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# Debt and Taxes: The Sale-Rent Housing Price Ratio in Dublin since 1945

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## Abstract

The recent Great Recession highlights the importance of housing to the broader economy, yet few reliable long-run series exist for sale and rental prices of housing. Using hedonic methods, frequency conversion techniques, and a detailed dataset of over one million sale and rental listings from newspapers and online, we construct new quarterly indices of sale and rental prices for Dublin, Ireland for the period starting in 1945 and an annual panel for six areas of the city over the same period. The series show four major market cycles, as well as three distinct phases for housing yield, with downward shifts in the early 1970s and again in the late 1990s. There is some evidence of rents converging across markets within the city but sale prices have diverged over the same period. An error-correction econometric analysis confirms the predictions of economic theory, that credit conditions in the credit market and user cost drive changes in the yield over time.

*Keywords: housing price ratio, housing markets, economic history, user cost.*

*JEL codes: E32; G12; N14; N94; R21; R31.*

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## 1. Introduction

Housing matters. It is the dominant asset in household balance sheets and the single largest component of household expenditure. The importance of housing was underscored by its central role in the recent Great Recession – with many high-income countries, such as the US, UK and Spain, experiencing substantial boom-bust cycles in their housing markets. Yet despite the importance of housing in the broader macroeconomy, there remain few reliable time series for housing prices, either sale or rental, extending back before the 1980s, which would allow putting the episode of the 1990s and 2000s into a longer-run perspective.<sup>1</sup> This is in part due to the illiquidity of the sales market and the high dimensionality of housing as a good: each dwelling is unique and infrequently traded.

Ireland was home to the world’s most extreme housing market cycle of the 1990s and 2000s, with nominal sale prices rising by a factor of four in ten years to 2007, before falling by almost 60% in the following five years. But as with other countries, there remains a paucity of research examining the structural factors at work over the long run that created the conditions for housing to drive a national boom and bust. This paper aims to address that gap, by constructing new housing price indices, both sale and rental, for Dublin, Ireland, from World War II until today. It does this by applying modern hedonic methods of index compilation to newly built datasets of sale and rental listings from Dublin’s newspapers and to rich online data for recent years. The calculation of both sale and rental price indices allows the estimation of the ratio of sale to rental prices of housing, the “housing price ratio”, a fundamental barometer of conditions in the housing market. Exploiting frequency conversion techniques, sale and rental indices and the housing price ratio are calculated at quarterly frequency for the city as a whole over this seventy-year period and at annual frequency for each of six districts within the city.

The research here connects to a growing literature that analyses housing prices over the long run; see, for example, Eicholtz et al. (2018) for rent prices in Europe since the 16<sup>th</sup> century and Knoll et al (2015) for sale prices globally since the mid-19<sup>th</sup> century. It is closely related to the work of Ambrose et al. (2013), who examine the ratio of sale to rental prices in Amsterdam since the mid-17<sup>th</sup> Century, and to Himmelberg et al. (2005), who incorporate user cost to reassess the performance of housing prices across U.S. cities in the decade to 2005. Its reliance on real estate listings means it is also part of a rapidly increasing literature that uses this rich source type to examine the performance of housing, either as an asset (sales) or as part of the cost of living (rental); see, for example, Shiller (2005), Kholodilin (2016), Kholodilin et al (2019), and Officer and Williamson (2018).

Given the geographic scope, the work here builds on a literature examining the performance of the Irish housing market. This literature, summarized in the table in Appendix A, is principally interested in sale prices (either nominal or inflation-adjusted), rather than rental prices or the ratio of the two. It can be divided into four phases, the first phase of which dates from the early 1980s; see, for example, Kenneally & McCarthy (1982) and Thom (1983), the latter of which includes a measure of credit conditions. The second phase of research dates from the late 1990s/early 2000s and arose due to the rapid increase in sale prices (e.g. Harmon & Hogan (2000), Kenny (1999)), but ignored non-price credit conditions. Similar theoretical concerns arise when reviewing the third phase, which dates from the mid-2000s and includes international reviews of the market, such as IMF (2003) and Rae & van den Noord (2006). Since the end of the housing boom in 2008, a fourth phase has emerged, which places a lot more attention on theoretical foundations and on non-price conditions in the mortgage credit market. Lyons (2018a) explicitly examines the housing price ratio since 2000 in a single-stage error-correction framework, finding credit conditions (as measured by first-time buyer loan-to-

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<sup>1</sup> For an overview of existing data series for many countries, including descriptions of their limitations, see Knoll et al (2017).

value and the system-wide credit-deposit ratio) to be central in explaining sale price rises between 2000 and the peak of the market.

Almost all existing work on Irish housing prices to date has relied at least in part on price series that, while official, do not adjust for the mix of properties traded over time. Sale price series rely on simple averages before the mid-1990s, while rent price series that contribute to official measures of inflation are based on surveys of lettings agents. The lack of mix-adjustment may result in mismeasurement of trends both over longer horizons, when quality drifts may be substantial, and over market cycles, where demand for attributes may be cyclical (Lyons 2018b). More recent work, such as Kelly et al. (2018) and Lyons (2018a) are notable exceptions, using hedonic methods on substantial datasets.<sup>2</sup> To our knowledge, the latter is also the only published work to examine the housing price ratio, with other work relying on implicit or explicit assumptions on demand and supply drivers of housing.

This paper builds on Lyons (2018a) and on recent cliometric contributions documenting the performance of the Irish economy over the long run. It presents new housing price indices, using modern methods of mix-adjustment, for both sale and rental segments for Dublin, Ireland, from 1945 on, at both annual and quarterly frequencies, the latter based on frequency conversion techniques. Those same methods, together with the depth of the dataset, allows the compilation of annual indices for each of six markets within the city. The collation of sale and rental indices allows the calculation of the ratio of sale to rental prices for Dublin housing. In addition to presenting the first consistent series for this ratio for Dublin over the long run, this paper also contributes a theoretically grounded empirical analysis of the determinants of this key metric of housing market health.

The paper outlines a number of stylised facts in relation to the performance of Dublin housing since World War II. Sale prices rose by an average of over 8% per year, well ahead of general inflation (5%). The findings here revise the path of rental price substantially upwards, with significant implications for measuring the cost and standard of living in Ireland over the last seven decades. The paper also finds four major market cycles, as reflecting in rising and falling sale and rental prices, as well as three broad phases of yields. Lastly, the econometric analysis finds that – in line with economic theory and prior work – user cost and credit conditions are central in determining the equilibrium yield in the housing market.

The rest of the paper is structured as follows. The following section outlines the basic economic theory underpinning the approach adopted here in focusing on the housing price ratio, while Section 3 describes the dataset used, including different newspaper and online sources for housing prices as well as other sources used in the second-stage regression analysis. The fourth section presents the new sale and rental housing price indices, at city and district levels, and discusses the resulting trends, before presenting an econometric analysis of the city-level figures. The final section concludes.

## 2. Theory

The demand for any good depends on its price, the income of consumers and other demand shifters such as taste or, in the case of long-lived goods, credit conditions. Applied to housing, the quantity of housing demanded,  $h$ , can be approximated linearly by:

$$\ln(h) = -\alpha \ln(hp) + \beta \ln(y) + z,$$

with a  $t$  subscript possible to denote the model over time, and where  $z$  refers to demand shifters, as discussed below. The fixed supply of housing in the short run allows the demand function to be inverted, so that price is a function of quantity, income and other demand shifters. If income elasticity were unitary, algebraic simplification would leave housing prices as a function of the

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<sup>2</sup> To this may be added Deeter et al. (2017), although their series ends in 1949 and for the twentieth century covers properties that had largely switched from residential to commercial usage.

income to housing ratio and other shifters. This inverted demand approach underpins, often implicitly rather than explicitly, most of the existing research on Irish housing prices, outlined in Appendix A and discussed in Section 1 above.

