The Diffusion of Monetary Policy Over Short Horizons into Local Rental Markets

Abstract

In a recent paper, Dias and Duarte (2019) demonstrate that a contractionary monetary policy raises rent. They conjecture that monetary policy affects the housing tenure decisions -- rent versus own (RVB). As the cost of homeownership rises, renters on the margin substitute away from purchasing towards renting and this pushes up rents. In this paper, using purchase and rental data on 20 individual CBSAs, I extend their work by explicitly testing this hypothesis on rent appreciation at the local market level, by using RVB within an error correction framework. This is a short-horizon analysis. I find that roughly twelve months after mortgage rates have altered the RVB ratio, rent appreciation changes, but the magnitude of that response to what is an identical shock varies across CBSAs.

Key words: Central banks and their policies, housing demand, rental demand, rent appreciation, housing tenure.

Economic Literature Codes: E31, E43, R23 and R21

1. Introduction

In a recent paper, Dias and Duarte (2019) find that, in contrast to house prices, housing rents increase after a contractionary monetary policy shock. Although it is reasonable to expect that all nominal prices of goods and services (rents included) should decline (or at least not increase) after a contractionary monetary policy shock, this is not what they find. The policy shock is identified as high-frequency surprises on federal funds 3-month futures around policy. They posit that monetary policy affects housing tenure decisions — own versus rent. They argue "If both the supply of housing for rental and of housing for ownership are inelastic in the short run, and there is limited convertibility between homes for sale and homes for rent, when interest rates go up, mortgage rates rise, and the cost of homeownership increases. As homeownership costs rise, the demand for rental housing also increases, and, as a result, housing rents rise."

Certainly, mortgage rates and home prices quickly respond to monetary shocks. Gorea et al. (2023) find that a contractionary monetary policy surprise raises average 30-year mortgage rates by 0.25 percentage points and lowers housing list prices by 1 percent within two weeks and 1.4 percent after week three. But why should we expect policy shocks to impact rents in the first 12 months? There are two reasons why we should not: first, renters do not take out a mortgage and second most renters sign rent contracts that limit their ability to move in the current time period. Thus, it is more reasonable to expect that in the first several months following a contractionary monetary policy, home price appreciation (HPA) slows, but rent appreciation (RRA) stays roughly static because most renters have a rental contract.[1] In those early months following a contractionary shock, it becomes cheaper to rent than to own. Property demand slows. Markets, however, are dynamic. Dias and Duarte (2019, page 6, chart of housing rents) and Chart A2 in the Appendix shows that following higher mortgage rates in the 12 to 16 months prior, renters are confronted by an increased demand for rental properties and rent appreciation quickens.

I extend their work in three ways: First, I reproduce their findings at the national level -- housing rents increase after a contractionary monetary policy shock -- using a SVAR model and the 30-year FRM as a measure of policy change (shown in Charts A1 and A2, in the Appendix) and then at the CBSA level. Second, I explicitly test their hypothesis on housing tenure choices by deriving a rent versus own variable (RVB) from property prices and property tax rate and rents and subsequently measuring the short-term impact of RVB on rent appreciation (RRA). Thirdly, my work shows that each CBSA is different and respond

[1] Data from the U.S. Census Bureau's Property Owners and Managers Survey in 1995 (single-family and multifamily units) showed that 44.4 percent of all units had annual leases, 4.0 percent had leases longer than one year, 36.1 percent had leases less than one year, and 15.5 percent had no leases.

differently to a single national mortgage. The speed of rents adjustment to relative prices (RVB) is impacted by vacancy rates, employment changes, credit scores and other factors.

To account for the fact that the speed of rent adjustments to relative prices (RVB) is also impacted by vacancy rates, employment changes, credit scores, the thickness or depth of the rental market (how many properties in the CBSA are rental properties) and other CBSA specific confounders, I explore these relationships using an identical model for 20 individual CBSAs. This helps to eliminate the problems of these and other fixed-effect confounder. It is widely understood, furthermore, that house prices suffer from serial correlation which must be accounted for. Rents also suffer similary.

