

The Price-Rent Ratio During the Boom and Bust: Measurement and Implications*

Jaclene Begley

Fannie Mae

Lara Loewenstein

Federal Reserve Bank of Cleveland

Paul S. Willen

Federal Reserve Bank of Boston and NBER

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Abstract

We use micro-level data to study the joint evolution of prices and rents on residential property. We first decompose the change in the price of occupant-owned property into three components: (1) changes in rent; (2) changes in the relative price of investor- and occupant-owned property; and (3) changes in the price-rent ratio. We show that (3) accounts for most of the variation and argue that this significant implications for theories of the 2000s housing boom and bust. Using a dataset that allows us to compute it at the property level, we show that the price-rent ratio moves similarly across all property types, but varies significantly by geography. We argue that the latter variation can be partially explained by differing expectations of population growth.

*The views in this paper are not necessarily those of Fannie Mae, the Federal Reserve Bank of Boston, the Federal Reserve Bank of Cleveland, the Federal Housing Finance Agency, or the Federal Reserve System.

1 Introduction

Price-rent ratios offer important housing market insights. Variations across time and space in price-rent ratios can provide information about local real estate markets, including future market expectations and speculative market behavior. Since no-arbitrage conditions imply that prices should equal the discounted flow of future rents, high prices can be reconciled with relatively low rents by assuming that people have optimistic expectations about future rents. Concerns about asset price bubbles arise when there are suspicions that these expectations are unrealistic. This is especially relevant to the 2000s housing boom.

However, price-rent ratios are difficult to measure accurately. A key hindrance is the lack of comparable rents for owner-occupied housing. Measurement issues are especially apposite to owner-occupied single-family housing, which comprises the largest share of the housing stock in the United States (63 percent of the occupied housing stock as of 2015).¹ Rents are not observable on these properties, and there is often no comparable rental stock from which to estimate rents. To address this, rental rates may be imputed, such as in the price-rent ratio series created by Davis, Lehnert, and Martin (2008), and many early studies use Census or Bureau of Labor Statistics (BLS) data to estimate imputed rent for owner-occupied homes.²

As an example, Figure 1 displays the lack of consistency across three different versions of the price-rent ratio over time: a series described in Davis, Lehnert, and Martin (2008) that uses hedonic methods to estimate rents for owner-occupied housing; the ratio of the national CoreLogic house price index over the BLS index of owner-equivalent rent; and the inverse of an unweighted average of cap rates on residential commercial real estate from Real Capital Analytics (RCA), which is only available from 2002 onwards. There are certainly similarities between the three measures: all the show a marked increase during the early 2000s. However the ratio of the indices from CoreLogic and BLS show substantially higher growth relative to the measure from Davis, Lehnert, and Martin (2008), especially when considering their respective values in 1995. The measure from RCA shows similar growth from 2002 to 2005 as the CoreLogic/BLS measure, but does not depict as substantial of a decline during the Great Recession.

In this paper, we make three contributions to the literature. First, we decompose the price-rent ratio into three components: (1) changes in rent; (2) changes in the relative price of investor and occupant-owned property; and (3) changes in the price-rent ratio. Using micro-level data on prices and rents we show that (3) accounted for the majority of the variation of the price-rent ratio during the 2000s housing boom. We argue that this has implications for the debate over the causes of the housing boom.

¹American Housing Survey 2015

²See Carson, Johnson, and Steindel (2006) and Verbrugge and Poole (2010) for a detailed discussion of these data.

Second, using data on prices and rents on the same properties, we construct time series of price-rent ratios across states and property types, including single-family homes. We show that there is little variation in growth in the price-rent ratio across property types. The price-rent ratio of single-family homes and large multi-unit residential properties rose and fell similarly during the 2000s. This is illuminating because while it is possible that owner-occupiers are constrained in their housing choice, it is unlikely that large-scale investors face similar constraints. While individual households face debt-to-income and loan-to-value constraints, the income used to back an investor loan is the current and future income produced by the property. Therefore the concern to investors and their lenders is whether price is supported by the expected future income stream from the property. In the case of residential commercial properties, this is largely driven by the rent.³ Despite the lack of variation across property types, we show that there is significant variation in the evolution of the price-rent ratio across states. For example, California and Florida experienced large increases in their price-rent ratios during the 2000s, while the price-rent ratio in Michigan declined.

Third, we discuss economic determinants of price-rent ratios. Theoretically, we show in a simple framework that a relaxation of credit constraints cannot explain an increase in the price-rent ratio. In our model, the price-rent ratio is a function of interest rates and house price growth. A relaxation in credit constraints does not affect either the interest rate or house price growth, so has no effect on the price-rent ratio. Furthermore, in equilibrium, changes in the interest rate lead to an equal and offsetting increase in house price growth, leaving the price-rent ratio unchanged. Therefore, the only thing explaining increases in the price-rent ratio in the 2000s is optimistic house price expectations. We then show empirically that the price-rent ratio does not have a stable relationship with interest rates, but that the different paths of the price-rent ratio across states can be explained by variation in measures of expectations for future population growth.

We proceed as follows: in Section 2, we discuss the relevant literature; in Section 3, we discuss our data sources; in Section 4, we decompose the price-rent ratio into three components; in Section 5, we analyze the price-rent ratio using prices and rents from the same properties; in Section 6, we present a theoretical model of price-rent ratios; in Section 7, we discuss empirical evidence of economic determinants of price-rent ratios; and in Section 8, we conclude.

³Specifically, commercial real estate investors will look at the ratio of net operating incomes (NOIs) to values to assess cap rates. A property's NOI is its rental income stream less building operating expenses.

2 Literature

Price-rent ratios are well-studied for both single- and multifamily properties, however the literature often treats these as distinct topics. This is partially because price-rent ratios in the single-family market are difficult to estimate as most homes are owner-occupied and no decent data on market rents for owned homes exists (while in contrast, the multifamily investment market relies on the ratio as a fundamental indicator for investment decisions). Much of the early single-family research relies on Census and/ or BLS data and this literature focuses on price-rent ratios in the context of housing price expectations and market efficiency, such as Case and Shiller (1990) and Mankiw and Weil (1989), who also note the challenges of attempting to estimate these ratios using Census or BLS data.

Given its potential to provide valuable information on future expectations, much of the price-rent ratio literature is focused on unpacking this relationship and identifying market speculation, or bubbles. Case and Shiller (2003) define a bubble as when homebuyers pay prices that are higher than they normally would pay because they expect to be compensated by future price increases. However, they focus more on price-income ratios than on rents. Himmelberg, Mayer, and Sinai (2005) argue that differences in appreciation rates and local taxes explain disparities in price-rent ratios across markets. They develop a user-cost model of imputed rent that incorporates interest rates, mortgage rates, depreciation, risk premiums, marginal and property tax rates, and long-run price appreciation. They find that prices-rent ratios remain fairly consistent over time, and note this is consistent with purchasers in strong housing markets anticipating future growth rates (e.g. ‘superstar cities’).

Focusing specifically on differences across housing markets, Capozza and Seguin (1995) make the case for examining spatial variation in price-rent ratios. They argue that in a competitive market, expected returns will be the sum of the rental yield and the future expected price appreciation—areas with high rental yields will have lower expected appreciation. Their empirical analysis similarly finds that price-rent ratios are predictive of future price appreciation within metropolitan areas and also shows evidence of market “euphoria,” in response to recent local income growth (pg.4). Later work by Gallin (2008) confirms that price-rent ratios are predictive of future prices and notes these ratios they are more effective at predicting values, but not rents. Similarly, Sinai and Souleles (2005) show that areas with high price-rent ratios are places with high expected future growth. Focusing only on apartments in Manhattan, Bram (2012) confirms that differences in the price-rent ratio over market cycles can be largely attributed to local market speculation (such as expected market conditions and capital gains).

Glaeser and Gyourko (2008) highlight a number of potential measurement flaws in conventional price-rent ratio data, and not surprisingly, the recent literature offers novel approaches and data to better capture price-rent ratios. Davis, Lehnert, and Martin (2008)

were the first to construct an aggregated time series index of ratios going back to 1960. Using microdata from the Decennial Census of Housing and the BLS to estimate imputed rents for owner-occupied single-family homes, they then extrapolate trends over time. They find that price-rent ratios decline dramatically after 1995 and continue to decline through 2006. Campbell et al. (2009) further show that these declines are driven by expectations of future housing market growth and/or declines in the required risk premium for housing, and that risk-free interest rate changes may have less influence than previously thought.

