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Micro-level evidence from Ireland

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Abstract

In this paper, we use unique supervisory property-level rental data to estimate a rental equivalence (RE) measure for owner-occupied housing (OOH) for the Irish housing market. Our data from the official, domestic rental regulator allow us to simultaneously address three significant issues which have arisen in the empirical application of rental equivalent measures. First, we are able to consider the differences in using data on both new and existing rent levels in the analysis, we can also control for other utility costs and finally we are able to estimate a RE measure in the absence of rent controls. To better approximate the OOH structure of the Irish residential market, we also avail of regional data to estimate 32 separate hedonic rent models and use the results to reweight the RE index. We find that our subsequent estimate of RE results in a reduction in the Irish headline rate of consumer price inflation by 0.4 percentage points. Furthermore, we show there are considerable differences in the inflation rate if new relative to existing rents are used in the rental equivalence measures with measures based purely on existing rents biasing downwards both the rental equivalence measure and the overall consumer price index. This suggests that considerable care is required for policymakers in using rental equivalence methods in the presence of data gaps.

Keywords: Inflation; Owner-Occupied Housing; Rental Equivalence; Market Rents
JEL Classification: E31, R31

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1 Introduction

Measuring the cost of owner-occupied housing (OOH) for inclusion in the consumer price index (CPI) has been an area of considerable academic and policy debate (Dougherty and Van Order, 1982). Given home-ownership constitutes the majority tenure type in many Western economies, and that housing is one of the largest cost items facing households, the approach chosen to measure the cost of housing for homeowners in the CPI is likely to have a non-trivial impact on the official rate of inflation.

Across many national statistical agencies, a number of different measures are used to measure the cost of housing; these include the payments, net acquisitions, rental equivalence and the user cost approach. While there is considerable debate as to the merits of these different methodologies (Hill, Steurer, and Waltl, 2019; Diewert, Nakamura, and Nakamura, 2009; Diewert and Shimizu, 2019), the rental equivalence approach has long been used by the statistical agencies of a significant number of countries (such as the US, Japan, Denmark, Norway, Switzerland, and South Africa). The approach is also advocated in ILO et al. (2004). By directly measuring the opportunity cost to the homeowner of their property (or what they could expect to pay for the consumption services of living in their home), the rental equivalence measure is theoretically suited to the consumption focus of consumer price index measurement (e.g not based on asset values) and it is also directly comparable to the cost of housing for renters which is incorporated into the CPI.

Despite its attractiveness from a theoretical perspective, a number of issues have been cited in the literature concerning the rental equivalence approach, mostly to do with its empirical application. Three data-based critiques have been put forward. First, rental data on the stock of existing rents, not the flow or new rental price, has been historically used Ambrose, Coulson, and Yoshida (2018). This is problematic as, if a homeowner were to put their property on the market, then it is the new or marginal rent they would receive as opposed to the average or stock rent level. Using data on existing as opposed to new rents may then underestimate the cost of OOH housing in the CPI. Second, the services the household obtains from renting the property are not equivalent between OOH and renters. For example, if rental prices include certain utility costs then rents will diverge from the "shelter cost" of housing which the rental equivalence approach seeks to capture (Verbrugge and Poole, 2010). Third, rental equivalence cannot be estimated correctly in residential markets where rent controls prevails as the market prices are clearly impacted by price controls (Hill, Steurer, and Waltl, 2019). A further methodological criticism has been put forward by Arévalo and Ruiz-Castillo (2006) who notes the selection bias between homeowners housing stock and renters housing stock can distort any estimated index and must be fully accounted for in index design.

In this paper, we use a unique tenancy level dataset in the absence of rent price controls to address some of these concerns. More specifically, we draw on supervisory tenancy-level data from the Irish rental regulator on all newly registered rental agreements in Ireland to estimate a rent index on the flow price of new rents similar to Ambrose, Coulson, and

Yoshida (2015). To develop an OOH-adjusted rent index and address the selection bias noted by Arévalo and Ruiz-Castillo (2006), we estimate 32 separate hedonic regressions to develop adjusted regional-housing type rent prices. We then use the OOH regional housing structure from the Irish Census of Population to re-weight the 32 indices to create a rental equivalence measure for new rents that mirrors the OOH structure in the Irish market. We then incorporate this re-weighted index into the Irish CPI to estimate the counterfactual impact on consumer price inflation. Our data also allows us to strip out the impact of other utility costs on rental price variation which ensures the services value of rents is as close as possible to the "shelter cost" concept which equates to the OOH housing opportunity cost, a point noted by (Verbrugge and Poole, 2010).

Our data also allow us to quantify the impact of using stock rental data (existing rental agreements) relative to flow rental data (new rents) in estimating rental equivalence measures. As our microdata provide both stock (existing rent) and flow (new rent) registrations, we can directly estimate OOH-adjusted rent indices based on new and existing rents in the Irish market. This provides a direct comparison on a long debated issue of whether to use stock or flow rent data in estimating rental equivalence measures.

The literature on the practical implementation of the rental equivalence approach is somewhat ambiguous on the issue of stocks versus flows. As noted by Bentley (2018), Lewis and Restieaux (2015) argue that the use of stocks data is best practice citing IMF, ILO, OECD, Eurostat, UNECE, and Bank (2004). However, IMF, ILO, OECD, Eurostat, UNECE, and Bank (2004) do not appear to favour one approach versus the other. IMF, ILO, OECD, Eurostat, UNECE, and Bank (2004) conclude that the rental equivalence approach is based on "estimating how much owner-occupiers would have to pay to rent their dwelling". Johnson (2015) contends that arguments could be made for using the marginal cost of renting depending on what the exact purpose of the rental equivalence approach is. Ambrose, Coulson, and Yoshida (2015) argue that their repeat rent index, which uses only new contracts with new tenants, is better for studies of the housing market, while they acknowledge that the indexes compiled by the Bureau of Labour Statistics (BLS) may be more appropriate for measuring cost-of-living indexes because they represent rents of the typical household. The BLS indexes tend to reflect rents that are up to a year old. Consequently, given this uncertainty, we think our contribution is important in quantifying the subsequent impact on general inflation rates of approaches based on either a stocks or flows approach.

A number of papers are close to our research. First, Ambrose, Coulson, and Yoshida (2018) uses the newly developed repeat rent index (RRI) by Ambrose, Coulson, and Yoshida (2015) and estimates the impact on the US CPI of using new rental prices rather than existing rents. They then link the estimates to interest rate setting through the estimation of the counterfactual Taylor rule under different CPI calculations. However, in that study, the authors do not re-weight the RRI to take the structure of owner-occupied housing into account in order to deal with the selection bias from different housing stock characteristics. We therefore extend their work to develop a OOH new rent index and show

that the impacts on the CPI are non-trivial in this adjustment. The benefits of microdata estimates of rental equivalence are highlighted by Garner and Verbrugge (2009)

Two main findings emerge. First, we demonstrate that adjusting for the structure of owner-occupied housing, controlling for other utilities costs and using new rental tenancies data leads to an inflation estimate for OOH that is approximately two percentage points lower than the equivalent for a sample of renters. This in turn leads to a clear impact on the overall measurement of consumer price inflation. Using our OOH-adjusted index relative to that based purely on a sample of renters results in the rate of consumer price inflation (average monthly annualised inflation rate) being lower by nearly 0.4 percentage points.

Second, we quantify the impact of using rent levels for new versus existing tenancies in estimating an OOH rental equivalence measure. The OOH index using existing rents is materially lower than the index based on new rents with a resulting, considerable impact on the rate of consumer price inflation: the annualised change in inflation was 0.6 percentage points lower using the existing rents relative to new rents.

From a broader policy perspective, these results suggest that policymakers and statistical agencies who are deploying the rental equivalence approach should attempt to address some of the associated data gaps as they have a considerable impact on the associated measurement of official inflation rates.

The rest of the paper is structured as follows: section 2 presents the methods and data. Section 3 estimates the main OOH rent index and the impact on inflation. Section 4 considers the differences between using stock (existing rent) versus flow (new rent) data. Section 5 concludes.

2 Methods and Data

2.1 Data and Background

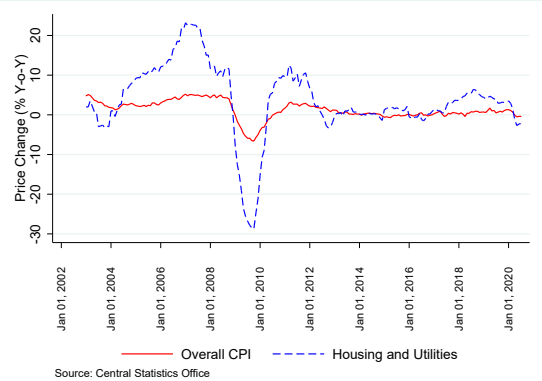
Ireland has traditionally had a very high share of home ownership; in the latest census of population nearly 68 per cent of households were reported as homeowners (either outright or with a mortgage). This had fallen from a peak of nearly 80 per cent in 1991 due to a multitude of factors including affordability issues Corrigan, Foley, McQuinn, O'Toole, and Slaymaker (2019).[1] Given the concentration of households in OOH, it is critically important in Ireland as in other economies as to how OOH pricing is treated in the measurement of the CPI. Figure 2 presents the trend in Irish CPI as well as the pricing of housing and utilities. The official measurement of housing cost presently adopted in the Irish market by the Central Statistics Office (CSO) for OOH is the payments approach. The payments approach uses a combination of data on house prices, interest rates and loan-to-value ratio assumptions. Consequently, the approach results in relatively large fluctuations in the measurement of the housing cost series, as house prices are typically much more volatile in

[1] Irish census data can be found at www.cso.ie.