My contribution to the literature is to demonstrate empirically the slow changes of rent appreciation (RRA) to a change in mortgage rates through the subsequent alteration of the relative cost of renting-versus-owning. Monetary policy slowly and unevenly diffuses though the rental markets of America's CBSAs.

Section 2 initially reviews the previous research on interest rate changes and home price appreciation. It then extends this research onto the rental market for three-bedroom single family detached properties. In that section, I lay out the methodology for estimating the impact of HPA on RRA. Section 3 explains the data. The results and interpretations are in Section 4. My conclusions are in the last section.

2. Background, previous research, and model

To study the effect of relative prices on the tenure decision of renters, I derive a measure of the relative cost of renting versus buying[2]

2.a RVB

In thinking about home prices and rents, one must go back to Poterba (1984) who develops the home buying/rent decision in terms of a user cost of capital. The cost of owning a home is the price times the user cost of capital (UCK) and is normally written as

$$P * UCK = P * ([k + \tau_p + m - E(\pi)] - [(k + \tau_p) * T_f]) \quad (1)$$

Where P is the home price; k is the mortgage rate; τ_p is the property tax rate, a tax payment relative to house price; m is the maintenance cost, $E(\pi)$ is the expected home price

[2] Here owning and buying are used interchangeable as a measure by the monthly financial cost involved in owning a home.

appreciation and T_f is the federal tax rate[3]. Poterba argues that in equilibrium, the entire cost of owing (buying) must equal the cost of renting an identical house. Or, for every city, markets adjust until the cost of renting equals the cost of owning for a month.

$$R_{it} = UCK_{it} * P_{it}, \text{ or } R_{it} = B_{it}, \quad (2)$$

This introduces the idea that tenants of a three-bedroom rental properties if they can afford to buy a home are looking at the relative cost (RVB, where $RVB_{it} = R_{it} / B_{it}$) in the duration of time before their lease expires. Renters do not take out mortgages. Since this is true, then asking the question what drives rent appreciation must include how do mortgage rates impact home prices and HPA. Initially changes in mortgage rates impact only HPA and not rents and RRA. It is only over time that HPA impacts RRA.

2.b Modelling rent: VECM, the fundamentals approach

Many house price researchers argue that the city-level house price adjustment process is best described by a two-stage model in which house prices grow with income, population, employment, and other economic and non-economic variables (zoning restrictions, weather, migration). In stage one, we can think of all of these fundaments in a single variable $\mathbf{X}_t$. These variables are the fundamentals economic forces driving growth. House price growth also exhibits momentum and mean reversion. The mean reversion in the short-run is a response to the disequilibrium force of the difference between the actual market price (P_t) and the fundamental or equilibrium price (P_t^*) which is determined by all of the market forces (or, $P_t^* = f(\mathbf{X}_t)$). The fundamentals approach thus involves two stages of modelling: The first stage involves estimation the long run relationships of P_t^* to the fundamentals and then the derivation of the error term ($P_t^* - P_t$) which is used in the second stage as the error correcting force (ECT). The ECT brings about reversion of P_t over time towards P_t^*. The second stage is a measure of short-run behavior. This approach has not been favored for modelling the rental market.

2.c Modelling rent: VECM, the rental approach

Other researchers have taken a different approach to modelling home prices which can also applied to rents. As noted above, Poterba (1984) develops the home buying/rent decision in terms of a user cost of capital. He argues that in equilibrium, the entire cost of owing (buying) must equal the cost of renting an identical house. Or, for every city, markets adjust until $R_{it} = B_{it}$ (Equation 2), where $B_{it} = UCK_{it} * P_{it}$.