It is possible to separate demand shifters into those that affect owner-occupied housing and those that affected rental housing. The assumption is that income and housing supply ( $h$ ,  $y$ ) affect both segments. Other factors can be added, for example the headship rate as a summary measure of demographics. To the extent that such factors affect both segments, however, 'dividing through' by the rental price of housing will mean that the right-hand side consists of only those factors unique to demand for owner-occupied housing, such as user cost.

The impact of user cost on housing is the subject of a large literature. A seminal paper is Poterba (1984), who uses basic financial theory, in particular the concept of arbitrage, to describe the equilibrium ratio of sale to rental housing prices (hereafter, the housing price ratio,  $hpr$ ). In equilibrium, sale prices should reflect the discounted future stream of rental prices and, if the discount rate matches interest rates, then the simplest version of a housing price ratio equation has  $hpr$  as a function of interest rates. These interest rates are real, rather than nominal, and thus can be separated out empirically to distinguish between nominal interest rates (after tax) and expected capital gains. To capture the full cost to users of owning housing, other factors that are relevant include depreciation and maintenance, transaction and property tax costs, although often these do not vary substantially over time, and any risk premium.

In addition, and especially since the Great Recession, a growing number of papers have outlined the importance of including non-price credit conditions – in effect, capturing the distance of the credit supply curve from the origin – in determining the housing price ratio. While no direct measures of credit conditions exist, they have been estimated either using a latent variables approach (Fernandez-Corugedo & Muellbauer, 2006) or using a theoretically motivated proxy, such as the deposit required of the typical first-time buyer (Duca et al., 2011; Lyons, 2018a).

As far as we are aware, there is no research on how to calculate the risk premium associated with housing, other than to directly survey market participants. It is for this reason that this important and likely cyclical factor is omitted from studies. In principle, expected capital gains are also unobserved, although – in addition to survey data in some markets – a number of papers have found that, empirically, recent capital gains are typically reliable proxies of current expectations (see, for example Muellbauer 2007).

To summarize, economic and financial theory suggest that the housing price ratio will depend not only on nominal interest rates, but also on expected capital gains and credit conditions, as well as typically less volatile factors such as depreciation and property taxation. Theory – and empirical evidence – also suggest that changes, sudden or otherwise, in a component of the user cost such as property taxation will be reflected in the ratio of sale to rental housing prices.

### **3. Data**

This section outlines the datasets of real estate listings used in the analysis carried out, before also outlining the measurement of various series suggested by economic theory as relevant for understanding the housing price ratio.

#### **3.1 Listings overview**

The analysis here uses both sale and rental listings for the housing market in Dublin, Ireland. For both segments, two principal sources are used. The first, which covers the period from 2001 on for rental and from 2006 for sale, is an archive of online listings maintained by daft.ie, Ireland's largest property portal, as described in more detail by Lyons (2018a). This includes over 250,000 sale and almost 650,000 rental listings meeting size and location criteria. In particular, listings have information about number of bedrooms and bathrooms, the property type, and its

location in the Dublin market, using a set of almost 200 micro-markets that nest within the city's *Eircode* postal district system.

For the period from 1945 to 2006 (2001 for rental), the analysis relies on a newly compiled dataset of 33,427 listings from three main newspapers: the *Irish Times*, Dublin's newspaper of record, throughout, with additional listings taken from the *Irish Independent* (sales) and *Evening Herald* (rental) from 1996 until the online listings start. To compile this dataset, online archives of each newspaper were consulted. For each year, an initial sample of one set of listings per quarter was collated, with all valid listings on a given date digitized. For a listing to be included in the analysis, it was necessary for it to have information on four key attributes: the date (always available from the newspaper), the property type (in particular house or apartment), its size and its location, both of which are described in more detail below. Information about age, in general terms (as described below) was also recorded where mentioned. Where one set of listings per quarter did not generate sufficient sample size, additional sets of listings within the quarter were consulted.<sup>3</sup> Table 1 outlines the size of the dataset, by period and segment.

**Table 1. Newspaper listings dataset, by period**

Period	Five-year totals		Annual averages		Year-area averages	
	<i>Sale</i>	<i>Rental</i>	<i>Sale</i>	<i>Rental</i>	<i>Sale</i>	<i>Rental</i>
1945-1949	1,355	291	271	58	45	10
1950-1954	2,437	744	487	149	81	25
1955-1959	2,194	629	439	126	73	21
1960-1964	2,326	533	465	107	78	18
1965-1969	1,184	406	237	81	39	14
1970-1974	1,047	400	209	80	35	13
1975-1979	999	253	200	51	33	8
1980-1984	1,642	584	328	117	55	19
1985-1989	1,252	319	250	64	42	11
1990-1994	664	228	133	46	22	8
1995-1999	2,595	4,469	519	894	87	149
2000-2004	2,815	2,486	563	497	94	83

*Note: Cells show total or average number of listings, by segment. Year-area averages show the average number of listings for each of six city areas, as described in the text.*

### 3.2 Hedonic attributes

In line with internationally agreed best practices for policymakers today, such as those followed by Eurostat (de Haan & Diewert, 2011) and the IMF (Silver 2017), a hedonic approach is used to measure housing prices over time. In each empirical specification, all dimensions of property attributes are treated as (vectors of) categorical variables. In addition to date/time (the coefficients of interest), the four principal dimensions of property attribute used as regressors to control for the property mix are the property's type, age, size and location. The categorical

<sup>3</sup> The post-1996 dataset is larger due to both segments being the subject of two student dissertations.

nature of the hedonic specification allows the choice of a control property, whose value is reflected in the regression's constant, as well as the treatment of missing or partially complete information, for example on age or size, as discussed below.

### **Type**

Property type is assigned using two levels. At the top level, a property is assigned either as a house or as an apartment. Underneath this, where possible, a property is further assigned to a sub-type, for example duplex or flat within apartment or semi-detached or terraced within house.

### **Age**

Age is likely to be an important determinant of a dwelling's value to its occupants (and owners). However, it is infrequently included in ads and often, where included, only discussed in general terms, using phrases such as 'interwar' or 'modern'. For that reason, a general three-way categorisation of age was included in regressions. In addition to properties of an unknown age (coded age == 99), properties were classified into three categories: *new* (including terms such as 'off plans', new build' and 'first letting'), *modern* (the control), and *old* (including terms such as 'period', 'interwar' and 'pre-war').

### **Size**

A number of size metrics were used by housing market participants over the period considered. It is important to note that floor area in square meters/feet was almost never used, especially before the 21<sup>st</sup> century. Number of bedrooms or, less frequently and typically earlier in the period covered, total number of rooms was used as the main metric of size. Some listings, however, include number of bathrooms and/or number of reception rooms as additional or alternative measures of size.

To maximise the size of the valid dataset in each year, a flexible empirical specification is adopted. Specifically, each size indicator (number of rooms, bedrooms, bathrooms and reception rooms) is treated as a vector of categorical variables, i.e. only taking a value of 0 or 1. This allows non-linear (and indeed non-polynomial) price relationships between size categories as well as the inclusion of a greater number of listings. For example, for bedrooms, a categorical variable is included for each of the dwelling sizes, from one to six bedrooms. Where an otherwise valid listing does not include bedroom number, it is given a value of 99; given the categorical nature in the empirical specification, this has no effect on the estimate of values of size. For a listing to be valid, in addition to property type (house or apartment), it must include at least one of the four size measures.<sup>4</sup> Observations with more than one measure of size, for example the inclusion of both number of bedrooms and number of reception rooms, knit the various size metrics together.

