 2013) are utilised. These estimates were produced as part of a medium term economic modelling exercise and here those corresponding to the economic recovery scenario are used. These are applied in favour of the assumptions made by the CSO as they are based on a consistent economic scenario. Furthermore, internal migration also needs to be accounted for and the number of people moving across county boundaries is assumed to be 1.5% of the size of the population which is the historical proportion observed. However, as Census 2011 showed that only 1.4% of the population moved across counties, probably because of negative equity, high unemployment, reduced income and increase international emigration, the proportion is assumed to increase to 1.5% by 2019 and remain at that rate until 2021.

Given that the cohort component model is applied at the county level, the international migration has to be apportioned across the counties. The spatial patterns of internal and international migration is based on the CSO recent pattern, which applies the pattern observed in the most recent intercensal period. This implies a net immigration into the large cities and is similar to the traditional pattern that pertained during the period up to the late 1990s, and stands in contrast to the pattern that was observed between the late 1990's and the most recent census, when the cities experienced net-emmigration. While these patterns differ, the general pattern of results does not depend on these underlying assumption as long as a migration pattern is chosen that assumes net-immigration in the cities and surrounding counties, which is consistent with recent patterns of employment growth, which has been concentrated in the cities and particularly Dublin in recent year.

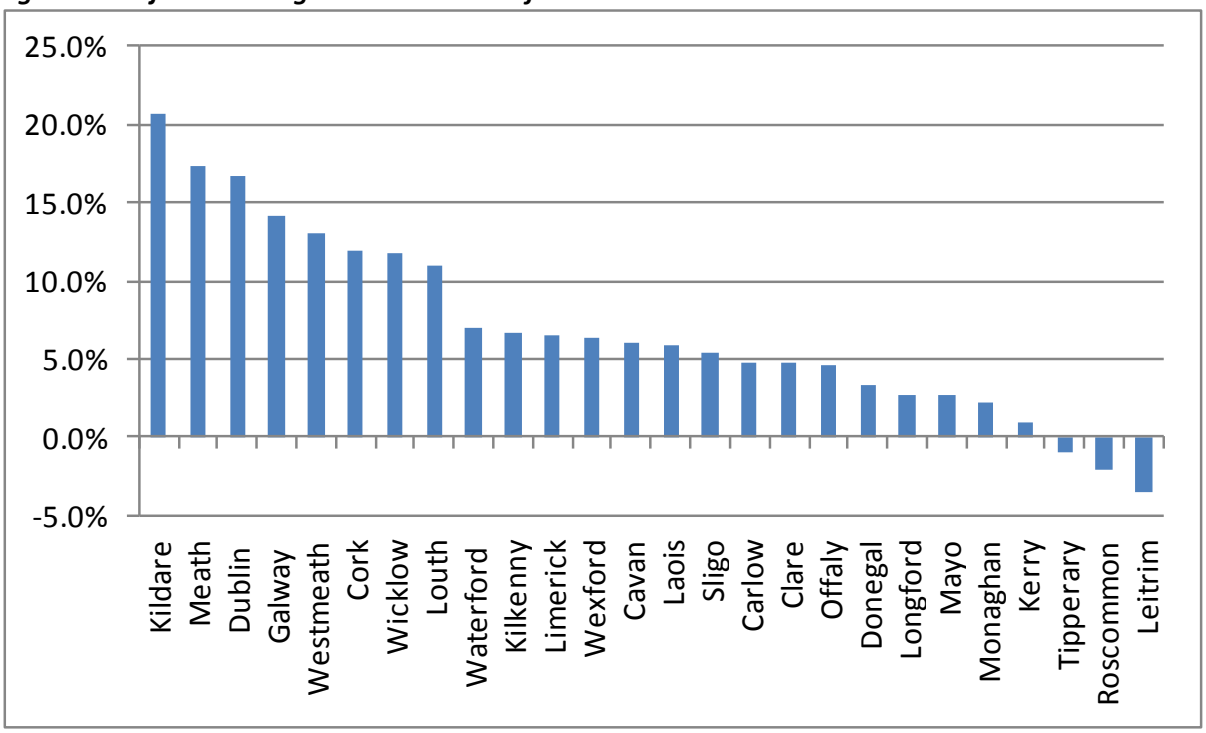
Utilising these assumptions the cohort component model generates the population by single year of age for the years 2012 to 2021. Given that the relevant demographic unit for the analysis of housing is not the number of persons but the number of households, these must also be projected. This is achieved by taking the county level population and applying the average household size, which is assumed to be declining in each county by the rate assumed in the ESRI national demographic model that is used to generate the demographic aspects of the ESRI Medium Term Review (see FitzGerald et al 2012). These assumptions imply that there is no convergence in the average household size across counties. Furthermore, it does not take into account of differences in household formation

[3] These are utilised here given the starting population is for 2011 but migration estimates are available for the period 2011 to 2013.

due to differences in the age structure of each county, which would require a separate analysis that is beyond the scope of the present study.

Figure 1 shows the projected change in the number of households across counties. This shows that counties Meath, Kildare and Dublin are expected, given the assumptions applied, to experience significant growth in the number of households. These numbers might overestimate the growth in households in Kildare and Meath, as these have larger cohorts of persons aged under 15 years of age due to higher fertility than Dublin, where fertility is low and which attracts younger migrants that are at the stage of forming their first households.

