

Lyons, Ronan

Conference Paper

Search costs, sorting and "property ladder" effects: Evidence from the valuation of amenities

52nd Congress of the European Regional Science Association: "Regions in Motion - Breaking the Path", 21-25 August 2012, Bratislava, Slovakia

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Lyons, Ronan (2012) : Search costs, sorting and "property ladder" effects: Evidence from the valuation of amenities, 52nd Congress of the European Regional Science Association: "Regions in Motion - Breaking the Path", 21-25 August 2012, Bratislava, Slovakia, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/120604>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Search costs, sorting and “property ladder” effects: Evidence from the valuation of amenities

Ronan C. Lyons, Department of Economics, University of Oxford

1 Introduction

Housing is among the most important markets in modern economies. It constitutes the single most important class of consumption good in, for example, the U.S. urban CPI (32%) and in the UK RPI (24%). Housing is also the most prevalent investment good: a 2001 study found that 54% of US household wealth was in real estate, while a study of wealth in Ireland in 2007 estimated the proportion to be 72% (Bank of Ireland 2007, Luckett 2001). Unsurprisingly, housing has assumed a central role in explanations of the global economic and financial crisis starting in 2007.

Ireland’s economic fortunes have in many respects been a microcosm of those globally. The period from the mid-1990s to 2007 was one of very strong economic growth in Ireland, initially export-led but in later years fuelled by the availability of cheap credit and an unprecedented building boom. Since 2007, the economic downturn has been severe. National income fell from €163bn in 2007 to €128bn in 2011, fiscal deficits reached 10% of GDP by 2010 and unemployment rose from below 5% in 2007 to almost 15% by 2011. Despite the global nature of the crisis, central to the dramatic change in Ireland’s economic fortunes were domestic factors, in particular the end of a domestic real estate bubble. This highlights the links that exist between housing and other aspects of the economy, including financial stability, the labour market, the government finances, and public service provision. To understand how a housing cycle can affect economic fluctuations, it is important not only to understand the channels through which housing and the wider economy are related, but also how the housing market itself works.

Yet the mechanics of the housing market remain poorly understood. Housing is an inherently spatial market and, property-specific attributes aside, differences in price reflect location-specific amenities. With nominal house prices falls of 50% between 2006 and 2011, Ireland’s housing market is a natural case study. This paper uses a new detailed dataset of property advertisements in Ireland over this period to investigate four hypotheses in relation to the housing market and its cycles. The first hypothesis is that amenities (and disamenities) are reflected in real estate values, while the second is that relative valuations attached to particular amenities differ between rural and urban locations. Thirdly, relative valuations may differ across sales and lettings segments. Lastly, relative amenity valuations may vary across the housing market cycle. While the first hypothesis is well established in the literature, the remaining three are contributions of this paper.

The motivation behind the first hypothesis, that a location’s amenities will be reflected in the housing market, is well-established in the literature, following Rosen (1974). The second hypoth-

esis – that valuations differ between rural and urban segments – is motivated by a Tiebout-style theory of household sorting, by income or other factors such as age or employment sector. The latter two hypotheses relate to understanding why bubbles in housing occur. The valuation of amenities may differ across sales and lettings segments if indivisibilities related to search costs in the housing market disproportionately affect renters. They may also vary if owner-occupiers seek to lock in amenities that are in fixed supply. Put another way, buyers pay for amenities in the expectation of amenity-specific capital gains. One would expect that if these expectations of amenity-specific capital gains exist, they would be greatest during the bubble and of least concern in the crash. This would be reflected in the price of amenities falling between bubble and crash periods. Alternatively, the valuation of amenities may be smaller in the bubble than in the crash, if there is a pervasive need to “get on the ladder” in the frenzy of a bubble.

The paper is structured as follows. Sections 2 outlines briefly the economic theory and existing literature in relation to amenity valuation and the structure of prices in the housing market, while section 3 provides details on the data used in this analysis. Section 4 outlines the model and empirical strategy and Section 5 presents the results. Section 6 concludes.

2 Theory & Literature

2.1 Bid-rent gradients

Standard urban economic theory holds that households with the highest opportunity cost of distance from the central business district will locate closest to it (Straszheim 1987). A household derives utility from its quantity of land consumed (q), its location or distance from the centre (u), and the numeraire composite consumption good (z), with expenditure including rent per unit of house size (r) and transport costs (T). Choice of location must satisfy a condition equating the change in rent to the trade-off between monetized value of the disutility of a longer commute and the change in transport expenditure: $\partial r / \partial u \cdot q = V_u / V_z - \partial T / \partial u$. The bid-rent gradient from the CBD outwards can be assumed, via partial equilibrium analysis, or derived, via general equilibrium analysis, where assumptions are made about utility levels at different locations. Either way, households will move away from the centre, along the rent gradient, until the marginal disutility of a longer trip just offsets the savings achieved for land consumed. Such theory is subject to an important caveat, though: it assumes cities have one centre, whose location is exogenous.

2.2 Hedonic Markets and Implicit Prices

Allowing an n -dimensional amenity vector and relaxing the restrictions on the location of amenities across the city space suggests a more complicated bid function. Rosen’s (1974) model contains a

market for good z comprising $i = 1, \dots, n$ attributes (or amenities), where $p(z_1, \dots, z_n)$ is increasing in all its arguments and has second derivatives. The value function $\theta(z_1, \dots, z_n; u, y)$ represents the expenditure a consumer is willing to pay for different alternative values of z , given utility and income and is the multi-dimensional counterpart to the bid-rent gradient. The optimum will be where the value function θ and market prices $p(z)$ are tangent to each other. In practical terms, this means that the value of an amenity should be reflected in the price.

Since Rosen's (1974) seminal paper, a large empirical literature has developed, estimating the implicit price of a wide range of amenities. Much of the early literature was focused on environmental public goods – reviews are given by Smith & Huang (1995) on air quality, Boyle & Kiel (2001) on water quality and Kuminoff et al. (2010) on environmental amenities. There is also a large literature on the effect of transport facilities on property values (see for example Debrezion et al. 2007). The literature on the hedonic pricing of amenities in the Irish property market is somewhat more limited, although there is evidence that both urban green space and transport access are reflected in house prices (Mayor et al. 2008, 2009). A good overview of the hedonic valuation of amenities method and recent research on the value of education, transport and safety amenities is given by Gibbons & Machin (2008). They stress the use of quasi-experimental approaches exploiting supply variations. Literature on other amenities – in particular social capital but also market-depth – is much less developed at this stage, most likely as the bulk of empirical work is at city-level, giving less variation in population-specific characteristics than at country-level.

