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Abstract

Rent-price ratios are a critical tool in understanding housing markets. For decades the vast majority of rent-price ratios were estimated with an index comparison approach despite the widely accepted potential for bias in using this method. More recently two new methods – hedonic imputation and direct matching – have been developed and are aimed at improving the reliability of these estimates. Using transaction-level observations from the Melbourne metropolitan area we test for differences between the three methods. Finding considerable deviations between them (up to 20%), we illustrate that between-tenure compositional differences and geographic levels of aggregation explain most, but not all, divergences in rent-price ratio estimates from the three methods.

Introduction

The relationship between home rents and sale prices is a fundamental metric in the analysis of housing markets [Shiller, 2007, Bracke, 2015]. This relationship, often referred to as a 'rent-price ratio', is used as a key input variable or observed metric for a variety of research objectives. These include, but are not limited to, the identification of housing bubbles or market disequilibrium [Capozza and Seguin, 1996, Himmelberg et al., 2005, Hill and Syed, 2016], analysis of rent vs. buy decisions [Beracha and Johnson, 2012] and estimation of returns to housing [Gelain and Lansing, 2014, Engsted and Pedersen, 2015].

The vast majority of the body of literature in this field estimates rent-price ratios (and related user cost calculations) by comparing sales price index values to rent index values. The potential for and likelihood of bias resulting from the index comparison method due to the fact that sold homes and rented homes often differ in structural and land characteristics and location is well noted [Himmelberg et al., 2005, Glaeser and Gyourko, 2007, Verbrugge, 2008, Garner and Verbrugge, 2009].

Recently, more complex methods that utilize property-specific observations – hedonic imputation

and direct matching – have been developed and tested [Smith and Smith, 2006, Hattapoglu and Hoxha [2014], Bracke [2015], Hill and Syed [2016]]. While these two methods are able to compare more equivalent samples of rented and sold homes, they do offer a higher cost in terms of data requirements and computation.

To date, there has been little comparative work examining if the different methods produce different rent-price ratios and, if so, what factors are creating the variation in estimates. As a result, there is little advice available for the applied researcher on the choice of method and the consequences of that choice. In this paper we set out first to test if different methods create different rent-price ratio estimates. Finding considerable deviations in the ratio estimates, we then seek to explain these differences by examining two factors: 1) between-tenure sample composition, and; 2) geographic aggregation.

We conduct this analysis using a dataset of more than 710,000 sales and rental observations from the Melbourne (Australia) metropolitan region over the January 2011 to December 2015 time period. Melbourne is a particularly interesting case to study as nearly all of the rental properties in the region are held by small-scale, private investors equating to a large number of properties, both houses and apartments, that have both sold and rented in our study period.

Existing Research

Depending on the discipline or use, the relationship between rents and prices may be referred to (and calculated as) 'price-to-rent ratio' [Himmelberg et al., 2005, Glaeser and Gyourko, 2007, Goetzmann et al., 2012], 'rent-price ratio' [Campbell et al., 2009, Bracke, 2015], 'rental yield' [Fu and Ng, 2001] and 'dividend price ratio' [Hwang et al., 2006]. Within this study we will use the term 'rent-price ratio.' Being expressed as such, the annual rental amount is the numerator and the sale price or home value is the denominator.

A diverse collection of housing research utilizes rent-price ratios (RPRs) or their reciprocal as a key metric. One of the more common purposes is in the testing of market fundamentals and/or equilibrium [Capozza and Seguin, 1996, Ayuso and Restoy, 2006, Ambrose et al., 2013, Sommer et al., 2013, Hill and Syed, 2016]. RPRs are also employed in the identification of periods of mispricing or

bubbles [Himmelberg et al., 2005, Smith and Smith, 2006, Brunnermeier and Julliard, 2008, Pavlidis et al., 2013]. Related, a number of studies make direct comparisons between rents (rental user costs) and the full user costs undergone by home owners in lieu of rent-price ratios [Himmelberg et al., 2005, Verbrugge, 2008, Feng and Wu, 2015]. Despite this slight departure in method, user costs are heavily dependent on the underlying rent and home price levels and, therefore, are as susceptible to biasing effects from estimation methods as the more traditional RPRs calculations.

A second class of research that commonly uses RPRs examine how expectations of housing returns and/or future capital appreciation can impact market decisions [Hwang et al., 2006, Gelain and Lansing, 2014, Hattapoglu and Hoxha, 2014, Engsted and Pedersen, 2015]. Finally, rent-price ratios are also occasionally used as independent or explanatory variables in peripherally-related studies explaining mortgage supply [Goetzmann et al., 2012], house prices levels [Hwang and Quigley, 2006] and spatial arbitrage opportunities [Glaeser and Gyourko, 2007].