Figure 1. Projected Change in the Number of Households between 2011 and 2021

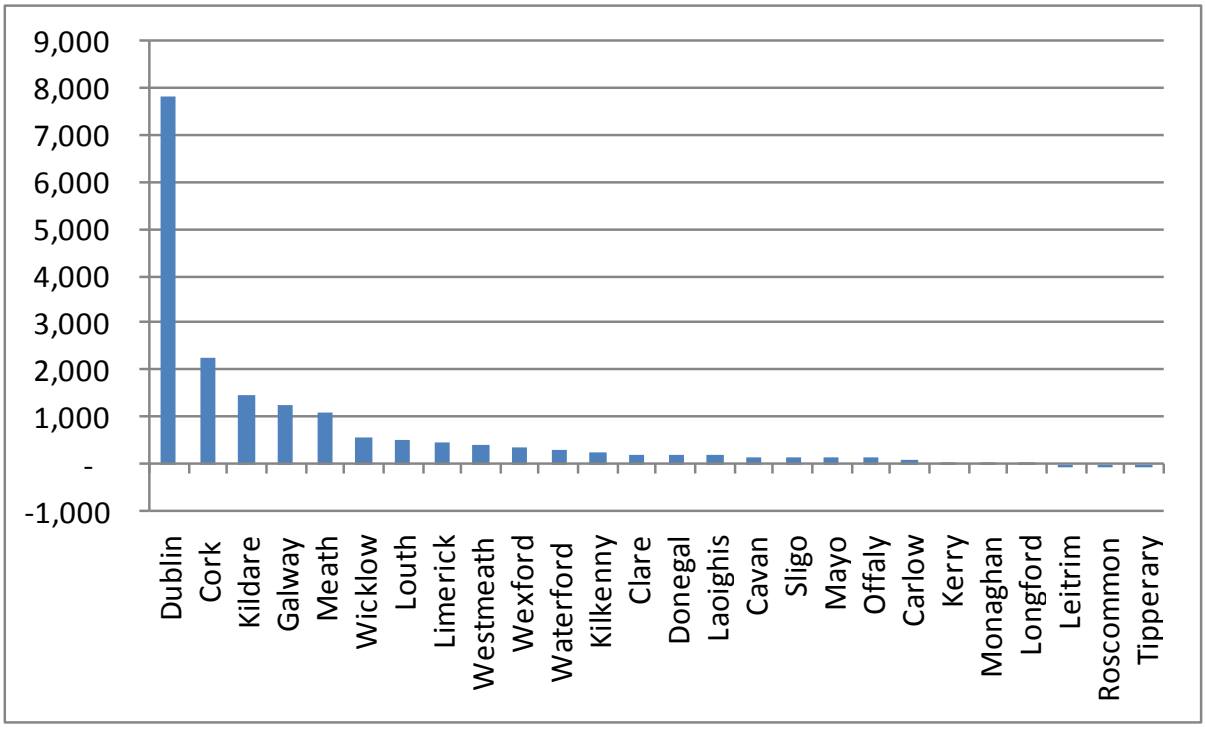


Source: Own Calculations.

The proportional changes shown in Figure 1 do not reflect the absolute number of additional households which determine the level of demand for additional housing. This is shown in Figure 2 which shows that increase in the number of households is projected to be particularly large in Dublin, and to a lesser extend the other large cities and the surrounding counties around Dublin. For Dublin the annual average increase is projected to be almost 8,000 households, which has significant implications for the required housing units, particularly if one considers that during 2013 only 1,360 units were completed in Dublin[4]. For the state as a whole on average just under 18,000 additional households are projected to be created each year between 2011 and 2021 , which is similar to the 20,000 predicted in Duffy et al (2014).

[4] The numbers are from the Department of Environment, Community and Local Government, Housing Statistics: http://www.environ.ie/en/Publications/StatisticsandRegularPublications/HousingStatistics/

Figure 2. Estimated Annual Average Increase in the Number of Households 2011 to 2021



Source: Own Calculations.

2.2 Implied Housing Demand

Using the projected household numbers it is possible to analyse the housing requirement going forward. If all housing units were fully occupied in 2011, then the required additional units would simply equal the number of additional households i.e. 18,000 housing units would need to be added annually during the period 2011 and 2021.

However, Census 2011 identified significant numbers of vacant housing units, which need to be taken into account when assessing the required additions to the housing stock. While one would expect a certain number of properties to be vacant at any point in time for example while they are for sale or while they are being refurbished, a comparison of the vacancy rate for 2011 with that in 1996 shows that the vacancy rate in 2011 is significantly higher than traditionally observed (see Figure 3)[5].