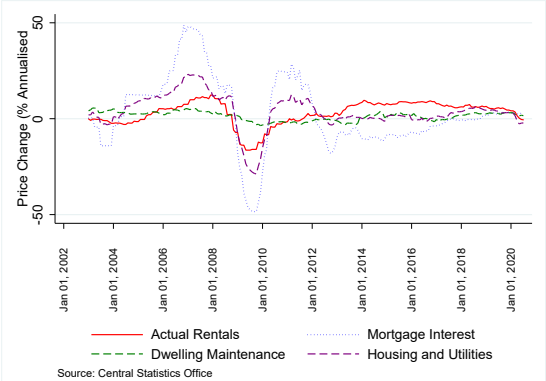
the Irish market than private rents (as presented in panel (b) of Figure 2). The variation between renters cost of housing and the cost of OOH due to issues around mortgage interest and dwelling maintenance etc can have significant implications for the measurement of the CPI. For example, using mortgage related pricing for non-mortgaged homeowners does not give a very accurate costing for this group as the type of accommodation and the systemic differences in costs (as interest rates and other mortgage costs may differ over time) faced by those with and without a mortgage may be substantial.

Figure 1: Consumer Price Inflation (CPI) in Ireland

(a) Overall CPI and Housing and Utilities



(b) Housing Inflation Sub-series Various



Given this context, we draw on a unique, extensive micro data set to estimate a rental equivalence measure of OOH. One of the particular novelties of this paper is the use of the supervisory micro data at a tenancy level provided by the Residential Tenancies Board (RTB), the Irish private rental market regulator. In Ireland, every new and part IV renewal tenancy must be registered by law with the RTB.[2] The obligatory legal submission by the landlord provides information on the level of the contracted rent (in €), the frequency of the rent payment, the duration of the contract and the extent to which the tenant pays other utility costs. Other utility information captured is whether the tenant pays electricity, oil, TV licence, waste, gas and other charges in addition to the rental payment. Information is also provided on the property including the address, the floor area (in sq metres), the dwelling type (e.g. house, apartment, bedsit, part of house, maisonette), property type (semi-detached), detached, terraced, number of bedrooms, number of occupants. As the submission of these forms is mandated under law as part of the Residential Tenancies Act 2004, an extensive database is available for analysis. These data have been used to produce a regular index monitoring the Irish rental price trends (Lawless, McQuinn, and Walsh, 2018).

For the purposes of this paper, we use the registered tenancies covering the period August 2012 to December 2016 inclusive. Two legislative changes in Ireland dictate the

[2]Part IV renewals are tenancies that have been in existence for between 4 and 6 years and the landlord is required to re-register this tenancy with the RTB to indicate that it is still active, as well as provide updated rental and property characteristics.

choice of this period. In January 2017, the first rent control measures on private rental prices were introduced in the market. These "Rent Pressure Zones" caped rental price increases for the two largest cities at 4 per cent per annum.[3] As our interest is in estimating rental equivalence measures without rent controls, we end the sample just before the rent regulations began. The starting period, 2012, was chosen to ensure sufficient new and existing tenancy registrations were included as the database does not contain all existing (renewal) tenancies before this point.

The RTB dataset contains information on both the flow and the stock of rents. The dataset contains mainly flow data, since it consists of primarily new tenancies (i.e. defined as registered tenancies of those who begin a new lease at any given quarter). On the other hand, the stock of rents measures the pool of rents for ongoing tenancies by tenants who began their lease in the past. The RTB dataset also contains a small proportion of renewed tenancies, which correspond to tenants who hold the same lease continuously for 4/6 years, at which point the tenancy agreement must be legally re-registered.

We begin by considering the data on new rental agreements. These data are best placed to proxy the opportunity cost to homeowners by representing the rental price they would receive if they placed their property on the market at the present time. The summary figures for the sample used in this paper are presented in table .

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Rent Amount (Month (€))	886.59	537.837	103.8	12000	347064
Tenancy Length (Months)	12.949	6.46	4	48	347064
No of Bedrooms	2.43	0.954	1	5	347064
Floor Area	93.498	99.562	8.359	1000	347064
No of Bedspaces	3.743	1.557	1	8	347064
numberoftenants	1.778	0.939	1	6	347064
Detached House	0.1	0.3	0	1	347064
Semi-Detached House	0.228	0.419	0	1	347064
Terraced House	0.144	0.351	0	1	347064
Other flats	0.064	0.246	0	1	347064
Part House	0.012	0.11	0	1	347064
Apartments	0.464	0.499	0	1	347064
Electricity	0.820	0.384	0	1	347064
Oil	0.255	0.436	0	1	347064
TV License	0.746	0.435	0	1	347064
Waste	0.506	0.5	0	1	347064
Gas	0.396	0.489	0	1	347064
Other	0.279	0.448	0	1	347064

The average rent over the sample period was approximately €890 per month. The

[3] An analysis of the impacts of these measures can be found in O'Toole, Martinez-Cillero, and Ahrens (2019)

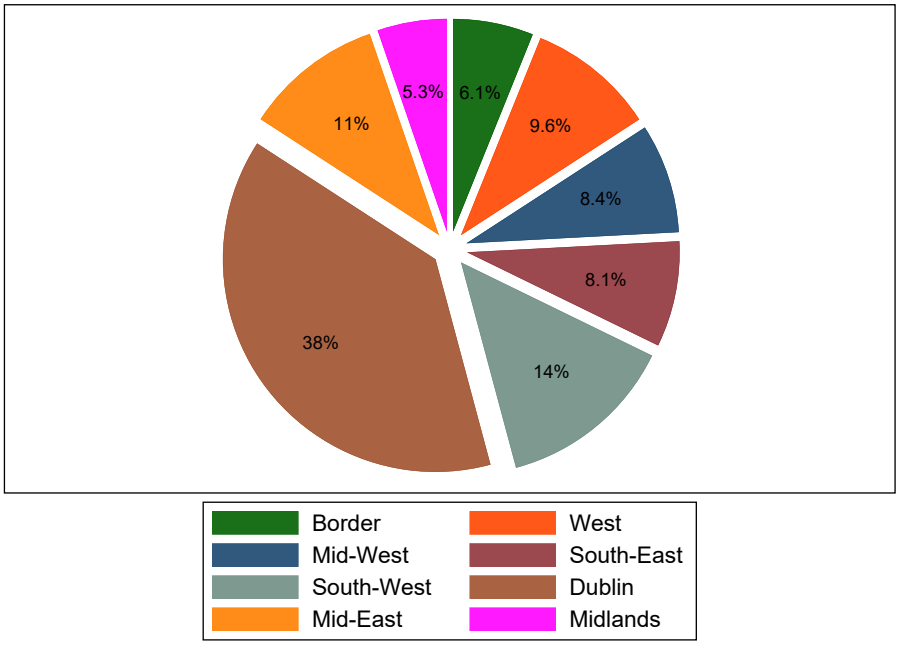
average tenancy length was just under 13 months in duration, but with considerable variation. The standard deviation tenancy length is approximately 6 months, with max and minimum tenancy lengths of 4 and 48 months.

The average number of bedrooms per property was approximately 2.4 but ranged from 1 to 5. The number of bedspaces was somewhat larger at over 3.7 suggesting multi room occupancy in many cases. In terms of the structure of dwellings, 10 per cent of properties were detached houses, 23 per cent were semi-detached houses, and a further 14 per cent were terraced houses. Apartments accounted for 46 per cent of the total.

An important aspect considered in this paper is controlling for the cost of other utilities that could force a wedge between the appropriate opportunity cost to a homeowner and other renters i.e. the rent could be higher (lower) than the opportunity cost if it included other costs. It can be seen that 80 per cent of renters also paid electricity which suggests one-in-five did not and are likely to have this cost included in their rent. A further 25 per cent paid their oil bills, 74 per cent a TV licence, 50 per cent their waste charges, and 50 per cent their gas bills. The high share of households not paying any other charges is a clear indicator that landlords are pricing some of these costs into the rent and therefore this must be controlled for when developing an owner-occupied housing cost.

Figure 2: Share of Tenancies

(a) Share of New Tenancies by NUTS3 Region



Finally, Figure 2 presents the structure of registered tenancies in terms of their geographic location. This is a critically important component as it is likely that renters have a different housing location structure throughout the country than owner-occupiers. This, again, must be accounted for in any estimate of a rental equivalence measure. Nearly 40 per cent of rental tenancies are registered in Dublin, the capital city.