### **Location**

In relation to understanding within-city variation, the long timespan presents challenges, as the city grew significantly during the period analysed. At one end of the spectrum, analysis is possible at the level of city in aggregate and can allow for within-year variation (for example at quarterly frequency) but at the cost of ignores changes in within-city variation over time. At the other extreme, allowing for heterogeneous within-city trends for each of 200 'micro-markets' within the city requires a sufficient volume of listings for each market in each period.

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<sup>4</sup> This can be relaxed by including properties with no known size information as a separate category, without affecting the overall results substantively. Unusually large properties (for example, where bedroom number is known to be above six) are treated separately, typically with a coding of 9. Again, these can be excluded without affecting the results substantively.

For the purposes of the analysis here, the dataset is used in two ways. The first is at the level of the city in aggregate. This allows for annual series of sale and rental price indices, while the use of frequency conversion techniques allows for quarterly housing price series. The annual city-level series is analysed using the regressors discussed in Section 3.3 below.

The second approach is to exploit the depth and spatial variety of the dataset, by splitting the city into six markets, each of which is observed throughout the period being analysed. These six markets are based on the city's modern Eircode 'routers' (or subdivisions used by the national postal service). Eircodes are address-specific postcodes, in use since 2015 but, for most of the contiguous city of Dublin, the routers are based on a pre-existing postal district system, originally set up in the nineteenth century. The concentration of roughly 25 Eircode routers used in the city currently into six markets is necessary as the volume of listings for certain routers in earlier periods, and especially for the rental segment, is small. The six areas, with corresponding postal districts/Eircode routers, are as follows:

1. North Dublin [ND] – Dublin 1, 3, 5, 7, 9, 11, 13, 15; Malahide [K36], Swords [K67]
2. South inner city [SI] – Dublin 2, 4
3. South suburbs [SS] – Dublin 6, 6W
4. South-west city [SW] – Dublin 8, 10, 12, 14, 16, 20, 22, 24; Lucan [K78], Maynooth [W23]
5. South-east city [SE] – the Blackrock Eircode router [A94; Blackrock, Booterstown, Monkstown, Mount Merrion, Stillorgan]
6. South county/North Wicklow [SC] – Dublin 18, Glenageary [A96; Ballybrack, Dalkey, Dun Laoghaire, Glenageary, Killiney, Sandycove]; Bray [A98], Greystones [A63]

### 3.3 Macroeconometric series

#### *Credit Conditions*

As outlined in Section 2, two of the principal factors suggested by theory as determining the housing price ratio are price and non-price conditions in the credit market. Price conditions are taken from Stuart's (2017) database on long-run Irish economic aggregates, in particular the short- and long-term interest rate series. Non-price conditions are given by the ratio of credit to deposits, where the level is taken from official statistics and extended backwards using Stuart's (*ibid.*) series for deposits (narrow money) and private sector credit.

#### *User Cost*

Section 2 outlined the main elements of user cost aside from nominal interest rates. These include expected capital gains, property taxes, and other holding costs (including depreciation, maintenance and a risk premium). As suggested above, depreciation/maintenance will be ignored, as its largely static nature over time cannot have an influence in a dynamic model. Similarly, no provision will be made for a risk premium – as is standard in the literature – due to the difficulty in its measurement. In line with the existing literature, such as Duca et al (2016) and Muellbauer (2007), one- and four-year annualised changes in nominal sale prices are examined for fit, as proxies for expected capital gains.

There is some additional important variation in user cost over the period. Much of the housing stock in Dublin was, until legislative changes in the 1970s, subject to a ground rent. This ground rent was set in nominal terms, typically for very long lease lengths. Of a sample of almost 1,500 Dublin deed transcriptions examined for the period 1900-1949 (after which the Registry of Deeds is no longer indexed by location), the mean lease length was 543 years, with the median length 460 years. For example, Reuben Street (in Dublin 8) was constructed between 1903 and 1905 and the ground rent for each home was £3.50 for a period of 999 years. With the general cost of living rising substantially in the second half of the twentieth century, this represents a steady fall in the real user cost associated with owner occupancy. This factor is incorporated into the econometric analysis using the general inflation rate.



## ***Real Economic Variables***

In addition to price and non-price conditions in the credit market, recent capital gains, and inflation (as a proxy for underlying ground rents), it is possible that conditions in the real economy may affect the ratio of sale to rental housing prices. Unemployment, changes in wages, and changes in real and nominal disposable income for Ireland are taken from Gerlach & Stuart (2015), Gerlach et al (2016) and Stuart (2017).

### **4. Analysis**

This section has three subsections, of which the last (Section 4.3) describes the results of an error-correction framework analysis applied to the housing price ratio at city-level and annual frequency, to examine its principal determinants. The first two subsections relate to the compilation of housing price series, at city level (Section 4.1) and for each of the six city areas (Section 4.2). For each of the seven markets, there are three series of interest: housing sale prices, housing rental prices, and the housing price ratio.

For both geographic scopes, the principal frequency of analysis is annual. The annual series for the six sub-city markets stem from frequency conversion techniques applied to underlying staggered quinquennial indices. The same techniques are also applied to the annual city-level analysis, to produce indices at quarterly frequency; the full series is given in Appendix B. All indices have 1948 as their base, to be consistent with Irish official statistics; a major revision of its consumer price index was launched that year.

As is standard with hedonic regressions used to produce price indices, standard errors are largely uninformative: the focus is on conditional averages, rather than the extent to which those averages are precisely estimated. Similarly, where the time span covers sufficiently large general price inflation, the R-squared will be uninformative: the year variables, almost by construction, will account for most of the variation, resulting in very large R-squared statistics. (The root mean square error is more informative as a measure of fit.) For that reason, results are presented graphically rather than in tabular form in Sections 4.1 and 4.2 below, although Appendix C outlines sample regression output for sale and rental segments at city level and annual frequency, for completeness.

#### **4.1 City-level series**

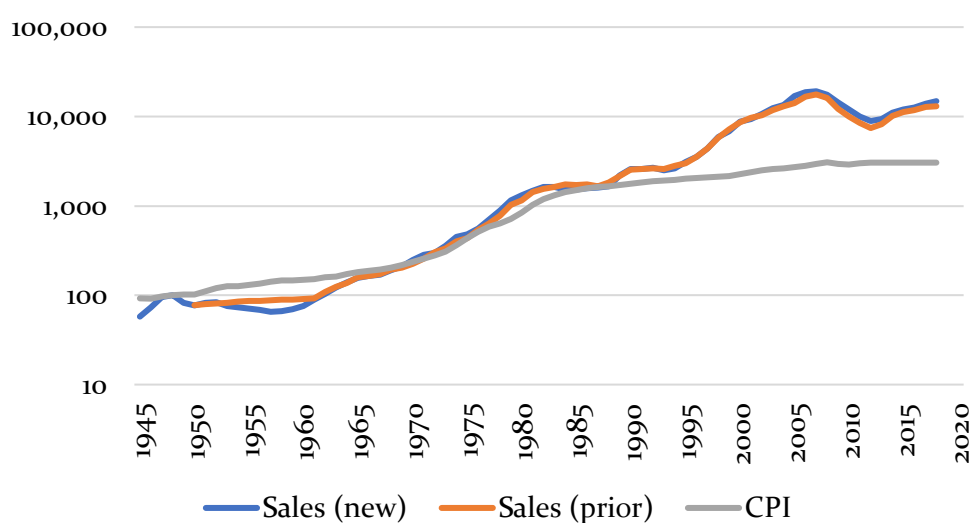
As outlined in Section 3.2, the core empirical specification across the datasets examines the (log of) the listed price, either sale or rental, as a function of property type, age and size (as measured by number of bedrooms, bathrooms, reception rooms, and/or total rooms), area in the city, and period. For rental properties, the frequency of payment is also controlled for. Online rental listings (from 2001) have some additional property features, such as lease length and the presence of white goods and utilities, which are also controlled for.