Three comments on the literature are worthwhile. The first is that, by and large, well-specified studies – controlling for omitted variables and exploiting supply-side variation where possible – do find that a wide range of amenities factored into accommodation costs. There is often little agreement across researchers on the magnitude, but this may be understandable given the variance in regions, sample sizes, exact specifications and market cycles. The second is that, principally due to sample size constraints, there is no reason to assume that amenities have time-constant prices, yet this is overwhelmingly the strategy adopted in the literature to date Kuminoff et al. (2010). Lastly, there is very little information on the valuation of amenities in the lettings segment of the residential property market.

2.3 Income sorting

One of the four hypotheses investigated is whether the marginal price associated with particular amenities is greater in urban areas, where incomes are higher, than elsewhere. This is related to a long-standing literature on local public expenditure, following Tiebout (1956). His theory was that households would sort by income according to the optimal bundle of public services and taxes offered by different municipalities. Where certain amenities are luxuries, straightforward income

elasticity analysis would suggest that the amenity prices would be greater in areas with higher incomes. With higher income households predominantly in urban areas, the expectation is that the price of amenities would be greater in cities than elsewhere.

2.4 Amenity valuation by tenure

The same household may reward different amenities when buying or renting. The market for accommodation is one where matching is important, as both occupants and properties have idiosyncratic attributes. Suppose that search costs (s) in the property market, whether renting or buying, involve indivisibilities: finding somewhere to live cannot be done without a certain minimum amount of time spent online and visiting properties (κ), in addition to any tenure-specific search costs and/or intensities. Suppose also that prospective buyers and tenants have maximum thresholds (t) to their search costs that are roughly proportional to the value of the transaction (λV , where V denotes the value of the transaction): in practical terms, those buying their home for the next twenty years might be prepared to spend six months searching for the right property, but those renting for the next two years might not. In such a market, there would be a disproportionality in the $s(\kappa) : t(\lambda)$ ratios for the same household buying or renting: renters are likely to hit their thresholds of search costs sooner. For example, while both buyers and renters may prefer properties closer to coast, only buyers may hold out and reward these amenities. Thus, one may expect certain amenities, particularly those that could be regarded as secondary, may not be rewarded to the same extent in the lettings market as in the sales market.

An alternative theory is that there are factors that encourage buyers to “over-capitalize” amenities: in the frenzy of the bubble, buyers are concerned about securing access amenities that are in fixed supply (for example nearby schools). In particular, buyers may worry about the cost of accessing amenities in the future, leading to a greater valuation by buyers than renters. This may also arise if transaction costs, such as legal fees and transaction-based taxes, restricting buyers’ mobility (but not renters’), encouraging buyers to lock in supply of particular amenities.¹

2.5 Valuation of amenities over the market cycle

Higher price housing could be more volatile over the market cycle, due to the presence of down-payments and the importance of housing in net wealth (Stein 1995). A negative shock to house prices hinders movers from making their next down payment, depressing demand. If high-priced homes are purchased primarily by trade-up buyers, then their prices should have a greater variance over the real estate cycle. The prior expectation, according to this liquidity constraint model, is

¹Even if the buyer does not value a particular amenity, they will be prepared to pay for it, if they believe that the amenity will contribute to future capital gains (Hilber & Mayer 2009).

for procyclical amenity prices, as houses with higher prices (greater amenities) rise and fall more dramatically than those with lower prices. Alternatively, expectations during the bubble of capital gains may lead to a “property ladder” effect, where greater importance is attached by buyers to having any property, even one with poor amenities, than at other points in the cycle. Consequently, relatively less importance is attached to amenities, and thus countercyclical amenity prices would be evidence of “property ladder” effects.

Case & Mayer (1996) provide some insight into the relationship between amenities and the market cycle. They relate relative house prices changes over the 1981-1994 Massachusetts boom and bust to seven sets of variables, including amenities. They find that amenities such as employment, education and low crime shifted the distribution of prices during the boom, but far less so if at all during the bust. For example, towns with a larger share of residents working in the declining manufacturing sector witnessed smaller increases in house prices over the boom-bust cycle. Distance to Boston mattered both in the boom and the bust: over the period as a whole, for a town one standard deviation closer to Boston than the average (15 miles compared to 32), house prices grew 5% faster, reflecting either Boston’s high-income employment mix or the amenities it offers to nearby residents. Nonetheless, Case & Mayer (1996) do not find evidence in favour of Stein’s (1995) liquidity constraints hypothesis that the spread of house price is procyclical. Controlling for amenities, low-priced towns saw faster house price growth to 1988 and then greater falls after that.

In their analysis of the 1970s-1980s Houston bubble and bust, Smith & Tesarek (1991) find evidence in favour of Stein’s (1995) hypothesis of a procyclical spread in house prices. Over a broader time frame, though, vacancy was key with higher-end properties recovering faster. Case & Shiller (1994) explore two other 1980s boom-bust cycles in U.S. cities, those of Boston and Los Angeles. In Boston, there is evidence of a shift in house price inflation to the lower tier after other tiers had stabilised (1987-9), giving that part of the market the greatest boom in prices. Similar to Houston, once prices started to fall, the higher tier bottomed out earlier. In LA, there was very similar appreciation across high, medium and low tiers of housing. Price falls, which had not finished by the time of publication, differed noticeably across segments, with higher tier housing seeing significantly larger falls. Their results, particularly for Boston, run somewhat counter to the liquidity constraint model presented above.

A more recent property market crash was that in Japan in the 1990s. For two major Japanese cities, Tokyo and Osaka, Hirayama (2005) outlines the extent of 1990-2002 price falls by property type. While the price of new single-family dwellings fell by 10%, second-hand condominiums fell by 30% in Osaka and 40% in Tokyo. The biggest price falls (60%) were concentrated in bubble-era condominiums, either “super-luxury condominiums” in central districts, whose price had risen most dramatically in the boom years, or “suburban bubble condominiums”, which faced competition from steady streams of fresh supply.

Across these different studies, one theme is that the bubble is in some senses a suspension of normality. For example, evidence from the 1980s cycles in Boston and L.A. hints at the distribution being frozen in time as prices rose, as though the bubble prevented market agents from revising their assessments of the relative worth of particular attributes (Case & Shiller 1994). Once prices started to fall, agents had time again to revalue attributes, resulting in the changed distribution. Similarly, in the bubble in Tokyo, rapidly rising prices meant that families were pushed to buying condos – something that did not last into the bubble (Hirayama 2005).²

2.6 Categories of amenities

A multitude of location-specific attributes may impact on a property's desirability. A natural ordering of these amenities is by permanence or mobility, with first-nature endowments of geography at one end of the spectrum and population-specific amenities at the other. For the purposes of this analysis, five categories of amenities are considered:

1. Geography suggests that landscape and natural capital may matter, such as proximity to coastline or lakes. This categories also includes distance from “disamenities” such as waste facilities, mobile phone masts or power stations.
2. Transport facilities, such as motorways, train stations or light rail services, often feature prominently in property advertisements and quality of life rankings.
3. Also prominent in property advertisements are human capital amenities, such as nearby primary or post-primary schools and hospitals. It should be noted that, particularly with a busy facility such as a hospital, there may be disamenities associated with living too close to certain facilities.
4. Amenities relating to market depth are those of von Thunen and Alonso recast: people need to be near centres of economic activity both as suppliers (of factor services) and as consumers (of market goods and services).
5. Lastly, households may value population-specific (rather than location-specific) amenities, what one may term social capital amenities. Such amenities are less easy to measure, but may include the professional composition of a neighbourhood, its ethnic homogeneity or diversity, or perceptions of safety and crime.