2.2 Method

2.2.1 Hedonic Rental Estimation and Rental Trends

As a first step, we estimate a range of hedonic models for rental prices which assess the impact of various housing type, regional indicators and variables capturing other utilities and costs on rental pricing. The aim of these models is to demonstrate the impact of these variables on new rents. Within these models, we also include a serious of time dummies for the month-year of the data. The set of coefficients on these dummies represents the inflation trend which can be used in calculations for the CPI. Our baseline specification for the hedonic model is as follows:

$$ln(R_{i,t}) = \alpha_0 + \beta \mathbf{X_{i,t}} + \gamma \mathbf{D_{i,t}} + \omega \mathbf{U_{i,t}} + \tau_{\mathbf{t}} \mathbf{T_t} + R_r + \epsilon_i \tag{1}$$

where $ln(R_{i,t})$ is the monthly rent price of property i in period t. Please note that these data are repeated cross sectional datasets so the notation $R_{i,t}$ contains a comma to distinguish these data from panel data which would follow the same property over time. We include three vectors of control dummies to purge the rental data of variation not relating to the trend in the market value of rents. All control variables that are in continuous format are included in logs, unless otherwise noted. The vector of tenancy controls, $\mathbf{X}$, includes variables on payment frequency, number of tenants and tenancy length; the vector D of dwelling characteristics include the floor area of the property, the number of bedrooms, the number of bedspaces, dummies for the dwelling type (detached house, semi-detached house, terraced house, other flats, apartments or sub divided part of a house). The vector U includes dummies for whether the tenant pays other utilities. We include a separate dummy for the payment of electricity, oil, TV licence, waste, gas and others. Our empirical estimation strategy will therefore be to estimate a series of hedonic models which ensure that the variation in rental trends is not affected by variation in the included covariates. These trends are taken as the coefficients (τ_t) for each time period on the vector of time dummies T_t and are used as the rate of inflation for rents in our various scenarios. The coefficients are taken as an exponent to get the non-log trend in rental prices.

2.2.2 Adjusting for Owner-Occupied Housing

One contribution of this paper is to ensure that the rental equivalence measure for OOH is closely tailored to the structure (in terms of housing types and regions) of housing for owner-occupiers. The difference between the housing structure of homeowners and renters (due to differences in demand and supply factors in accessing homeownership and valuing characteristics) is noted as a serious source of selection bias by Arévalo and Ruiz-Castillo (2006). For example, the composition and location of the housing stock is likely very different for renters and thus any rental equivalence measure must be adjusted to "look like" the OOH structure.

To approximate the structure of owner-occupier housing, our approach is as follows.

Table 2: Share of Property Types and Regions for Owner-Occupied Housing

	Detached house	Semi- detached house	Terraced house	Apartment
Border	0.071	0.013	0.005	0.001
West	0.080	0.015	0.005	0.001
Mid-West	0.070	0.023	0.012	0.001
South-East	0.063	0.020	0.010	0.001
South-West	0.092	0.034	0.020	0.002
Dublin	0.038	0.116	0.075	0.022
Mid-East	0.079	0.046	0.017	0.004
Midlands	0.044	0.014	0.005	0.001

We first obtain Irish census data on the structure of the owner-occupied housing stock for the year 2016. The Irish census provides data on a regional, housing-type basis which allows us to identify 32 different housing type-area indicators. The data is presented in table 2 above. They can be interpreted as the percentages of each type of housing present in each region (the overall sum of these shares is 1). For example, the largest concentration of semi-detached and terraced houses, and apartments is in Dublin (11.6 per cent, 7.5 per cent and 2.2 per cent, respectively), while the largest concentration of detached houses is in the South-West region (9.2 per cent).

To ensure that any rental equivalence measure adopted approximates the structure of OOH, our estimation strategy is as follows. First, we estimate 32 separate hedonic rental models for each region and housing type with a similar structure to equation (1):

$$ln(R_{i,t}^{rh}) = \alpha_0 + \mathbf{\Gamma^{rh}Z^{rh}} + \tau_{\mathbf{t}}^{\mathbf{rh}}\mathbf{T_t^{rh}} + \epsilon_i^{rh} \tag{2}$$

where r and h denote the 32 housing type region groupings as presented in table 2 where Z above includes all variables noted from equation (1) from matrices $X_{i,t}$, $D_{i,t}$, and $U_{i,t}$ with the exclusion of variables for housing type. These are excluded as each model is estimated for a separate housing-type thus allowing variation across housing types to be picked up across all the variables in the regression.

The final estimate of OOH based on rents is taken as the weighted average of the coefficients on the time dummies from the regional housing type regressions from equation (2) combined with the weights from table 2.

$$\pi(OOH)_t = \sum_{rh=1}^{32} \left(\omega_{rh} \times \tau_t^{rh}\right) \tag{3}$$

As above, the final level index is taken as the exponent of the above measure of inflation as the dependent rent variable is measured in log levels.

3 Estimating an OOH Rent Index and the Impact on Inflation

3.1 Hedonic Rent Indices: Exploring the Factors Impacting Rents

We first estimate a series of models which test the relationship between our property characteristics and other variables on the rent prices. Table 3 contains three columns. The first column controls for standard tenancy and property characteristics, the second column includes regional dummies for the NUTS 3 regions in Ireland the final column contains the controls for the other utility costs that renters face which may be different in pricing for owner-occupied housing and would likely distort the overall rental price series as a measure of the opportunity cost of home ownership if included.

In column (1), the findings suggest that rents are increasing in tenancy length, the number of bedrooms, and in the floor area. Rents are also increasing in the number of tenants in the property. These findings are intuitive and associate larger, longer, and more densely concentrated tenancies with higher rental prices. Considering the variables covering property type, we find that, relative to detached houses, the rents for semi-detached, terrace and apartments are higher. These factors also likely capture the geographic location which we control for in column (2). For example, most apartments are located in Dublin, the capital city which also is the area with the highest rents in Ireland.

In controlling for regions (with Dublin being the omitted category), it can be seen that there is considerable variation in rents (with rents substantially lower than Dublin). Many of the coefficients on the other variables also drop in magnitude which suggests the variation across regions in the different characteristics may matter considerably. In some regions (such as the Border or Midlands) rents are nearly 80 to 90 per cent lower than in Dublin when other factors are controlled for.

Finally, in column (3) we introduce the series of dummy variables which control for the various other utilities costs. The interpretation of these indicators is the extent to which rent levels are higher or lower depending on whether the household has to pay these costs. For example, rent is approximately 3 per cent lower for those tenancies who pay electricity, 6 per cent lower for those who pay for oil, 3 per cent higher for those who pay a TV licence, and 7 per cent lower for those who pay for waste charges. While it may seem counter intuitive, the lower prices for those tenancies paying additional costs can reflect the fact that the base rent may be adjusted depending on whether the landlord or tenant pays these outgoings. If the landlord pays, then the rent is likely to be higher ceterus paribus to capture this and vica versa.

Unlike other observational econometric examinations of the drivers of rents, we are actually not concerned with the endogeneity of these factors or indeed the direction of the coefficients. What is important from the perspective of our particular study is that the variation which is left in the time dummies in the model is purged of variation across

Table 3: Hedonic Models of New Rents

	(1)	(2)	(3)
Tenancy Length	0.129***	0.015***	0.010***
	(0.002)	(0.002)	(0.002)
No of Bedrooms	0.134***	0.297***	0.291***
	(0.003)	(0.002)	(0.002)
Floor Area	0.077***	0.090***	0.083***
	(0.002)	(0.001)	(0.001)
No of Tenants	0.247***	0.137***	0.128***
	(0.002)	(0.001)	(0.001)
Semi-detached	0.123***	0.049***	0.024***
	(0.003)	(0.002)	(0.002)
Terrace	0.215***	0.064***	0.024***
	(0.003)	(0.002)	(0.002)
Apt/Flat	0.321***	0.140***	0.078***
	(0.003)	(0.002)	(0.002)
Border		-0.904***	-0.857***
		(0.002)	(0.002)
West		-0.602***	-0.560***
		(0.002)	(0.002)
Mid-West		-0.751***	-0.724***
		(0.002)	(0.002)
South-East		-0.742***	-0.706***
		(0.002)	(0.002)
South-West		-0.499***	-0.475***
		(0.002)	(0.002)
Mid-East		-0.405***	-0.392***
		(0.002)	(0.002)
Midlands		-0.807***	-0.770***
		(0.003)	(0.003)
Electricity			-0.031***
			(0.002)
Oil			-0.067***
			(0.002)
TV License			0.026***
			(0.002)
Waste			-0.069***
			(0.001)
Gas			0.084***
			(0.001)
Other			0.084***
			(0.001)
Constant	5.569***	6.237***	6.309***
	(0.010)	(0.007)	(0.007)
Observations	347041	347041	347041
Payment Frequency Dummies	Y	Y	Y

Standard errors in parentheses.
Omitted categories: Dublin, Detached.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

these factors. This ensures that the rental trends, as indicated by the time dummies, are not affected by the variation in tenancy, regional, utility pricing and property factors. To explore the impact of this, we use the exponentiated coefficients from the time dummies in columns (1) to (3) in table 3 and create three monthly indices of rent prices. These are presented in Figure 6. The simple index uses the time dummies associated with the regression in column (1) of table 3, the regional controls index is taken from the regression in column (2) and the region and utilities index from column (3). The first chart presents the index, the second chart (b) presents the year on year growth and the third chart is the three month rolling average to provide a more smoothed trend. It can be seen that controlling for the utilities and regional factors has a quite considerable impact on the inflation rate generated with the time dummies.

