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Is There a Stationary Home Price-Rent Relationship in US Housing Markets?

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Abstract

Asset pricing models imply there should be a stationary relationship between house prices and rent. Several previous studies for the U.S. examine this hypothesis by testing for stationarity in the ratio of home values to rents, and fail to reject nonstationarity. However, this method implicitly tests for both a unit root and a particular cointegrating relationship. In addition, most previous studies employ an index for home prices in such tests, which of course entails issues such as representativeness of the housing transactions included and coverage of a particular housing market. In this paper, we employ the actual median dollar price of houses sold in four regional U.S. housing markets, and divide by the rent of primary residence index-, essentially "deflating" house prices by rents. We do, as previous studies have, test for unit roots in the ratio of prices to rents, but we also test for cointegration between the two to avoid imposing a particular cointegrating relationship. The results indicate clear stationarity in the price/rent relationship for three of the four regions, with findings for the West region mixed. In addition, there are positive linear trends for the ratio of house prices to rents, so while prices and rents are together (trend) stationary, the relationship has changed over time, similar to the long term increase in the price/earnings ratio for equities. Finally, for error correction, we find that rents typically respond to disequilibrium, whereas home prices usually do not, which is contrary to some previous findings that have used different data or examined markets subject to rent control.

JEL Codes: R30, R31, G12.

Keywords: General real estate markets, Housing supply and markets, Asset pricing, House prices, Rents.

Introduction

Bubbles in housing are obviously costly for investors, lenders and homeowners once a crash occurs. They also harm the overall economy as (erroneously high) home values lead to a misallocation of resources. Housing bubbles can make the business cycle more volatile. Similarly, Claessens, Kose and Terrones (2012) find that recessions in the wake of a decrease in housing price are harsher and longer than other recessions.

There have thus been a number of studies on how housing is tied to fundamental determinants, with the purpose of discerning how far home values may be straying away from these determinants into bubble territories. Some papers have specified theoretical asset pricing models showing that, as rents are the explicit or implicit cash flow generated by housing, rents are the key fundamental for housing, and house prices and rents should have a stationary relationship (Mekhid and Zemcik (2009)). If prices and rents do not appear to have a stationary relationship, or if there are deviations from this stationary relationship, this can be taken as evidence of a bubble. There have accordingly been numerous papers on whether home values and rents have a stationary relationship (Gallin (2008), Mekhid and Zemcik (2009), Ambrose, Eicholtz and Lindenhall (2013), Andre, Gil-Alana and Gupta (2014), Teng, Zheng and Zhu (2020), Phillips and Shi (2023), Hansen, Moller Pederson and Schutte (2024)).

Most of these studies (Gallin (2008) and Ambrose, et al. (2013), with exceptions) test for the stationarity properties of the ratio of house prices to rent. This is somewhat problematic, as a unit root test on a ratio tests for nonstationarity *and* a particular cointegrating vector. Testing for cointegration, which Gallin (2008) does for the U.S. market and Ambrose, et al. (2013) do for the city of Amsterdam, would allow testing for a stationary relationship without imposing this additional, implicit null hypothesis. In addition, when the ratio of house prices to rents is used, we are unable to tell whether prices or rents do most of the adjusting to any disequilibrium (Gallin and Ambrose, et al. find that prices, rather than rents, do most of the adjustment to deviations from a long-run relationship).

Another issue is that all previously cited studies, with the exception of Phillips and Shi (2023) use indices, rather than actual prices, for both home values and rents. Home price (and rent) indices obviously have issues of accuracy, market coverage and representativeness of the houses sold. Phillips and Shi (2023) instead use actual Australian dollar values for house prices and "deflate" these values with indices for rent. These authors do not test for a unit root versus stationary relationship, but rather test the house price/rent ratio for nonstationary versus explosive behavior, so the possibility of a long-run relationship is not investigated.

In this study, we gather data on actual median U.S. dollar values for houses sold in the four census regions of the US (midwest, northeast, south and west). As there is no equivalent "median rent" dollar value available, we employ the rent of primary residence for the four regions. We test for unit roots in the price/rent ratio, as has been done in previous studies. The results clearly show stationary long term relationships in the Midwest and South regions, but ambiguity for the Northeast and West Regions. We also find that the price/rent ratios for the four regions exhibit linear trends. Thus, while at least for some regions, the price/rent relationship tends to be stationary, there has been a steady change in the relationship, just as with the price/earnings relationship for equities. This may be due to greater land costs for houses per resident than for rental units, which can make houses more costly to produce over time (Yao (2021)).

We then test for cointegration so as not to impose a specific cointegrating vector and find a clear, stationary relationship between prices and rents for the Northeast, as well as the Midwest and South, which highlights the importance of allowing for such flexibility instead of just testing for unit roots on a ratio. The cointegration results for the West are ambiguous, depending, as was the case for unit root tests, on the testing procedure employed.

Finally, we investigate the error-correction for the four regions. We find that rents, rather than home prices, do most of the adjustment to any disequilibrium between the two variables. This is the opposite of what Gallin (2008) reported for U.S. aggregate data and Ambrose, et al. (2013) reported for Amsterdam. Ambrose, et al. (2013) noted that for part of their sample, rents were regulated in Amsterdam, and hence could not be adjusted.

This paper proceeds as follows. The next section describes the previous literature. The third section explains our data and methodology. The fourth section describes our results, and the fifth concludes.

Previous Literature

Bubbles of course represent a mispricing of assets and lead to excessive resources entering the housing sector. Banks and investors in housing-related assets such as REITs would also act as indicators of whether a given housing market is in a bubble. In addition, once a bubble collapses, the economy can be dragged into recession. The Great Financial Crisis of 2007-2009 was associated with the worst contraction since the Great Depression of the United States. The relationship between house prices and rents has thus been employed as an indicator of bubbles.