Everyday experience indicates that housing and rental markets at time t do seem to function in the classical economic framework of perfect competition as Poterba suggests. Marginal

[3] The 2017 tax cuts and jobs severely reduced the benefits of itemizing taking the mortgage interest deduction.

buyers and sellers have access to an exceptionally large information set, and can substitute (at the time immediately before the transaction) without costs between renting and buying. A potential buyer of a home faces the choice outlined by Equation 2, (the rent/buy decision). If we think of each CBSAs as being a collection of economic agents, home prices should adjust upward under higher demand until the R_{it}/B_{it} approximates 1.0. For every city, markets are always adjusting towards $R_{it}/B_{it} = 1$. This relationship between B and R introduces an error correction term of RVB into the short-run market framework which is the basis for an error correction model (ECM).

Moreover, following Poterba (1984), it is reasonable to think that most of the economic forces that move house prices move rents. The actions of the would-be homebuyer at the time of purchase (time t) reflect the would-be homebuyer's consideration of his income, employment position, how the city is expanding around him, etc. Since this is the case, rent captures the influence of the fundamentals. It is not necessary to model all of the fundamental economic variables. One can then construct a long-run model of rents determination, as

$$\ln R_t = \alpha + \gamma_1 \ln B_{t-k} + \xi_t \quad (3)$$

This is Equation 2 specified in logs, where k is some lagged time period. This would represent the first stage in the ECM modeling process. We can then use $\ln RVB_{t-k}$ or ξ_t as our error correction term in stage two. To use either RVB_{t-k}, or ξ_t the relationship between R_t and B_t should be stationary. The second stage model is thus,

$$\Delta \ln R_t = \alpha + \beta \ln RVB_{t-k} + e_t \quad (4)$$

Here, the sole determinant of rent appreciation in time t is the lnRVB ratio from t-k. Under this approach, the long-run function is not estimated. The variable $\ln RVB_{t-k}$ acts as the error correction term. It is an internal force which changes the market. When RVB goes out of balance, the marketplace adjusts (i.e., R and P adjust) and ΔR and ΔP move RVB back towards a stationary value of 1.0 (mean reversion to a value of 1.0). [4]

Verbrugge (2008) uses a VECM approach on sample data from 1988 to 2003 to model the effect of RVP and UCK (rather than RVB) on RRA. He constructs a rent index using a post-1987 CPI rent microdata set comprised of rent of only single-family detached dwellings. Using a VECM model on the nation, four regions and 10 individual CBSAs, he finds "rents generally do not appear to react to quarterly changes in the user cost of capital, not even with a lag." He does point out that RRA responds to HPA. Home price inflation

[4] A Dickey Fuller test was applied to the error term of Equation 3 for each CBSA's RVB to test for stationarity.

is partially responsible for rent inflation. Verbrugge (2008) does include the vacancy rate for each geography.

Gallin (2008) uses national data of the tenant rent index from the Consumer Price Index. The data is quarterly from 1970: Q1 to 2005: Q4. The problem with the CPI survey data is that it is survey data and includes observations data from multifamily structures. Using a lag of four quarters and a VECM model, he finds that 100 bps decline in the UCK would lower RRA by 40 bps after 4 quarters. Ambrose, Eichholtz and Lindenthal (2013) follow Gallin's approach to examines the long run relation between prices and rents for houses in Amsterdam from 1650 through 2005. Fout, Haidorfer and LaCour-Little (2017) using data from 2009-2015 on fifty CBSAs find that prices and rents are, in general, co-integrated and that home prices and rents respond to RVB with a 12-month time lag in ways consistent with economic theory.

2.d Modelling rent, modifications, and full model

Conceptually all information about fundamentals is contained in both B and R (they should be equal, or heading towards each other). To model rent appreciation, I modify Equation 4, by first including a lagged dependent variable and its counterpart to account for inertia in HPA and RRA. Next, I include the lnRVB lagged 12 months. The time lag was suspected to be 12 months assuming that most tenants of SFR properties have one-year leases. As specified, changes in the mortgage rate twelve months earlier due to a contractionary policy immediately raises B, but does not immediately change R and thus it lowers RVB.