²Other research with the same dataset used here highlights a marked increase in the spread of price differentials associated with different property types in Ireland 2006-2011 (Lyons 2012). For example, controlling for location, the differential between a four-bedroom property and a two-bedroom property increased from 54% to 70%. In contrast, in the lettings market there was marked compression in the spread of rents over the same period. This suggests “property ladder” effects, and thus countercyclical amenity prices, rather than buyer lock-in concerns (and procyclical amenity prices).

Category	Cohort	Sales		Lettings	
		Count	Percent	Count	Percent
Size	One-bedroom	9,557	2.7%	69,684	10.2%
	Two-bedroom	56,242	16.1%	252,827	37.2%
	Three-bedroom	161,395	46.3%	223,224	32.8%
	Four-bedroom	99,852	28.7%	112,806	16.6%
	Five-bedroom	21,458	6.2%	21,848	3.2%
Region	Dublin	105,112	30.2%	319,934	47.0%
	Other cities	44,800	12.9%	107,874	15.9%
	Leinster	104,777	30.1%	159,054	23.4%
	Munster	55,182	15.8%	57,447	8.4%
	Connacht-Ulster	38,633	11.1%	36,080	5.3%
Total		348,504	100.0%	680,389	100.0%

Table 1: *Dataset size, by cohort*

3 Data

3.1 Advertised Prices

The principal dataset used comes from the online accommodation portal, Daft.ie, which provides price (rent) information as well as property attributes, including location. Over the period 2006-2011, Daft.ie was the largest property website in Ireland across a range of metrics including number of properties, estate agents, page impressions per month and unique IP addresses per month. Daft.ie’s parent company estimates that its coverage of both sales and lettings markets is above 90%. With rich local listings, this enables a depth of modelling of regional property markets in Ireland heretofore impossible without great expense.

The sales component of the full dataset includes 348,504 properties listed for sale between 2006 and 2011, after excluding properties whose exact location was not known to a sufficient level of accuracy (see Section 3.2). Of these, 147,265 were existing ads whose price had changed. The dataset captures sellers’ expectations and so includes as a separate entry existing ads where the price, and thus seller’s expectation, has been changed. After excluding properties whose location is not known to sufficient accuracy, the lettings component of the dataset comprises 680,389 ads, of which just over one quarter (195,851) were existing ads whose advertised rent had changed. Summary stats for both components of the dataset are given in Table 1. Compared to the sales dataset, there are a greater proportion of smaller properties and Dublin properties: the most common property size is two-bedroom, while Dublin properties comprise almost half of all ads.

There are three distinguishing features about this dataset. The first is its size (over a million observations), not only relative to the size of Ireland’s housing market – the country had in Census 2011 just over two million households – but also in absolute terms, compared to studies from other countries. In their review of 69 hedonic studies of willingness to pay for environmental amenities in the two decades to 2006, Kuminoff et al. (2010) find that only about one in five (22%) contains

more than 10,000 observations. The second is the fact that the dataset covers an entire country. Only about one in ten hedonic studies (9%) has been at the national level (Kuminoff et al. 2010). The third distinguishing feature is the fact that both sales and lettings markets are included: this is the first study of this type known to the author that has comparable data for both.

Selection Effects The dataset represents neither a typical sample of properties being transacted nor the entire population. This means that the issue of sample selection arises. In the case of the lettings segment, leaving aside privately negotiated roll-over leases, any bias that exists would likely be against rent supplement properties (paid by the taxpayer) whose vacancy is passed on by word-of-mouth. This cohort is likely to be very small relative to the market as a whole and suffer from non-market-determined rents. In the sales segment, there is a greater potential for bias, as estate agents have greater choice of property portal. In particular, some estate agents with portfolios of properties skewed towards the higher end of the price distribution typically did not list on Daft.ie in 2006-2007. Thus, Daft.ie's coverage of the top end of the price distribution during the bubble's final stages could be systematically affected. To correct for this, 34,000 advertised listings by estate agents not on Daft.ie, principally from the period 2006-2007, were included in the sample.

Bid-ask spreads Another concern in relation to the data is that price information included is advertised, and not transaction, prices, measuring sellers' expectations. These expectations can be seen as a leading indicator of the market but in an extremely illiquid market, an asking price from January may be associated with a transaction in September – or none at all – and it is unclear *a priori* how accurate asking prices will be in capturing trends in transactions. Preliminary evidence, however, suggests a very close correlation between the two (Lyons & McIndoe-Calder 2012). Even if the correlation between asking and transaction prices is unknown, given the poor informational infrastructure in the Irish real estate market, with no publicly available micro-datasets, analysis based on advertised prices is better than no analysis at all. Secondly, even when the market was at its most illiquid, with lending volumes down almost 95%, asking prices produced persistently rich datasets, with tens of thousands of observations per quarter.

3.2 Location

Three dimensions of a property's location are used in this research: its regional market, to enable accurate pricing of different property types, its local market, to capture factors not included in the analysis, and its exact physical location, used to calculate distance to amenities.

Regional markets Five broad regions in the Irish property market are defined. The first is Dublin city. The second regional market contains the four other cities in Ireland combined (Cork, Galway,

Limerick and Waterford), whose populations vary from 50,000 to 275,000. These are not contiguous but may share marginal price effects due to their status as regional cities. The other three regional markets are based on Ireland's provinces, but excluding the city areas: Leinster, Munster and Connacht-Ulster. The model includes interacted time-type and time-size controls, allowing the relative price between, for example, two and three-bedroom properties or between semi-detached properties and apartments to vary between bubble (2006-2007) and crash (2009-2011) periods.³ Furthermore, these are interacted with each of the regional markets. Statistical significance of region-type-time variable combinations signifies that the price differential (or change in price differential, for crash variables) in a particular region is different to that in Dublin.⁴

Local markets At a more granular level, areas are grouped into one of about 400 local markets. These are fixed effects, designed to capture the impact on price of locality-specific factors that are not included in a given specification, including location-specific and population-specific attributes or indeed any pure label effects. These markets have been manually configured for each part of the country, according to a combination of the volume of listings, geographic coherence and market logic. Each is interacted with the *let* categorical variable, allowing the fixed effect for each local market to vary between sales and lettings segments.