Campbell and Shiller (1987) famously developed a model in which the value of an asset is the present discounted value of expected future cash flows. Applied to equities, this model implies that a firm's stock price and dividends ought to be cointegrated. For housing, Gallin (2008) examines rents and prices in the U.S. market. The author cites another work by Campbell and Shiller (2001) on stock prices and dividends to motivate the investigation of whether there is a stationary relationship between rents and prices in the U.S. He employs quarterly Freddie Mac index data on house prices from 1970-2005, and the tenants' rent component of the consumer price index for rent. He finds prices and rents at the national level do appear to be cointegrated. In addition, in estimating error correction models, the author finds that prices adjust more to disequilibrium than rents do.

Mekhid and Zemcik (2009) motivate their study with a present-value asset-pricing model which implies that house prices and rents should have a stationary relationship. The authors obtain data on house prices for twenty-three U.S. cities from

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the OFHEO (now called the FHFA) database, and use "Rent of Primary Residence" from the Bureau of Labor Statistics with data spanning 1975-2006. The authors first test for a stationary relationship between rents and prices by employing the Pedroni panel cointegration method. However, the authors cannot reject the null of no cointegration between rents and prices. The authors then employ the cross-sectionally augmented Im, Pesaran and Shin (CIPS) panel unit root test on the price-rent ratios for the 23 metro areas. The authors do not reject the null of a unit root in the price-rent series; thus, their results do not indicate a stable long-run relationship between prices and rents.

A different approach to discerning the relationship between house prices and rents was taken by Andre, Gil-Alana and Gupta (2014). These authors investigated prices and rents in OECD countries from 1970-2011. The authors obtain home price indices for sixteen countries and take rent indices from CPI data. The authors test whether the price-rent ratios in these countries exhibit long memory, or fractional integration. The concept of long memory is best understood by starting with the notion that a variable may have a unit root, and needs to be differenced once to become stationary. Alternatively, a variable may be stationary, and need to be differenced "zero" times to have this stationarity property. A variable, however, may exhibit fractional integration, in which it must be differenced more than zero but less than once to be stationary. Andre et al. (2014) find, that in most nations, the price-rent ratio is either nonstationary (must be differenced once for stationarity) or even explosive (it must be differenced more than once for stationarity), again indicating a lack of a stationary long-run relationship between the variables.

One stylized fact about the U.S. housing market in the last several decades is that house prices have become geographically quite dispersed. Yao (2021) develops a model to explain the fact that housing prices across different US regions have become more dispersed than rents. Her model incorporates the fact that apartments consume less land, per resident, than houses do. Tang, Zheng and Zhu (2020) also seek to explain the growth of geographical housing price dispersion, relative to fundamentals (rents) since 1975. The authors obtain data on house prices and rents across cities in the U.S. The authors obtain data on house prices and rents from a dataset created by Van Niewerburgh and Weill (2010). The authors extrapolate the data with the Freddie Mac index (for house prices) and a variety of methods (for rents) into 2017, so dollar values are used for both house prices and rents.

Tang, et al. (2020) find, using the CIPS panel unit root test, that they cannot reject the null of a unit root in all price-rent ratios. The authors further state "while different MSAs have different growth rates of housing prices, they have the same average growth rate of rental prices. The comparison suggests that rentals are not the main reason for the rapid rise in the dispersion of housing prices. The comparison also

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encouraged us to further investigate housing price-to-rent ratios. Through a panel data unit root test we find that house-price-to-rent ratios are also nonstationary" (p.2). This is another finding of no stable relationship between prices and rents.

Phillips and Shi (2023) examine the price-rent ratio in Australia with the intent of detecting bubbles in eight metro areas. The authors gather data on house prices in Australian dollar figures. For rents they use indices. They employ a method somewhat different than those used in previous studies. First, they utilize a method known as the endogenous instrumental variable (IVX) technique to decompose the price-rent ratio into fundamental versus nonfundamental components. They then test for explosive behavior in the nonfundamental portion of the ratio with a test that posits a null hypothesis as one of a unit root, and the alternative as explosive behavior (of course, the possibility of a stable relationship is not allowed under either the null or alternative). The authors do find evidence of bubble behavior in different Australian cities over their 1990-2017 sample.

Hansen, Moller, Pederson and Schutte (2024) used a similar approach to detect bubbles in the U.S. during the COVID-19 pandemic. The authors gather data on house prices for 382 U.S. MSAs. For rent, the authors acknowledge that rental data is not available for all of these cities, and they thus employ the BLS rent index for the four U.S. regions. For house prices, they employ the Freddie Mac house price index. Each index for a given MSA is divided by the rent index for the corresponding region (i.e. the Freddie Mac price indices for New York City, Boston Philadelphia etc., are divided by the Northeast rent index from the BLS). In current study, to obtain a clear view of the interaction of rents and prices, we follow Phillips and Shi (2023) and use dollar values for house prices, as they are available for the four US regions, and "deflate" them with rent indices for the corresponding US geographical areas.

Data and Methodology

To clearly match house prices and rent data from the same geographical markets, we obtain data on the median price of houses sold for each of the four U.S. Census regions (midwest, northeast, south and west). These data are from the Census Bureau, and are available on the St. Louis Fed's FREDS website (https://fred.stlouisfed.org/). The data are quarterly. For rent, we obtain the "Rent of Primary Residence". These data are compiled by the Bureau of Labor Statistics and are also available on the FREDS website. These rent figures are available bimonthly going back to 1977. We transform the data to quarterly data to match the housing price data. Both series are thus quarterly and range from 1978:1-2023:3. As neither series is seasonally adjusted, we seasonally adjust both series via the Census X-12 method. We display summary statistics for the eight series in Table 1.