I re-write Equation 4 as,

$$\Delta \ln R_{it} = \alpha + \beta_1 \Delta \ln P_{it-3} + \beta_2 \Delta \ln R_{it-3} + \beta_3 \ln RVB_{it-12} + \beta_4 \mathbf{Z}_{it} + e_{it} \qquad (5)$$

where $RRA_{it} = \Delta \ln R_{it.}$

I am trying to account for 1) the auto-regressive nature of home prices and rents, and 2) the simultaneous delayed impact of mortgage rates on RRA through mean reversion of RVB twelve months after any house prices changes have occurred.

In order for the models to be stable: $-1 < \beta_2 < 1$, $-1 <= \beta_3 < 0$. The auto-regressive nature of HPA and RRA must take a smaller signal from the prior month; rent appreciation should respond negatively to high RVB.

An expansionary monetary policy relaxes credit constraints, an operative credit channel would tend to amplify the effects of monetary policy on house prices. According to this view, a monetary expansion has two effects. The first is to lower the mortgage rate. And

second, by easing the availability of credit, the expansion would also increase the demand for owner-occupied housing by more than would be implied by the interest rate reduction alone. A contractionary monetary policy works in the opposite direction. To account for this second effect, the variable $\mathbf{Z}_{it}$ contains the vacancy rate from 12 months prior, the share of homes that are rental properties (non-owner occupied), the year-over-year change in the employment rate and a dummy variable for a period of time when mortgage rates fell during Covid-19 pandemic. I run Equation 5 twenty times, once for each CBSA. By using percent change, I am tracking behavior over time for each CBSA. In essence, I am comparing each city to itself. This reduces the number of unidentified fixed-effect cofounders.

3. Data

3.a Rent

The unit of analysis is the core based statistical area. Altisource Residential Corporation tracks single family housing rents at the CBSA level. The Altisource data starts in 2009. Altisource gathers asking and actual rents from a large sample of property managers of single-family properties. Rents from units in multifamily properties are not included in the sample. They provide the median rent for five different bedroom counts on a monthly basis.[5] The data is neither seasonally adjusted, nor adjusted for quality. It also does not include the cost of utilities. The Altisource.com data measures the contract rate of new and existing renters similar to what is measured by the Census' owners' equivalent rent. Fout, Haidorfer and LaCour-Little (2017) have verified that the Altisource 3-bedroom SFR data track the owner's equivalent rent and the tenants rent from Census. [6]

3.b Prices

The price data for 3-bedroom houses comes from Zillow.com. The price data reflects the typical value for homes in the 35th to 65th percentile range. The values are then smoothed, and seasonally adjusted. The values of home prices are based on changes derived from a neural network methodology similar to a repeat sales transaction values built up from Zillow's housing prices model.

3.c User cost of capital

[5] Altisource purchases its rental data from investors, property managers and other proprietary data sources. In addition, they use MLS data where possible. On a weekly or bi-weekly schedule, their data providers provide them with both asking and actual rents. As a result, they have current asking and actual rents at the CBSA level. Altisource estimates that they have around 15% to 30% coverage of the rental properties outstanding in each of the CBSAs.

[6] Zillow.com, CoreLogic and Altisource.com.

The user cost of capital is defined in Equation 1. The interest rate k is the Freddie Mac 30-year survey rate plus points; property tax rates are derived as average property taxes paid in each CBSA reported in the IRS report of income divided by the Zillow.com median home price (see immediately below). T_f is the federal tax rate by income class. The variable m in the user cost of capital equation is 3.5 percent of the property value for three-bedroom properties. A final issue to address is expected house price growth $E(\pi)$, which I do not attempt to measure. Several earlier authors attempt to measure $E(\pi)$ with backward looking estimation such as $E(\pi) = (P_t - P_{t-1})/ P_{t-1.}$ There are two major problems with using past home price growth: 1) it misses turning points and 2) it misleadingly lowers the user cost of all CBSAs since all recent history shows strong positive home price growth and strong future HPA is not a given.