Figures 1 and 2 show new annual housing price indices for Dublin, sale and rental, compared to the official consumer price index (CPI) and to the best estimates of price inflation in each segment before the publication of these series. The best prior estimates of sale price inflation for Dublin come from a simple average produced by the Department of the Environment, starting in 1970, and figures from the Valuation Office and sporadic surveys prior to this. The first hedonic index for Irish sale prices dates from 1996 and was based on mortgages issued by one lender (Irish Permanent, later permanent-tsb). The official Central Statistics Office index of sale prices, based on comprehensive administrative data on transactions, starts in January 2005; it and an index of listed prices published by daft.ie are extremely highly correlated. The best prior estimates of rental price inflation are from the private market rent sub-index of the Consumer Price Index, published by the Central Statistics Office. Unfortunately, the methodology underpinning the construction of this sub-index is not explained. However, discussions with officials at the CSO indicate that it is likely this took the form of a written or

telephone survey of lettings agents. Therefore, it is unlikely that any form of formal mix adjustment was included.

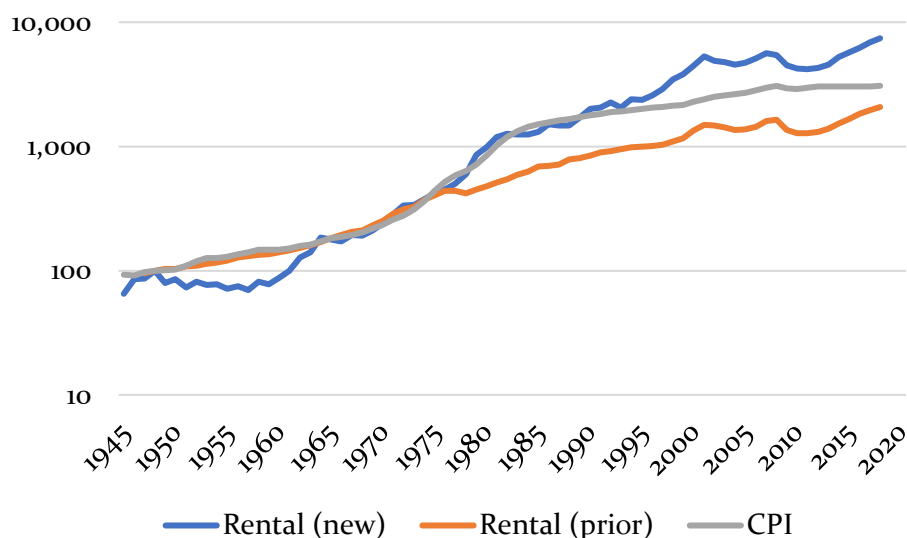
Between 1945 and 2018, the general price level in Ireland increased by a factor of roughly 33. The new sale price index – similar to existing evidence – suggests much greater inflation in housing. The hedonic index suggests that sale prices rose by a factor over 250 between 1945 and 2018, or a rate of almost 8% per year on average. This compares with an AGR of just under 5% in general prices. As shown in Figure 1, this difference between general prices and housing prices would be somewhat more accentuated if the start date was 1960, rather than 1950. Notwithstanding that, much of the gap between trends in housing and general prices stems from the post-1985 period: between 1950 and 1985, the increase in general prices was very similar to that in the sale price of housing (roughly by a factor of 15 in both). With one or two small differences, the new index of sale prices shows very similar increases in housing prices to existing evidence, based on a numerous sources spliced together: an AGR of 8.0% since 1950 compared to 7.8% in the prior index.

**Figure 1. Sale prices indices for Dublin housing (1948=100)**



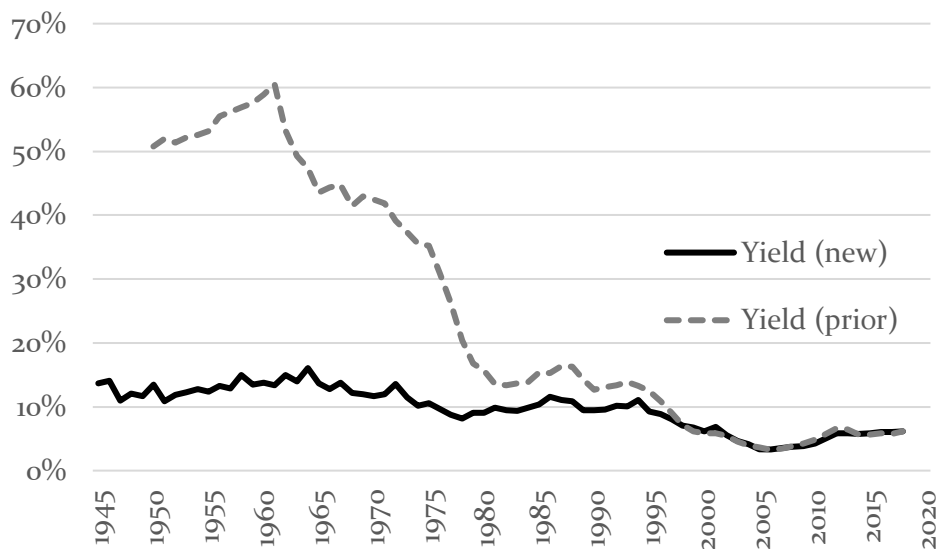
While the new sale indices are broadly in line with existing estimates of overall inflation in the post-war period, the new rental index – shown in Figure 2 – suggests significantly greater price inflation than previously understood. The existing CSO sub-index on private market rents suggests they increased by a factor of just 13 between 1948 and 2000, compared to an increase in general consumer prices of 23. In contrast, the mix-adjusted method here suggests private market rents increased on a like-by-like basis by twice as much as general prices (a factor of 45). While the spatial composition of the two series differs – the new index here focuses on Dublin, while the CSO index is designed to cover the entire country – this is unlikely to drive the discrepancy. Throughout the time period, given its large share of the population, Dublin dominated the private rental market. In the early 21<sup>st</sup> century, for example, it accounted for roughly 40% of the private rental market by tenancies (and more by market value). Given its nominal AGR of 7.6% during the second half of the 20<sup>th</sup> century, this means that nominal rents in the rest of the country would have had to be significantly *lower* in 2000 than in 1945, to generate a national nominal AGR of less than 5%.

**Figure 2. Rental prices indices for Dublin housing (1948=100)**



The second reason to doubt existing rental price series comes from evidence in relation to yields on housing. The housing price ratio, when expressed as the annual rent relative to the capital value of the dwelling, gives a percentage annual return, known as the gross yield. Figure 3 presents two series for the gross yield on residential property in Dublin. The first is based on existing series, including the CPI rent component, while the second is based on the listings dataset, regression analysis, and resulting hedonic indices described above. For both prior and new series, the level of the index is set to 6.1% in 2018, which is the weighted average gross yield for Dublin residential property for 2018. (This choice affects the level but not trend for either series.) Gross yields for Dublin housing are calculated for earlier years by combining the estimated year-on-year changes in both sale and rental housing.