A number of studies focus on creating price-rent ratios on the same, or very similar properties. For example, Smith and Smith (2006) use Multiple Listing Service (MLS) data for 10 markets, matching rental and sale listings on property characteristics. Pancak (2017) uses Zillow price-rent ratio data, which offer aggregate estimates based on estimated market values and rents for the same properties within specific geographies. Similar to Himmelberg, Mayer, and Sinai (2005), she attributes large variations across neighborhoods to local contextual differences, such as property tax rates, household incomes, and property vintages. Using a unique dataset from a London real estate agency, Bracke (2015) is able to look at rents and sales on the same units and draws similar conclusions for London.

For commercial real estate, there is a long literature devoted to understanding cap rates (rent-price ratios). The main thread of this literature focuses on investor perspectives and the role of macroeconomic factors in driving national cap rate trends: as a function of capital market risk premiums, property fundamentals, and local market growth rates (Archer and Ling 1997; Chervachidze and Wheaton 2013). Many studies argue that cap rates are a reflection of investor expectations of future growth, but that investors are slow to update expectations and often base projections on past experiences, rather than incorporating inevitable mean reversion in their expectations (Sivitanides et al. 2001; Jud and Winkler 1995; Hendershott 2000; Hendershott and MacGregor 2005). These papers do not use property-level data, but rather rely on capital markets data; on aggregated real estate market data, such as national market history reports; or on appraisal-based cap rates at the metropolitan level from the National Council of Real Estate Investment Fiduciaries (NCREIF).

There are a handful of studies that attempt to disentangle the key factors that drive local variations in cap rates. These studies argue that cap rates should reflect the risk inherent in future cash growth and terminal valuation and tend to agree that cap rates internalize local economic forces. Sivitanidou and Sivitanides (1995, 1999) were the first two studies to use panel data to show the importance of local market conditions in differentiating cap rates across time and space. They find that local markets have a stronger influence on cap rates than national markets; and specifically highlight local factors such as vacancy rates, employment stability, and past rental growth. Chichernea et al. (2008) finds that

local supply constraints are an important driver of cap rates, as is local market liquidity. Similarly, McAllister and Nanda (2015) argue that the most mature local markets are more likely to have foreign investment, which will also drive down cap rates. This is consistent with Ghent (2018), who notes that institutional investors are more likely to go to cities with higher property turnover and lower dividend yields.

While there are certainly distinctions between the two markets, Gyourko (2009) notes that there are more similarities than differences between the commercial and residential real estate sectors, although the lack of arbitrage opportunities in the housing sector could lead to larger breaks from fundamentals in the residential housing market. Similar to the single-family literature, the most recent commercial literature explores the determinants of changes in cap rates across the housing market cycle of the early 2000s. For example, Clayton, Ling, and Naranjo (2009), using RERC survey data, show that rental growth rate expectations grew during the period when cap rates were falling from 2002–2007, and their cap rate model shows that market fundamentals such as unleveraged discount rates and rental expectations were the main drivers of cap rates from 1996 through 2007, but changing investor sentiment also played a role. Duca and Ling (2018) argue that the lower cap rates during the early 2000s were the result of a decline in risk premiums related to weaker regulatory capital requirements.

Another view comes from Stanton and Wallace (2018), who argue that commercial mortgage standards did not ease dramatically in the commercial market during the housing boom, but rather, that the spread between CMBS and corporate bond yields for higher rated bonds fell after loosening capital requirements in 2002. Using Trepp data for 1995–2008, they show no substantial difference in credit terms, even during 2005–2007, when CMBS pools allowed mezzanine financing. Similarly, Gyourko (2009) notes an increase in interest-only loans during this time period, but also that a proliferation of commercial loans that were underwritten treating prospective rent increases as certain. He argues that the growth of interest-only loans is consistent with the view that property values will continue to rise.

Our paper builds on this literature by using micro data to compare the price-rent ratios for both residential real estate and commercial real estate markets across time and space. Similar to Bracke (2015), we are able to examine prices and rents on the same properties. Using same-property price-rent ratios, and exploring spatial variation across both single- and multifamily properties collectively provides a unique comparison that provides a new look at the forces driving the changes in this ratio over the past two decades.

3 Data

To capture prices and rents across different residential properties, we use multiple property- and loan-level data sources. These include data collected from public records and the multiple listing service (MLS) by CoreLogic, data on securitized commercial real estate loans from Morningstar, and property-level commercial real estate data compiled by CoStar. Summary statistics from these data sources are available in Section A.1 in the appendix.

3.1 CoreLogic Real Estate Database

The CoreLogic real estate database is a property-level dataset with information on real estate and mortgage transactions, foreclosure actions, tax assessor characteristics, and sale listings for (mainly) residential properties across the United States. The data on sale listings are from the MLS data, which contain listings for properties that are on the market for sale or rent. The information on mortgage and real estate transactions come from public records coalesced by CoreLogic from county registers of deeds.

Within the CoreLogic real estate database, there are two sources of prices and rents on the same properties. The first are investment properties that are listed in MLS. The second are properties listed for rent in MLS, with a corresponding sale transaction in the property records.

3.1.1 Multiple Listing Service

The CoreLogic MLS data comes directly from participating regional boards of realtors, who contribute their data to a centralized database. As of February 2014, over 90 boards participated, providing coverage for approximately 56 percent of all active listings nationwide. On average, CoreLogic has 10 years of history for these boards and it has more than 20 years of data in select markets.

This is a rich dataset, containing a wide array of information often included in property listings, including information about the physical characteristics of the property (number of bedrooms, bathrooms, etc.), as well pertinent information such as the expected annual tax bill. This latter information is especially useful, as it allows us to control for property-level tax rates.

The MLS data contain listings for owner-occupied and renter-occupied properties. These listings indicate whether, for what price, and on what date, an actual transaction occurred. Unless otherwise specified, we only use actual transaction prices and dates. For renter-occupied properties, there are rental listings for both individual rental units and sale listings for entire renter-occupied properties targeted to real estate investors. Listings differentiate the type of property: single-family, apartment, condominium, and multi-unit.⁴ For sale

⁴We drop any properties with missing property type or parcel number information.

listings of renter-occupied investment properties, the listings generally include information on both the rental income and net income generated by the property, so we can directly observe both their list and sale prices, as well as property income.⁵ The majority of properties listed for sale as investments with associated rental income are multi-unit properties. Therefore, we restrict this sample to multi-unit properties.

Our second source of property-level data on prices and rents comes from rental listings in the MLS data. These rental listings contains information on property-level rent, which we merge with sales transactions from the public records. This is described in more detail below.

3.1.2 Public Records

The public records data contain information on deeds reflecting legal transfers of property and mortgage liens recorded on properties. Any time a person sells or purchases a home, that transaction is recorded in the public records, whether or not the person purchased the home using a mortgage. A separate transaction is entered into the records if the buyer used a mortgage to make the purchase. Any new lien on a property, such as a home equity loan or a refinance, is also recorded in the public records.

We have all public records data collected by CoreLogic from 2000 to 2014. However, CoreLogic does not have data from all municipalities and, due to differences in recording procedures and technology, data for different municipalities begins at different points in time.

We merge rental listings from the MLS data to sale transactions in the public records data using a unique identifier to identify properties that are rented, and sold within a limited time frame (one year). This gives us a measure of both the rent and price on the same property from which we can calculate a price-rent ratio. This merged sample contains more single-family homes and has better information about property characteristics since we have information from both the assessor in the deeds table and the rental listing in MLS. We did not find any significant differences in sale prices and rental rates between properties for which we did and did not find a match.

The combination of information on investment properties from MLS and the matched sale and rent information from MLS and the public records gives us a substantial sample of single family homes, condos, and multi-unit buildings. We remove all non-arms length transactions. We also supplement missing information on square footage and property tax amounts using information collected by CoreLogic from tax assessors.

⁵The distinction between net income (or net operating income (NOI) and rental income is usually that the net income is rental income less property operating expenses. We do not know if these values are expected values or based on past experience. Additionally, for some properties we only have rental income *or* net income, and in other cases the rental and net incomes are equal. We do not have information to clarify distinctions between these cases in our data.

3.2 Morningstar Commercial Real Estate MBS and Costar Group

We use commercial mortgage-backed securities (CMBS) data from Morningstar LLC. These data include information on every commercial real estate loan in publicly-issued CMBS deals and property-level information on the collateral underlying those loans. These data have been collected monthly since the mid-1990s.⁶ Along with other information, the property-level characteristics include the property street address and the property-level NOI (which reflects the rental income less property operating expense, as described above). The NOI for each property is updated on a semi-regular basis.