3.d Property and federal income tax rates

Property tax rates are calculated for each CBSA for each month. The IRS reports the average property tax amount paid each year for each income cohort. I divide the IRS data on average yearly property taxes paid by the median price of the home each month to get a property tax rate (PTR) each month.[7] Since the property prices are reported monthly, the calculated property tax rate has a monthly periodicity. The federal income tax rate for each CBSAs is based on the combined IRS reported amounts of federal income tax receipts for all households in a CBSA with adjusted gross income between $75k to $100k divided by the number of reported households in that bracket. The result is a federal income tax rate with an annual periodicity. Source: IRS Report of Income.

3.e Vacancy rate

Vacancy rate for all properties. Source: Census, Periodicity: quarterly.

3.f Employment

Monthly employment numbers are year-over-year changes in counts of all employees, Source: BLS, Periodicity: monthly.

3.g Landlord share of existing homes: The landlord share is ($Llord_i = 1 – HOR_i$), where HOR_i is the homeownership rates, a ratio of the housing stock. The denominator includes the total number of units (rented and owned) in $CBSA_i$. Thus, the denominator includes apartment units rented, single family detached units (properties) rented, and properties owned and occupied. The numerators are just units owned. Source: Census, Periodicity: quarterly.

Summary data are in Table 2 in the appendix.

[7] The IRS data is only for those who itemize. Tax data on those taking the standard deduction are thus not included.

4. Results

4.a Model results, the impact of RVB on RRA

Because most renters of an SFR property have a contract fixed for one year and do not take out a mortgage, changes in mortgage rates filter into rent appreciation only twelve months later through the RVB variable.

Table 1. β_3 Coefficient for 20 CBSAs

	(1)	(2)	(3)	(4)
	Jan-13 to Sep-23			
	L12RVB	**P-value**	**Significance**	**R-sqr**
Albuquerque, NM	-0.05	0.00	***	0.84
Baltimore, MD	-0.13	0.00	***	0.71
Boston, MA	-0.08	0.00	***	0.65
Chicago, IL	-0.06	0.00	***	0.55
Dallas, TX	0.00	0.84		0.75
Denver, CO	-0.02	0.07	'	0.74
Houston, TX	0.00	0.61		0.65
Indianapolis, IN	-0.03	0.01	**	0.46
Las Vegas, NV	-0.05	0.00	**	0.73
Los Angeles, CA	-0.06	0.00	***	0.64
Memphis, TN	-0.04	0.07	'	0.71
Miami, FL	-0.03	0.05	*	0.81
Milwaukee, WI	-0.08	0.00	***	0.75
Minneapolis, MN	-0.05	0.00	**	0.70
New York, NY	-0.02	0.05	'	0.45
Phoenix, AZ	-0.12	0.00	***	0.69
San Francisco, CA	-0.10	0.00	***	0.77
Seattle, WA	-0.04	0.00	**	0.72
Tulsa, OK	-0.08	0.00	***	0.74
Washington, DC	-0.04	0.00	**	0.71

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' ' 0.1 ' ' 1

Altisource data runs from Jan-13 to Sep-23 for 16 CBSAs. Minneapolis, MN use a 15 mor

Altisource data data is from Jan-13 to Aug-21 for Las Vegas, NV and Phoenix, AZ.

Zillow.com data runs from Jan-16 to Sep-23 for Boston, MA and New York, NY

Other lag lengths on the lnRVB variable were tried with less robust results.

Higher mortgage rates increase the cost of borrowing (buying a home) and B rises immediately (RVB falls), the higher B lowers the demand for single family purchases and raises the demand for rental properties. A lower RVB means renting has gotten cheaper

(alternatively, a higher RVB means buying has gotten cheaper). Thus, the sign on the β_3 coefficient has to be negative to be logically correct – when it is cheaper to rent than to buy in prior periods (RVB falling), rents demand rises and RRA quickens. The coefficient β_3 for this variable (Table 1, Column 1) is negative and significant for 18 out of my 20 CBSAs. The negative β_3 coefficient suggests that a lower RVB in the period 12 months prior, perhaps due to rising mortgage rates, would be followed by rents rising in month t. Although it cannot be shown empirically for every CBSA, monetary policy affects the housing tenure decisions as Dias and Duarte (2019) and this paper conjecture. To be more specific, a contractionary monetary policy raises mortgage rates, and at the same time, makes home buying more expensive. This lowers the relative cost of renting.