**Figure 3. Gross annual yields for Dublin housing (percent)**

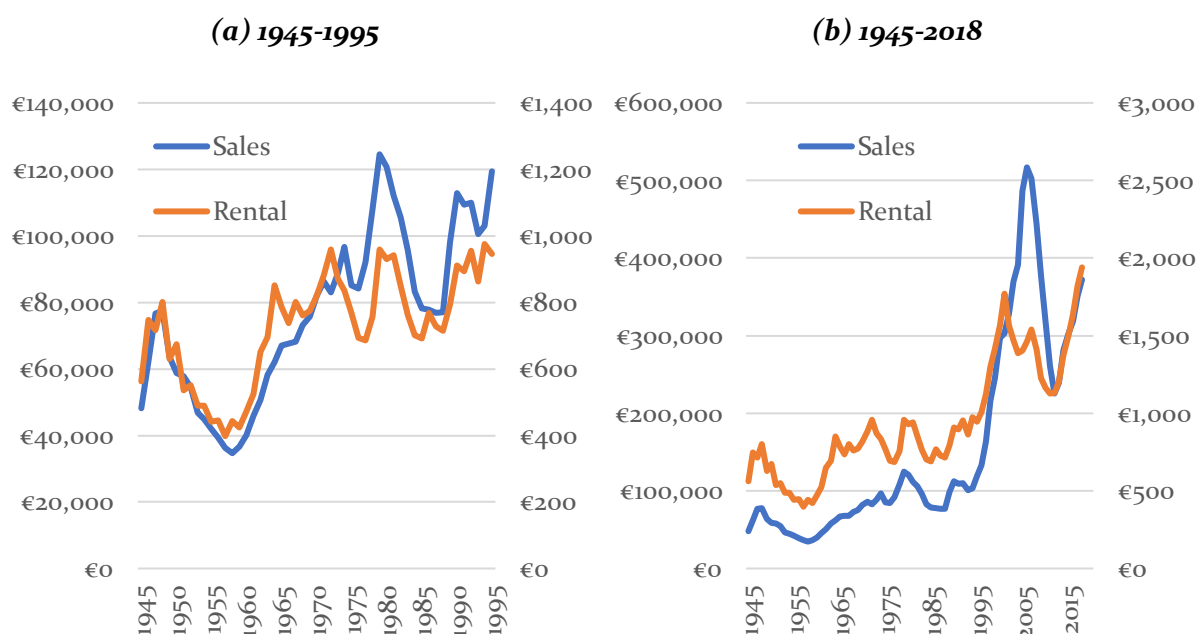


While both new and prior series suggest very similar yields after 1980, the two series diverge considerably before this. In particular, prior series imply implausibly high gross yields on housing earlier in the period, with an annual yield over 50% during the 1950s. By contrast, while the yield according to the new series is at its highest between 1945 and 1965, its peak is 20% (housing sold for five times its annual rent), rather than 50% (housing sold for twice its annual rent). This much lower level of yields is supported by individual property listings from the

period: in the Ballsbridge area of Dublin, a number of three-bedroom houses were advertised around 1960 for a rent of £500 per year, while during the same period, similar properties were listed for sale for prices between £2,000 and £3,000.

The final figure in this sub-section, Figure 4, presents both sale and rental prices of Dublin housing in real terms, expressed in 2018 euro, over two time periods. To do this, it uses the weighted average price of Dublin housing in 2018, published in the Daft.ie Reports, to anchor the series and applies the year-on-year changes in housing and general price indices to extend the two series back to 1945. The left-hand panel covers the period to 1995 only and is included given the dramatic increase in sale prices that occurred after this period, which hides market cycles before this date and is shown in the right-hand panel. The left- and right-hand axes are set such that where sale and rental price series overlap, the gross annual yield is 12% in the left-hand panel and 6% in the right-hand panel.

**Figure 4. Inflation-adjusted prices for Dublin housing (2018 euro; sale prices and monthly rents)**



The real (i.e. inflation-adjusted) series are shown, as stripping out general price inflation makes it simpler to assess market cycles, as well as to compare values over time. The left-hand panel shows the overall synchronicity of sale and rental prices before 1995: having risen sharply in the immediate post-war period, both fell during the 1950s, a time of economic hardship – with the series bottoming out in 1957 and 1958, just before Ireland ended its policy of protectionism. Thereafter, both sale and rental prices grew strongly until the early 1970s – with a local peak in rents in 1964, a year of rapid wage increases. The falls seen in the mid-1970s were undone with a boom in the late 1970s, itself undone with real housing prices falls during the economic crises of the mid-1980s. The right-hand panel adds the dramatic increase in real housing prices, both sale and rental, after 1995, with different peaks for the two segments – 2001 for rents and 2006 for sale prices, but with both bottoming out in 2012.

A summary of the movement in real sale and rental housing prices, together with the percentage point change in the gross yield, is given in Table 2. The extent of the real prices falls (in the 1950s) and rises (in the 1960s and 1970s) is immediately apparent: while in reverse order, they are of similar magnitude to the later Celtic Tiger boom/bust cycle. Three other features are of note. Firstly, sale and rental prices comove, but with greater volatility in the sale segment. This means that, in line with theoretical expectations, the yield on housing (as measured by annual rents) is negatively correlated with the housing market cycles. Lastly, the most recent housing

market upturn is an important exception to this general trend: despite a 65% real increase in the price of housing 2012-2018, the yield if anything increased slightly during this period.

**Table 2. Change in inflation-adjusted sale and rental prices (percent) and in gross yield (percentage points) of Dublin housing, by market cycle**

	SALE	RENTAL	YIELD
1948-1958	-55%	-45%	2.9%
1958-1979	259%	116%	-5.9%
1979-1987	-38%	-24%	2.1%
1987-1995	55%	30%	-1.8%
1995-2006	333%	54%	-6.0%
2006-2012	-56%	-23%	2.6%
2012-2018	65%	72%	0.2%

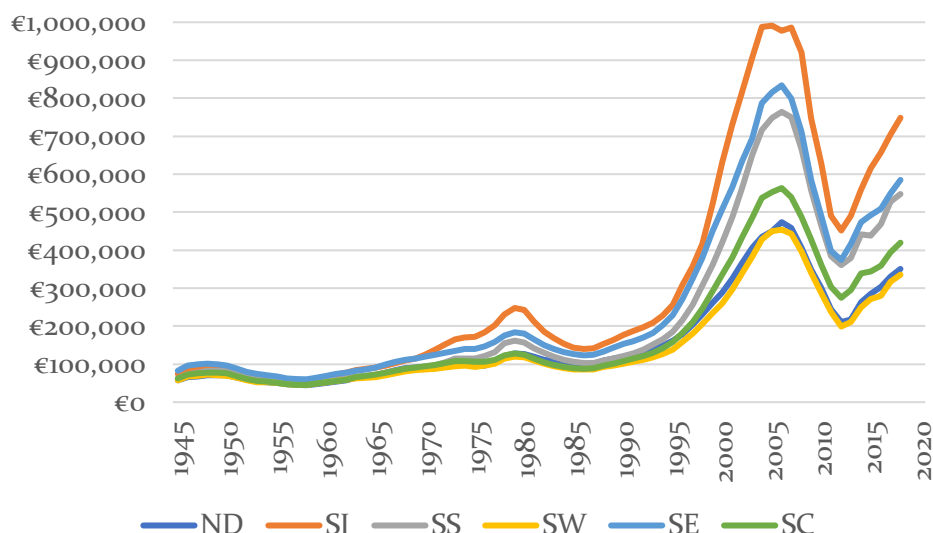
This analysis at city-level presents five stylised facts.