The average figures for the series across the time period are presented in table 4. It can be seen that controlling for region and utilities would have increased the overall inflation rate by approximately 1 percentage point which is substantial in economic terms. This highlights the importance of using our rich data to strip out these factors from the trends in the hedonic models.

Table 4: Summary Impacts on CPI by Rent Index

Variable	Mean	Std. Dev.	Min.	Max.	N
Simple	0.058	0.031	-0.008	0.126	41
Regions	0.071	0.02	0.029	0.111	41
Regions + Utilities	0.069	0.019	0.029	0.103	41

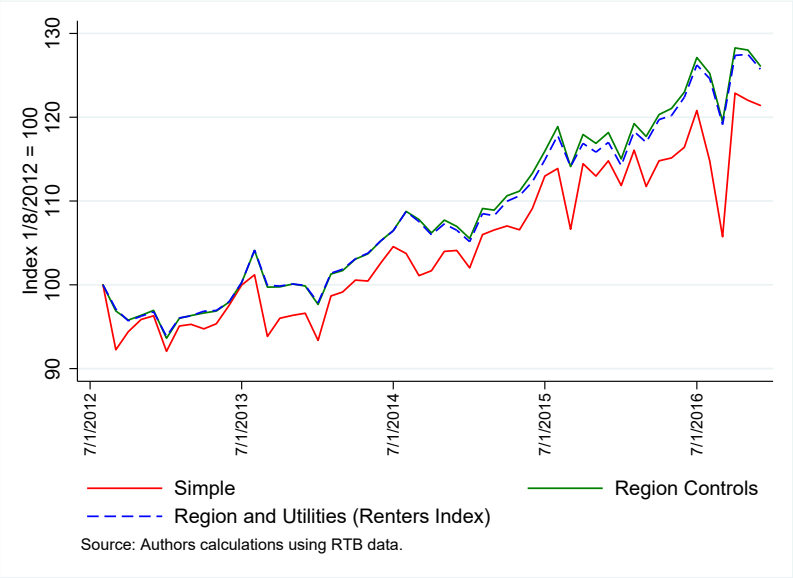
3.2 Adjusting for Housing Structure of Owner-Occupied Housing

The next step in developing a bespoke rental equivalence measure for owner occupied housing is to estimate equation (2) for each of the 32 region-housing type groups and to use the re-weighting in equation (3) to calculate a monthly OOH RE index. For brevity, we do not report the econometric estimations for each of these groups[4]. The re-weighted OOH index is presented in figure 4 where it is juxtaposed with the renters index (regional and utilities) which is presented above. It can be seen that there are substantial and time varying gaps between the two series with periods where inflation is rising in the renters series but falling in the OOH series. This highlights the critical importance of ensuring that the series is adjusted correctly to capture the composition of OOH for a rental equivalence measure. The difference in the means of the two series are presented in table 5. The average rental inflation for the OOH index is just under 5 per cent. It is nearly 7 per cent for the unadjusted, renters only sample. This shows the re-weighting process lowers the inflation rate by a full 2 percentage points.

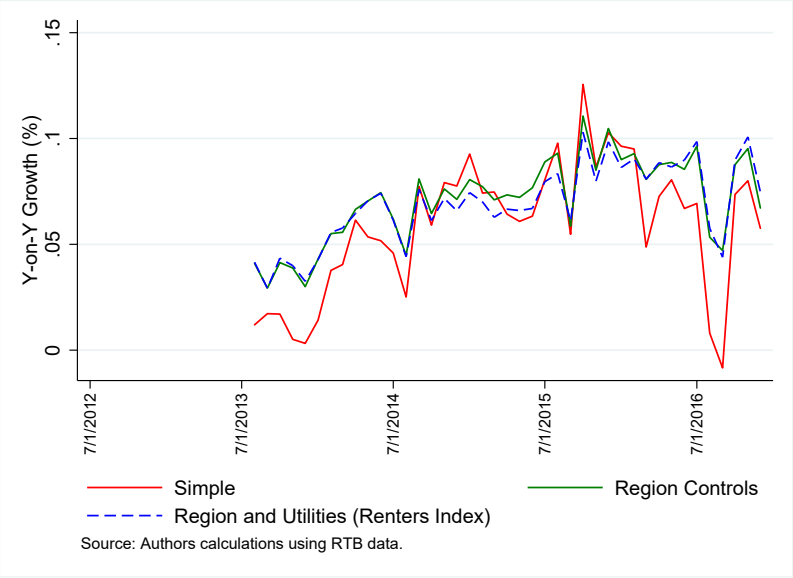
[4]These are available on request from the authors

Figure 3: Hedonic Measures for New Rents

(a) Indices (8/2012 = 100)



(b) Year on Year Growth Rates (%)



(c) 3 Month Rolling Average

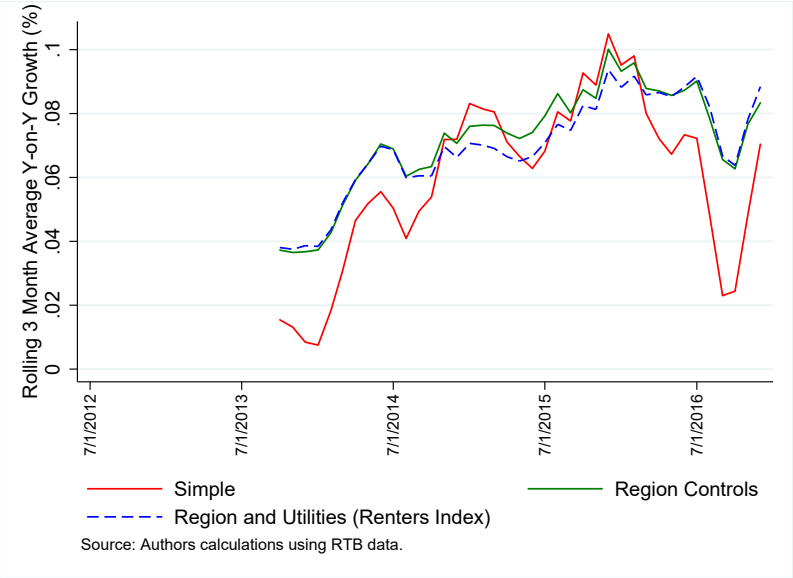
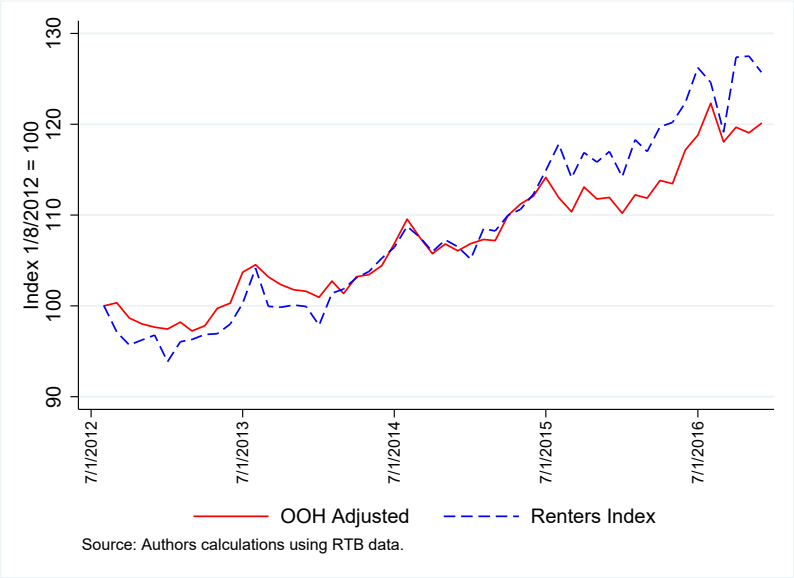
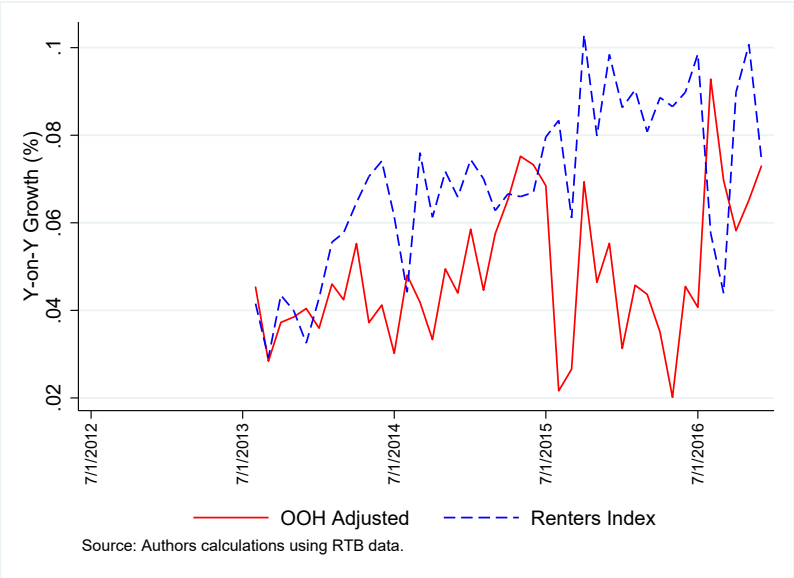