We limit our sample to multifamily properties and remove any properties identified as mixed-use, since those may have different price-rent ratios than purely residential properties. Any properties marked as student housing, military housing, or cooperatives⁷ are also removed from our data sample.

While Morningstar includes detailed information on property-level rental income, it does not identify loans originated for the purpose of purchasing a property as opposed to a refinance. Valuations of properties for refinances will be based on appraisals, and will not necessarily reflect the market value of the property. To identify property transactions, we merge the Morningstar CMBS property-level data with multifamily sale transaction data from the CoStar Group using property addresses.

CoStar collects and analyzes data on all types of commercial real estate sale transactions and leases; and we focus on multifamily properties. CoStar’s data goes back to 1980 and includes detailed property characteristics.⁸ However, only a small percentage of sale transactions in CoStar have information on rents or NOI. Again, we remove any non-arms length transactions and any properties labeled as student housing, subsidized housing, senior living, or mobile home parks.⁹

The combination of the Morningstar and CoStar data give us the dates of sale transactions, sale prices from Costar, and NOI over time from Morningstar. We take the NOI from Morningstar that is both closest to—and no more than—a year before or after the sale transaction date in CoStar. The ratio of the sale price and the nearest NOI give us an analog to our earlier same-property price-rent ratios.

⁶ Morningstar pulls the information from the Commercial Real Estate Finance Council Investor Reporting Package (CREFC IRP), which standardizes the information provided by loan servicers to the trustees of CMBS pools. See <http://www.crefc.org/irp>.

⁷ Cooperative buildings are multifamily buildings where multiple people (usually the residents) own a stake in the ownership of the entire building. This is distinct from condominium buildings where property owners own a single unit. It is not clear what NOI for these properties is reflecting, so we remove them.

⁸ CoStar collects this information in a variety of ways, including the public records, property listings on their website and others, and contacts with property owners.

⁹ Table A.5 in the appendix contains a comparison of properties in CoStar for which we could and could not find a match in the Morningstar CMBS data. As expected, the properties for which we found a match are significantly larger than the average in the entire CoStar sample.

4 Decomposing the Price-Rent Ratio

There are insights to be gained from a price-rent ratio created from given prices on owner-occupied properties and rents on renter-occupied properties. To see this, note that such a price-rent ratio can be rearranged and decomposed in the following way:

$$\text{price}_o \equiv \frac{\text{price}_o}{\text{price}_r} \cdot \frac{\text{price}_r}{\text{rent}_r} \cdot \text{rent}_r \quad (1)$$

where price_o is the price of owner-occupied housing, and price_r and rent_r are the price and rent of renter-occupied housing respectively.

This equation implies that an increase in house prices could reflect an increase in (1) the ratio of the price of owner-occupied housing relative to the price of renter-occupied housing (which we will refer to as the price-price ratio); (2) the price-rent ratio in the renter-occupied market; or (3) rent on renter-occupied properties. Each of these three components is directly observable and does not require having prices and rents on the same properties.

Which of these components makes the most significant contribution to house price growth in the early 2000s has implications for different theories of what drives house prices, and is especially relevant for understanding the origins of the 2000s housing boom.

For example, suppose that there is no ability to substitute between owner- and renter-occupied housing: that they are completely separate markets. Then a relaxation in credit constraints in the owner-occupied market will have no impact on rents or prices of renter-occupied housing.¹⁰ Therefore, the second and third term would be unchanged and any increase in prices would be reflected largely in an increase in the price of owner-occupied housing relative to the price of renter-occupied housing. On the other hand, if house prices are growing because households expect rents (both implicit rents on owner-occupied housing and observable rents on renter-occupied) in the future to rise, then the increase in house prices would largely reflect an increase in (2): an increase in the price-rent ratio on renter-occupied property.

We empirically test how much each component of the decomposition contributed to the rise and fall in prices during the 2000s housing boom, we estimate the relative growth of prices of owner-occupied housing, prices of renter-occupied housing, and rents on renter-occupied housing. To do this we follow the literature on repeat-sale price indices to control for individual unobservable property characteristics. Repeat sale indices rely on the assumption that individual property characteristics are constant over time. This assumption allows us to write the difference in the price or rent of a property at time t_2 and the sale price or rent

¹⁰This would, of course, be different if credit constraints were relaxed in both the owner-occupied and rental market. However, we follow the vast literature on this topic, and assume a relaxation of constraints solely in the owner-occupied market.

of the same property at time t_1 , where $t_2 > t_1$, as the sum of the change in the corresponding index between the two transactions:

$$p_{it} = \alpha_i + \sum_{-\infty}^t \phi_t \Rightarrow p_i(t_2) - p_i(t_1) = \sum_{t_1+1}^{t_2} \phi_t.$$

Relying on this relationship, we run the following regression:

$$p_i(t_2) - p_i(t_1) = \sum_{t_1+1}^{t_2} \phi_t + \sum_{t_1+1}^{t_2} \phi_t^{\text{own}} \times \mathbf{I}(p_o) + \sum_{t_1+1}^{t_2} \phi_t^{\text{rent}} \times \mathbf{I}(\text{rent}) + \sum_I \text{CBSA}_i. \quad (2)$$

The left-hand-side variable is the log change in the sale price (for owner-occupied and renter-occupied properties) or rent (for renter-occupied properties) between two different transactions. The ϕ_t are year dummy variables, which are equal to one for $t_1 + 1$, t_2 , and every year between $t_1 + 1$ and t_2 . It also controls for both observed and unobserved property characteristics. In addition, we include CBSA fixed effects. The omitted property category on the right-hand side is the price of renter-occupied housing; The values of ϕ_t^{own} and ϕ_t^{rent} are relative to the price of renter-occupied housing.

Not only does this regression allow us to decompose changes in owner-occupied house prices, but it also provides a way to test for substitutability between renter- and owner-occupied housing. If these two housing stocks are perfect substitutes, then the relative price of owner-occupied housing would be equal to one ($\phi_t^{\text{own}} = 1$ for all t).

The coefficients on the rent and prices of owner-occupied properties also provide a way to test for different theories of what has driven house prices. If there is no substitutability between owner- and renter-occupied housing, then a relaxation on credit constraints for owner-occupied housing is the main driver of house prices, then $\phi_t^{\text{own}} > 0$ and $\phi_t^{\text{rent}} = 0$. This is because as credit constraints are relaxed, demand for owner-occupied housing increases relative to renter-occupied housing, so there should be a greater positive change in the price index for owner-occupied properties relative to renter-occupied properties. Since neither prices nor rents of renter-occupied properties are affected, the price-rent ratio for renter-occupied housing remains stable. On the other hand, if the owner- and renter-occupied markets are perfect substitutes then a relaxation of credit constraints should not only affect the prices of both owner- and renter-occupied properties, but since a relaxation of constraints results in an immediate increase in demand for housing, it should also affect rents. In either scenario, an increase in the price-rent ratio is inconsistent with a relaxation of credit constraints.

Alternatively, if optimistic beliefs about future rents (and subsequently prices) were the main driver of the housing boom, $\phi_t^{\text{own}} = 0$ and $\phi_t^{\text{rent}} < 0$ for all t . This is because beliefs

about land prices and/or population growth affect prices about both owner-occupied and renter-occupied housing, but the current spot-price of housing—the rent—is unaffected.

We estimate this regression using our full sample of rents and prices from all of our data sources: CoreLogic, CoStar, and Morningstar. Rents come from MLS rental listings in CoreLogic and NOI values in Morningstar. Prices of owner-occupied properties come from for-sale listings of single-family houses and condo units in CoreLogic, where we have removed any properties for which we observe a rental listing at any point in our sample. Prices of renter-occupied properties come from properties in CoreLogic for which we observe a rental listing and from sale transactions in CoStar.

Figure 1 contains plots of ϕ_t^{rent} and ϕ_t^{own} . Given the patterns in the price-rent ratio we established in Section 5, it is unsurprising that we find that rents on renter-occupied properties grew less than price on renter-occupied properties during the 2000s housing boom, and then grew faster than prices during the bust; this is equivalent to an increase in the price-rent ratio.

What is less expected is that prices on owner-occupied properties display the same, (although substantially less pronounced) pattern. In other words, prices on owner-occupied properties grew and fell less than prices on renter-occupied properties. This is the opposite of what was expected if there had been a relaxation in credit constraints in the owner-occupied market.