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Table 1
House Price and Rent Summary Statistics

	Mean	Maximum	Minimum	Std. Deviation
Midwest Rent	182.77	336.88	71.51	66.29
Midwest House Price	177,004	415,466	54, 592.71	86, 646.19
Northeast Rent	218.91	417.07	69.62	95.78
Northeast House Price	269,570	905,522.9	54,752.44	162,520.2
South Rent	182.82	375.27	66.88	73.87
South House Price	170,172.4	439,842.6	48,269.65	91,515.1
West Rent	209.78	442.77	62.42	95.83
West House Price	231,344.2	577,477.7	59,246.13	131,911.9

The contents for each region are the median price of the houses sold. The rent index is the Rent of Primary Residence.

To investigate whether there is a stationary relationship, we will test each of the rent and price series for unit roots. To anticipate our results, all series appear nonstationary except for house prices in the West, where the results are somewhat ambiguous and conflicting between different tests.

We then test for unit roots in the ratio of median home prices to the rent indices. We "deflate" home prices in this fashion by dividing actual dollar home values by rent indices, as did Phillips and Shi (2023). We find that two regions appear to have stationary ratios, but there are ambiguous results, again depending on the test used, for the other two regions.

As testing for a unit root in the price-rent ratio is tantamount for testing a joint null in which rents and prices have a stationary relationship *and* a particular cointegrating vector, we test for cointegration between prices and rents for each of the four regions. There are different methods for testing for cointegration. In recent years, the autoregressive distributed lag (ARDL) method has been used. However, with this method, one variable must be specified as exogenous. As rents and prices may affect each other, the ARDL is an inappropriate technique for prices and rents (this is especially the case since, as noted, Gallin (2008) and Ambrose, et al. (2013) have found that in the US and Amsterdam, house prices do most of the adjusting to disequilibrium, whereas we find that rents most often do most adjustments via our US regional data).

We thus employ the Johansen-Juselius trace and max tests for cointegration. Given the trending nature of the data, displayed in Figures 1 to 4, we allow for drift in both the short term model and the cointegrating vector. We note that theory implies a cointegrating vector of (1,-1) for prices and rents (Ambrose, et al. (2013) p.489). However, these authors used indices for both rents and prices. We cannot test for this particular implication of theory, as we use dollar values for home values and indices for rents. Having tested for cointegration, we next examine error correction, as did Gallin (2008) and Ambrose, et al. (2013), to determine whether rents or prices appear to do most adjusting to disequilibrium.

To obtain further evidence on how prices and rents interact, we estimate vector error-correction models (VECMs) for prices and rents in each of the four regions. We estimate impulse response functions (IRFs) for the two variables and observe how each responds to a shock to the other. Finally, we calculate forecast error variance decompositions (FEVDs) for each VECM to determine how much prices explain of rents' FEVD and vice-versa.

Results

Table 2 displays the results of unit root tests for home prices and the rent of primary residence in each of the four regions. We clearly fail to reject a unit root for the rents of all regions and the prices of all regions, with one exception. Prices in the western region still appear to have unit roots according to the Phillips-Perron test. However, we can reject the null of a unit root at the ten percent, but not the five percent level (the p-value is 0.0683) with the ADF test. When investigating whether prices and rents have a stationary relationship, this is a point to which we shall return.

As discussed, testing for a stationary relationship between rents and prices by testing for a unit root on the ratio of the two is problematic, as one is testing both for stationarity and a particular cointegrating vector. However, this has been standard practice in some previous studies, so we test the ratios and present the results in Table 3.

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Table 2
Unit Root Test Results for Home Prices and Rents

	ADF Test Statistic	Phillips-Perron Test Statistic	5% Critical Value
Midwest Rent	2.838	10.288	-3.43
Midwest House Price	-1.049	-1.567	-3.43
Northeast Rent	0.595	1.279	-3.43
Northeast House Price	3.679	-.023	-3.43
South Rent	3.294	6.45	-3.43
South House Price	-0.273	-1.49	-3.43
West Rent	2.25	3.67	-3.43
West House Price	-3.307	-1.9	-3.43

A constant and trend were included in all regressions. Lags were chosen by the SIC criterion for the ADF test and the Newey-West criterion for the Phillips Perron test. As displayed, for no regional median home price or rent index can we reject the null of a unit root at the five (or even ten) percent level with the exception of house prices in the West (the p-value on the ADF test was 0.0683).

Table 3
Unit Root Tests for Home Price/Rent Ratios

	ADF Test Statistic	Phillips-Perron Test Statistic	5% Critical Value
Midwest Ratio	-3.56	-4.58	-3.43
Northeast Ratio	-0.319	-4.62	-3.43
South Ratio	-5.07	-4.16	-3.43
West Ratio	-3.49	-2.6	-3.43

A constant and trend were included in all regressions. Lags were chosen by the SIC criterion for the ADF test and the Newey-West criterion for the Phillips-Perron test.

Graphs for the “rent-deflated” housing prices, or the housing price-rent ratio, are displayed in Figures 1 through 4. We note that, before testing for unit roots, the ratios appear to have linear trends. We will include trends in the unit root tests. These trends also mean that, even if we find a stationary relationship between prices and rents for a given region, the price-rent ratio still changes over time. Prices and rents are, even if

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trend-stationary, not, to use Pesaran's (2007) term, "cotrending". A slowly changing price-rent ratio should perhaps not be surprising. For equities, the price-earnings ratio has risen over time, but is still used as a metric of equity valuation. Given Yao's (2021) finding that housing costs have risen more than rents due to greater land required for houses, some increase in the price-rent ratio over time has perhaps been inevitable.