1. When measured on a like-for-like basis, the sale price of housing rose by an average of 8.4% per year, in nominal terms, between 1945 and 2018, compared to an average increase in consumer prices over the same period of roughly 5%.
2. Market rents increased by an average of 6.3% per year during the same period. Given this is well above the prior estimate of 4.4%, this substantially revises our understanding of the path of rental prices for Dublin, with implications for measuring the cost and standard of living in the Irish economy since World War II.
3. There have been three phases in gross yields since 1945, of roughly equal duration: averaging 13% (and in the range 11%-16%) for the first 25 years, to the early 1970s; averaging 10% (and in the range 8-11%) for the next 25, ending in the late 1990s; and yields below 8% thereafter, bottoming out at less than 3.5% in the mid-2000s.
4. Trends from real series of housing prices reveal roughly four major housing market cycles since 1945. Inflation-adjusted sale and rental prices peaked in the late 1940s, again in the early 1970s and the early 1980s, and lastly in 2006 (2001 for rents). Market troughs occurred in the late 1950s, the mid-1970s, the mid/late 1980s, and lastly in 2012.
5. While sale and rental prices typically comove, sale prices move in greater magnitudes, meaning the yield compresses during market upswings (such as 1958-1979 and 1995-2006) and grows during price busts (such as 1948-1958 and 2006-2012). The period since 2012 is a notable exception to this pattern.

#### 4.2 Within-city variation

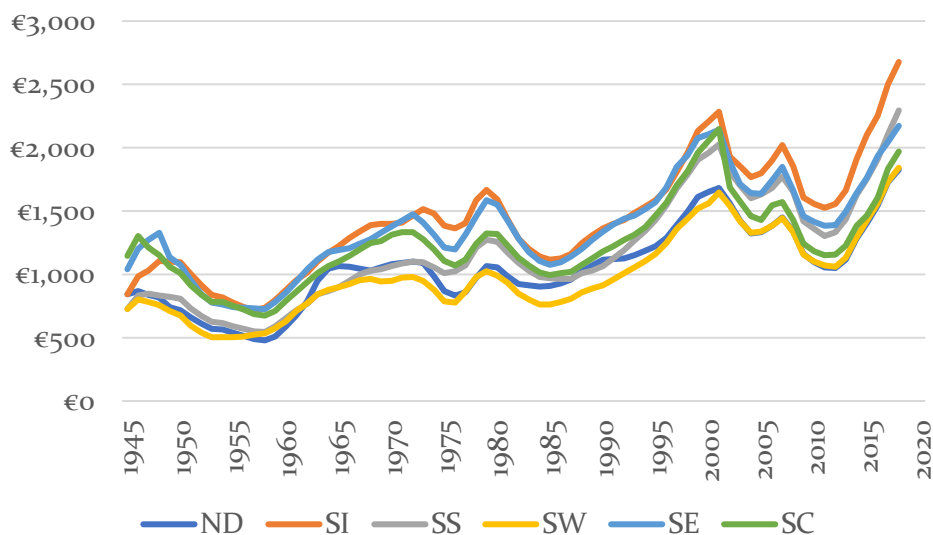
This section presents the results of the within-city analysis, for the six consistent markets within the city over the period analysed. To generate indices of annual frequency, frequency conversion methods are applied to the newspaper dataset. (Sample sizes are sufficiently large, for each area, in the datasets of online listings.) Specifically, a set of regressions is performed separately for each of the six city markets. For each of the six markets, five staggered regression analyses are undertaken, using quinquennial (five-year) categorical variables. Once the full set of regressions is performed for each city market, an average for each year is calculated, giving an annual index for each.

**Figure 5. Average sale price of Dublin housing, by city market (2018 euro)**



Figures 5 and 6 present inflation-adjusted graphs of sale and rental prices, at annual frequency, for each of the six markets described in Section 3.2. As with the city-level analysis, the post-1995 boom/bust cycle dominates in the sales market. Stripping out general inflation, the overall scale of change in the seven decades to 2018 ranges from just under a factor of 5 in North and South-West Dublin to almost 8 in the South Inner City. By contrast, increases in inflation-adjusted rents were significantly smaller in scale: the areas with the smallest changes 1948-2018 saw rents increase by less than 75%, while the largest increase of 175% was seen in the south suburbs.

**Figure 6. Average monthly rental price of Dublin housing, by city market (2018 euro)**



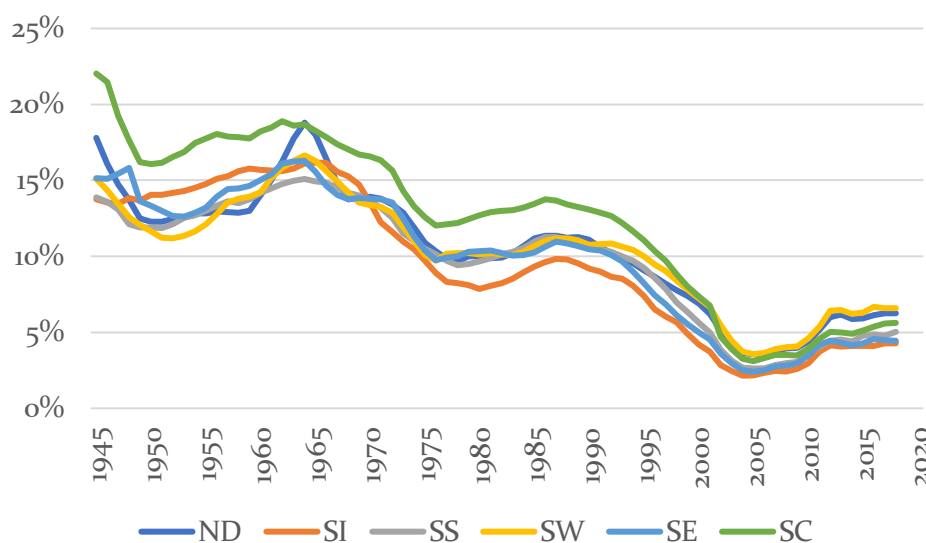
An overview of the start-to-end changes is given in Table 3. There is a strong correlation between initial sale price and subsequent change in sale prices: albeit with a small sample size (six areas), the correlation coefficient is +0.46. The final row of Table 2 shows the compression in yields on housing in Dublin over the same period. In South County Dublin, for example, yields fell by 12 percentage points, from an estimated 18% in the late 1940s to 6% in the late 2010s.

**Table 3. Summary statistics for changes in housing prices by city market, 1948-2018**

	NORTH DUBLIN	SOUTH INNER	SOUTH SUBURBS	SOUTH WEST	SOUTH EAST	SOUTH COUNTY
SALE PRICE, 1948 (2018€)	€71,388	€95,832	€82,541	€72,157	€100,851	€78,261
SALE PRICE CHANGE	4.9	7.8	6.6	4.7	5.8	5.4
RENTAL PRICE CHANGE	2.2	2.4	2.8	2.4	1.6	1.7
YIELD	-7.5%	-9.5%	-7.1%	-6.0%	-11.4%	-12.0%

Figure 7 presents annual estimates of the yield, by city market, for the period under consideration. The dominant trend is one of yield compression, over roughly three phases – as suggested by the city-level analysis discussed above. Nonetheless, the ranking of city markets changes. The South-West market – comprising even postal districts from Dublin 8 up (excluding Dublin 18) – had the lowest gross yields in the early 1950s but the highest yields by the end of the period. Conversely, the South Inner City (Dublin 2 and Dublin 4) went from second-highest yields of the six areas analysed to the lowest. This change had already occurred by the early 1970s. It is suggestive of the re-emergence of attraction of urban cores, a trend that has gained international attention in the 21<sup>st</sup> century.