To visualize each component of the decomposition described in Equation 1, we use the implied repeat-transaction indices from our estimation of Equation 2.¹¹ Since the indices are in logs, we then take the difference between the indices to capture each of the three components of variation in owner-occupied house prices. The result is depicted in Figure 4. It is apparent from Figure 4 that the largest component of the variation in owner-occupied house prices is the price-rent ratio on renter-occupied housing. Rents did increase between 2000 and 2006, but at a substantially lower rate than prices. The price-rent ratio mirrors the price index of owner-occupied housing so closely because the price of renter-occupied housing grew more than the price of owner-occupied housing, as depicted by the negative price-price ratio.

5 Comparison of Prices and Rents on the Same Properties

¹¹The ϕ_t^{own} capture the change in price index of owner-occupied properties relative to the change in the price of renter-occupied properties. The changes in the price index of renter-occupied properties are captured by the year fixed effects. Therefore, the repeat sale index in year t is the cumulative sum of the ϕ_t^{own} and year fixed effects up until year t . The calculation of the rent index for renter-occupied properties is calculated similarly.

In this section, we estimate price-rent ratios using our dataset of prices and rents on the same properties. Similar to the price-rent ratios discussed in the introduction, the price-rent ratio calculated in Section 4 is a ratio of indices, where the indices are calculated on two overlapping, but not identical, property samples. The advantage of looking at prices and rents on the same properties is that it lines up very closely with the theoretical concepts: the rent we use for our analysis is the rent used by the buyer of the property to value it. The disadvantage is that the sample of properties is a subset of the properties for which we have either rental income data or sales transactions data.

We use our property-level price-rent ratios to directly calculate price-rent ratio indices. The smaller data sample precludes the calculation of a price-rent ratio index using repeat transactions. Instead, to address potential selection issues, we calculate price-rent indices using a hedonic method in which the main hedonic variables are the specific geographic location of each property.¹² We make use of the exact latitude and longitude of the property. We draw a grid over each CBSA in our sample. The hedonics for each property are then the distance to the four nearest grid points, the square footage of the property, and the natural log of the distance of the property from that CBSA's central business district (CBD). The antilog of the coefficients on year dummies are the index. Details of the hedonic method used are described in Section A.3. We calculate this index separately for different property types—single family homes, condos, smaller multi-family homes, and large residential commercial real estate properties—and across different states.

We find that the price-rent ratios evolve similarly across property types, but grow at substantially different rates in different states. The results depicted in Figure 5. The similar path of the price-rent ratios across property types is striking, especially given that there are some differences in the calculation of the ratio for different property types. For example, the single-family homes category are properties for which we identified a closed rental listing in MLS and matched it to a sale in the deeds data. Therefore, the price-rent ratio for single family homes represents the ratio for new tenants. In contrast, the income information for the larger residential CRE properties may represent both new and continuing tenants and therefore may be discounted from the market value. It is possible that these differences could result price-rent ratio growing at different rates, but that does not appear to be the case.

There is considerable variation in how the price-rent ratio evolved in different states across the US. California, Nevada, and Florida, which had especially large housing booms in the early-mid 2000s, experienced large increases and subsequent decline in their price-rent ratio. On the other hand, states such as Ohio and New York saw little increase in their price-rent ratios during the 2000s, and even saw their price-rent ratios decline below its 2000

¹²In our data, detailed property characteristics are not described consistently and most are missing for a substantial number of observations (see the data appendix for more details).

value during the Great Recession.

Michigan is an interesting example. Its price-rent ratio fell throughout the 2000s, first more slowly and then at an increasing rate during the Great Recession. During the current expansion, the price-rent ratio has increased again, but only slightly. It has not exceeded its value in 2007.

This variation in the growth of price-rent ratios across geography illustrate what the price-rent ratio is capturing: expectations. When rents in the future are expected to rise relative to the price of other goods, then the price of housing rises relative to current rents. One possible driver of higher future rents is an expected increase in population growth (a hypothesis we explore in more detail in the Section 7). However, there is little reason to expect the population growth of certain states—such as Ohio and Michigan, both of which were impacted by the decline in manufacturing employment in the 1990s and 2000s—to increase. Therefore it is not surprising that the price-rent ratios in these two states did not increase. In this context, the decline in the price-rent ratio in Michigan reflects expectations that population growth in the state would decline.

We conclude this section with an exercise that illustrates the potential importance of considering prices and rents on the same properties. A measurement issue with property prices is that they are only observed when properties transact. Rents, on the other hand, can, at least in theory, be observed continuously. Using price and rent indices calculated on two different groups of properties can lead to mismeasurement if changes in prices are driven by properties that sell while changes in rents are driven by those that do not.

To explore this issue, we run a repeat transaction regression similar to Equation 2 in Section 4. However, we divide up the sample of rents into properties which observe a transaction anytime between 2000 and 2018 and those for which we do not. We then compute two price-rent ratios. Both have a repeat sale index of renter-occupied properties in the numerator (all of these properties—by definition—have sold). The values in the denominator are the repeat rent indices for sold and unsold rental properties. The results are depicted in Figure 6, with the same repeat sale index of owner-occupied properties from Figure 4 for comparison. The rents of properties that transacted during the 2000s housing boom grew more than the rents of unsold properties. This implies that the price-rent ratio using rents of properties that transacted grew less than the price-rent ratio using only rents of unsold properties. There are multiple reasons why rents on transacted properties grew more. We include CBSA fixed effects in our repeat sale regression, so it is not due to across CBSA variation in rent growth, but it could be because of within-CBSA geographic variation in rent growth. Alternatively, it could be because properties that are sold are more likely to be renovated, and consequently command higher rents post sale. Whatever the reason for the different growth rates in rents, this exercise illustrates the difficulty in estimating price-rent

ratios using data on prices and rents from that do not come from the same properties.

6 Continuous time model

We consider a continuous-time, non-stochastic model of an economy with two goods: consumption and housing. The housing stock is fixed (there is no construction) and does not depreciate. One can think of housing in our model as land. There are three types of households: owners, renters and investors. Each household, regardless of type, consists of $N(t) = e^{nt}$ members.

Homeowners and renters maximize:

$$\max_{\{c(t), h(t)\}_{t=0}^{\infty}} \int_{t=0}^{\infty} e^{-\rho t} N(t) \log (c(t)^{1-\theta_i} (h(t)/N(t))^{\theta_i}) dt, \quad (3)$$

where $c(t)$ is consumption and $h(t)$ is housing. The discount rate, ρ , is common across all households. Members of owner and renter households receive either high or low labor income (y), which grows at the common rate g . There is no within-households variation in income, so henceforth we refer to low- and high-income households with incomes Ny_1 and Ny_2 respectively. The weight on housing, θ , is a function of income where $\theta(y_i) = \theta_i$. Specifically, low-income households have a higher utility-weight on housing. We justify the negative correlation between θ and y by pointing to a long literature on the link between budget shares on housing and income (see Federal Housing Administration (1947) and, more recently, Albouy, Ehrlich, and Liu (2016)).

Owners allocate their flow income to saving, consumption and net additions $x_o(t)$ to their stock of housing at unit price $p_o(t)$, the price of owner-occupied housing. There is a single financial asset which pays endogenous interest rate $r(t)$ meaning that homeowner financial wealth evolves according to:

$$\dot{a}(t) = N(t)y(t) + r(t)a(t) - N(t)c(t) - p_o(t)x_o(t),$$

and their holdings of housing evolve according to,

$$\dot{h}(t) = x_h(t).$$

In addition, owners face what we call a “spending constraint”, a limit on how much income an owner can devote to housing:

$$p_o \cdot h = \frac{\bar{\theta}_o}{(r - \dot{p}_o/p_o)} Ny. \quad (4)$$

The weight on housing is set so that $\theta_1 > \phi(\rho - n)/(\rho + g) > \theta_2$. Therefore, in equilibrium, low-income households are constrained and high-income households are not. We view the spending constraint as a reduced form for the limits imposed by credit availability. A key feature of equation (4) is that increases in price growth expectations relax the constraint. Two facts motivate this modeling choice. First, there is direct evidence that lenders took price expectations into account when setting credit standards: all else equal, higher price growth expectations reduce the likelihood of default.¹³ Second, Foote, Loewenstein, and Willen (2016) argue that a constraint in the level of house spending or the interest payments on house spending lead to counterfactual shifts in the cross-sectional distribution of housing when expectations or interest rates change.

Renters allocate their flow income to consumption, rent and savings, so their wealth evolves according to:

$$\dot{a}(t) = N(t)y(t) + r(t)a(t) - N(t)c(t) - \text{rent}(t)h(t).$$

Renters also face a spending constraint:

$$\text{rent} \cdot h = \bar{\theta}_r Ny.$$

Similar to owners, low-income renters are constrained while high-income renters are not.