Exact location The final locational attribute used is the property's physical coordinates. The addresses of each property advertised is converted upon listing by Daft.ie into XY coordinates. Also given is a level of accuracy with which these coordinates are known. Both are products of addresses being applied to the Geodirectory service, run jointly by Ireland's official mapping and postal services. This accuracy can vary from area-level through townland, village and street-level to building-level. Only building-level and street-level locations would be accurate enough to include in a study of amenity valuation which calculates distance based on XY coordinates, hence those listed at a poorer level of accuracy were excluded.

3.3 Property attributes

Among the independent variables are a range of property-specific controls, which also come from the daft.ie dataset. These are grouped into four categories: the time the ad was listed (by calendar quarter), property type (house or apartment being the chief distinction), property size (measured in bedrooms and bathrooms, and in the case of lettings properties the occupancy of the bedrooms), and other features including facilities and terms of the ad.

³2008, a period when the market was still in adjustment, is included in neither period and acts as a control where relevant.

⁴For more on the specifics of these interacted variables, see Lyons (2012).

Variable	Description (controls in <i>italics</i> ; segment-specific variables denoted by [S] (sales) and [L] (lettings))
Time	Categorical time variables for each quarter from 2006:I to 2011:IV
Type	Apartment (<i>basic</i> , duplex [S] or flat [L]); house ([S]: terraced, <i>semi-detached</i> , detached, apartment, bungalow)
Bedrooms	Number of bedrooms (one, two, <i>three</i> , four, five)
Bathrooms	Number of bathrooms relative to number of bedrooms as follows: one-bed (<i>one</i> or more), two-bed (<i>one</i> or more), three-bed (<i>one</i> , two or more), four-bed (one, <i>two</i> or more), five-bed (one, <i>two</i> or more)
Bedroom size	[L]: stated occupancy of bedrooms (measured by number of single rooms): one-bed (<i>zero</i> or one), two-bed (zero, <i>one</i> or two), three-bed (zero, <i>one</i> or more), four-bed (zero, one, <i>two</i> or more), five-bed (zero, one, <i>two</i> or more)
Features	[L]: information is available for a range of utilities (including central heating, an alarm system, cable TV and the internet), white goods (washing machine, dryer, dishwasher and microwave) and other features (wheelchair accessible, parking and [S] garden)
Terms	[L]: a range of contract terms are also included (whether pets are allowed, whether rental allowance is considered, a short or long lease, relative to a 12-month control, and [S] whether an agent is used)

Table 2: *Summary of property-specific variables used*

The precise variables are explained in Table 2. All variables are set up as categorical variables. The literature suggests that where possible, regional differences in price differentials associated with particular property types should be allowed for (Allen et al. 1995). Thus, following Lyons (2012), all type, size and feature variables are interacted with bubble and crash periods, to allow price differentials for different properties to vary over the market cycle. Type and size variables are also interacted with regional markets, to allow differentials (and changes in differentials) to vary around the country. These type-period-region variables are also interacted with a categorical variable for the lettings segment, to allow price differentials to vary by segment.

3.4 Location-specific attributes

Included in the models as explanatory variables are a range of variables capturing the distance of each property from a range of location-specific amenities. In total, 22 spatial amenities are included, covering each of the five categories of amenity outlined in Section 2.6: environmental amenities and facilities; transport facilities; human capital services; market depth; and social capital:

1. **Environmental amenities:** Four natural endowments are included in the research, coastline, bathing facilities, lakes and rivers, and two environmental disamenities are also included: waste facilities and polluting facilities. All data are from Ireland's Environmental Protection Agency, except for lakes and rivers, which are from Ireland's Water Framework Directive.
2. **Transport amenities:** Four location-specific transport amenities are included: train stations,

rail track (from the Railway Procurement Agency), and the primary road and secondary road networks (from NavTeq). The nature of the station is also known, in particular whether the station is light rail (*Luas*), suburban, Intercity, or Northern Ireland Rail. Roads with a “functional class” of 1 are part of the primary road network, while those with functional class 2 are the secondary road network.

3. **Human capital amenities:** Proximity to primary and secondary schools and to hospitals is also included in this research. The coordinates of all primary and secondary schools were provided by the Department of Education and Skills in Ireland, while the location of hospitals was provided by researchers at the National Institute of Regional & Spatial Analysis at NUI Maynooth.
4. **Market depth amenities:** Three labour market variables are included, based on information from the April 2006 Census: the neighbourhood unemployment rate, the average commute in kilometres, and the proportion of people employed in agriculture, as a simple index of employment opportunity. These can be best thought of as area-level fixed effects, as they are not time-varying and labour market conditions changed substantially over the period under consideration. Two other Census-based “market depth” variables are included: the percentage of single people in an area (a “marriage market premium” might exist in the rental market), and population density, motivated by New Economic Geography. All Census-based variables are based on associating with any property the attributes of the Census district in which it lies. There are just over 3,400 Census districts in total in Ireland.
5. **Social capital amenities:** These are significantly more difficult to measure and often belong in analysis of underlying demand, rather than prices. The focus is on attributes more likely to be taken as given by market actors at a point in time; four are included in this analysis. Two factors are fixed in the short run: an area’s spaciousness (the average building size, in rooms) and its maturity (proportion of pre-1914 buildings). The other two variables are measures of community that market participants may take as relatively exogenous: the percentage of the population that speaks Irish regularly (Irish-speaking (*Gaeltacht*) areas may exhibit community cohesion effects), and the proportion of an area’s population in State-provided accommodation.

An overview of the 22 location-specific variables is given in Table 3. Those calculated using 2006 Census information, rather than distance – best interpreted as fixed effects – are marked in italics.

Category	Amenity
Environmental	Coastline; bathing facilities; lakes; rivers; waste facilities; polluting facilities
Transport	Train stations (by type); rail track; primary road network; secondary road network
Human Capital	Primary schools; secondary schools; general hospitals
Market Depth	<i>Unemployment rate; average commute; proportion in agriculture; proportion of single people; population density</i>
Social Capital	<i>Area spaciousness; area maturity; proportion of Irish speakers; proportion in State-provided accommodation</i>

Table 3: Summary of location-specific variables used - Census-based in italics

4 Model

The price of each property in the database can be represented as the sum of the estimated value of its constituent components as well as an error term, ϵ , reflecting the gap between the predicted value and the actual value; in matrix algebra:

$$\log(\text{price}_i) = \beta_0 \text{let}_i + X'_{1i}\beta_1 + X'_{2i}\beta_2 + X'_{3i}\beta_3 + X'_{4i}\beta_4 + \epsilon_i \quad (1)$$

where: let_i refers to whether the property is for sale or to let, X'_{1i} refers to property-specific characteristics, including size and type, X'_{2i} refers to the time period; and X'_{3i} refers to local market fixed effects, and X'_{4i} refers to location-specific amenities.