4.b Model results, other variables

It is sometimes questioned whether vacancy rates - the balance of supply and demand - affect the cost of housing. Saunders and Tulip (2019) find strong evidence that vacancy rates drive rent changes. Whereas Verbrugge (2008), and Belsky and Goodman (1996) do not. The vacancy rate was significant and negative (higher vacancies from 12 months earlier slows rent appreciation) in only 4 out of my 20 CBSAs. Thus, the evidence from this research suggests the impact of vacancy rate is not strong. Employment growth and landlord shares also do not play consistent significant roles in rent determination.

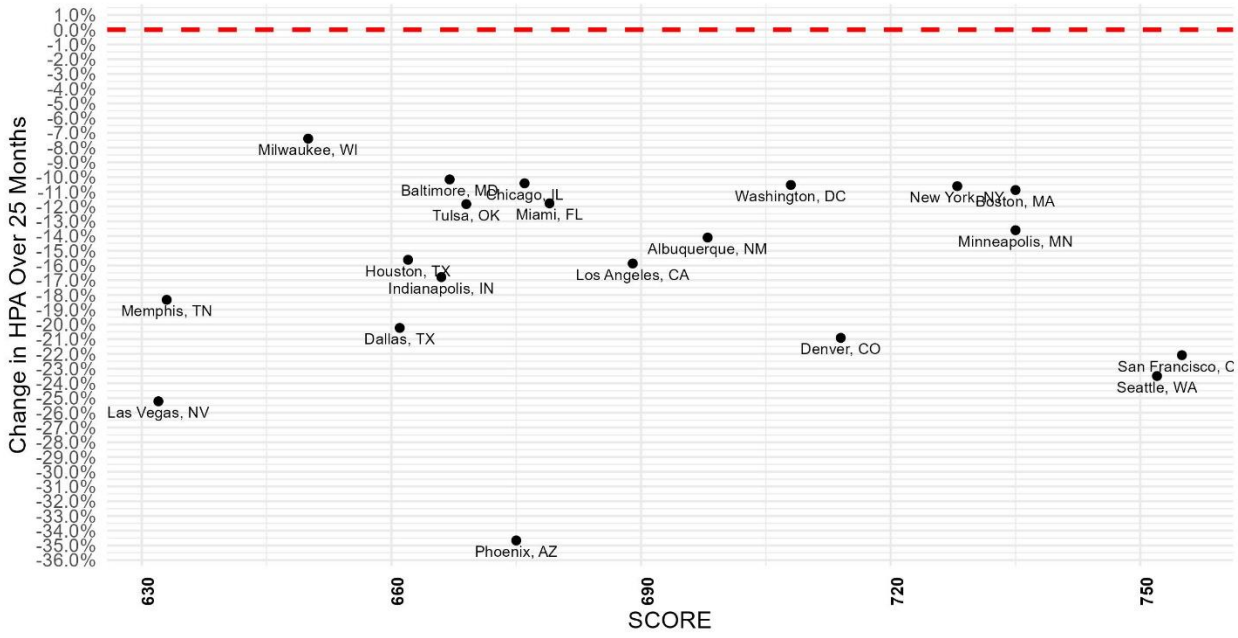
4.c Model results, interpreting coefficients.

The β_3 coefficient measures the speed of adjustment in each CBSA averaged across time. The magnitude of the 18 significant coefficients are reasonably close to each other, but the differences in β_3 coefficients indicate that the diffusion of monetary policy to each CBSA is CBSA specific. The rental market in Baltimore, MD, Boston, MA, Phoenix, AZ, and San Franciso, CA respond the fastest (highly negative β_3 values).