Figure 4: OOH Adjusted Index and Renter Index

(a) Indices (8/2012 = 100)



(b) Year on Year Growth Rates (%)



(c) 3 Month Rolling Average

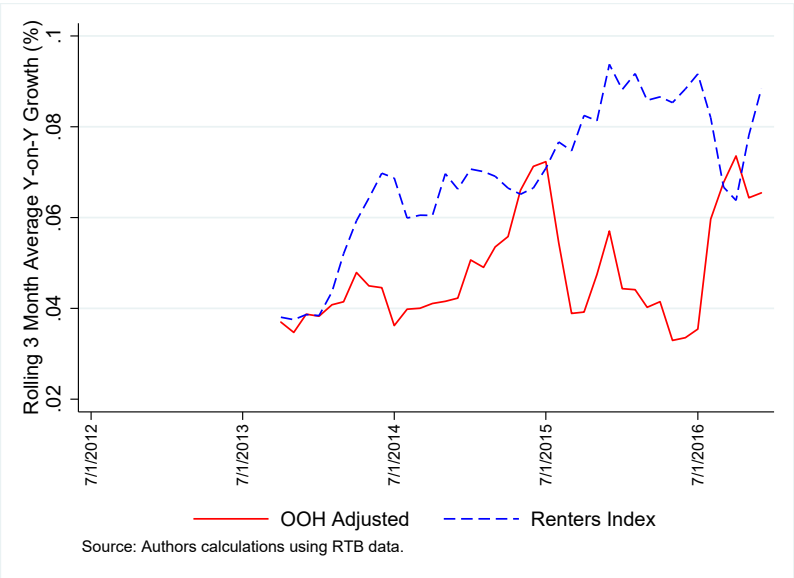


Table 5: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
OOH Index	0.048	0.016	0.02	0.093	41
Renters Index	0.069	0.019	0.029	0.103	41

3.3 Testing the Impact on Inflation

The final aspect of this section is to test the impact of using the rental equivalence approach on the consumer price index. In order to carry out this research, Ireland's national statistical agency, the Central Statistics Office (CSO), provided us with the weighted indices by item and the unpublished disaggregation of the National Accounts used to calculate inflation in Ireland for the years in question. As aforementioned, at present Ireland uses a payments approach to measure the cost of OOH. A number of items included in the official CPI must therefore be removed before the index generated under rental equivalence presented in figure 4 is integrated into the CPI. When setting rent prices landlords factor in the costs associated with property ownership, maintenance costs are perhaps the most obvious example. As a result of this, the items associated with the costs usually borne by the landlord are removed from the consumption basket in order to avoid double counting when switching from the payments approach to the rental equivalence approach (IMF, ILO, OECD, Eurostat, UNECE, and Bank, 2004). The items removed from the consumption basket are those used by Ahrens, Beirne, Economides, Kostarakos, McQuinn, and O'Toole (2020) to measure the cost of OOH in Ireland by generating a payments approach index. Some of the items removed from the consumption basket include mortgage interest payments, services for the maintenance of heating systems and building materials. Appendix 2 provides a list of all the items removed as part of this process.

Having removed the payments approach items, the next step is to calculate the weight that the cost OOH should be given within the CPI under the rental equivalence approach. Generally, the weights ascribed to a given item or group of items within a CPI should correspond to the share of total household expenditure that is spent on those items. The items included in the CPI consumption basket are classified into various groups and sub-groups using the COICOP system[5]. In Ireland, CPI weights are updated every year in December using national accounts data down as far as the 4-digit COICOP level of classification. Below this level, the Household Budget Survey (HBS) is used to allocate a share of these weights to each of the items included within a group. The HBS shares are only updated when the results from a new HBS become available (usually every 4 to 5 years). In general terms, the CPI weights used for year t+1 are sent in December of year t using the national accounts data from year t-1 (the most recent national accounts data available in December of year t). In order to ensure that the weights used in year t+1 approximate as closely as possible the expenditure patterns of previous year (year t) the national accounts data

[5]COICOP stands for ' Classification of Individual Consumption by Purpose ' see CSO (2016a) for more details.

Table 6: December 2015 Weight of OOH in the CPI

Weight of OOH under RE	0.163
Weight of OOH under Payments Approach	0.056

are price uprated from year t-1 to December of year t. The CPI weight for owner occupied housing under rental equivalence is derived from the value of imputed rents for owner occupied housing in the national accounts. In a census year, the value of imputed rents is calculated by applying the rents associated with various property types to the stock of owner-occupied housing. For intercensal years the value of imputed rent from a census year is grown forward using an indicator of the stock of quality adjusted housing and a price index.[6]

In order to generate a CPI weight for the rental equivalence index in December 2013, the value of imputed rent is taken from the 2016 national accounts (census year) and is price adjusted to estimate the 2012 level using the rental equivalence index we develop. This is to ensure consistency between the method used to give OOH its weight and its inflation rate under the rental equivalence approach. An implicit assumption in this step is that the stock of owner-occupied housing was the same in 2012 and 2016. This 2012 value of imputed rents is then price uprated to December 2013. Total spending from the 2012 national accounts on another item within the CPI basket (that derives its CPI weight from the national accounts) is also price uprated up December 2013 (we use breads and cereals). The relationship between these price uprated national accounts figures is used to generate a scalar that is applied to the existing December 2013 CPI weight for breads and cereals. This gives us an appropriately sized weight for the rental equivalence index in the CPI. All of the other items in the CPI basket are then reweighted to take account of this addition and the removal of the payments approach items. These steps are repeated for each year the CPI under rental equivalence is presented. An important point to note is that the weight OOH receives in the CPI differs substantially between approaches. This is evident in Table 6 which shows the weight allocated to OOH in December 2015 under the payments approach and under the rental equivalence approach.

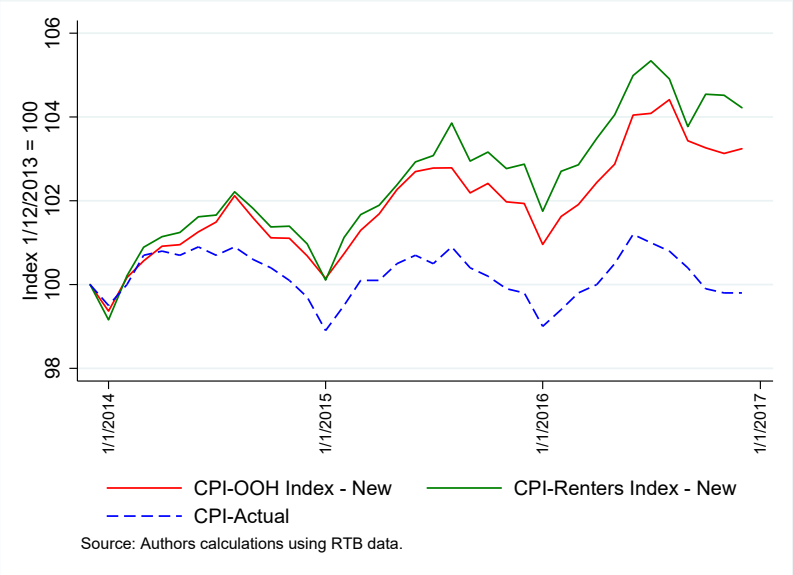
To provide some comparison, we also include the renters index which does not make the OOH adjustment and the actual Irish CPI figures for context. The CPI indices and annual year-on-year growth rates are presented in figure 5. The first difference which is very noticeable is that the rental equivalence measure has a dramatic impact on the overall CPI.This is unsurprising given the larger weight allotted to OOH under RE and the larger price inflation trend in the rental data used in the generation of the RE index when compared to the weight and price inflation of the payments approach items. Ireland has a very high share of owner-occupied housing (nearly 70 per cent) and this is reflected in the value of imputed rents from which this larger CPI weight is derived under RE.

[6]For more information on how the CPI is calculated in Ireland see CSO (2016b) and CSO (2016a).