Investors derive utility from only consumption ($\theta = 0$). Their income growth, the discount rate and population growth is identical to residents. Investors buy rental properties at price $p_r(t)$, rent them to renters at $\text{rent}(t)$, and can also invest in the riskless asset at rate $r(t)$. Investor wealth evolves according to

$$\dot{a}(t) = N(t)y(t) + \text{rent}(t)h_r(t) + r(t)a(t) - N(t)c(t) - p_r(t)x_r(t), \quad (5)$$

and their holdings of housing evolve according to,

$$\dot{h}(t) = x_r(t). \quad (6)$$

In our base case, we assume that the renter-occupied and owner-occupied markets are segmented: renter-occupied housing cannot be converted into owner-occupied and vice versa; and renters cannot switch to owning and vice versa. We assume that investors are initially endowed with the entire stock of both renter- and owner-occupied housing, which we denote as \bar{h}_r and \bar{h}_o respectively, with associated prices per unit p_o and p_r .

¹³See Gerardi et al. (2008)

Consumption growth for all households in the model is:

$$\frac{\dot{c}}{c} = g = r - \rho. \quad (7)$$

As utility is Cobb Douglas, both unconstrained renters and owners allocate a constant fraction of their income to housing. For renters this means that:

$$h_{r,\text{Unc}} = \frac{\theta Ny}{\text{rent}}.$$

For owners, the relevant price for allocation of income is not the price of purchasing housing, but the user cost. Therefore, unconstrained owner demand is:

$$h_{o,\text{Unc}} = \frac{\theta Ny}{p_o \cdot (r - \dot{p}_o/p_o)}.$$

For constrained renters and owners the constraints determine spending:

$$h_{r,\text{Con}} = \frac{\bar{\theta}_r Ny}{\text{rent}},$$

$$h_{o,\text{Con}} = \frac{\bar{\theta}_o Ny}{p_o \cdot (r - \dot{p}_o/p_o)}.$$

For investors, the flow return on investing in housing equals rent plus any capital gains. Absence of arbitrage therefore implies:

$$\text{rent} = p_r \left(r - \frac{\dot{p}_r}{p_r} \right). \quad (8)$$

In any equilibrium, investors will be indifferent between investing in the riskless asset or in housing.

In equilibrium, along the balanced growth path,

$$r = \rho + g, \quad \dot{p}_r/p_r = \dot{p}_o/p_o = g + n \quad \text{and} \quad r - \dot{p}_r/p_r = r - \dot{p}_o/p_o = \rho - n. \quad (9)$$

If we assume that there α_o share of constrained owners, then market clearing implies that the price of owner occupied housing is:

$$p_o = ((1 - \alpha_o)\theta + \alpha_o\bar{\theta}_o) \frac{Ny}{(r - \dot{p}_o/p_o) \bar{h}_o} = \frac{1}{\rho - n} ((1 - \alpha_o)\theta + \alpha_o\bar{\theta}_o) \frac{Ny}{\bar{h}_o}, \quad (10)$$

and that rent is:

$$\text{rent} = ((1 - \alpha_r)\theta + \alpha_r\bar{\theta}_r) \frac{Ny}{\bar{h}_r}. \quad (11)$$

From equations 8 and (9), the equilibrium price of renter occupied real estate is:

$$p_r = \frac{\text{rent}}{(r - \dot{p}_r/p_r)} = \frac{\text{rent}}{\rho - n} \quad (12)$$

Using equations (12) and (10), we can now assess the how elements of the model affect the components of the decomposition of the price of owner-occupied housing we initially described in Section 4:

$$\begin{aligned} p_o &= \text{rent} \cdot \frac{p_o}{p_r} \cdot \frac{p_r}{\text{rent}} \\ &= \text{rent} \cdot \frac{((1 - \alpha_o)\theta + \alpha\bar{\theta}_o) \frac{Ny}{h}}{\text{rent}} \cdot \frac{1}{\rho - n} \end{aligned} \quad (13)$$

According to equation (13), a shock to beliefs (n) or discount rates (ρ) will only affect the ratio of the price of renter-occupied housing relative to rent, while a shock to credit availability (θ_o) will affect the ratio of the price of owner-occupied housing to the price of renter-occupied housing.

It is worth noting that in this model the price-rent ratio is a function of population growth and the subjective discount factor, not interest rates per se. An increase in r has no effect on the price-rent ratio because an increase in r is exactly offset by an increase in g , the growth rate of income (and therefore prices), as can be seen in Equation (7). This implies that just as in standard asset pricing models, a shock to income growth (a shock to g) has no effect on the price-rent ratio because it is exactly offset by an increase in interest rates. An increase in population growth affects the price-rent ratio because it increases future rents *relative* to the price of other goods.

7 Determinants of the Price-Rent Ratio

To be completed.

8 Conclusion

To be completed.

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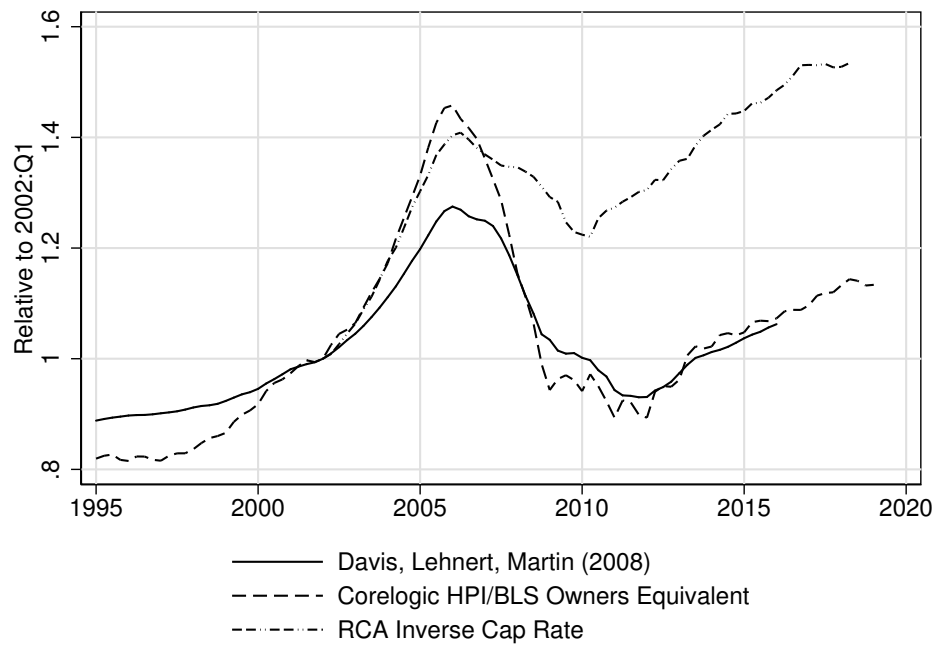


Figure 1. PRICE-TO-RENT RATIOS. *Note:* Different measures of the price-rent ratio. The series from Davis, Lehnert, and Martin (2008) and the ratio of Corelogic HPI to BLS owners equivalent rent are for owner-occupied housing. The series from RCA is an unweighted average of cap rates on large renter-occupied properties. *Source:* Davis, Lehnert, and Martin (2008), CoreLogic, BLS, and RCA Analytics.