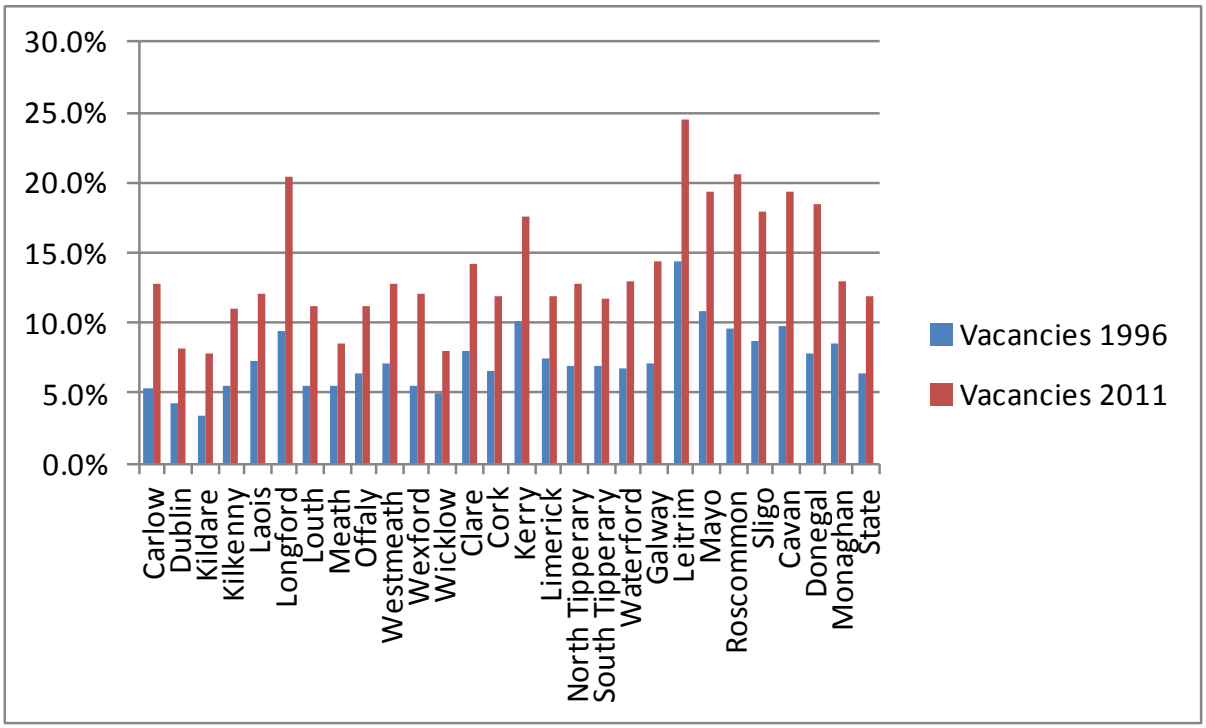
The vacancy rate clearly varies across counties and the spatial pattern is relatively constant over time, with a correlation coefficient for the vacancy rates between 1996 and 2011 is 0.82.This is important since, excluding holiday homes, some 230,000 housing units were vacant in 2011, while the demographic projections indicate that over the 10 year period to 2021 some 180,000 households will be added, which implies that no new properties would need to be built in that time period, but of course many vacant properties are in locations that are not projected to experience population growth.

Given that in 1996 the housing market was relatively 'normal' in that it neither showed any signs of an asset bubble as occurred in the period between 2000 and 2007, nor had a property bubble been

[5] Holiday homes are not considered in the calculations.

recently burst as is the case with the 2011 data. One could therefore assume that the vacancy rates in 1996 are therefore normal rates and that there are natural differences across counties, for example due to differences in the age of the housing stock implying vacancy rates due to higher refurbishment rates or perhaps due to differences in the market size. Alternatively one can assume a common normal vacancy rate of for example 5%.

Figure 3. Vacancy Rates 1996 and 2011



Source: 1996 Vacancies from Fitz Gerald (2005), 2011 vacancies from CSO Census of Population.

In addition to accounting for the vacancy rate both at the start of the period and at the normal level, the fact that some housing units become obsolete needs to be taken account of. Houses can become obsolete due to fires or other structural defects. It is therefore important to reflect the fact that without new construction the housing stock will decline. FitzGerald (2005) estimated that the depreciation rate of housing in Ireland for the period 1991 to 1996 was 0.41%. This figure is used in the calculations below.