In the majority of studies RPRs are calculated by comparing rent and sale price index values for a particular geographic area. The index comparison approach can, therefore, be considered an 'aggregate' method of calculation. While this method is computationally cheap and the data is often readily available, it does suffer from a number of issues, most notably the fact that the composition (type, quality and location) of homes that sell are often vastly different from those that rent [Hattapoglu and Hoxha, 2014, Bracke, 2015].

Recently, there has been increased interest in both describing the trends that explain movements in the rent-price ratios [Campbell et al., 2009] as well as improving the methods used to calculate the RPR estimates themselves [Hattapoglu and Hoxha, 2014, Bracke, 2015, Hill and Syed, 2016]. To address issues pertaining to compositional differences, two additional methods have been used to create alternate estimates of rent-price ratios using property-level observations; 1) hedonic imputation; and 2) direct matching.

The hedonic imputation method utilizes hedonic price models of rents and sale prices to create an imputed sales price for rental observations and an imputed rental amount for sales observations [Hattapoglu and Hoxha, 2014, Hill and Syed, 2016]. Hattapoglu and Hoxha [2014] create three sets of rent-price ratios, sold with imputed rent, rented with imputed price and imputed rent divided by

imputed price. Sensitivity tests on their aggregated (at neighborhood level) rent-price ratios shows only a small difference in the impact of the three sets of numerator and denominator combinations on their results. Hill and Syed [2016], on the other hand, only utilize the imputed rent divided by imputed price approach. Finally, Bracke [2015] estimates a rent and sales price for a set of properties and then regresses that ratio on a set of structural characteristics to determine each variables' impact on the rent-price ratio.

Direct matching involves matching rents and sale prices from the same or similar homes. Bracke's [2015] work in London uses direct matches of homes that have both sold and rented. To avoid issues of changes in market prices over time, he limits the matches to those within six months of each other. Leveraging the unique Chonsei system in Korea, Hwang et al. [2006] are able to directly observe rental and sales prices of apartments in Seoul to analyze 'dividend-price ratios' (rent-price ratios). Due to a limited number of perfectly matched pairs, Smith and Smith [2006] opt for a proximity matching approach that derives a rent-price ratio from similar, but not identical, homes that have both sold and rented.

A review of literature shows that despite the the potential for bias resulting from differences in the rent and sale samples, most academic research and industry application of rent-price ratios employ an index-based approach. Recently, more complex methods such as the hedonic imputation and direct matching approaches have been presented and tested; however, no comparison to date shows the level of difference in estimates, if any, that exists between the choice of estimation method.

Estimating Rent-Price Ratios

Table 1 highlights the differences between the three methods in terms of comparison type and data usage. The index comparison method first aggregates within each tenure type and then computes the ratio between rents and prices. Conversely, the impute and match methods first compute a property-specific ratio and then aggregate up to a geographic level. The data used by each method varies as well. The index method uses predefined price and rent indexes, the impute methods uses the full set of transactional data in the market, while the match method uses a limited sample of matched rentals to sold properties (usually the same property). As a result of these differences,

variations in the estimates are likely in the event that the rental and sold markets have a different composition of homes. A complete explanation of each follows.

Table 1: Summary of Price-Rent Ratio Methods

Method	**Comparison Type**	**Data Requirements**
Index Comparison	Aggregate	Index Values
Impute Regression	Property-Specific	Full Sample of Transactions
Direct Match	Property-Specific	Matched Sample of Transactions

Index Comparison

The index comparison method involves comparing a rent index value to a price index value at the same time for the same area. Presuming that a rent-price ratio (RPR) can be derived from nominal rent and price values at the base period of the indices, then the RPR can be calculated by multiplying the base period RPR by the ratio of the rent to price index values in all other (non-base) periods. The rent-price ratio at time t in a particular geographic area j, $RPR_{j,t}$, is represented as:

$$RPR_{j,t} = \frac{NVR_{j,0}}{NVP_{j,0}} * \frac{IVR_{j,t}}{IVP_{j,t}} \tag{1}$$

where $NVR_{j,0}$ is the nominal base (time = 0) rental amount in area j, $NVP_{j,0}$ is the nominal base (time = 0) price, $IVR_{j,t}$ is the rental index value at time t, and $IVP_{j,t}$ is the price index value at time t. If a series of nominal rental and home prices are available, then the RPR at time t in area j can be calculated by dividing the nominal rent series value by the nominal home price series value:

$$RPR_{j,t} = \frac{NVR_{j,t}}{NVP_{j,t}} \tag{2}$$

where $NVR_{j,t}$ and $NVP_{j,t}$ are the nominal rental value and nominal sales values in area j at time t, respectively.

Hedonic Imputation

The hedonic imputation approach uses property-level transaction data to impute the likely rental amount for sales and likely sale price for rentals. More specifically, a hedonic price model is built using all sales observations and then used to predict the likely sale price of all rental observations at the time of the rental contract. Likewise, the same is done using all rental observations to predict the likely rental amount at the time of the sale for sold properties. This process creates a sale price and rental amount for each observation in the dataset. For sales, the sale price is observed and the rental amount is imputed; for rentals the rental amount is observed and the sale price is imputed. The relationship between these two values represents the observation specific (as of the date of the observed transaction) rent-price ratio.