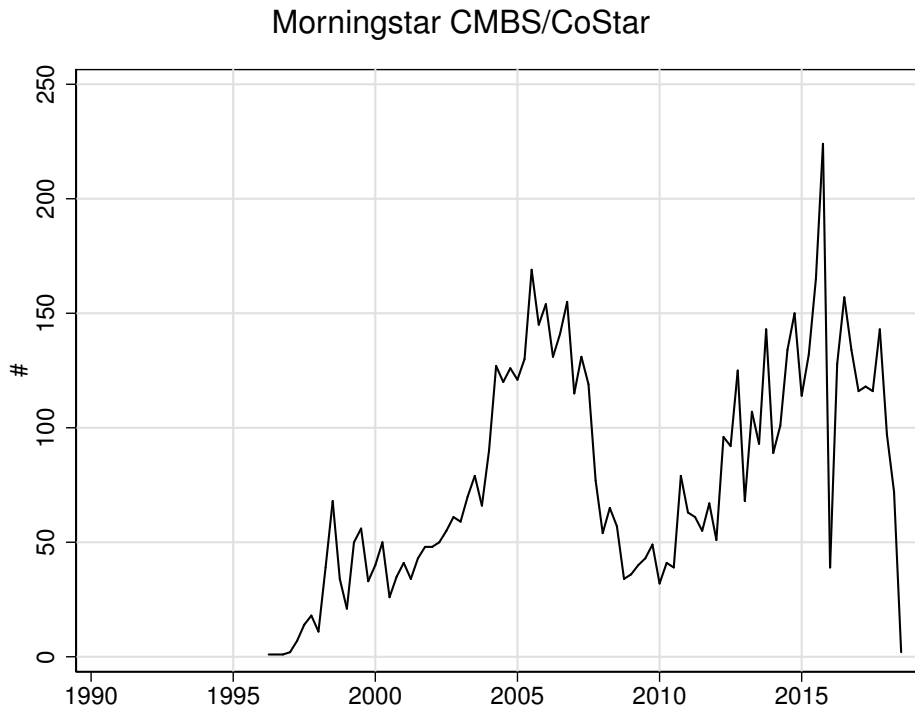
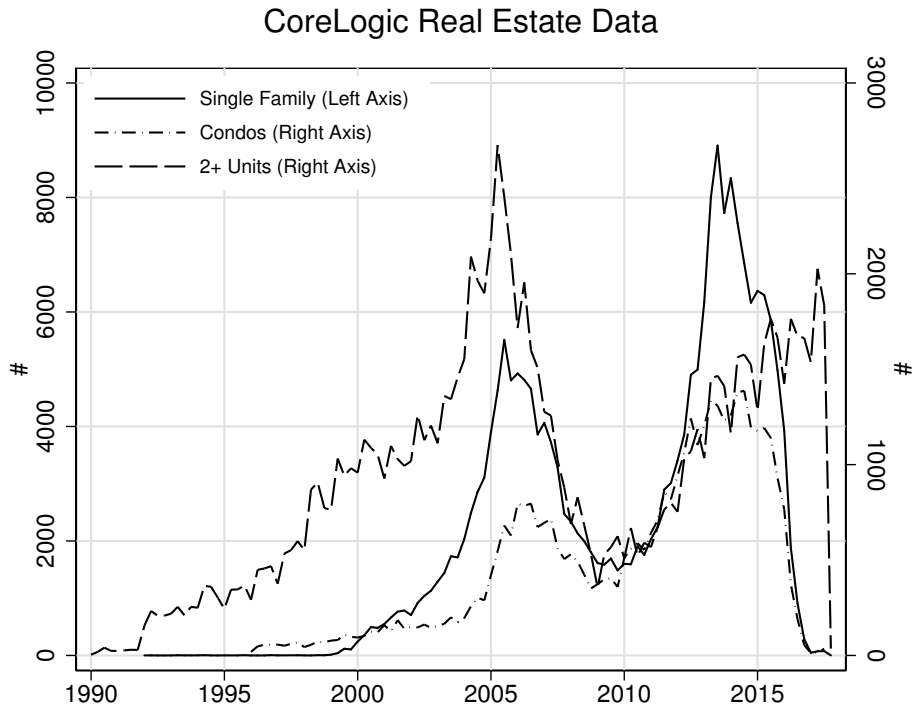


Figure 2. NUMBER OF OBSERVATIONS OVER TIME. *Note:* Each observation represents one concurrent measure of price and rent on the same property. *Source:* CoreLogic Real Estate database, Morningstar CMBS, CoStar.

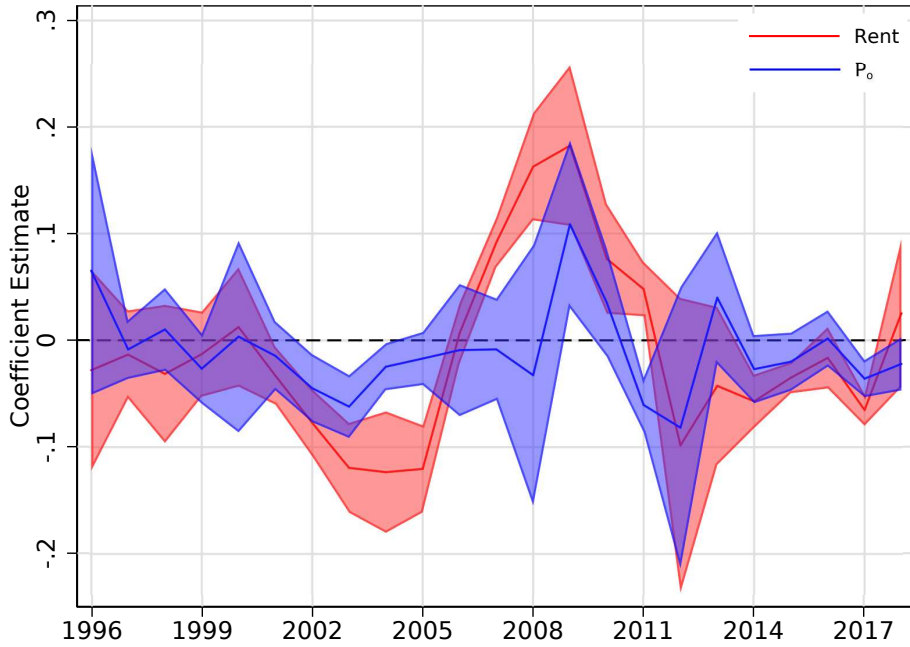


Figure 3. RELATIVE PRICES OF OWNER-OCCUPIED PROPERTIES AND RENTS. *Note:* These are plots of the regression coefficients ϕ_t^{rent} and ϕ_t^{own} from Equation 2. The values are relative to prices of renter-occupied properties. *Source:* CoreLogic Real Estate Database.

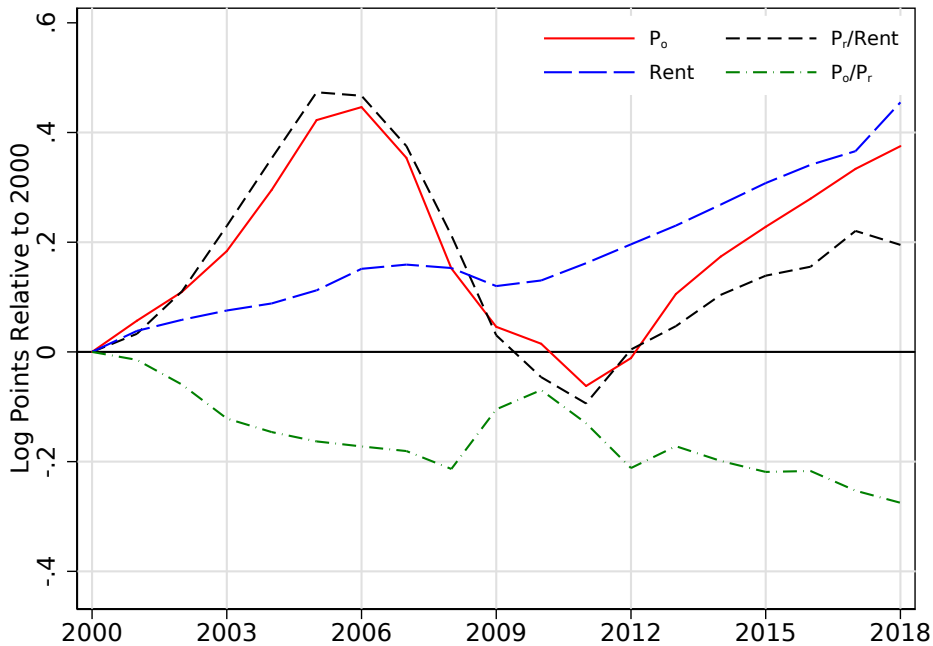


Figure 4. DECOMPOSING CHANGES IN HOUSE PRICES. *Note:* These are repeat-transaction indices, and a price-rent ratio based on the ratio of these indices, based on Equation 2. *Source:* CoreLogic Real Estate Database.