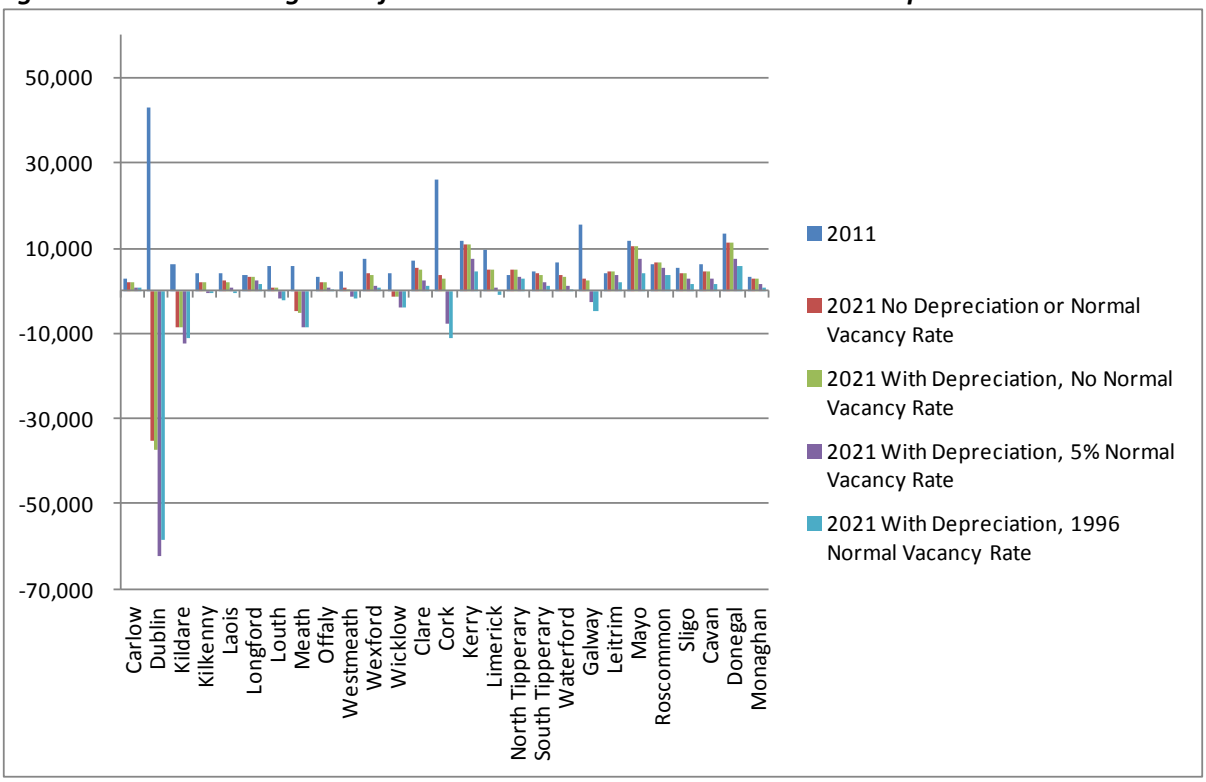
In order to assess the implications of the demographic projection on housing demand the number of available housing units is calculated by subtracting the change in the number of households from the number of vacant units. In the first instance the calculation is done assuming zero depreciation and without allowing for a natural rate of vacancy i.e. it identifies the 'pure' demographic effect. Alternatives incorporating depreciation, the 1996 vacancy rates and a common 5% natural vacancy rate. The results are shown in Figure 4. In the graph negative numbers indicate the number of housing units that would need to be constructed to meet the projected demographic demand while a positive number indicates excess supply by 2021 assuming no units are completed in the period. Thus, accounting for the initial number of vacant units, depreciation and some level of normal rate of housing vacancy a total of around 60,000 housing units would need to be built in Dublin to meet the projected demographic demand. Other counties which will need to expand their housing stock include Kildare, Meath, Wicklow, Cork, Galway, Louth and Westmeath. However, for many more

remote counties the level of vacant stock and the projected demographic change is such that no additions to the housing stock are necessary to meet demand.

Of course some house building has occurred since 2011. In total over the years 2011 to 2013 just over 24,000 housing units have been completed. These need to be netted off in order to identify the completions required between 2013 and 2021 to meet demand. In total for those counties which would without additional construction experience a housing shortage just under 90,000 housing (or approximately 12,500 per year) units will need to be completed to meet demand, which is considerably smaller than the 180,000 implied by the increase in the number of households, reflecting the impact of the significant oversupply, and the fact that some construction has taken place.

Over 60% of these are required in Dublin and another 26% are accounted for by counties Louth, Meath, Kildare and Wicklow. In contrast just 33% of the completions during the 2011 to 2013 period were recorded in these counties. Thus the analysis here shows that housing supply issues are almost exclusively concentrated in the Greater Dublin region.

Figure 4. Vacant Housing Stock for 2011 and 2021 under Alternative Assumptions



Source: Own Calculations. Note: Negative numbers indicate the number of housing units that would need to be constructed to meet the projected demographic demand while a positive number indicates excess supply.

2. County Level Housing Market Dynamics: Modelling Changes in House Prices, Completions and Vacancies

The previous section considered the impact of demographic change on the required housing supply in each county. It did however not consider either the factors that might lead to the required supply being met nor did it consider the implication of the additional demand on prices. In order to address

these issues conventional regression approach is used combining the data for the counties across time periods in a panel.

3.1 Model

While the county level housing variables have not been modelled in Ireland a number of studies have modelled regional housing markets in other countries. Leishman and Bramley (2005) estimate a model of house prices for district council areas in Scotland, as a function of in- and out-migration, income, lagged house price growth and socio-economic characteristics. Unfortunately, data on migration at the county level only exists for Census years, which means that this model cannot be estimated for Ireland.

The methodology followed here is that proposed by Hwang and Quigley (2006) who estimate models of the change of house prices, the change in the stock of housing and the change in vacancies for 74 US metropolitan regions for the period 1987 to 1999. For example they specify the change in house prices as a function of the change in the stock of housing, vacancies, the change in house prices in the previous period, changes in household numbers, changes in the household income, changes in the user costs and rent, employment. A number of recent papers have highlighted the importance of spatio-temporal relationships particularly for price changes (see Meen, 1999, Kuethe and Pede, 2011, Brady, 2014), and to account for the possibility of spatial spillovers of key variables the time lagged spatial lag of these variables is also added to the specification. The construction of these variables is explained below.