In Chart 1, we see the declines in HPA following mortgage rates going up by 432 bps after Aug-21 as we might have anticipated. In Chart 2, we see the increases in RRA for eight of the 20 CBSA. Twelve of the twenty CBSAs saw rent appreciation decline. Rents (YOY) for SFR properties were still rising in these twelve CBSA as of Sep-23, but just not as fast. The labor markets have been strong in the U.S. during this period. Both charts map appreciation against the average credit score for all people living in the CBSA. In Chart 2, the CBSAs with the higher scores, map onto the larger increases in RRA and have higher speeds of adjustment to L12lnBVR (the β_3 coefficient). It appears that CBSAs with high average credit score and high home prices adjust faster. Renters in those CBSA are price conscious and have some financial strength to quickly move between the two markets. The dynamics are faster and the transmission of monetary policy faster.

Chart 1. Aug-21 to Sep-23: Changes in HPA and scores.

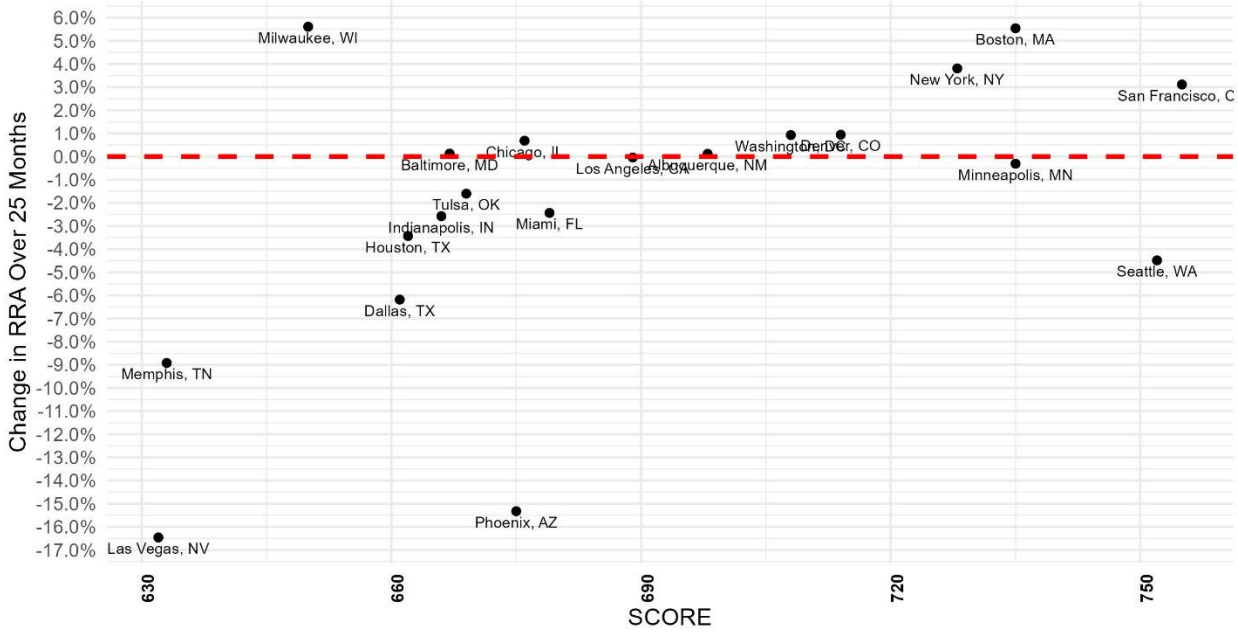
Changes in HPA in the 25 months since mortgage rates first went up after Aug-21



Source: Altisource.com, Zillow.com, Transunion and CHTR

Chart 2. Aug-21 to Sep-23: Changes in RRA and scores.

Changes in RRA in the 25 months since mortgage rates first went up after Aug-21



Source: Altisource.com, Zillow.com, Transunion and CHTR

5. Conclusions

I have focused on the purchase and rental markets of only single-family properties. It contains no information about rents of apartments in multifamily properties. Renting a home is a substitute for owning a home. The Harvard Joint Center for Housing and the Census department reports that there about 47.4 million non-owner-occupied units in the United States. One single family detached property (SFR) counts as one unit. This stock of 47.4 million units includes 15.3 million detached SFR homes and 8.2 million duplex units in SFR homes (also called attached SFR).[8] Thus, the SFR property rental market is large.