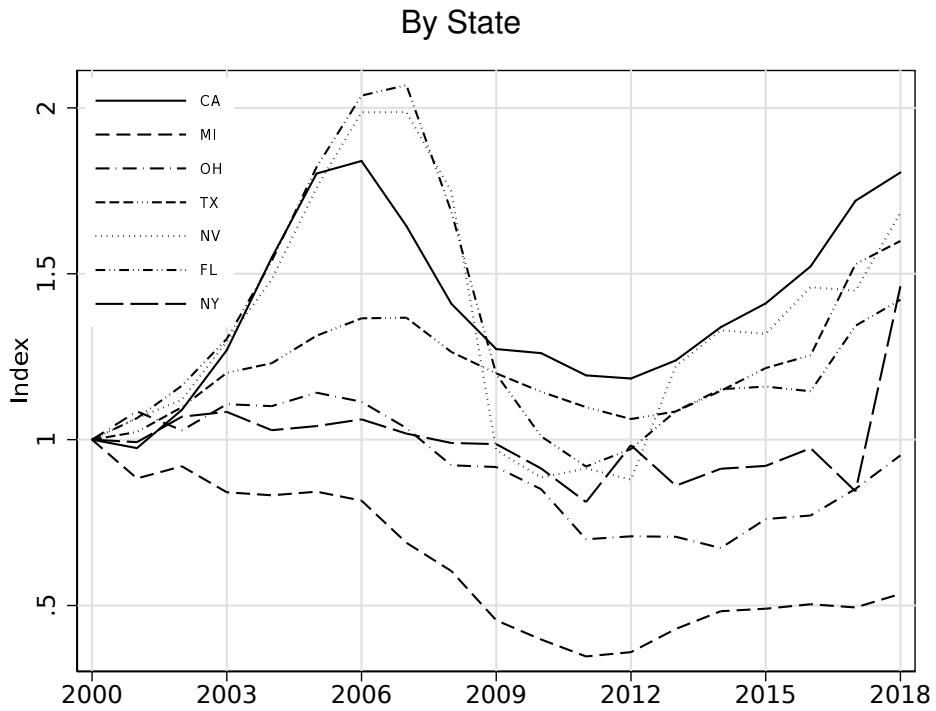
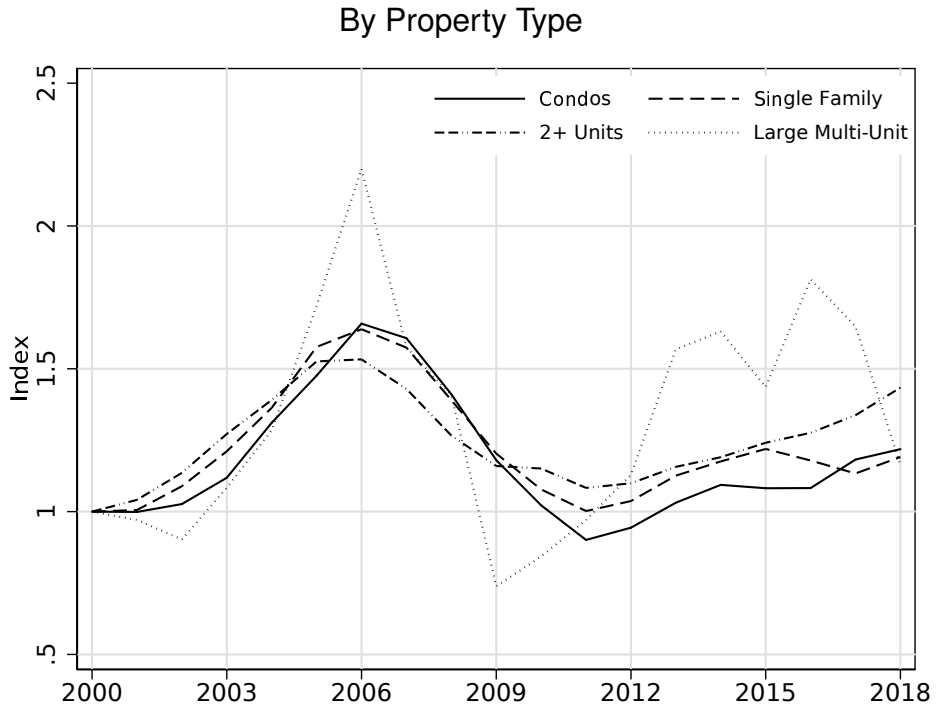


Figure 5. PRICE-RENT RATIOS BY PROPERTY TYPE AND STATE. *Note:* Indices are derived from a hedonic index of property size, and geographic location. *Source:* CoreLogic Real Estate Database; CoStar; Morningstar CMBS.

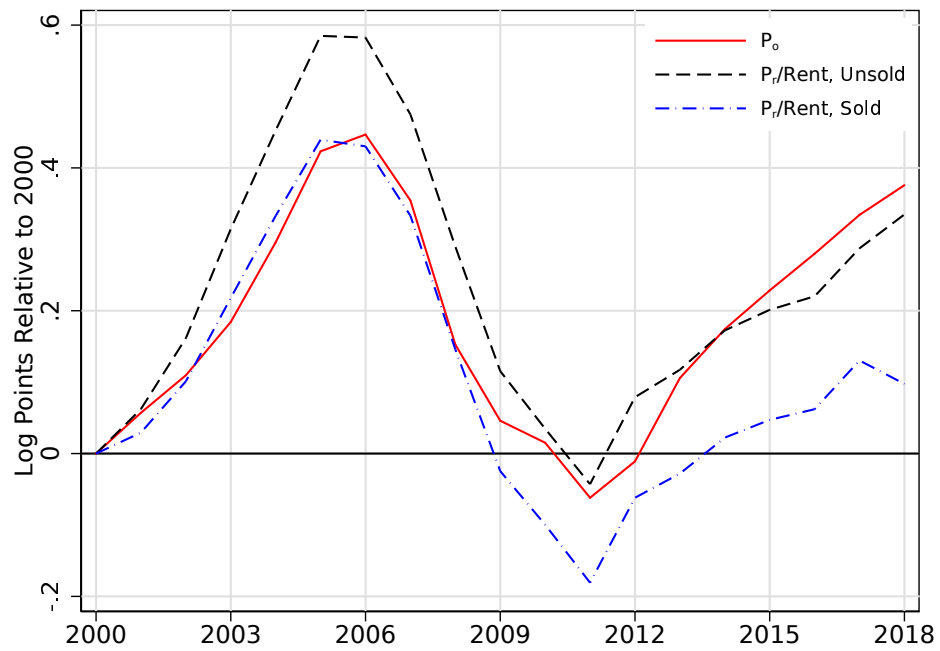


Figure 6. COMPARING RENT GROWTH ON PROPERTIES THAT DID AND DID NOT TRANSACT. *Note:* *Source:* CoreLogic Real Estate Database; CoStar; Morningstar CMBS.

A Appendix

A.1 Data

In this section we provide additional details about our data.

Table A.1 contains summary statistics of a 10 percent sample of sales in the MLS dataset.

Table A.2 contains summary statistics of all rental listings in MLS. These are the properties for which we attempt to find sale deeds within one year of the rental transaction.

Summary statistics of the entire CoStar multi-family dataset are provided in Table A.4.

We conduct a similar exercise as above for the CoStar/Morningstar matched sample. In Table A.5 we compare sale transactions for which we are and are not able to match to a corresponding observation of net operating income in the CMBS database. The universe of properties in CoStar is substantially broader than the universe of properties underlying CMBS, so we expect there to be dramatic differences between the matched and unmatched samples in CoStar. As expected, the median sale price from the matched sample is almost \$9 million, while, the median sale price in the unmatched CoStar sample is under \$1 million. We do not expect as big of a difference between the matched and unmatched properties in the CMBS database. However, we do see that the matched properties have somewhat higher value and net operating income than the unmatched sample.

A.2 Construction of Weighted, Repeat-Sale House and Rent Price Indexes

We follow the methodology described in Gerardi, Shapiro, and Willen (2007). The house price or annual rental rate of household i at time t is given by the following process:

$$\ln P_{it} = \ln \bar{P}_t + \mu_{it} + \eta_{it}$$

where \bar{P}_t is the house price level or annual rental rate of the CBSA, η_{it} is white noise, and μ_{it} is a Gaussian random walk with mean equal to zero, $E[\mu_{i,t+k} - \mu_{it}] = 0$, and variance proportional to the distance in transactions on the same property, $E[\mu_{i,t+k} - \mu_{it}]^2 = k\sigma_1^2 + k^2\sigma_1^2$.

The index is calculated using a three-stage process on paired sales of properties of different types (single-family, multi-family, apartments, etc.). In the first stage, the log price of a second sale minus the log price of the first sale is regressed on a set of time dummy variables, D_t :

$$\dot{p}_t = \sum_{t=1}^T \beta_t D_t + \omega_i, \tag{14}$$

where $\dot{p}_t = \ln P_{i,t+k}^{2nd} - \ln P_{it}^{1st}$, and the dummy variables have the value +1 for the time of the second sale, and the value -1 for the time of the first sale, and are zero for all other time periods in the data.

In the second stage, the squared residuals, ω_i^2 are regressed on k and k^2 :

$$\omega_i^2 = A + Bk + Ck^2. \quad (15)$$

In the third stage, 14 is estimated by GLS, using $\hat{\omega}_i$ —the square roots of the predicted values of equation 15—as weights.