As was noted above the lack data at the sub-national data has been a major constraint in conducting such an analysis for Ireland. Thus, the variables used here are more limited than those available to Hwang and Quigley (2006), but nevertheless cover the most important drivers of the housing market.

Specifically, the change in the stock of housing is modelled as a function of changes in the stock of housing, changes in the vacancy rate, changes in the number of households, changes in household income, changes in the unemployment rate and changes in the number of planning permissions granted. In order to capture spillover effects time lagged spatial lags of the change in prices, housing stock and the vacancy rate are also added.

The change in the housing stock is modelled as a function of current and lagged changes in the vacancy rate, lagged changes of prices, stocks, households, the unemployment rate and planning permissions. The spatially lagged variables are also included as is a dummy for counties which were subject to the Upper Shannon Rural Renewal Scheme which was a tax incentive scheme aimed at increasing the number of housing units built in the relevant counties. Finally , the change in the vacancy rate is modelled as a function of the change in the housing stock, the change in house prices, the lag of the change in the vacancy rate, the changes in the number of households, changes in household income, changes in the unemployment rate and changes in the number of planning permissions granted. Again the spatially lagged variables are included.

3.2 Data

This section describes important shortcomings in the available data and how these are dealt with.

Firstly, there is an inconsistency between housing stock estimates from the CSO for Census years and the number of housing completions recorded by the Department of Environment, Community and Local Government (DoECLG). Using just the stock estimates for census years results in insufficient observations to estimate a proper model. In order to generate a consistent time series for the housing stock, completions and vacancy rates the completions from DoECLG are rescaled to be consistent with the CSO stock estimates. This way a consistent stock series is generated and using household numbers which are interpolated for the intercensal years vacancy rates are constructed. The second shortcoming in the existing data is the lack of consistent time series for house prices covering the boom period and the crash period. The data from the PTSB/ESRI house price index covers the period 1996 to 2006, while the DAFT asking price data is for 2007 to 2013. In order to generate a time series covering the period 1996 to 2013 a price index is generated for each county where the more recent underlying prices are asking prices for 3 bedroom houses taken from the DAFT data. With the exception of the number of planning permissions which are only available at the county level from 2001, the data cover the period 1996 to 2011.

The variables used in the analysis are listed in Table 1. All variables are expressed as the log difference i.e. the difference between the logarithm of the variable in the current period minus the logarithm of the variable in the previous period. This implies that the first observation in the data is lost. The variables are the price, the stock, the vacancy rate, households, income, the unemployment rate, planning permissions and the spatial lag of the price, stock and vacancies. The spatial lags are calculated as the average house price in the neighbouring counties in for the preceding period[6]. This variable is included to capture spillover effects from one county neighbouring counties. The lagged value is used because otherwise spatial panel estimators which are difficult to implement would have to be used[7].

[6] If a county has three neighbours then the spatial lag is equal to the sum of 1/3 times the house price of each of the neighbouring counties.
[7] See Anselin, 1988

Table 1. Variable Description for the Regression Analysis

Variable	Description	Source
p_{it}	Log difference of the house price index	Constructed using the PTSB/ESRI house price index and asking prices from Daft.ie – see text for details.
s_{it}	Log difference of the stock of housing	Constructed using the housing stock from the CSO Census of Population, 1991, 1996, 2002, 2006, and 2011
v_t	Log difference of the vacancy rate	Constructed using the vacancy rates from the CSO Census of Population, 1991, 1996, 2002, 2006, and 2011
hh_{it}	Log difference of the number of households	Constructed using the household numbers from the CSO Census of Population, 1991, 1996, 2002, 2006, and 2011
hy_{it}	Log difference of the average household income	From the CSO County Incomes and Regional GDP
ur_{it}	Log difference of the unemployment rate	Constructed using the CSO data on the Live Register of Unemployed Persons
$perm_{it}$	Log difference of the number of units for which planning permission was granted	From the Department of Environment, Community and Local Government housing statistics.
SLp_{it-1}	Spatial Lag of lagged log difference of the house price index	
SLs_{it}	Spatial Lag of lagged log difference of the stock of housing	
SLv_t	Spatial Lag of lagged log difference of the vacancy rate	
Shannon	Dummy variable =1 for counties that were subject to the upper Shannon Rural Development Scheme	The relevant counties are Leitrim, Roscommon, Longford, Cavan and Sligo.

3.3 Estimation and Results

For each equation a number of different estimates are produced using alternative estimators and specifications. Specifically, the equations are estimated using a pooled ordinary least squares estimator with standard errors clustered on the county (which is equivalent to the random effects panel estimator) and with county fixed effects. In addition to controlling for heteroskedasticity the residuals may also suffer from both serial correlation and spatial autocorrelation. The latter could be dealt with using spatial econometric techniques which would increase the complexity of the estimation, or they can be accounted for using a variance-covariance matrix that is robust to any misspecification, such as that proposed by Driscoll and Kraay (1998). The latter has the advantage that it requires no prior knowledge of the form of spatial dependence or serial correlation, and therefore requires no explicit parameterisation of the form of the dependence. Both the change in the stock and the change in the vacancy rate are modelled as dynamic processes including lagged values of the dependent variable. Including lags in a panel setting results in a correlation between the error term and the lagged value, which renders ordinary least squares biased and inconsistent. To deal with this problem Arellano and Bond (1991) proposed a method to correct for this problem and this method is also applied for the two dynamic equations.