The first and underlying hypothesis of this research is that access to an amenity will be reflected in the price. For market depth and social capital amenities, a property's access is given by Census 2006 results. For the remaining categories of amenity – environmental, transport and human capital – access to amenities is in the form of a distance. The measure of access used (X'_{4i}) is the log of the Euclidean distance in metres, calculated using ArcGIS software.

For the three other hypotheses investigated in this research, namely that amenity valuations differ between rural and urban locations, between sales and lettings segments and between the bubble and the crash, distances (or Census scores) are interacted with a range of categorical variables.⁵ Any property in Ireland's five cities (Dublin, Cork, Galway, Limerick and Waterford) is classified as urban, the remainder as rural. Any property listed before January 1 2008 is included in the bubble period, while any listed on or after January 1 2009 is included in the crash period. The typical baseline cohort is, then, rural properties for sale listed during 2008.

The log specification is a useful approximation for increasing order of magnitude in distances:

⁵For six amenities (lakes, bathing facilities, density of population, Irish language, state housing and proportion in agriculture), no urban-rural split was included, as there are limited supplies of the amenity in either rural or urban segments. Additionally, for train station, a rural-urban split would reflect different train services, which can be captured directly, by including interactions for the various station types. For two amenities, the average commute and population density, two additional interactions with log-distance were included: both bubble and crash were interacted with let, to allow the change over the course of the market cycle vary by segment.

100 metres further away is treated very differently when the starting point is 250 metres compared to 25 kilometres. Nonetheless, it is quite restrictive in one sense: a change in distance between 55 metres ($ldist = 4$) and 148 metres ($ldist = 5$) is treated equivalently to one from 1.1km ($ldist = 7$) and 3km ($ldist = 8$). While distance may matter, it is not clear *a priori* that this exact relationship will hold. Thus, for all amenities, four further sets of interactions with log-distance were included. The first two are log-distance interacted with buffer variables that take a value of 1 if a property is within 250 metres of an amenity and if a property is between 250 metres and 1,600 metres (roughly one mile). The latter two are these variables in turn interacted with *let*. These variables enable the relationship between amenity value and distance to vary by distance and also by segment.⁶

5 Results

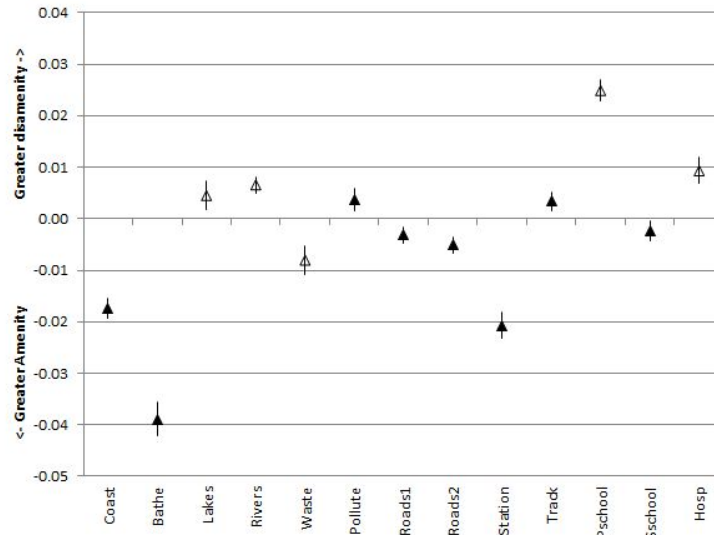
5.1 Valuation of Amenities

Figures 1 and 2 outline how the cost of accommodation is related to the presence of 22 amenities. Figure 1 outlines the effect for distance-based amenities (environmental, transport and human capital). As these are all represented on the log scale, where greater distance (a higher log score) reflects poorer access to a desired amenity, the coefficient should be positive. All distance-based amenities have a statistically significant effect on accommodation costs. However, not all accord with prior expectation: those markers that are open (rather than filled black) have an effect counter to expectation.

There are five amenities where the sign is the opposite to initial expectation but in only one case, that of waste facilities, is this a puzzle. For both lakes and rivers, proximity is punished, rather than rewarded – this suggests that flood risk, not captured elsewhere in the model, may be important. Similarly, there is a clear negative association between accommodation costs and proximity to both primary schools and hospitals. This may reflect costs of congestion. Almost one quarter of all properties in the dataset have locations within 250 metres of a primary school, while just 4% are more than a mile away, meaning the interactions allowing for a different relationship between distance and costs below 0.25k and between 0.25k and 1.6k are important. These interactions suggest that what is captured is indeed congestion effects. The reward for distance from a primary school is less pronounced for properties at a distance of 250m-1.6k than at a distance of less than 250m. The full set of coefficients for these interacted buffer-log distance variables, and their degree of statistical significance, is given in Table 4, alongside the base effect (the coefficient on log-

⁶All properties and the bulk of amenities are indicated on the map as points, whereas in reality they are polygons. Thus, one other modification, to prevent small distances (and any measurement error at small distances) skewing the results was to set the minimum log-distance from an amenity to 3 (20 metres), or 4 (55 metres) where the property's location is known only to street level.

Figure 1: *Coefficient (and 95% confidence interval) on log-distance for amenities (I)*



distance from Figure 1). The disamenity of proximity to lakes in particular, but also rivers, is acute at small distances (less than 250m), but only for the sales segment: in the lettings segment, the coefficient shows that proximity is not punished.

Figure 2 outlines the effect on prices and rents of the nine Census-based amenities (market depth and social capital). The bulk of these amenities have clear effects on cost of accommodation in line with expectations: increasing the proportion of pre-1914 properties in an area (area maturity) by ten percentage points boosts prices by about 2%, while increasing the average number of rooms in an area (area spaciousness) by one room has almost twice as large an effect. All three labour market metrics have significant effects. Increasing the 2006 unemployment rate by five percentage points is associated with a fall in the cost of accommodation of about 4%, while there is an effect of 6%-7% associated with increasing the proportion of the labour force in a district involved in agriculture by ten percentage points, or increasing the average commute by 10km. Across the property market as a whole, a greater proportion of single people in an area is associated with lower prices. For two amenities, the proportion in State-provided housing and density of population, there are effects that, at reasonable magnitudes, are small. Lastly, for the proportion that speak Irish regularly, there is a positive but noisy relationship with costs of accommodation.