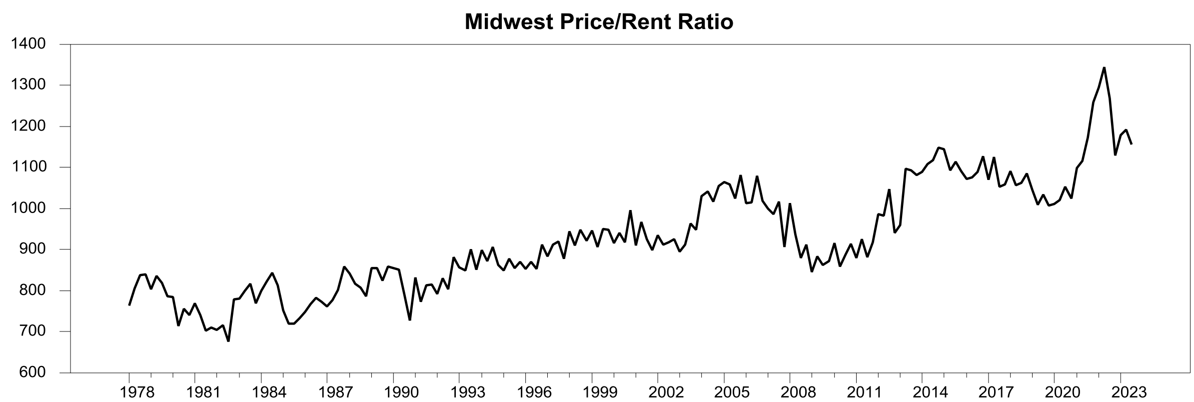

Figure 1. Midwest Price/Rent Ratio

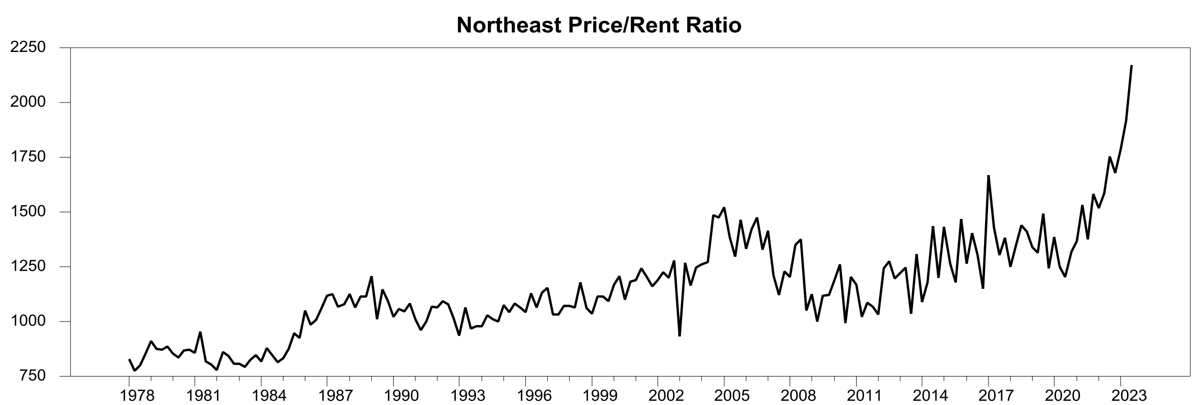

Figure 2. Northeast Price/Rent Ratio

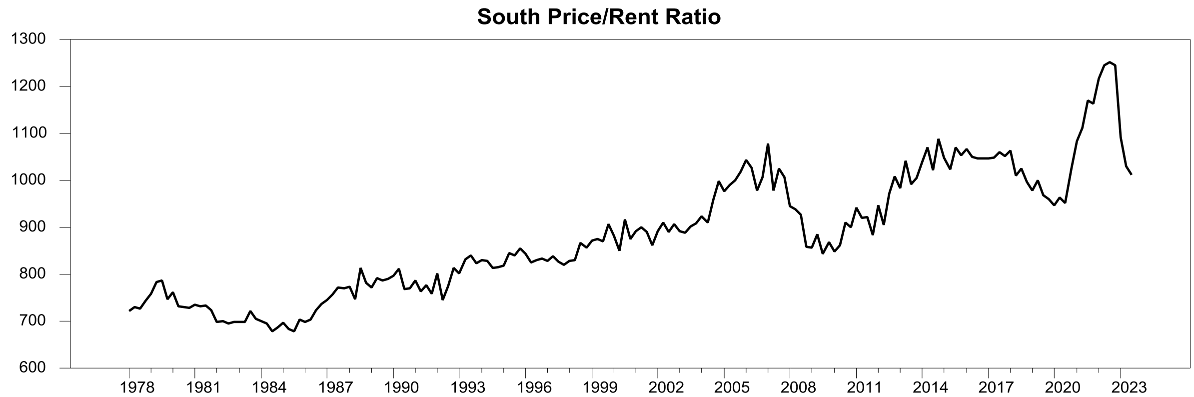

Figure 3. South Price/Rent Ratio

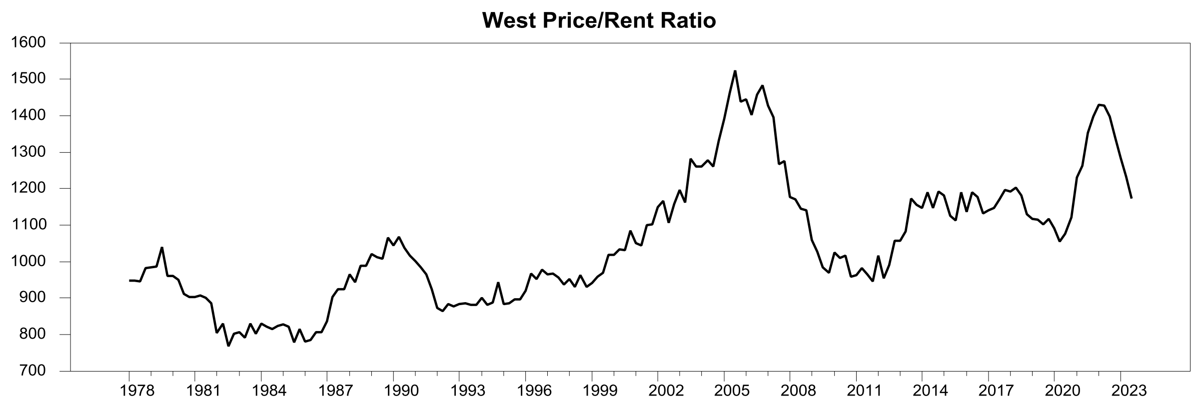

Figure 4. West Price/Rent Ratio

As displayed, we can reject the null of a unit root with the ADF test for the Midwest, South and West. However, we cannot reject the null of a unit root for the Northeast ratio with the ADF. In addition, we can reject the null of a unit root with the Phillips-Perron test for three regions-including Northeast, but cannot do so for West.

We next turn to the Johansen cointegration test, which does not impose a particular cointegration vector. The results are displayed in Table 4. As shown, for both the trace and max tests, we can reject the null of no cointegration between prices and rents for three regions-all but the West. For the Northeast, this result may indicate that there actually is a stationary relationship between prices and rents, and unit root tests on the ratio may have led to ambiguous results owing to an implicit restriction on the cointegrating vector.

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Table 4
Cointegration Test Results

	Lags	Trace PValue	Max PValue
Midwest	2	0.0001	0.0003
Northeast	1	0.000	0.000
South	3	0.000	0.0026
West	2	0.019	0.13

The p-values are for the trace and max tests for no cointegrating relationships against the alternative of more than zero (trace) and one (max) cointegrating vectors. Lags were chosen by running a standard vector-autoregression and using one less than the number of lags chosen by the SIC criterion.

For the West, however, we can reject the null of no cointegration by the trace test at the five percent level (indeed, the p-value is less than two percent). However, we cannot reject a lack of cointegration with the max test at even the ten percent level. The max test may be a more reliable indicator of cointegration than the trace test is. The null hypothesis, for both tests, is that there is no cointegrating relationship between the two variables. The alternative hypothesis with the trace test is that there are more than zero cointegrating relationships, whereas with the max test the alternative is a more specific one cointegrating relationship (of course, as there are only two variables, there can be at most one cointegrating relationship). Lutkepohl, Siukkonen and Trenkler (2001) find that the max and trace tests are similar in power (the likelihood of correctly rejecting the null of no cointegration) but the trace test has worse size properties (a tendency to incorrectly reject the null hypothesis when it is true) than the max statistic does. Thus, whether prices and rents share a long-run relationship in the West is unclear. This result is perhaps not surprising given the ambiguous results on house prices as well as the price-rent ratio for the West.