Table 2 shows the results for the price change model. A number of different specifications were estimated including county fixed effects and including a lagged dependent variable[8] and the change in planning permissions, which reduces the number of observations[9]. The county fixed effects account for all factors that are specific to a particular county and do not change over time.

Overall, the model explains a significant proportion of the variation in the data (at least 71%). The first two column of the table shows the results for the pooled ordinary least squares estimator. A 1% change increase in the stock of housing is expected to reduce prices by 2.1% when planning permissions are included in the analysis which reduces the sample size considerably given the shorter sample of 2001 to 2011. Over the longer period 1995 to 2011, the variable is no longer statistically different from zero. A 1% increase in the number of households is expected to increase prices by almost 4%. A higher vacancy rate is expected to increase prices, which can only be explained by supply rationing by property developers/owners, but again this effect is only to be found to be statistically significant over the shorter sample size. The lagged price and planning permissions appear to have no statistically significant impact. Interestingly, the spatial lag of prices is positive and significant and suggest that a 1% increase in prices in neighbouring counties during the previous period would increase prices by 0.59%. This is consistent with a 'house price ripple' where pressure in the housing market in one county induces buyers to seek housing in the neighbouring county, thereby raising demand prices. Furthermore, a higher vacancy rate in the neighbouring counties reduces the price in the county, which indicates another spillover effect. The results are very similar if one includes county fixed effects, but the effect of household growth is much higher. Furthermore, the statistical significance of the individual variables changes once the county fixed effects are added. Applying the misspecification robust Driscoll-Kraay standard errors does not increase the significance levels, which suggests that the heteroskedastictiy robust standard errors are more appropriate. Thus, the preferred results are those in columns 3 and 4.

A comparison with the results from Hwang and Quigley (2006) reveals that effect of stock changes is considerably greater for Irish counties. They also found higher vacancies to reduce prices, while past price increase of one percent was found to increase current prices by half a percent. However, the estimated income elasticities are not significantly different from those found for Ireland. Indeed the estimates presented here are also similar to those found in Leishman and Bramley (2005). Likewise the inverse of the employment elasticity in Hwang and Quigley (2006) is not dissimilar to the unemployment elasticity found here.

[8] The dynamic panel model with a lagged dependent variable was also estimated using the appropriate Arrelano-Bond estimator, which showed that the lagged dependent variable was statistically insignificant and that the model did not suffer from serial correlation.

[9] Other specifications for example including the mortgage interest rate were also estimated, but as these were found to be inferior (the interest rate was not found to be statistically significant) they are not reported here.

Table 2 Panel Data Regression Results for Changes in House Prices (p_{it})

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled OLS	Pooled OLS	County Fixed Effects	County Fixed Effects	Driscoll & Kraay	Driscoll & Kraay
s_{it}	-1.95**	-1.07	-1.20*	-1.02	-1.21	-1.02
v_t	0.51***	0.22	0.36**	0.18	0.36**	0.18
p_{it-1}	0.03		-0.03			
hh_{it}	3.42***	2.31**	5.35***	3.98***	5.37***	3.98**
hy_{it}	0.40*	0.31**	0.30	0.22**	0.29	0.22*
ur_{it}	-0.10***	-0.07***	-0.13***	-0.09***	-0.13**	-0.09*
$perm_{it}$	0.02*		0.02		0.02	
SL p_{it-1}	0.65***	0.80***	0.53***	0.68***	0.50***	0.68**
SLs_{it-1}	0.00	0.00	0.00**	0.00***	0.00***	0.00**
SLv_{t-1}	-0.27*	-0.25	-0.14	-0.17**	-0.15	-0.17
County Fixed Effects	No	No	Yes	Yes	Yes	Yes
Observations	260	364	260	364	260	364
R^2	0.70	0.73	0.74	0.76	0.74	0.76

Note: ***, **, * is 1%, 5%, 10% significance level respectively.

The second model that is estimated is a model for the change in the stock of housing. After some experimentation the explanatory variables included are lags. This reflects the fact that the decision to build a housing units is made some time before the unit is completed. Again models are estimated with and without county fixed effects and using alternative methods (results in Table 3). The basic model fits the data well as it explains 90% of the variation in the data. While current changes in the vacancy rate increase the housing stock, the lag reduces the change in housing stock suggesting a supply response due to oversupply. This corresponds with the observed low rate of construction following the economic crash in Ireland. Rising prices in the previous period increase the change in stock as does an increase in the number of households, and stock changes in the previous period. The latter suggests that stock changes are persistent i.e. counties with rising stock continue to grow their stock. The coefficient on the change in income changes sign depending on the specification and is statistically insignificant in a number of cases.

A rising unemployment rate reduces the stock change as expected. The change in planning permissions was found not to matter at all which is surprising since the variable measures the number of units for which planning permissions are granted, but is likely to be explained by the fact that a proportion of planning permissions are not taken up immediately or indeed not at all.