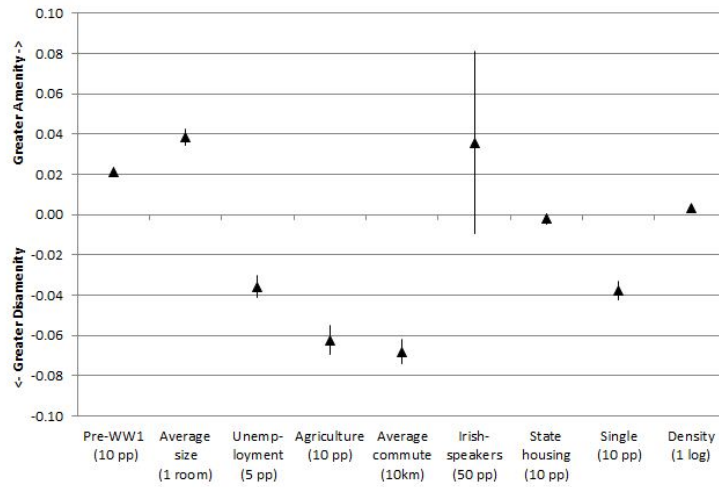
5.2 Urban and Rural Valuations

The second hypothesis of this research is that the valuation of amenities will vary across urban and rural segments. As outlined in Section 4, no interaction between distance and urban/rural status was included for certain amenities whose supplied is effectively tied to urban or rural segments.

Amenity	Base effect	<250m (all)	<250m (lettings)	0.25k-1.6k (all)	0.25k-1.6k (lettings)
Coast	−0.017***	0.002**	−0.002**	−0.002***	0.002***
Bathe	−0.039***	−0.002	−0.000	−0.001	−0.000
Lakes	0.005**	0.018***	−0.022***	0.005***	−0.005***
River	0.007***	0.004***	−0.003***	0.001***	−0.000
Waste	−0.008***	−0.013***	0.003	−0.004***	0.002***
Pollute	0.004***	0.001	0.001	−0.000*	−0.000
Roads1	−0.003***	−0.000	−0.002*	−0.001***	0.000
Roads2	−0.005***	−0.000	0.003***	−0.001***	0.001**
Station	−0.021***	0.005***	−0.004***	0.001***	−0.000
Track	0.003***	−0.003***	0.001	−0.000*	0.000
Primary School	0.025***	−0.001	−0.001	−0.004***	0.002***
Post-prim School	−0.002*	−0.000	−0.000	−0.002***	0.002***
Hospital	0.009***	0.001	−0.005***	0.002***	−0.003***

Table 4: *Coefficients on interacted buffer and log-distance variables*

Figure 2: *Coefficient (and 95% confidence interval) on log-distance for amenities (II)*



Controlling in this manner for differences in supply, higher relative valuation of amenities would be reflective of income differences and income-elastic demand for amenities, similar to Tiebout-style sorting by income. Table 5 outlines the coefficients associated with a range of categorical variables interacted with log-distance, including one for urban locations.

Urban interactions were included for fourteen of the 22 amenities. For nine of the fourteen, there is amplification of the amenity (or disamenity) effect. This is the case for six of the ten distance-based amenities, including three environmental amenities (coastline, waste facilities [with a sign counter to expectations] and polluting facilities), rail track (a disamenity that is three times more costly in cities) and primary and secondary schools. For secondary schools, proximity is clearly rewarded in cities, while the effect outside cities is smaller and with some variance.

For each of the four Census-based variables for which urban interactions were included, there

Amenity	Base	Urban	Lettings	Bubble	Crash
Coast	−0.017***	−0.019***	0.016***	0.002**	−0.004***
Bathe	−0.039***		0.014***	−0.006***	0.011***
Lakes	0.005**		−0.009***	0.003***	−0.005***
River	0.007***	−0.008***	−0.007***	−0.001**	0.000
Waste	−0.008***	−0.010***	0.006***	−0.007***	0.004***
Pollute	0.004***	0.013***	−0.012***	−0.002*	0.002**
Roads1	−0.003***	−0.001	0.002*	−0.005***	0.003***
Roads2	−0.005***	0.001	0.008***	−0.002***	−0.000
Station	−0.021***		0.007***	0.001	0.001
Track	0.003***	0.006***	0.002	0.001	−0.004***
Primary School	0.025***	0.003***	−0.025***	0.000	0.005***
Post-prim School	−0.002*	−0.004***	−0.000	0.002	0.002*
Hospital	0.009***	−0.013***	−0.008***	−0.005***	0.004***
Maturity	0.210***	0.148***	−0.298***	−0.011	−0.058***
Spaciousness	0.038***	0.025***	−0.049***	−0.001	−0.005***
Irish-speakers	0.072		−0.150***	−0.267***	0.040
State housing	−0.020		0.025*	−0.041**	−0.033**
Unemployment	−0.715***	−0.694***	1.073***	0.066	−0.343***
Agriculture	−0.624***		0.477***	0.098*	0.134***
Av commute	−0.007***		0.001	0.003***	−0.004***
Single	−0.377***	0.303***	0.103***	0.018	0.033**
Pop Density	0.003**		−0.009***	−0.001	−0.006***

Table 5: *Coefficients on log-distance interacted with urban, lettings, bubble and crash variables*

were statistically significant and interesting results. For three – area maturity, area spaciousness and the 2006 unemployment rate – the effect on prices is roughly twice as large for urban properties than for rural properties. For the proportion of single people in a district, the urban coefficient largely offsets the base effect: whereas increasing the proportion of single people in an area outside the cities by ten percentage points is associated with 4% lower prices, the effect in cities is just 1%. This may reflect systematic differences in the age structure of single people by geography.

Of the three remaining amenities, the disamenity associated with proximity to hospitals is overturned in the cities. This may reflect a smaller marginal increase in congestion that urban hospitals bring, compared to hospitals elsewhere, although this is worth investigating more closely in further research. Only for two facilities, both primary and secondary road networks, was there no statistically significant impact on the cost of accommodation in cities compared to elsewhere. Access to the road network, it seems, is not a luxury.⁷

⁷The above results are from a pooled regression of all one million observations, with interactions for urban regions where appropriate. It is also possible, given sample sizes, to run separate regressions of all urban and all rural observations. Results (not shown due to space constraints) are largely the same: for most amenities, whatever effect exists is amplified in the urban segment. One interesting implication of this check is a quadratic relationship between prices and population density: once in a city, greater density is associated with lower prices but outside the cities, density and prices are – *ceteris paribus* – positively correlated.

5.3 Sales and Lettings Valuations

Table 5 also includes a column for the coefficient associated with a categorical variable for lettings properties interacted with log-distance. This is included for all 22 amenities. The expectation, as outlined in Section 2.4, is that a broader range of factors are incorporated into prices than rents and that the valuation of amenities or disamenities will be greater in the sales segment. This would be reflected by offsetting coefficients in the Lettings column in Table 5. For 19 of the 22 amenities, this is the case. While proximity to coastline and primary roads are amenities in the sales segment, and rivers, primary schools and hospitals are disamenities, these factors have a significantly smaller effect in the lettings segment and, outside urban lettings markets, perhaps no effect on rents at all. Similarly among Census-based amenities, the penalty associated with greater unemployment or a higher proportion working in agriculture was significantly smaller in rents than in prices. Whereas a five percentage point increase in 2006 unemployment was associated with 7% lower prices in urban markets, the rental effect was just 1.7%.