Examining Figures 1-4 helps shed light on why the West Region may be the one housing market where a stationary relationship between prices and rents is most in question. For the other three regions, there is a fairly smooth increase over the decades in the ratio. There is some volatility in all four regions-prices rise in the early 2000s and then drop after the middle of the decade, reflecting the bousing bubble and bust which led to the Great Financial Crisis. However, this episode is much more pronounced for the West than for the other regions. The run-up in the house price-rent ratio over the early 2000s decade is much sharper in the West than for the other regions, and the subsequent decline to 2011/2012 is much steeper.

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This does make sense, as the housing bubble, though a national phenomenon, affected some parts of the U.S. more than others. Some states in the West, such as California, Arizona and Nevada underwent much more severe boom and bust episodes than other states in the other regions. Thus this greater volatility in the West price-rent ratio makes it less likely we can decisively conclude this ratio is stationary, as we do for the other regions.

In Table 5, we present the results of the error correction estimates. In three out of the four cases-Midwest, Northeast and South-house prices do not respond significantly to disequilibrium, whereas rents do. For the West, both house prices and rents appear to respond significantly to disequilibrium. However, of course, it is not clear how much credibility should be put into the estimated error correction model for the West, as the results of the unit root tests on house prices and the Johansen test for cointegration are ambiguous.

Table 5
Error Correction

	Δ(House Price)	**Δ(Rent Index)**
Midwest		
Coefficient	-0.057844	1.23E-05
Std. Error	(0.05766)	(2.4E-06)
T-Stat	-1.003	5.126
Northeast		
Coefficient	-0.044	1.03E-05
Std. Error	(0.077)	1.4E-06
T-Stat	-0.577	7.2
South		
Coefficient	-0.0617	2.23E-05
St. Error	(0.0758)	5.3E-06
T-Stat	-0.814	4.25
West		
Coefficient	-0.064	3.23E-06
Std. Error	(0.0249)	1.6E-06
T-Stat	-2.58	2.006

This table displays the estimated error correction coefficients on the cointegrating vectors for prices and rents in each region.

Overall, however, these results point to a greater role for prices in driving rents than vice-versa, and rents responding to any deviations from long-run equilibrium much more than home values do. These results contrast to with those of Gallin (2008) and Ambrose, et al. (2013). Gallin (2008) examined a single national U.S. market,

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rather than different regions. For home values, he employed the Freddie Mac index, whereas we used actual median dollar values for houses sold and "deflated" them with a rent index to find cointegration and error correction. Ambrose et al. (2013), who also find greater responsiveness on the part of prices than rents do, used indices for both variables. These authors note that rent regulation in Amsterdam "hinders rental adjustment" (p.489). While rent control has existed in some individual US metropolitan markets, it does not appear, at the regional level, to prevent rents from responding to changes in prices.

In addition to a relative lack of rent control in the U.S., differences in ownership status and the nature of housing as both an asset and a liability (people are aware that they need to live somewhere throughout their lives) may serve to explain the more pronounced response of rents to disequilibrium than prices.