**Figure 7. Gross annual yields for Dublin housing, by city market (percent)**



The final two pieces of analysis draw together the trends from the various different city market series. Figure 8 presents the coefficients of variation for each of the three housing price series – sale, rental and yield – across the six city markets, calculated at five-year moving averages. What is striking is that there is no obvious trend towards a more integrated city-level housing market, at least in the sale segment. There, the coefficient of variation across the six city markets grew from less than 15% before 1970 to approximately 30% since 2000. If anything, the opposite trend has taken place in the rental market: at the start of the period, rental prices were more dispersed than sale prices, across the six markets, but converged, particularly after the late 1970s. Since 2005, there has been a slight increase in rent dispersion but the spread remained in 2018 roughly half what it was in the sales market.

**Figure 8. Five-year moving average coefficients of variation, by housing market series**

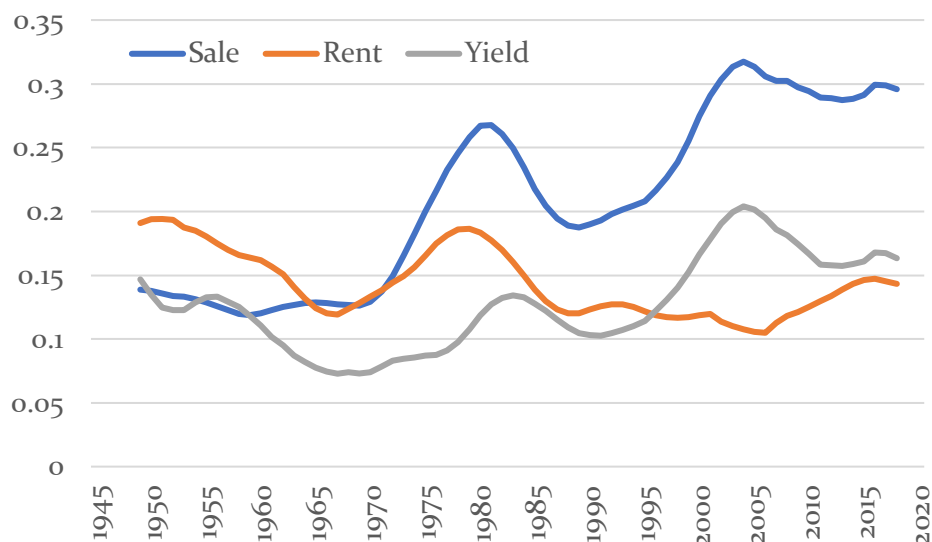
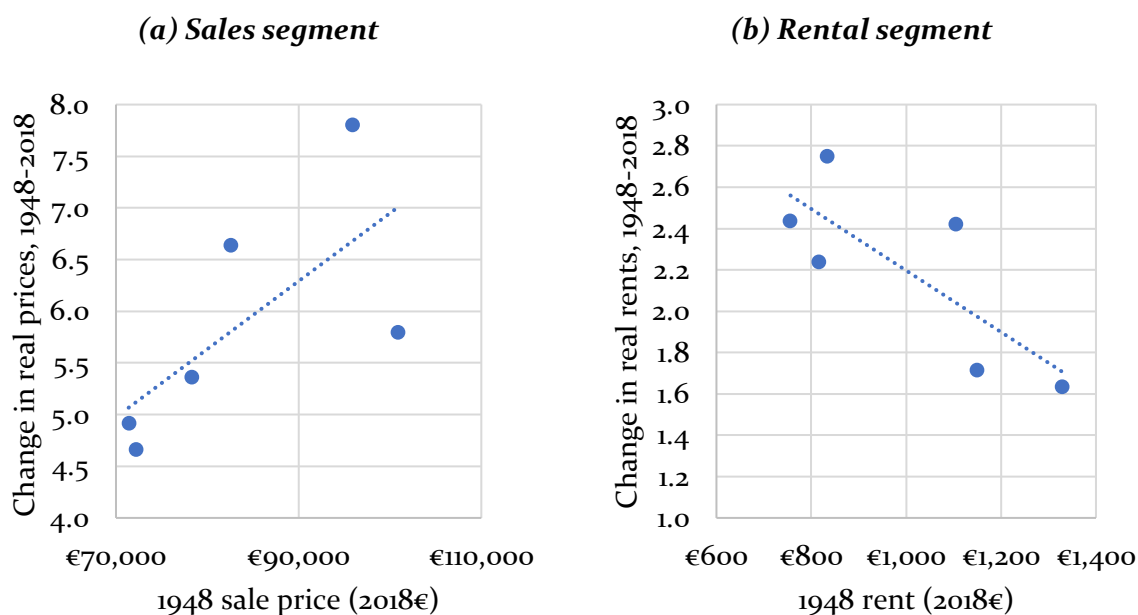


Figure 9 presents in two panels the correlation between initial sale and rental prices (1948 values, expressed in 2018 euro) and subsequent changes in those prices. What is striking is the opposite correlations across segments. There is a strong positive correlation between initial (late 1940s) sale price and the level of subsequent inflation over the following seven decades. However, in the rental segment, initial rents are negatively correlated with the extent of rent increases between 1948 and 2018. While trends in rental prices across Dublin suggest the emergence of a single rental market, trends in the sales segment suggest the opposite.

**Figure 9. Scatterplots of initial sale and rental prices and subsequent changes**





### 4.3 Determinants of the housing price ratio

This sub-section presents a parsimonious empirical specification of the determinants of the housing price ratio, as suggested by economic theory. It builds on the findings of Lyons (2018a), who finds that for the period from 2000 on, non-price conditions in the mortgage credit market in Ireland are central in determining the housing price ratio.

The outcome of interest is the change in the log of the Dublin housing price ratio, at annual frequency. At low yields, small absolute changes may represent large relative changes: for example, at a yield of 3%, a change to 2% is a fall in the yield of a half, unlike a fall from 13% to 12%. Thus, for statistical analysis, as distinct from the preceding graphical representation, the log of the ratio of sale to rental prices is preferred. This reciprocal housing price ratio – the multiple of annual rent needed to buy property – varies from 6 to almost 30 in the dataset. In log form, it varies from 1.8 to 3.4. Its annual changes have an average of just below +0.1 but are quite volatile, ranging from -0.17 to +0.21.

The method used for analysing the changes is a one-step error correction setting, with both long-run determinants and short-run dynamic factors included. The three principal determinants of the level of the housing price ratio, as suggested by economic theory, are the nominal interest rate, expected capital gain (as proxied by lagged price appreciation), and non-price conditions in the credit market (as proxied by the ratio of credit to deposits).

In addition to these long-run determinants, a variety of short-run dynamics were also examined. As in Lyons (2018a), changes in rents and changes in credit conditions are significant, while changes in wages and in unemployment are also important. The final factor included in the analysis is the annual inflation rate. While this could be interpreted as a dynamic factor, it may also be capturing the gradual erosion of the ground rent element of user cost (as discussed in Section 3.3).

The main results are shown in the first columns of Table 4. The first empirical specification, labelled ‘Full span’, explains changes in the housing price ratio as a function of the variables listed in the previous paragraph. In an error correction framework, the coefficient on the lagged level of the dependent variable can be interpreted as the speed of adjustment of the outcome of interest to its long-run relation, given in lagged levels. The speed of adjustment is here is relatively swift: almost 30% of the gap between the current and implied equilibrium levels is closed in a twelve-month period.

In addition, all the coefficients have the sign suggested by economic theory and are statistically significant at conventional levels. The ratio of sale prices to rental prices in the Dublin housing market is higher, everything else being equal, when:

1. Mortgage credit increases, relative to household deposits (as per Lyons, 2018a)
2. The rate of interest is lower
3. Recent sale price appreciation is higher
4. Recent general consumer price inflation is higher
5. Rents fell in the previous period
6. The ratio of credit to deposits rose in the previous period
7. Unemployment fell in the previous period
8. Wages rose in the previous period.