For an observed sale, the rent-price ratio is expressed as:

$$RPR_{i,t} = \frac{\widehat{R_{i,t}}}{SP_{i,t}} \tag{3}$$

where $RPR_{i,t}$ is the rent-price ratio for property i at time t (the time of the sale), $SP_{i,t}$ is the observed sale price at time t and $\widehat{R_{i,t}}$ is the predicted or imputed rental value at time t expressed by the following standard hedonic price or rent equation:

$$\widehat{R_{i,t}} = \beta_0 + \beta_1 X_i + \epsilon_i \tag{4}$$

where X_i is the vector of independent variables for property i, β_0 is a constant, β_1 is a vector of estimated coefficients and ϵ_i is an error term.

Likewise, for an observed rental, the rent-price ratio is expressed as:

$$RPR_{i,t} = \frac{R_{i,t}}{\widehat{SP_{i,t}}} \tag{5}$$

where $RPR_{i,t}$ is the rent-price ratio for property i at time t (the time of the rental), $R_{i,t}$ is the observed rental value at time t and $\widehat{SP_{i,t}}$ is the predicted or imputed sale price at time t expressed

by the following standard hedonic price or rent equation:

$$\widehat{SP_{i,t}} = \beta_0 + \beta_1 X_i + \epsilon_i \tag{6}$$

where X_i is the vector of independent variables for property i, β_0 is a constant, β_1 is a vector of estimated coefficients and ϵ_i is an error term. The property-specific rent-price ratios are then pooled at the geographic level of analysis, j, and an overall rent-price ratio is estimated by taking a measure of central tendency at time t.

Direct Matching

A third method used to calculate rent-price ratios is the direct matching approach. In this approach only properties that have both sold and rented in a given time period are considered. If insufficient pairs of sale/rentals of the same property are found, similar but different properties can be matched [Smith and Smith, 2006]. As sales and rentals are rarely, if ever, simultaneous, an adjustment must be made to account for the time between the two observations. An RPR value can be calculated at both the time of the sale and the time of the rental, so each matched pair creates two RPR estimates. In the case of a sale that then rented, first the rental amount is adjusted back in time via a rent index to the time of the sale to create the first estimate and then the sale price is adjusted forward in time to the date of rental using a sale price index to create the second estimate.

The rent-price ratio for the rental observation in this example matched pair is represented by:

$$RPR_{i,t} = \frac{R_{i,t}}{SPadj_{i,t}} \tag{7}$$

where $RPR_{i,t}$ is the estimated rent-price ratio for property i at time t (when it was rented), $R_{i,t}$ is the value that it was rented at and $SPadj_{i,t}$ is the sale price adjusted by a market index to time t.

Similarly, the rent-price ratio for the sale observation in a matched pair is represented by:

$$RPR_{i,t} = \frac{Radj_{i,t}}{SP_{i,t}} \tag{8}$$

where $RPR_{i,t}$ is the estimated rent-price ratio for property i at time t (when it was sold), $Radj_{i,t}$ is the rental value adjusted by a market index to the time at which the property sold, t, and $SP_{i,t}$ is the sale price at time t. Like the imputation method, the property-specific rent-price ratios are then pooled at the geographic level of analysis, j, and an overall rent-price ratio is estimated by taking a measure of central tendency at time t.

Data

To examine rent-price ratios estimates from the three methods discussed above we utilize property-level observations of home sale prices and rental lease amounts obtained from Australian Property Monitors (APM).[1] These data include all transactions of single family homes and apartments[2] in the Melbourne metropolitan region over the January 2011 to December 2015 time period. After removing incomplete and outlying[3] observations, more than 710,000 individual transactions remained – greater than 235,000 sales and 475,000 rentals. In addition to the transaction date and price, the data include more than 15 individual physical attributes of the property along with the property address, latitude and longitude. Unfortunately, information on home age and living area is not commonly found in transactional datasets within Australia and is unavailable for the purposes of this analysis.

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[1] http://www.apm.com.au, a member of the Domain Group

[2] Within the local Australian property industry and in our datasets, apartments and condominiums are labeled as 'units'. However, we will employ the more commonly used term 'apartment' so as to apply to the largest possible audience. Note that there is essentially no institutional rental market in Australia and thus when we use 'apartment' we mean a attached dwelling in a multi-family structure that is owned under a condominium-type regime. Or, in North American terms, a 'condominium'.

[3] Homes with more than eight bedrooms or bathrooms, lots of more than 40,000 square meters and homes sold for less than $150,000 or more than $4,000,000 or rented for less than $125 or more than $2,500 per week (rentals are quoted per week in Melbourne).

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