Although rents on individual tenants may only be set only annually, numerous properties are available for new leases throughout the year. Thus rents can change quite frequently. If house prices rise, rental property owners can observe this and conclude that the price of a substitute has risen, and accordingly raise rents.

In contrast, if there is an increase in rents, a homeowner may be little affected and not motivated to put their house on the market for a possibly higher price. The cash payments for shelter that homeowners must pay are generally fixed. Even if homeowners perceive, by observing rising rents, that they may be able to sell their home for more than before, they still must have somewhere to live (they face a housing "liability"). Sinai and Souleles (2005) model this phenomenon. Thus selling a house because of a perceived increase in value would not be attractive, as homeowners would have to buy another house, also increasing in price. Thus, few houses would be put on the market in response to rising rents. Thus, rents respond more to disequilibrium than do home values.

To further investigate the adjustment of rent to prices and vice-versa, we estimate four vector error-correction models for prices and rents in each region. We choose optimal lag lengths by the SIC criterion. The impulse responses for each region are displayed in Figures 5 through 12. The dashed lines are 95 percent error bands.

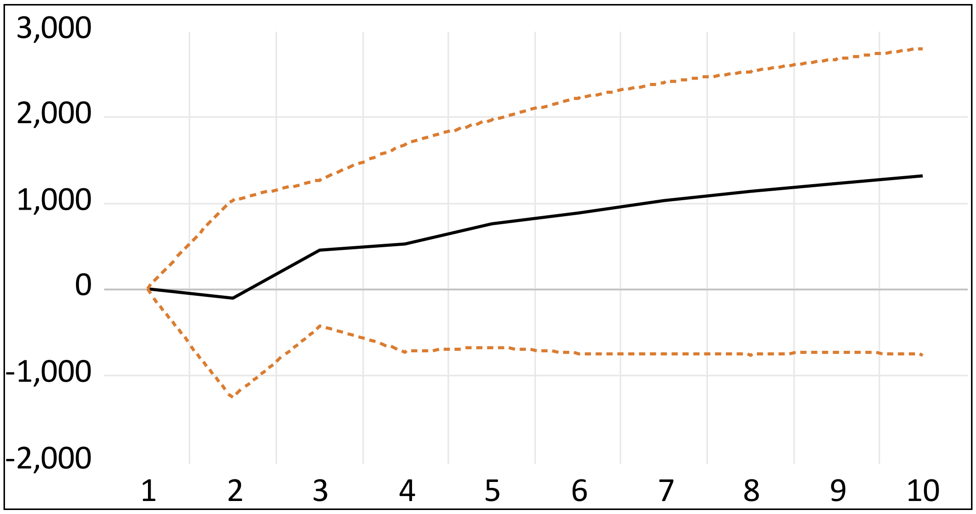

Figure 5. Midwest Impulse Response of House Prices to Rents

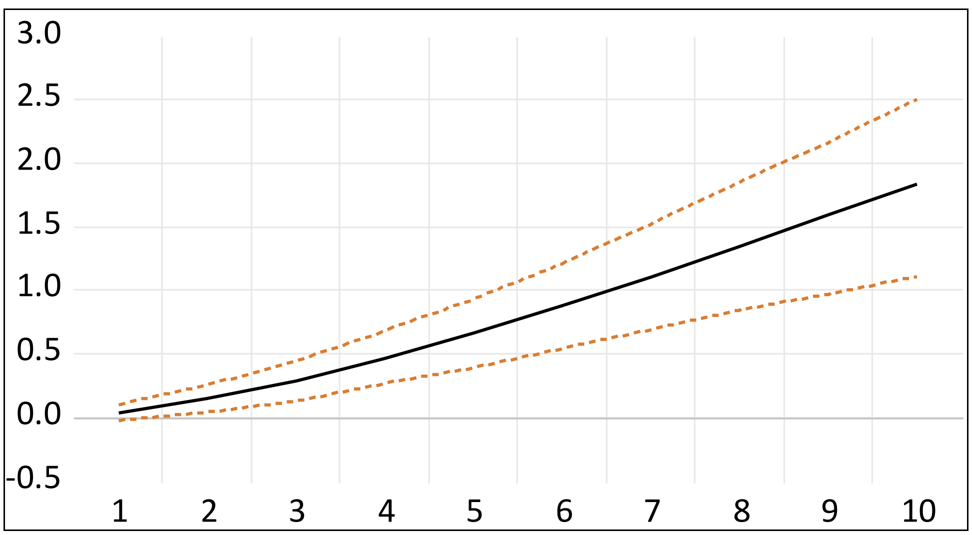

Figure 6. Midwest Response of Rents to House Prices

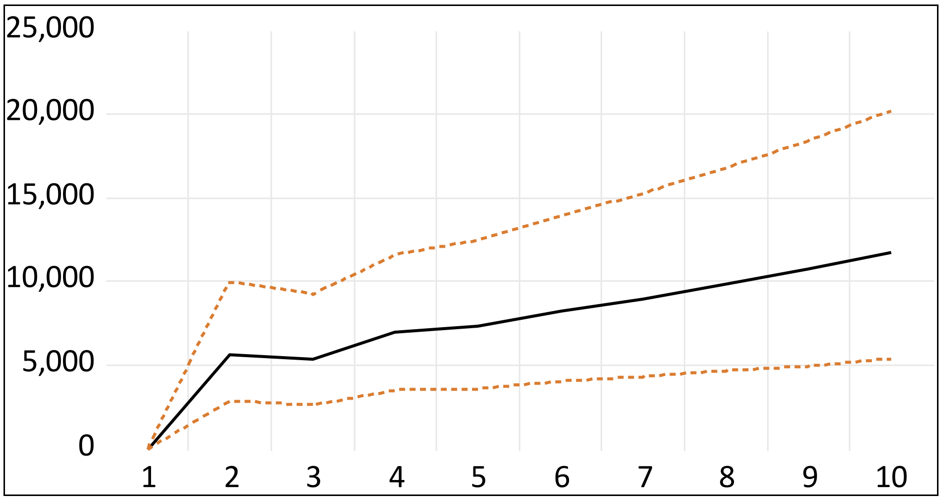

Figure 7. Northeast Response of House Prices to Rents

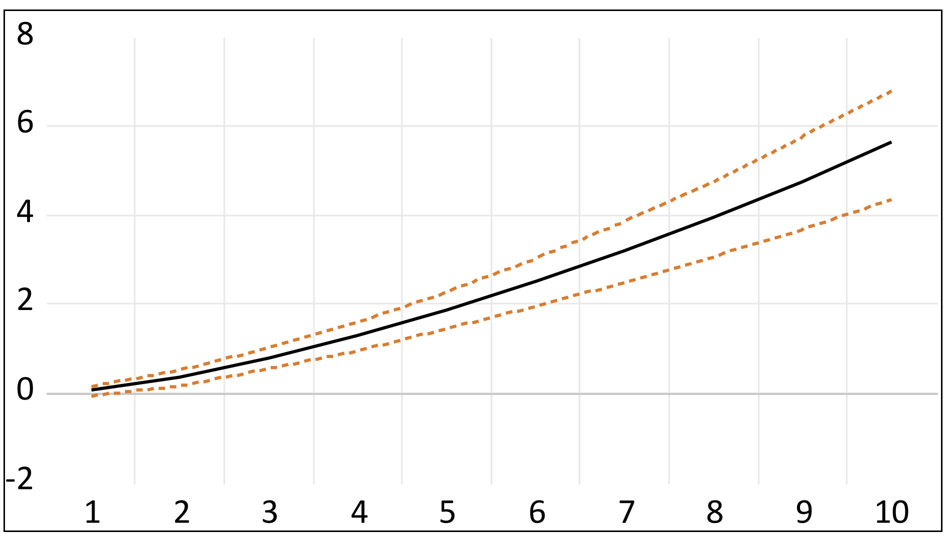

Figure 8. Northeast Response of Rents to House Prices

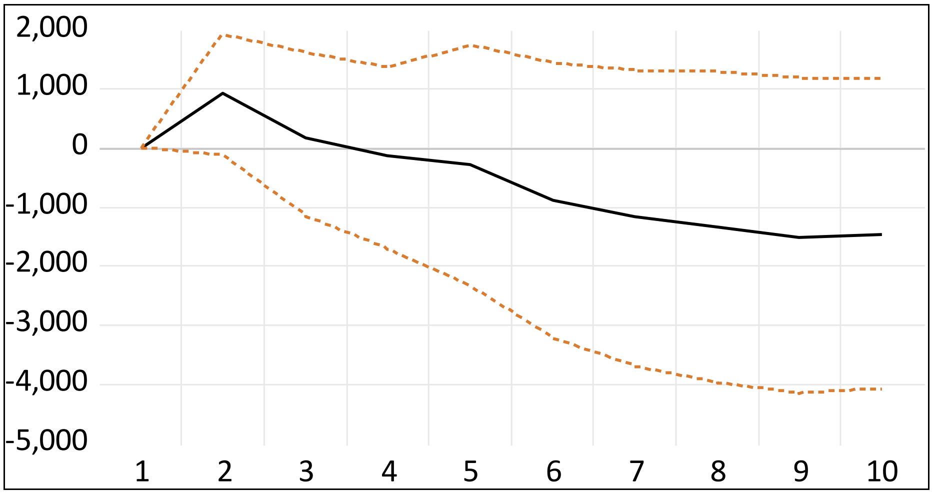

Figure 9. South Response of House Prices to Rents