The house price index is then constructed from the estimates of β_t :

$$P_t^{Index} = 100 * \exp(\beta_t).$$

We compare properties for which have multiple observations to those for which do not. These comparisons are contained in Tables A.6 and A.7 for the Corelogic data, and in Table A.8 for the CoStar and Morningstar CMBS data.

A.3 Construction of CBSA-level Hedonic Indices

Repeat-sales indices require having data on multiple transactions for each property. To make use of our full dataset of prices and rents on the same properties, we estimate CBSA-level price-rent ratio indices using a semi-parametric approach described in Colwell (1998). Our application of this technique closely follows Nichols, Oliner, and Mulhall (2013). This method involves superimposing a grid over each CBSA. Each vertex of the grid is an explanatory variable in the regression, which takes on a different value for each transaction based on the location of the property. For each transaction, we assign values to the four vertices of the rectangle in which the property resides. The values are barycentric weights based on the nearness of the property to each of the vertices and sum to one. For example, if a property is at the center of a rectangle, each vertex is assigned a value of 0.25. All the other vertices are assigned a value of zero for that property.

We allow one grid line both vertically and horizontally for every 1,000 observations. Therefore, in a CBSA with 10,000 observations, we would have 100 vertices. Of course, most CBSAs are not square. Any vertices without any associated properties are dropped from the regression. The minimum amount of grid lines allowed is 4, so each CBSA has at least 16 vertices as potential regressors.

We then run the following regression separately for each CBSA:

$$\ln(X_i) = \alpha_i + \beta_i \ln(\text{Sq. Ft.}) + \sum_k \theta_{k,i} Z_k + \sum_t \gamma_{t,i} D_t + \epsilon_i \quad (16)$$

Where the dependent variable $\ln(X_i)$ is the natural log of the price-rent ratio of a property of type i . The independent variables are the natural log of the square feet of the property, the natural log of the distance of the property from the central business district (CBD) of that CBSA, the location effects, and half-year time dummies. All independent variables are interacted with property type, so this specification is the same as running the regression separately for each property type. The regressions are not weighted.

We limit the regression to properties for which we observe both prices and rents within a given period as described in Section 3 above. The indices are calculated as the exponent of the average of the predicted values for each half-year, assuming all properties are the average size of properties in that CBSA, are multi-unit properties, and are located in the central business district. CBSA-level indices for all property types are created the same way using a version of Equation 16 where the half-year dummies are restricted to be the same for all property types.

A.4 Supplemental Figures

This section contains supplemental figures referenced in the text.

	Mean	Std. Dev.	Median	Min	Max	Count	Pct. Missing
Sale Price (2012 \$)	333,044.71	394,729.52	247,923.39	0.95	67,433,480.00	2,082,535	0.00
List Price (2012 \$)	341,775.31	423,314.54	252,929.69	0.95	81,883,512.00	2,082,535	0.00
Number of Rooms	7.31	80.16	7.00	1.00	71,544.00	798,477	61.66
Number of Bathrooms	2.30	0.96	2.00	0.01	150.00	2,010,109	3.48
Year Built	1978	26	1984	1780	2018	1970302	5
Year Built/Renovated	1998	20	2005	1870	2018	25363	99
Observations	2082539						

Table A.1. SUMMARY STATISTICS: SALES IN MLS *Note:* This is limited to properties listed for sale in MLS in the CBSAs in our sample. *Source:* CoreLogic Real Estate Database.

4

	Mean	Std. Dev.	Median	Min	Max	Count	Pct. Missing
Rental Rate (2012 \$)	18,294.58	94,219.04	1,465.12	48.61	1,257,553.25	3,647,716	0.00
List Price (2012 \$)	18,606.56	97,911.33	1,474.91	0.95	15,312,787.00	3,638,923	0.24
Number of Rooms	6.21	5.00	6.00	1.00	3,780.00	1,294,109	64.52
Number of Bathrooms	2.12	1.34	2.00	0.10	1,452.00	3,548,771	2.71
Year Built	1984	23	1989	1791	2018	3202228	12
Observations	3647716						

Table A.2. SUMMARY STATISTICS: RENTALS IN MLS *Note:* This is limited to properties listed for rent in MLS in the CBSAs in our sample. *Source:* CoreLogic Real Estate Database.

	Single Family			Condos		
	Matched	Unmatched Rentals	Unmatched Owner-Occupied	Matched	Unmatched Rentals	Unmatched Owner-Occupied
Percent of Sample (%)		80	99		79	97
Rental Rate (2012 \$/month)	1,403	1,420		1,445	1,398	
Sale Price (2012 \$)	193,535		204,427	180,431		184,071
Days on Market	37	38	83	42	42	82
Year Built	1996	1993	1983	1991	1988	1985

Table A.3. COMPARING MATCHED AND UNMATCHED PROPERTIES. *Note:* Values are medians for properties from 1990–2018. The percent matched is the remainder of the unmatched rental and owner-occupied samples. *Source:* CoreLogic Real Estate Database.

	Mean	Std. Dev.	Median	Min	Max	Count	Pct. Missing
Sale Price (2012 \$)	4,217,839.66	21,727,510.02	923,734.19	0.91	5,933,348,864.00	232,677	4
Sale Price per Sq. Ft. (2012 \$)	2,776.26	487,038.14	95.39	0.01	168,855,536.00	151,316	37
Price/Unit (2012 \$)	102,763.55	213,694.69	78,132.81	3.14	58,416,316.00	149,668	38
Gross Income (2012 \$)	361,368.25	1,579,612.23	101,770.38	1.11	360,187,296.00	96,007	60
Net Income (2012 \$)	248,097.53	3,321,630.28	62,734.92	-1,444,495.50	852,034,688.00	93,810	61
Cap Rate	7.95	2.48	7.69	-15.93	29.89	90,775	62
Building Square Feet	35,892.56	97,961.08	8,122.00	1.00	12,064,341.00	184,275	24
Year Built	1956	28	1962	1696	2020	224923	0.4
Observations	241359						

Table A.4. CoSTAR MULTIFAMILY PROPERTIES SUMMARY STATISTICS.

	CoStar		Morningstar CMBS	
	Matched	Unmatched	Matched	Unmatched
Percent of Sample	5	95	23	77
Sale Price (2012 \$)	8,802,587	863,822	.	.
Value (2012 \$)	.	.	9,235,447	5,724,484
NOI (2012 \$)	.	.	604,991	476,911
Building Square Ft.	115,039	7,910	.	.
Occupancy(%)	.	.	94	95
Year Built	1981	1961	1996	1992

Table A.5. COMPARING MATCHED AND UNMATCHED PROPERTIES. *Note:* Values are medians for properties from 1990–2018. *Source:* CoStar and Morningstar CMBS.

		Single Family Homes				Condos			
		Rentals		Sales		Rentals		Sales	
		Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single
∞	Percent of Sample (%)	70	30	47	53	71	29	49	53
	Rental Rate (2012 \$/month)	1,407	1,510	.	.	1,398	1,406	.	.
	Sale Price (2012 \$)	.	.	247,921	246,079	.	.	215,559	200,116
	Days on Market	37	37	75	80	40	40	73	80
	Year Built	1996	1991	1986	1984	1988	1986	1983	1984

Table A.6. COMPARING PROPERTIES WITH AND WITHOUT REPEAT TRANSACTIONS. *Note:* Values are medians for properties from 1990–2018. *Source:* CoreLogic Real Estate database.

	2-4 Unit Properties		5+ Unit Properties	
	Multiple Sales	Single Sale	Multiple Sales	Single Sale
Percent of Sample (%)	29	71	26	74
Sale Price (2012 \$)	189,765	175,863	231,846	216,695
NOI (2012 \$)	17,009	14,432	19,681	17,791
Days on Market	90	94	103	111
Year Built	1945	1940	1933	1936

Table A.7. COMPARING INCOME PROPERTIES WITH AND WITHOUT REPEAT TRANSACTIONS. *Note:* Values are medians for properties from 1990-2018. *Source:* CoreLogic Real Estate database.

	CoStar		Morningstar CMBS	
	Properties with...			
	Multiple Sales	Single Sale	Multiple Obs.	Single Obs.
Percent of Sample	17	83	93	7
Sale Price (2012 \$)	3,090,837	681,777	.	.
Value (2012 \$)	.	.	5,824,420	2,067,782
NOI (2012 \$)	.	.	452,790	344,156
Building Square Ft.	31,920	6,984	.	.
Occupancy(%)	.	.	95	95
Year Built	1970	1961	1994	1987

Table A.8. COMPARING PROPERTIES WITH AND WITHOUT REPEAT TRANSACTIONS. *Note:* Values are medians for properties from 1990–2018. *Source:* CoStar and Morningstar CMBS.