The remaining three empirical specifications examine, albeit informally, parameter stability over regimes. One concern might be that the period after 2000, captured in Lyons’s (2018a) model, is driving the result. This is not the case, however. As measured by root mean square error, the fit of the same model actually improves when the post-2000 period is omitted. The final two specifications examine whether the model changes between periods of higher and lower inflation. This does appear to be the case, with the coefficient on CPI inflation not significant (and with a changed sign) for the period from 1985.

**Table 4. Regression results for model of the change in the housing price ratio**

	Full span		Up to 2000		From 1985		To 1985	
	b	t	b	t	b	t	b	t
Lagged log of hpr	-0.272	-3.91	-0.338	-4.42	-0.593	-4.91	-0.391	-3.61
Lagged credit deposit ratio	0.318	4.26	0.27	3.8	0.66	4.35	0.289	1.47
Lagged rate of interest	-0.792	-2.75	-0.427	-1.35	-2.561	-4.14	0.001	0
Lagged changed in sale prices	0.245	2.95	0.285	3.11	0.26	2.67	0.281	2.31
CPI inflation	0.721	2.93	0.831	3.32	-0.527	-0.82	0.641	2.19
Change in rents	-0.69	-7.75	-0.651	-7.59	-0.53	-2.99	-0.663	-6.72
Change in credit deposit ratio	0.341	2.23	0.299	1.12	0.529	3.31	0.015	0.04
Change in unemp	-0.024	-3.6	-0.035	-4.63	-0.006	-0.42	-0.032	-3.84
Change in wages	0.433	2.53	0.354	2.18	0.633	2.73	0.308	1.35
Constant	0.46	3.6	0.588	4.13	1.096	4.61	0.689	3.54
Adjusted R <sup>2</sup>	0.654		0.682		0.772		0.699	
Root MSE	0.0604		0.0546		0.0511		0.0552	
Sample size	68		53		29		39	

## 5. Conclusion

This paper presented new housing prices indices for Dublin, Ireland, for the period since World War II. It did this by applying modern methods of index construction, in particular hedonic price regressions but also frequency conversion techniques, to a purpose-built dataset of over 30,000 newspaper listings, together with a substantial archive of more recent online listings. The resulting indices suggest a number of stylised facts that have implications both for understanding Ireland's path to economic development and for other countries.

The 'discovery' of four major cycles, three different phases of housing yield, and substantially greater inflation in private market rents than previously thought will be of interest to Irish policymakers and researchers interested in understanding that country's economic performance. The contribution to researchers elsewhere comes in part from the empirical findings, which confirm the predictions of economic and financial theory relating to housing, but perhaps at least as much from the methodology. As outlined in Knoll et al (2017), very few countries have reliable measures of housing prices indices extending back before the 1980s. This means that in many countries, such as the U.S., housing costs and thus general costs of living may be mis-measured over longer periods of time.

Ultimately, housing is central to modern economies and to individual households' welfare. The case of Dublin highlights the importance of credit conditions, as well as real economic conditions, in understanding apparent shifts in the housing market, for example from a high-yield equilibrium to a low-yield one. It also underscores the importance of within-city dynamics, and how these might differ by segment, with evidence of rental price convergence across areas of the city at the same that sale prices have diverged. The drivers of these trends is a topic worthy of future research.

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## Appendix A

The table below summarizes the relevant literature analysing price outcomes in the Irish housing market.

AUTHOR(S)	PERIOD	METHOD	FUNDAMENTALS	COMMENT
<b>KENNEALLY &amp; MCCARTHY (1982)</b>	1969IV-1976III	Quasi-inverted demand; 6-equation system	Y, S, rr, demog, q mort, rhp-1	Levels not logs, lack of statistical significance; unsuccessful inclusion of credit rationing
<b>THOM (1983)</b>	1971I-1980IV	Inverted D; quasi-ECM	Y, S, rr, demog, CCI, repayment, T	Coeff on Y 1.68, coeff on CCI 0.69
<b>MURPHY (1998)</b>	1974-1997	Inverted D	Y, S, rr, pop2534, dY	Coeffs on Y, r 1.4 and -0.35 respectively
<b>KENNY (1999)</b>	1975I-1997I	Inverted D; VECM	Y, S, rn	Unit elasticities imposed; Y measured by agg GNP (no demographics)
<b>HARMON &amp; HOGAN (2000)</b>	1972-1999	Inverted D	Y, S, rn, pop2534	Only Y significant; prices in 2000 above LR prediction
<b>MURPHY &amp; BRERETON (2001)</b>	1974-1999	Inverted D	Y, S, rr, pop2534, dY	LR equation unstable in period 1997-9; demand higher than predicted
<b>IMF (2003)</b>	1976-2002	Inverted D; ECM	Y, rr, pop2534	1976-97 model suggests 50% overvalued in 2002; no stock measure; SOA=0.31
<b>STEVENSON (2003)</b>	1978-2001	Ad hoc, based on inverted D	Y, S, rr, pop, conf, empl, rhp-1	Interpretation unclear; model without lagged DV performs poorly
<b>ROCHE (2004)</b>	1979I-2003I	Regime-switching; ad hoc	Y, rr, av mort, migr, c build, c land	Good fit, but likely due to endogeneity issues (incl of land values)
<b>MCQUINN (2004)</b>	1980I-2002IV	Inverted D; ECM in 3-eq system	Y, S, rr, av mort, migr, uc	User cost term dropped; LR coefficient on income very low (<0.2), SOA<0.14
<b>MURPHY (2005)</b>	1974-2004	Inverted D; two-stage ECM	Y, S, uc, rr, pop2534	Lower coeff on Y than S; dummies for financial liberalization; SOA=0.44

<b>RAE &amp; VAN DEN NOORD (2006)</b>	1977I-2004I	Inverted D; two-stage ECM	Y, S, r, pop2534	2nd-hand: coeff on Y and S similar (1.69, -1.68), SOA=0.34; new: only Y, S included
<b>STEVENSON (2008)</b>	1978I-2003I	Inverted D; two-stage ECM	Y, S, rr, pop2534	Large LR coefficients on Y (3.3), S (11); SOA=0.08 (t-stat of 2); 18% overvaluation by 2003
<b>MCQUINN &amp; O'REILLY (2008)</b>	1980I-2005IV	Inverted D; two-stage ECM	Y + rn (specific functional form), S	LR coeff on Y,r term 0.8; SOA=0.05; report that LTV when included not significant
<b>ADDISON ET AL (2009)</b>	1982IV-2009I	Inverted D; 2-eq system ECM	Y + rn (specific functional form), S	SOA=0.17; coefficient on joint Y,r term close to 1
<b>KENNEDY &amp; MCQUINN (2011)</b>	1982I-2010IV	Inverted D; 2-eq system ECM	Y + rn (specific functional form), S	Detailed results not reported; DOE price data replaced with hedonic price data post-1996
<b>BROWNE ET AL (2013)</b>	1980I-2012IV	User cost	N/A	Real user cost of capital negative 1980-4 and 1998-2008
<b>LYONS (2018)</b>	2000I-2016IV	Housing price ratio; one-stage ECM	hpr, rn, uc, past appreciation, ltv, CCI	Rapid adjustment to implied equilibrium relation; 10pp increase in first-time buyer LTV associated with 9% rise in sale prices
<b>KELLY ET AL (2018)</b>	2003-2010	Property-level model	Credit, Y, deposits, dwelling attributes	Elasticity of house prices wrt credit availability approximately 0.15

**Note:**



# Appendix B

Indices

## **Appendix C**

Sample regression output