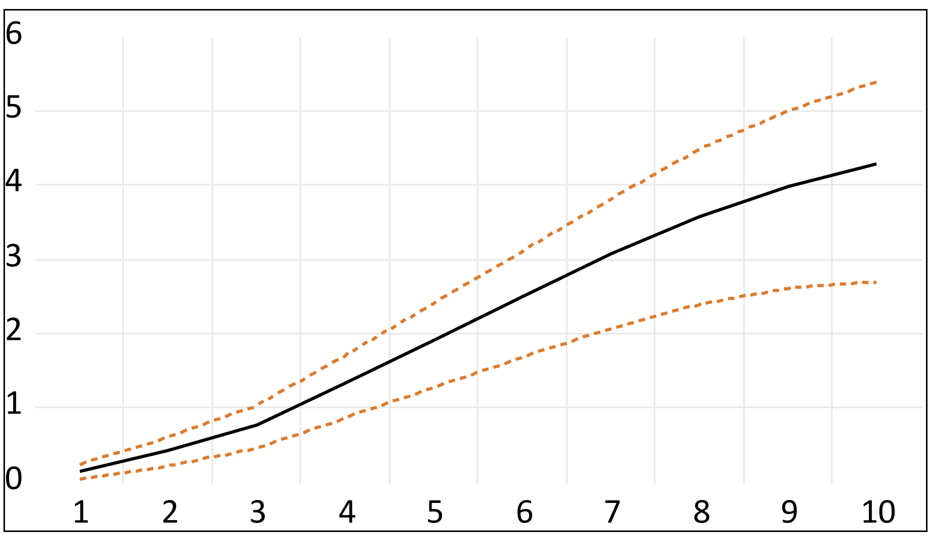

Figure 10. South Response of Rents to House Prices

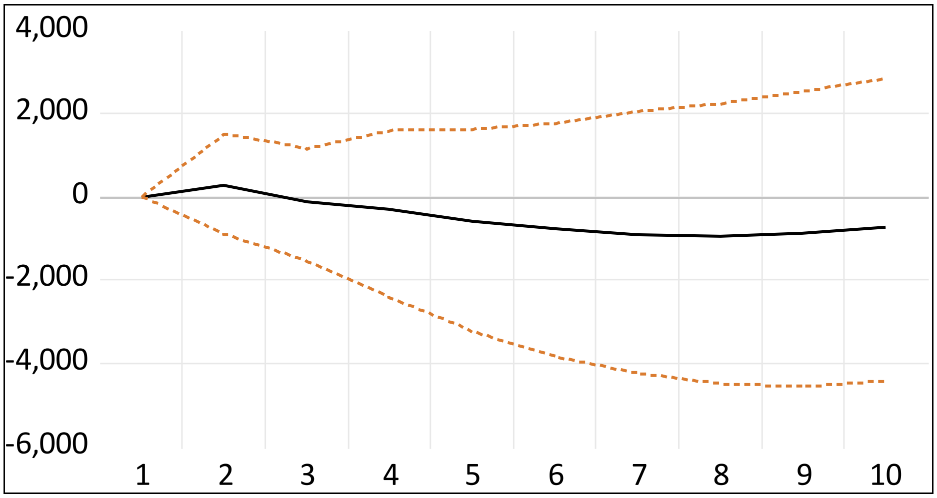

Figure 11. West Response of House Prices to Rents

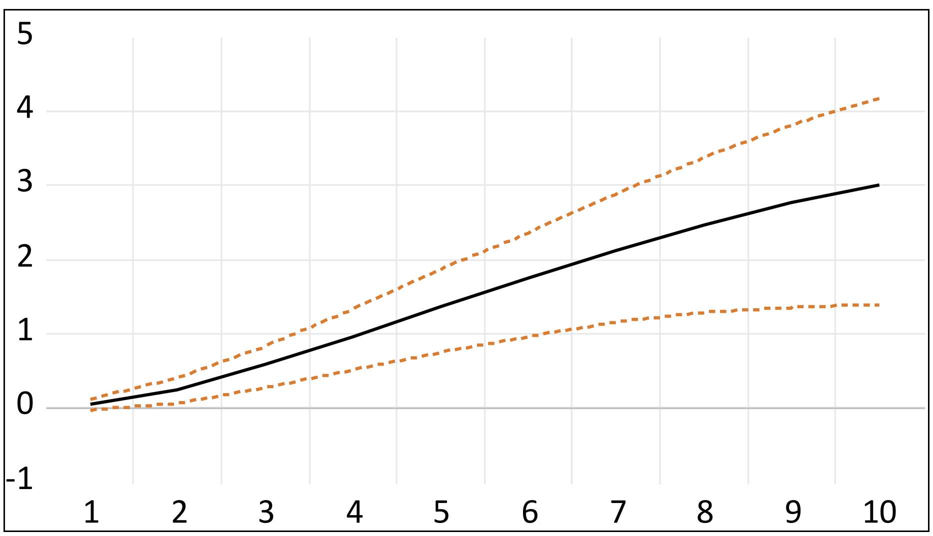

Figure 12. West Response of Rents to House Prices

As shown, in all regions, rents respond positively and significantly to a shock to home values. In contrast, only in the Northeast do house prices respond significantly (and positively) to a shock to rents. While all rent impulse responses steadily increase, the response of Northeast house prices to rents increases fairly slowly after the second quarter. Overall, the IRFs yield a similar picture as that of the error correction estimates-rents seem to respond to home values more than prices respond to rents.

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Table 6 displays the results from the forecast error decompositions. For prices, home values explain almost all of their own error variance, with that explained by rents in the single digits. Indeed, for the West, rents explain only four tenths of one percent of the home price error variance. In contrast, home values explain the majority of the rent error variance for all regions with the exception of the West. Even in this region, home prices explain over 37% of rent error variance. These results reinforce those of error correction and impulse responses that rents are more driven by prices than are prices driven by rents.

Table 6
Forecast Error Variance Decomposition Results

Variable	MW Prices	MW Rents	NE Prices	NE Rents	South Prices	South Rents	West Prices	West Rents
% Explained by House Prices	98.21	50.02	93.47	80.04	98.33	87.26	99.59	37.95
% Explained by Rent	1.78	49.97	6.57	19.95	1.66	12.73	0.4	62.04

These are the percentages of forecast error variance for house prices and rents in each region explained by prices and rents in the same region after ten quarters.