If that proportion that is not taken up adjusts to market conditions then completions need not be related to stock changes. Furthermore, given that stock changes are persistent there could be a degree of collinearity between stock changes and planning permissions. Finally, a dummy variable to account for the potential effect of the Upper Shannon Rural Development Scheme which involved tax incentives for housing developments was found to have had a positive and significant impact on the change in the housing stock.

In general, the estimated parameters except that for income changes are similar in all specifications, but that for the lagged dependent variable is smaller once the dynamic nature is properly estimated using the Arrelano-Bond estimator.

Comparing the results with those of Hwang and Quigley (2006), the parameters on the lagged price change is found to be very similar to that of the price change in the USA model. The lagged stock change has a slightly smaller effect in Ireland than the US, but it should be noted that Hwang and Quigley (2006) did not apply the Arrelano-Bond estimator, which implies that their results are biased. Interestingly, they also estimated income effects of different signs depending on the specification.

Table 3. Panel Data Regression Results for Changes in Stock of Housing (s_{it})

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pooled OLS	Pooled OLS	County Fixed Effects	County Fixed Effects	Driscoll & Kraay	Driscoll & Kraay	Arrelano & Bond	Arrelano & Bond
v_{it}	0.11***	0.10***	0.13***	0.10***	0.13***	0.10***	0.13***	0.10***
v_{it-1}	-0.05*	-0.05**	-0.04	-0.04*	-0.06	-0.05*	-0.04	-0.04**
p_{t-1}	0.01**	0.01**	0.01**	0.01*	0.02***	0.01***	0.02**	0.01*
s_{it-1}	0.62**	0.70***	0.56***	0.61***	0.65***	0.65***	0.47***	0.56***
hh_{it-1}	0.18**	0.16**	-0.16	0.24**	-0.29*	0.15	-0.24	0.19
hy_{it-1}	0.01*	-0.02***	0.00	-0.02***	0.00	-0.02*	0.00	-0.02***
ur_{it-1}	-0.01***	-0.01***	-0.01**	-0.01**	-0.01**	-0.01	0.00	0.00
$perm_{it-1}$	0.00		0.00		0.00		0.00	
SLp_{it-1}	0.03***	0.01***	0.03**	0.01	0.03***	0.01	0.03***	0.01
SLs_{it-1}	0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLv_{t-1}	-0.04***	0.02**	-0.03*	0.03***	-0.03**	0.03**	-0.02	0.04***
Shannon	0.00***	0.00***	0.00***	0.00***			0.01***	0.01***
County Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	234	364	234	364	234	364	234	364
R^2	0.93	0.90	0.95	0.90	0.94	0.82		

Note: ***, **, * is 1%, 5%, 10% significance level respectively.

The final model that was estimated is for the change in the vacancy rate (table 4). Here other than a lagged value of the dependent variable, current values of the variables are included in the model. Stock changes increase the vacancy rate while an increase in the number of households reduces vacancies. Thus, a one percent increase in the stock of housing increases the vacancy rate by four percent, while a one percent increase in the number of households reduces the vacancy rate by three percent. Increases in the vacancy rate in the previous period result in higher vacancy rates in the current rate again suggesting persistence. The coefficient on income is not always statistically significant and changes sign, while changes in the unemployment rate does not change the vacancy rate.

Table 4. Panel Data Regression Results for Changes in the Vacancy Rate (v_{it})

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pooled OLS	Pooled OLS	County Fixed Effects	County Fixed Effects	Driscoll & Kraay	Driscoll & Kraay	Arrelano & Bond	Arrelano & Bond
s_{it}	2.91***	3.50***	3.69***	4.05***	3.69***	4.05***	4.03***	4.32***
p_t	0.14***	0.07***	0.10***	0.06**	0.10**	0.06	0.10***	0.04*
v_{it-1}	0.25***	0.25***	0.19***	0.21***	0.19	0.21**	0.24***	0.25***
hh_{it}	-2.31***	-2.42***	-3.16***	-2.96***	-3.16**	-2.96**	-3.46***	-3.03***
hy_{it}	-0.15***	-0.02	-0.16***	-0.04	-0.16**	-0.04	-0.17***	-0.06
ur_{it}	-0.02	-0.04*	-0.01	-0.04**	-0.01	-0.04*	-0.01	-0.04***
$perm_{it}$	0.01*		0.00		0.00		0.00*	
SLp_{it-1}	0.06	0.02	-0.01	-0.03	-0.01	-0.03	-0.04	-0.07**
SLs_{it-1}	0.00	0.00	0.00***	0.00	0.00**	0.00	0.00***	0.00
SLv_{t-1}	0.09	0.07	0.04	0.05	0.04	0.05	-0.06	0.03***
County Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	260	364	260	364	260	364	234	338
R^2	0.85	0.79	0.87	0.81	0.87	0.81		

Note: ***, **, * is 1%, 5%, 10% significance level respectively.

3. Summary and Conclusions

Analysis of the Irish housing market at the subnational level has been largely ignored in the literature. This paper has considered the implications of projected demographic change on housing demand and has modelled the changes in key housing market variable as a function of fundamental housing market drivers at the county level.