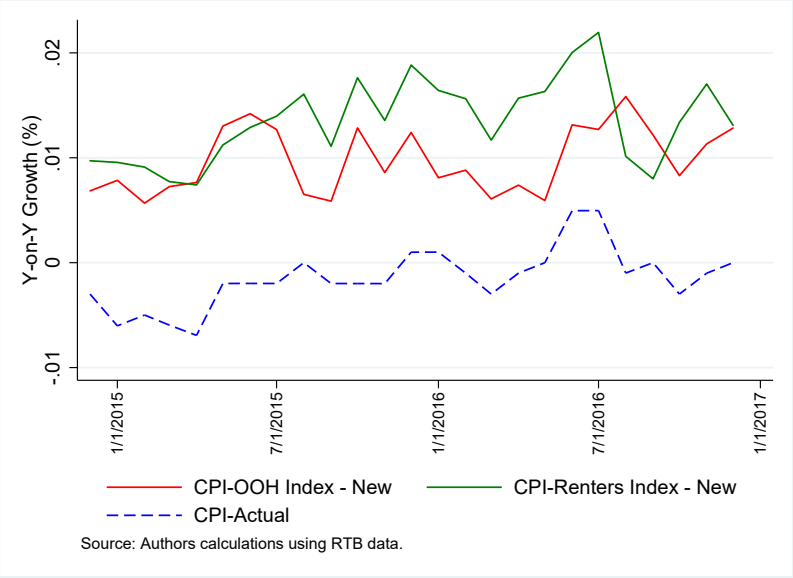
Including either the renting index or the owner-occupied rental equivalence measure both cause a dramatic rise in the rate of consumer price inflation. There are also very clear differences between the growth rates for the CPI when the renters and OOH indices are included separately. The OOH inflation level is lower reflecting the lower rate of price inflation for the adjusted RE series relative to the series based on rental only data. The variation between these two series is solely due to differences in our inflation measures from the microdata and can be seen as the "clean" impact of the different rental equivalence measures on inflation.

Figure 5: New CPI Indices with Rental Equivalence Measures

(a) Indices (12/2013 = 100)



(b) CPI Year on Year Growth Rates (%)



This can be very clearly seen in table 7. The average rate of the CPI when including the

OOH index for the period under examination was just over 0.01. The CPI with the renters index was nearly a half a percentage point higher at 0.014. This is quite a dramatic change in the overall rate of consumer price inflation solely due to the transformation of the rental data to approximate the owner-occupied housing stock. To explore whether this difference is statistically significant we undertake a simple paired t-test of the mean differences. The results indicate a significant difference at the 1 per cent level of 0.4 percentage points (the OOH weighted series is 0.4 percentage points lower).[7]

Table 7: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
CPI - OOH Index	0.01	0.003	0.006	0.016	25
CPI - Renters Index	0.014	0.004	0.007	0.022	25
CPI - Actual	-0.001	0.003	-0.007	0.005	25

In summary, the findings of this section point to a very clear impact on the overall measurement of consumer price inflation of transforming the rental equivalence measure to approximate the owner-occupied housing stock. Using our OOH-adjusted index relative to a renters sample lowers the overall rate of consumer price inflation by nearly 0.4 percentage points.

4 Do Differences in Stock and Flow Rental Measures Matter?

An important issue in the literature on rental equivalence measures noted by Ambrose, Coulson, and Yoshida (2018) is that the use of stock (existing contract) rental data to measure the "opportunity cost" of housing for owner-occupiers is incorrect as stock rents are often lower than the new market rents. This then underestimates the impact of what owner-occupiers could earn if they were to include their property on the market for rent. Ambrose, Coulson, and Yoshida (2018) demonstrate the impact of these changes on inflation by substituting a new rental series for the BEA simple series for the US which includes existing rent. While this substitution is highly informative, a more direct comparison which appropriately adjusts both series for the owner-occupier housing structure and adjusts the rental trends with a common hedonic rental transformation is warrented to ensure that any variation between existing and new rents is purely down to differences in trends and not to differences in property types or the regional mix of building structures across both markets.

To provide a more direct test of the impact of using stock (existing) versus flow (new) rental indicators on any rental equivalence measure for OOH, we draw on data collected

[7] Mean for OOH-weighted new series is approximately 1 per cent with plain vanilla renter new index at 1.4 per cent, the t statistic value is -4.34 with 24 degrees of freedom.

as part of the supervisory tenancy returns on existing tenancies. This section documents the impacts on the CPI of using the two different measures when controlling for common hedonic characteristics and adjusting both series to the OOH housing structure.

4.1 Data and Measurement of Existing Stock Rental Prices

To measure existing rental data in Ireland, we draw on a series from our supervisory dataset which relates to long term rental renewals or part IV tenancies as discussed above. In Ireland, if a tenancy runs to over four years in duration, the landlord is required by law to submit an updated registration of the rental agreement with the Residential Tenancies Board as a "Part IV" renewal. These renewals have expanded tenancy rights relative to shorter duration tenancies. For the purpose of our analysis, these data provide an ideal existing rental series to present as a counterweight to our new flow rents data. The renewal tenancies registration requires all the information of the properties to be re-submitted as well as updated information on the rent levels and tenancy details thus the data are directly comparable with our new rental series and the database provides common variables to hedonically estimate inflation series across the two series. Our series for these data is somewhat smaller than for new tenancies and contains 31,000 records. This is due to the fact that only a limited number of Irish rental agreements become long term in nature with the domestic private rental market being a much more transitory tenure type than in other countries. Summary statistics for the renewal tenancies are presented in table 8. It is clear that the level of rent is lower per month for renewal tenancies relative to new tenancies. Another notable difference is the housing type with a considerably lower share of apartments in the renewal tenancies.

Table 8: Summary statistics Renewal Vs New

Variable	**Renewal**	**New**
Rent Amount (Month (€))	805.737	886.59
No of Bedrooms	2.591	2.43
Floor Area	100.795	93.498
No of Tenants	1.806	1.778
Detached House	0.125	0.1
Semi-Detached House	0.332	0.228
Terrace House	0.176	0.144
Other flats	0.053	0.064
Part House	0.012	0.012
Apartment	0.314	0.464
Electricity	0.883	0.82
Oil	0.342	0.255
TV License	0.819	0.746
Waste	0.608	0.506
Gas	0.493	0.396
Other	0.239	0.279

4.1.1 An Existing Rents OOH RE Index

To estimate a OOH adjusted series for existing rents, we follow the process outlined above in section 2.2. This entails firstly estimating hedonical regressions for the existing rental series for each of the 32 regional housing type areas as documented in section 2.2.2. The hedonic model used on the renewal data is as set out in equation (2). Before moving to this step and to provide a more simple consideration of the differences in the trends between new and existing rental trends, we re-estimate equation (1) for both data types including all controls (utilities and regions) and plot the subsequent indices and growth rates. These are presented in figure 6. The figure first presents Indices set at 100 in August 2012, then the raw monthly year-on-year growth rate followed by a smoothed three month average trend. The trend in the two indices is clearly different with a consistently higher rate of inflation for new tenancies. Indeed, the smoothed average figure (c) provides a very clear indication of a significant difference in rental inflation between new tenancies and existing tenancies. In Ireland, for the period in question, this is not driven by the existence of rent controls. The gap is therefore likely to be driven by other considerations such as nominal rigidity, relationship factors and tenancy turnover costs as indicated by Aysoy, Aysoy, and Tumen (2014) and Shimizu, Nishimura, and Watanabe (2010).

To move to the OOH adjusted indices for both new and renewal tenancies, we estimate the model in equation (2) for renewal data then undertake the re-weighting as in equation (3) to create an existing rents OOH-adjusted rental equivalence measure. A comparison between the new and existing OOH RE measures is presented in figure 7. Very clear differences are evident in the trends between the two series. Indeed, the renewal series is in fact much more volatile in the early part of the sample period.

The mean differences are presented in table 9. The average annualised inflation rate for the OOH adjusted existing rent series is only 1.6 per cent which is considerably lower than the 4.8 per cent inflation rate for new rental agreements.