Conclusion

The finding that there appears to be a stationary relationship between house prices and rents would seem to indicate that deviations from this relationship could in principle be used as bubble indicators, at least in the Midwest, Northeast and South Regions. However, we also find that there are linear trends in the price-rent ratios for all four regions. Yao (2021) shows in a model that because houses take up more land than apartments do, home values should become more dispersed than rents over time, and house prices should increase more in response to land values than should rents. Yao states "As a result of the more intensive use of land, the total cost of building houses, which equals the house price in a competitive market, grows more than that of apartments" (p.5). This phenomenon may explain why the price-rent ratio has been rising over the past several decades. This finding also complicates, but does not eliminate, the use of the ratio as a bubble indicator.

In particular, we have found that while the price-rent ratio has risen over time, it is at least trend stationary in most regions. Thus there is some (nonzero) limit as to how much house prices can diverge from rents in the long run.

The long-term effects of a trend-stationary price-rent relationship mean that while home prices can rise higher than a given ratio with rents (due to the positive, linear trend), deviations from this (trend) relationship should not be permanent. That

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is, home prices and rents do have a stable, though non-constant, relationship.

Moreover, forecasters could estimate this trend, and deviations from this trending relationship can be indicative of housing market conditions. Thus if prices rise relative to their trending relationship with rents, this may indeed signal housing market froth.

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