The analysis of the impact of demographic change highlight the significance of the heterogeneity across the country. The analysis showed that while demographic change implies that between 2011 and 2021 180,00 additional housing units would be required, that the number of vacant dwellings implies that for many counties no additional housing units will be needed. Accounting for this only half of the 180,000 will be needed of which over 60% of these are required in Dublin and another 26% are accounted for by counties Louth, Meath, Kildare and Wicklow. Thus the additional demand is highly concentrated in the Greater Dublin area. Given that 33% of the completions during the 2011 to 2013 period were recorded in the Greater Dublin Area and given that the total number of completions is below what is needed to meet demand will result in significant housing shortages if the rate of housing completions is not increased rapidly.

Notwithstanding significant data challenges models for changes in key housing market variables namely price, supply and vacancies were estimated in section 3. While the models are not as comprehensive and robust as those found in the international (mainly US) literature, some useful results were nevertheless obtained. For example prices are expected to change significantly more in response to the change in household numbers than income. With significant population growth projected for the greater Dublin area this finding is consistent with the evidence that prices are rising in Dublin. The demographic projections suggest that the number of households will increase on

average by 1.5% in Dublin during the period 2011 to 2021. Given the estimated parameters this will increase prices in Dublin by 6% per year over the period, holding all other factors fixed. In contrast, the number of households in Leitrim is projected to decline by 0.3% per year over the same period, which will further reduce house prices in that county holding all other factors constant. Thus, the model results and the demographic projections imply increasing divergence in house prices across the country.

The second model shows that the change in the stock of housing is not terribly sensitive to changes in house prices, which could result in the demand in the Dublin area not being met by increases in supply, which would further fuel price rises and could result in similar unsustainable settlement patterns as seen during the boom. A 6% increase in the house price would increase the stock of housing by 0.06% in Dublin or just over 3,000 units, which is less than half the number required (although significantly more than are currently being built).

The vacancy rate is expected to respond strongly to increases in the number of households which are likely to grow significantly faster than supply of housing suggesting that overall vacancy rates will decline. Again taking Dublin as an example the projected increase in the number of households would reduce the vacancy rate by 4.5% per year on average, which given a vacancy rate of 8.2% would eliminate the overhang in the Dublin market rapidly.

References

Anselin, L. (1988), *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Publishers.

Arrelano, M., and S. Bond (1991) "Some Tests of Specifications for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, Vol. 58, pp. 277-297.

Central Statistics Office (2013) *Population and Labour Force Projection: 2016-2046.* Dublin: Central Statistics Office.

Brady, R., (2014) "The spatial diffusion of regional housing prices across U.S. states", *Regional Science and Urban Economics*, Vol. 46(1), pp. 150-166.

Driscoll, J., and A. Kraay (1998) "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data", *Review of Economics and Statistics*, Vol. 80, pp. 549-560.

Duffy, D., Byrne, D., and J. FitzGerald (2014) "Alternative Scenarios for New Household Formation in Ireland", Special Article in Quarterly Economic Commentary, Spring 2014. Dublin: Economic and Social Research Institute.

Fitz Gerald, J., (2005) "The Irish Housing Stock: Growth in Number of Vacant Dwellings". Special Article in McCoy, D., David, D., Bergin, A., Garrett, S., and Y. McCarthy. *ESRI Quarterly Economic Commentary, Spring*. Dublin: Economic and Social Research Institute

FitzGerald, J., Byrne, D., and N. Žnuderl, (2012), "The Impact of Changes in Educational Attainment on Life Expectancy in Ireland", *Journal of the Statistical and Social Inquiry Socitiey of Ireland*, Vol. 152, pp. 42-56.

Fitz Gerald, J., and I. Kearney (eds.) (2013) *Medium-Term Economic Review*. Dublin: ESRI.

Goodman, J., (1998) "Aggregation of Local Housing Markets", *Journal of Real Estate Finance and Economics*, Vo. 16(1), pp. 43-53.

Hwang M., and J. Quigley (2006) "Economic Fundamentals in Local Housing Markets: Evidence from U.S. Metropolitan Regions" *Journal of Regional Science*. Vol. 46 (3) pp. 425-453.

Kenny, G., (1999) "Modelling the Demand and Supply Sides of the Housing Market: Evidence from Ireland", *Economic Modelling*, Vol. 16, pp. 389-409.

Kuethe, T., and V. Pedea (2011) "Regional Housing Price Cycles: A Spatio-temporal Analysis Using US State-level Data", *Regional Studies*, Vol. 45(5), pp. 563-574.

Lyons, R., (2014) "East, West, Boom and Bust: The Spread of House Prices and Rents in Ireland, 2007 - 2012", *Journal of Property Research*, forthcoming.

Meen, G., (1999) "Regional House Price s and the Ripple Effect: A New Interpretation", *Housing Studies*, Vol. 14(6), pp. 733-753.

Morgenroth, E., (2002) “Evaluating Methods for Short to Medium Term County Population Forecasting”. *Journal of the Statistical and Social Inquiry Society of Ireland*, Vol. 31, pp.111-143;

Morgenroth, E., (2008) “The Impact of Demographic Change on Demand for and Delivery of Health Services in Ireland 2006-2021. Report 2: Demographic Projections for the period until 2021”, published online by ESRI and Health Research Board.

Roche, M., (1999) “Irish House Prices: Will the Roof Cave In?”*Economic and Social Review*, Vol. 30(4), pp. 343-362.