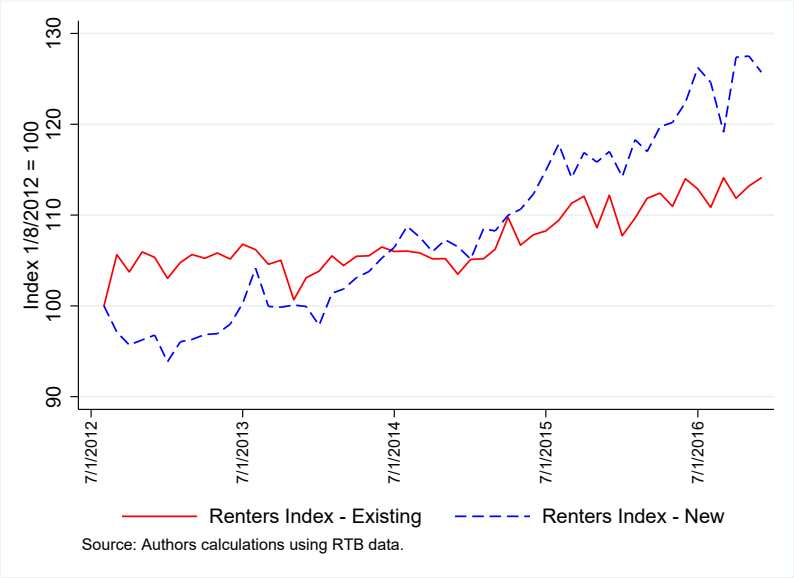
Table 9: Summary Statistics for Average Yearly Growth Rates (%)

Variable	Mean	Std. Dev.	Min.	Max.	N
OOH Adjusted Index - New	0.048	0.016	0.02	0.093	41
OOH Adjusted Index - Existing	0.016	0.04	-0.062	0.1	41

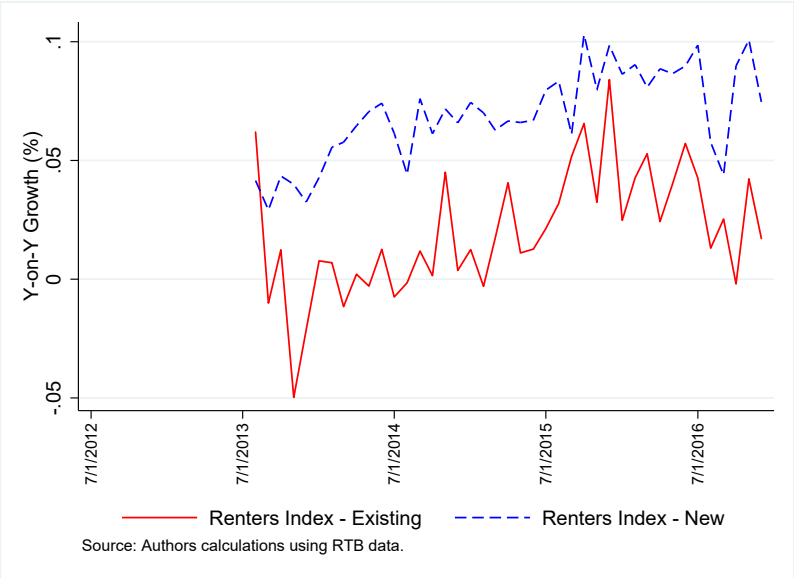
The analysis in this section clearly demonstrates that the impact of using new versus existing tenancies as a measure of rental equivalence for owner-occupied housing. If the goal is the replicate as close as possibile the opportunity cost to owner-occupiers of their property then using existing rents (which is not the price they would get on the market) is likely to considerably downward bias the estimate of inflation. In our worked example, the OOH rental index is two thirds lower if existing rent data is used relative to information on new rents.

Figure 6: Hedonic Measures for New and Existing Rents

(a) Indices (8/2012 = 100)



(b) Year on Year Growth Rates (%)



(c) 3 Month Rolling Average

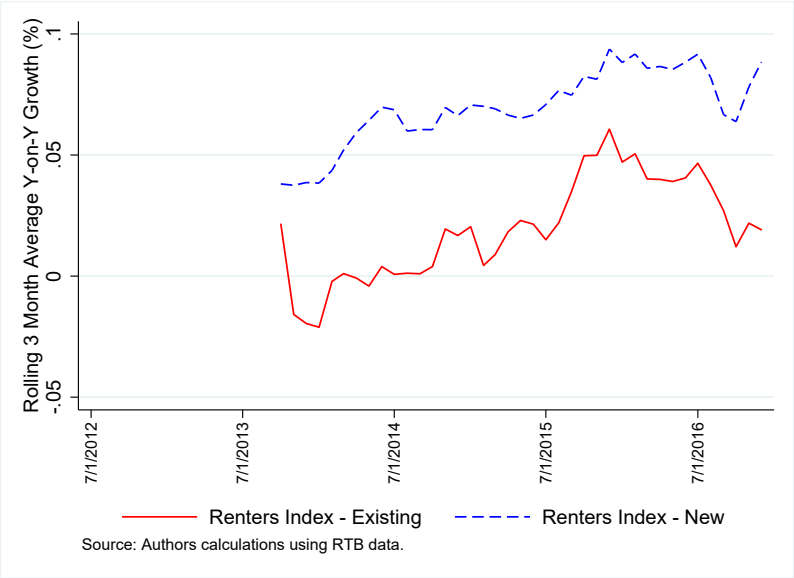
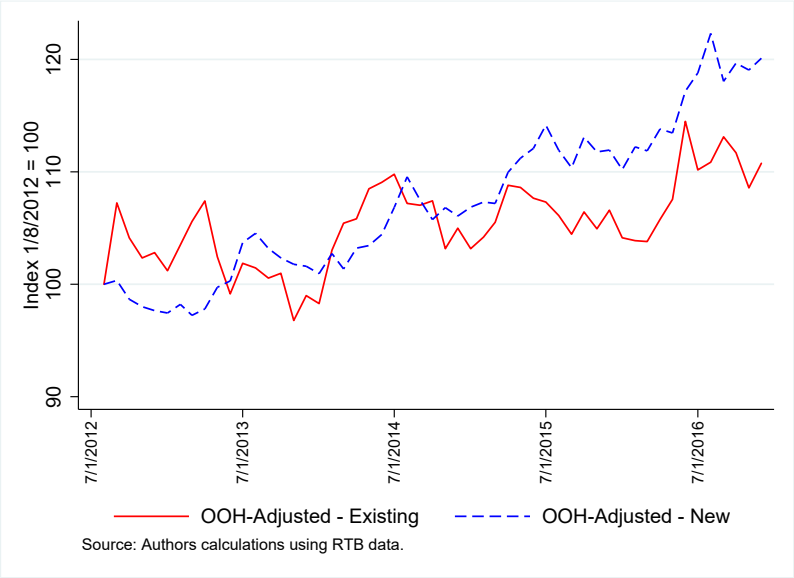
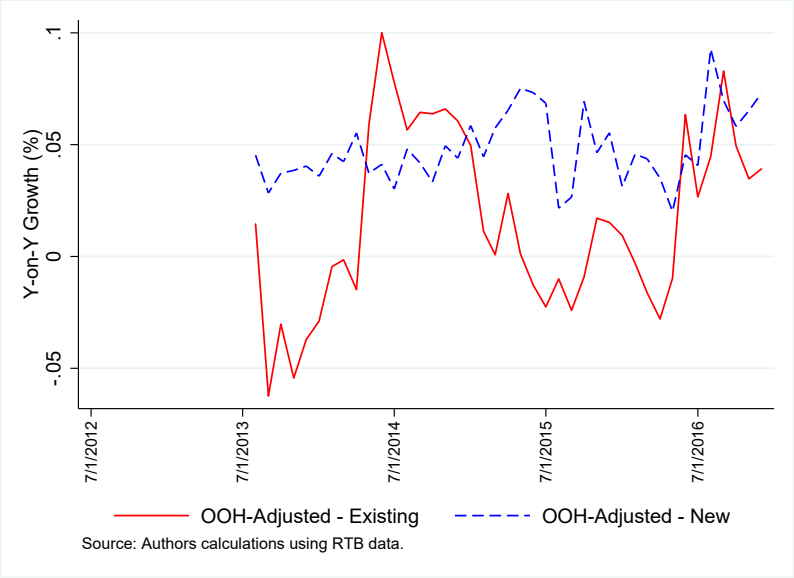


Figure 7: Hedonic Measures for New and Existing Rents

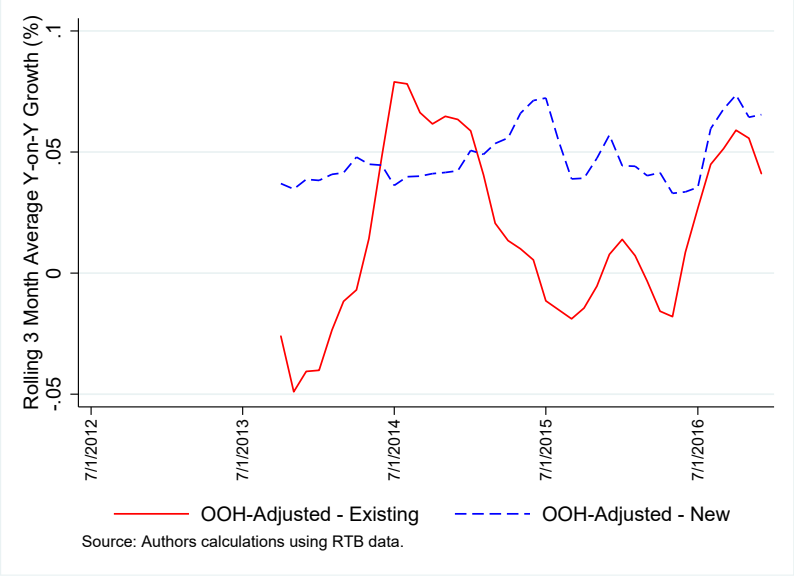
(a) Indices (8/2012 = 100)