Two final results are worth noting. The first is the coefficient on the average commute, interacted with the lettings segment: it is not different, in a statistically significant way, from the effect in the sale market. While many amenities that may be termed secondary are not rewarded in the lettings market to the same extent as they are in the sales segment, for a primary amenity such as access to employment, tenants care just as much as buyers. This is indicative of the search costs story outlined in Section 2.4.

5.4 Valuations over the Market Cycle

The final hypothesis to investigate is the valuation of amenities over the course of the market cycle, exploiting the end of long real estate bubble in Ireland in 2006-2007 and the huge change in market conditions by 2009-2011. Sections 2.4 and 2.5 outlined competing hypotheses of what might happen to the price of amenities in a bubble, with “amenity lock-in” effects implying procyclical amenity prices but “property ladder” suggesting the opposite. The final two columns of Table 5 include the coefficients associated with categorical variables for properties listed during the bubble (2006-2007) and crash (2009-2011), interacted with log-distance.

Results are grouped by three categories: distance-based amenities, distance-based disamenities, and Census-based amenities. For distance-based amenities, procyclicality would mean additional costs to distance in the bubble (– in ‘Bubble’ column) which fade in the crash (+ in ‘Crash’ column). Countercyclical amenity prices would be reflected in the opposite: + in the bubble, – in the crash. Of the six distance-based amenities (excluding waste facilities), there is evidence of countercyclical pricing for coastline but procyclical pricing for bathing facilities and road network access. The value of proximity to train stations was acyclical, while any changes on access to secondary

schools were marginal. Of the six distance-based disamenities, the bulk exhibited countercyclical pricing; just two disamenities – lakes and rail track – exhibited procyclical pricing.

Of the nine Census-based amenities, there is clear evidence of countercyclical pricing for two labour market amenities: unemployment and average commute. The penalty associated with an unemployment rate five percentage points higher in 2006 was 5% in the crash period, compared to 3.2% in the bubble.⁸ Similarly, the punishment associated with distance from work increased significantly: extending the average commute by ten kilometres had a cost of 4% in the bubble but 11% in the crash. However, the cost of a greater proportion working in agriculture diminished in the crash. This may reflect the limitations of using fraction in agriculture as a reduced-form index of employment opportunity: farm incomes increased substantially in 2010, for example, while construction employment and incomes fell further that year. Two more secondary amenities, an area's maturity and spaciousness, exhibit procyclical pricing, with rewards falling in the crash. The effect on the proportion of Irish speakers or State housing is less clear.

In sum, there is clear evidence that the relative price increased in the crash for seven amenities, including two important labour market amenities and geographical features such as coastline and proximity to polluters. Nonetheless, there was evidence of procyclical amenity pricing for an equal number of amenities, including access to the road network, proximity to rail track and an area's maturity and spaciousness.⁹

5.5 Summary of results

The specification allows valuations to vary across bubble and crash periods, urban and rural markets, and sales and lettings segments. For coherence of results, given also the inclusion of buffer-distance variables, Table 6 summarizes the effect of moving a property from one kilometre away (within the outer buffer) to 100 metres away (within the inner buffer). Figures presented are changes in the coefficient associated with the amenity (due to change in distance and the application of all appropriate interacted variables including buffers). They are listed as percentages, given validity of the log approximation. After each amenity's name is the expected sign, where $-/+$ reflects the possibility of congestion effects (or flooding risk) close-by. The final three columns show the difference in effect for the latter three hypotheses: crash relative to bubble, urban relative to rural, sales relative to lettings. If the hypotheses hold, all three should be positive for amenities (negative

⁸Given the huge change in labour market conditions between 2006 and 2011, this is predicated on 2006 unemployment rates capturing the ordering of areas at a given national unemployment rate.

⁹To check the robustness of these results, regressions were run on (1) only Dublin observations and (2) all non-city observations (results not shown for brevity). The bulk of these results still hold, for example the countercyclicity of the price of coastline or distance from primary schools, hospitals or (for Dublin) polluting facilities. There are some differences, however: the fall in the premium on area maturity, for example, is primarily a non-city phenomenon, as is the countercyclicity of the value attached to shorter commute distances.

Amenity	Bubble	Crash	Urban	Rural	Sales	Let	C-B	U-R	S-L
Coast (+)	9.8%	11.1%	14.5%	10.2%	10.2%	6.5%	1.3%	4.3%	3.7%
Bathe (+)	19.3%	15.4%	17.9%		17.9%	14.8%	-4.0%		3.2%
Lakes (-/+)	1.7%	3.5%	2.4%		2.4%	4.5%	1.8%		-2.1%
Rivers (-/+)	-1.5%	-1.9%	0.0%	-1.8%	-1.8%	-0.2%	-0.4%	1.8%	-1.6%
Waste (-)	2.0%	-0.4%	2.8%	0.5%	0.5%	-0.9%	-2.4%	2.3%	1.4%
Pollute (-)	-1.0%	-1.9%	-4.5%	-1.4%	-1.4%	1.4%	-0.9%	-3.1%	-2.8%
Roads1 (+)	3.3%	1.4%	2.3%	2.1%	2.1%	1.6%	-1.9%	0.2%	0.5%
Roads2 (+)	3.4%	3.0%	2.8%	3.0%	3.0%	1.0%	-0.4%	-0.2%	1.9%
Station (+)	11.0%	10.9%	11.1%		11.1%	9.5%	0.0%		1.6%
Track (-)	-2.7%	-1.7%	-3.8%	-2.5%	-2.5%	-2.9%	1.1%	-1.3%	0.4%
P/School (-/+)	-8.9%	-9.8%	-9.4%	-8.8%	-8.8%	-2.9%	-1.0%	-0.6%	-5.8%
S/School (+)	2.2%	2.2%	3.5%	2.6%	2.6%	2.6%	0.0%	0.9%	-0.1%
Hosp (-/+)	-4.4%	-6.5%	-2.7%	-5.6%	-5.6%	-3.8%	-2.0%	2.9%	-1.8%

Table 6: Summary table of effect of moving a property from 1km to 100m away from various amenities, for different cohorts

for disamenities), reflecting property ladder effects, income sorting and search costs.

This exercise recaps the principal results of this analysis. The first hypothesis was that amenities would be reflected in prices at all. Once potential effects of flooding (rivers) and congestion (primary schools and hospitals) are considered, almost all amenities are reflected with the correct sign: the only exception is waste facilities during the bubble. The second hypothesis was that any price effects would be larger in magnitude in urban segments, compared to rural segments, due to income effects. This is overwhelmingly indicated in Table 6 (column U-R). For just one amenity, distance to rivers, was there no evidence of urban amplification – instead, proximity to rivers is punished rurally (potential flood risk) but rewarded (marginally) in the city.