(b) Year on Year Growth Rates (%)



(c) 3 Month Rolling Average

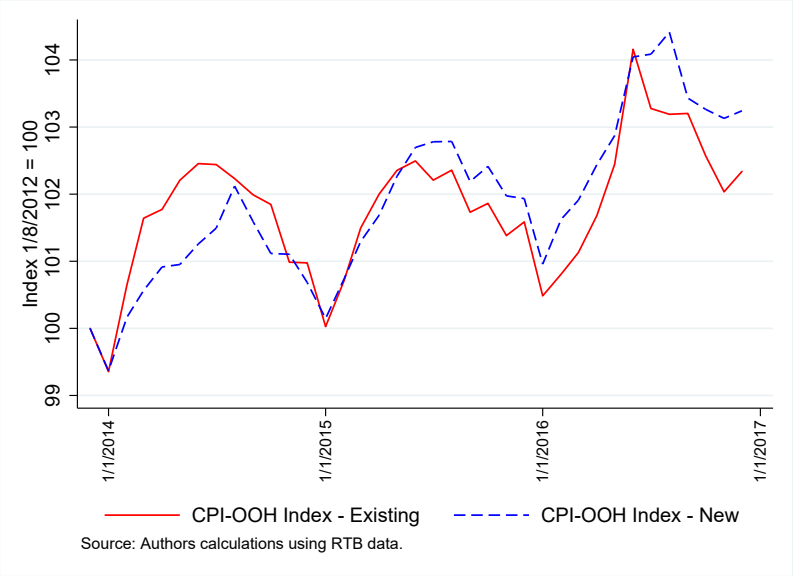


4.1.2 Testing the Impacts on CPI

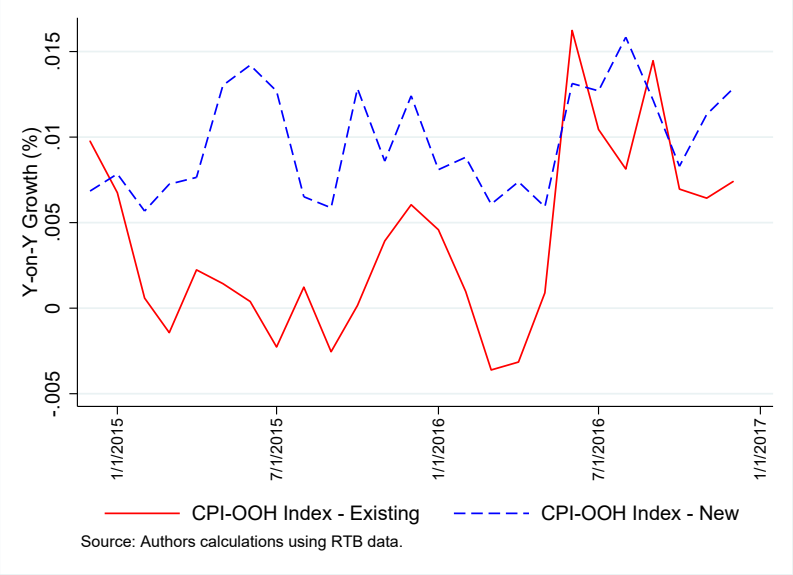
The final step in our analysis is to demonstrate the impact of the new versus existing rental inflation measures on the overall level of the Irish consumer price index. To do this, we replicate our approach above which includes the existing rents OOH index into the Irish consumer price index and compares the out turn with the new rent OOH index. The resulting series are presented in figure 8. A comparison of the growth rates of both series reveals significant differences. For most of the period, the CPI would be considerably underestimated by using the existing rent data.

Figure 8: New CPI Indices with Rental Equivalence Measures

(a) Indices (12/2013 = 100)



(b) CPI Year on Year Growth Rates (%)



This can be clearly demonstrated by a simple comparison of the means as presented

in table 10. The CPI inflation rate was 0.004 per cent using the existing rents OOH index relative to 0.01 using the new rents OOH index. A simple paired t-test of the difference between these two series indicates a significant difference at the 1 per cent level of 0.6 percentage points overall.[8]

Table 10: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
CPI - OOH Existing	0.004	0.005	-0.004	0.016	25
CPI - OOH New	0.01	0.003	0.006	0.016	25

The analysis presented in this section very clearly demonstrates the impact of using new versus existing rental data in estimating an owner-occupied housing rental equivalence index and including this in the consumer price index. While many countries indeed use existing rents, this is likely to bias downwards the OOH housing cost estimate, and the overall CPI as rental inflation for new tenancies is likely to outpace that of existing tenancies. These considerations have a non-trivial impact of the overall CPI.

5 Conclusion

This paper has attempted to address a number of measurement issues in relation to the estimation of rental equivalence measures for owner-occupied housing. We use novel supervisory data from the Irish rental regulator to address a number of data gaps in the existing studies such as new rental data, the inclusion of other utilities costs and the absence of rent controls. Furthermore, we deal with the selection bias that addresses differences in the structure of housing between owner-occupiers and renters.

Our research points to very clear impacts of addressing these issues on the measure of OOH housing cost and the overall level of the consumer price index. First, we demonstrate that adjusting for the structure of owner-occupied housing, controlling for other utilities costs and using new rental tenancies data leads to an inflation estimate for OOH that is approximately two percentage points lower than the equivalent for renters. This in turn leads to a very clear impact on the overall measurement of consumer price inflation. Using our OOH-adjusted index relative to a renters sample lowers the overall level of consumer price inflation by nearly 0.4 percentage points.

Second, we demonstrate a clear impact of using new versus existing rents in estimating an OOH rental equivalence measures. The OOH index using existing rents is materially lower than the new rent index with a considerable impact on the overall level of consumer price inflation: the annualised change in inflation was 0.6 percentage points lower using the existing rents relative to new rents.

[8]Mean for new series is approximately 1 per cent with the renewals at 0.4 per cent, the t statistic value is 6.05 with 24 degrees of freedom.

In summary, there are very clear trade-offs for statistical agencies and policymakers in setting and measuring OOH in the consumer price index. Our research shows that when using a rental equivalence measure, policymakers should be very mindful of data gaps and measurement issues and ensure that these are minimised so as to limit the impact of such issues on the overall rate of consumer price inflation.

6 Appendices

6.1 Appendix 1: New Versus Renewal Hedonic Characteristcs

Table 11: Hedonic Models of New and Existing Rents

	(Existing)	(New)
Tenancy Length	-0.007*	0.010***
	(0.003)	(0.002)
Number of Bedrooms	0.308***	0.291***
	(0.005)	(0.002)
Floor Area	0.065***	0.083***
	(0.003)	(0.001)
No of Tenants	0.073***	0.128***
	(0.003)	(0.001)
Semi-detached	0.036***	0.024***
	(0.005)	(0.002)
Terrace	0.041***	0.024***
	(0.005)	(0.002)
Apt/Flat	0.108***	0.078***
	(0.006)	(0.002)
Border	-0.808***	-0.857***
	(0.007)	(0.002)
West	-0.548***	-0.560***
	(0.006)	(0.002)
Mid-West	-0.617***	-0.724***
	(0.005)	(0.002)
South-East	-0.585***	-0.706***
	(0.006)	(0.002)
South-West	-0.457***	-0.475***
	(0.005)	(0.002)
Mid-East	-0.329***	-0.392***
	(0.005)	(0.002)
Midlands	-0.683***	-0.770***
	(0.007)	(0.003)
Electricity	-0.034***	-0.031***
	(0.006)	(0.002)
Oil	-0.042***	-0.067***
	(0.004)	(0.002)
TV License	0.040***	0.026***
	(0.005)	(0.002)
Waste	-0.031***	-0.069***
	(0.004)	(0.001)
Gas	0.068***	0.084***
	(0.003)	(0.001)
Other	0.055***	0.084***
	(0.003)	(0.001)
Constant	6.285***	6.309***
	(0.017)	(0.007)
Observations	31,506	347,041

Standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2 Appendix 2: Payments Approach Items

The table below lists the items removed from the CPI basket as they were deemed payments approach specific in line with the approach of Ahrens et al. (2020).

Table 12: Payments Approach Items

Item	COICOP
Mortgage interest	04.2.1.0
Floor Tiles	04.3.1.0
Paint	04.3.1.0
Paint Brush	04.3.1.0
Paint roller	04.3.1.0
Varnish	04.3.1.0
DIY household maintenance products	04.3.1.0
Taps/Mixer Taps	04.3.1.0
Building materials	04.3.1.0
Plumbers services	04.3.2.1
Electricians services	04.3.2.2
Services for maintenance of heating systems	04.3.2.3
Painters services	04.3.2.4
Carpenters services	04.3.2.5
Other house maintenance services	04.3.2.9
House insurance - contents (non-service)	12.5.2.0
House insurance - dwelling	12.5.2.0
Professional and legal services	12.7.0.2
Miscellaneous goods and services	12.7.0.4

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