The third hypothesis was, due to either tenant search costs or buyer lock-in concerns, any differentials would be larger in prices than in rents. Again, there is clear evidence from Table 6 (column S-L) that this is the case. For coastline, bathing facilities, primary and secondary roads and train stations, proximity is given a greater reward in the sales segment than in the lettings segment. Similarly, the penalty associated with proximity to rivers, primary schools and hospitals is greater in prices than in rents. For just two amenities (lakes and rail track) is the proximity differential greater in rents, and the significance associated with track is marginal (0.087). The final hypothesis was that the price of amenities would vary with the market cycle: either procyclically if lock-in concerns mattered most, or countercyclically if property ladder effects dominated. According to the exercise presented in Table 6, there is some evidence that “property ladder” effects are more important. The differential for six of the 13 amenities increased in the crash (coast, lakes, rivers, primary schools, hospitals and polluting facilities), while for four (bathing, road network and track) it diminished.

6 Concluding Thoughts

Understanding housing markets and their cycles is key to understanding economic fluctuations, due to the importance of housing as a good and an asset. This paper has explored four hypotheses in relation to housing markets. Following in the footsteps of a long literature, it traced the impact of amenities on property prices and also on rents, a less common feature of the literature. Twenty-two amenities, across five broad categories, were included in the analysis and almost all amenities had a clear impact on the cost of accommodation. For example, moving a property from 1km from the coast to 100m away was associated with a 10% increase in price.

This paper exploited the dataset's large size, its coverage of sales and lettings segments and huge variations in market conditions over the period to test three further hypotheses about the housing market. The first, that amenity valuation would be amplified in urban markets, reflecting income elasticities, was overwhelmingly found to be the case: an urban property moved from 1km to 100m from the coast would see an increase in price of almost 15% compared to 10% elsewhere. The second, that amenity valuation would be greater in prices than rents, reflecting either tenant search costs or buyer lock-in concerns. This was typically found to be the case: the rental premium for a coastline property was 6.5%, compared to 10% in sales. There is evidence from some amenities that tenant search costs may be the dominant channel (the lettings coefficient for a number of amenities offset the entire baseline coefficient). However, a better test of whether lock-in concerns exist was through the final hypothesis, that the price of amenities would vary with the property market cycle.

Procylical amenity prices suggest a "lock-in" effect: during a bubble, people pay over the odds to secure access to amenities in fixed supply. However, increasing amenity prices in the crash would suggest "property ladder" concerns dominated: normally people prefer to reward access to amenities, but in the bubble, the principal concern is not having any property, pushing up the relative price of low-amenity properties. There was no clear result from the 22 amenities, however the balance was in favour of countercyclical prices: the premium enjoyed by a property 100m from the coast compared to one 1km away rose from 9.8% to 11.1% between bubble and crash, the price of an additional 10km average commute from 4% to 11%.

Future work could extend the range of amenities included or exploit numerous variations in amenity supply during the period considered and use forthcoming data, including a new register of transaction prices, for complementary analysis, and 2011 Census results, for a more detailed examination of labour market amenities. Ultimately, with information on both sales and lettings segments, it will be worthwhile to understand the spatial variations in the rent-house price ratio, heretofore ignored in literature. Incorporating the search costs and lock-in/property ladder effects outlined earlier in a model with micro-foundations would be a significant step in that direction.

References

- Allen, M., Springer, T. & Waller, N. (1995), 'Implicit pricing across residential rental submarkets', *The Journal of Real Estate Finance and Economics* **11**(2), 137–151.
- Bank of Ireland (2007), Wealth of the Nation Report. Available at:
http://www.boi.ie/html/gws/includes/about_us/pdfs/wealth_nation_3007.pdf.
- Boyle, M. & Kiel, K. (2001), 'A survey of house price hedonic studies of the impact of environmental externalities', *Journal of Real Estate Literature* **9**(2), 117–144.
- Case, K. & Mayer, C. (1996), 'Housing price dynamics within a metropolitan area', *Regional Science and Urban Economics* **26**(3-4), 387–407.
- Case, K. & Shiller, R. (1994), 'A decade of boom and bust in the prices of single-family homes: Boston and los angeles, 1983 to 1993', *New England Economic Review* pp. 40–40.
- Debrezion, G., Pels, E. & Rietveld, P. (2007), 'The impact of railway stations on residential and commercial property value: A meta-analysis', *The Journal of Real Estate Finance and Economics* **35**, 161–180.
URL: <http://dx.doi.org/10.1007/s11146-007-9032-z>
- Gibbons, S. & Machin, S. (2008), 'Valuing school quality, better transport, and lower crime: evidence from house prices', *Oxford Review of Economic Policy* **24**(1), 99.
- Hilber, C. & Mayer, C. (2009), 'Why do households without children support local public schools? Linking house price capitalization to school spending', *Journal of Urban Economics* **65**(1), 74–90.
- Hirayama, Y. (2005), 'Running hot and cold in the urban home-ownership market: the experience of japans major cities', *Journal of Housing and the Built Environment* **20**(1), 1–20.
- Kuminoff, N., Parmeter, C. & Pope, J. (2010), 'Which hedonic models can we trust to recover the marginal willingness to pay for environmental amenities?', *Journal of Environmental Economics and Management* **60**, 145–160.
- Luckett, S. (2001), Did You Know? Homes Account for 44 Percent of All Wealth - Findings from the SIPP, Report, U.S. Department of Commerce.
- Lyons, R. C. (2012), 'East, West, Boom & Bust: The Spread of House Prices in Ireland, 2006-2011'.
- Lyons, R. C. & McIndoe-Calder, T. (2012), 'Price signals and bid-ask spreads in an illiquid market: The case of residential property in ireland, 2006-2011'.
- Mayor, K., Lyons, S., Duffy, D. & Tol, R. (2008), 'A Hedonic Analysis of the Value of Rail Transport in the Greater Dublin Area', *ESRI Working Papers* (264).
- Mayor, K., Lyons, S., Duffy, D. & Tol, R. (2009), 'A Hedonic Analysis of the Value of Parks and Green Spaces in the Dublin Area', *ESRI Working Papers* (331).
- Rosen, S. (1974), 'Hedonic prices and implicit markets: product differentiation in pure competition', *The Journal of Political Economy* **82**(1), 34–55.
- Smith, B. & Tesarek, W. (1991), 'House prices and regional real estate cycles: Market adjustments in houston', *Real Estate Economics* **19**(3), 396–416.

- Smith, V. & Huang, J. (1995), 'Can markets value air quality? A meta-analysis of hedonic property value models', *Journal of political Economy* **103**(1), 209–227.
- Stein, J. (1995), 'Prices and trading volume in the housing market: A model with down-payment effects', *Quarterly Journal of Economics* **110**(2), 379.
- Straszheim, M. (1987), 'The theory of urban residential location', *Handbook of regional and urban economics* **2**, 717–757.
- Tiebout, C. (1956), 'A pure theory of local expenditures', *Journal of Political Economy* **64**(5), 416–424.