This paper substantiates the hypothesis put forth by Dias and Duarte (2019) that housing rents increase after a contractionary monetary policy shock due to renters (potential homebuyers) adjusting their tenure choice. I formally test their hypothesis that the tenure choice of renters is determined largely by relative prices (RVB). I add to the discussion by highlighting three important forces driving the rental market in the United States:

1) *Markets adjust to relative prices:* Relative prices (RVBs) are the primary driver of subsequent rental growth in many CBSAs. In 18 of 20 CBSAs in my sample, the rental market responds to relative prices. Higher mortgage rates cause a substitution of the marginal renter to continue to rent rather than to buy.

2) *Rental market adjustment takes 12 to 16 months:* After a monetary policy change rental markets adjust, not right away, but in a lagged fashion to the change in mortgage rates and any subsequent home prices changes. Higher mortgage rate immediately drive the cost of buying a home higher while rents are neither immediately nor directly impacted. Both tenants and landlords are often locked into one-year contracts, and it takes time for a renter (or new household) who is trying to become an owner to shop for a home to buy. Thus, the quickening or slackening of rent appreciation that drives the tenure choice does not immediately occur in time period when mortgage rates have changed.

3) *CBSAs with low scores take longer to adjust:* The diffusion of a rise in the cost of buying a home spreads through the nation's rental markets, city-by-city. Home prices and renters' financial skills impact their ability to adjust to relative costs. Rent appreciation adjustments to relative prices is slower in CBSAs with low credit scores and lower priced homes. Renters with high scores have more ability to switch between the two markets. Evidence indicates that rent appreciation in CBSAs with low average credit score react at slower rates.

[8] Harvard Joint Center on Housing (2022). Note some rental units are in trailers.

References

Ambrose, Brent Piet M. A. Eichholtz and Thies Lindenthal (2013) "House Prices and Fundamentals: 355 Years of Evidence", *Journal Money Credit and Banking*

Belsky, Eric and John L. Goodman, Jr. (1996) "Explaining the Vacancy Rate - Rent Paradox of the 1980s", Journal of Real Estate Research, 1996, vol. 11, issue 3, 309-323.

Dias, Daniel A. and João B. Duarte (2019). Monetary Policy, Housing Rents and Inflation Dynamics. International Finance Discussion Papers 1248.

Gallin, Joshua (2008) "The Long-Run Relationship between House Prices and Rents", *Real Estate Economics.*

Gorea Denis (2023) & Augustus Kmetz & Oleksiy Kryvtsov & Marianna Kudlyak & Mitchell Ochse. "House Prices Respond Promptly to Monetary Policy Surprises," FRBSF Economic Letter, Federal Reserve Bank of San Francisco, vol. 2023(09), pages 1-5, March.

Fout, Hamilton, Anton Haidorfer and Michael LaCour-Little (2017). "New Evidence on the Co-integration of House Prices and Rents" 2017 ARES Housing Conference.

Hamilton, James D. (2008), "Daily Monetary Policy Shocks and New Home Sales," *Journal of Monetary Economics*, 2008, 55 (7), 1171–1190.

Harvard Joint Center for Housing (2022) The State of the Nation's Housing 2022. Joint Center for Housing Studies of Harvard University.

Li, Wie and Laurie Goodman (2016) "Comparing Credit Profiles of American Renters and Owners" Urban Institute, Housing Finance Policy Center, March.

Li, Dake, Mikkel Plagborg-Møller and Christian K. Wolf Local (2022) "Projections vs. VARs: Lessons from Thousands of DGPs", National Bureau of Economic Research, working paper 30207

Liu Haoyang, David Lucca, Dean Parker, and Gabriela Rays-Wahba (2021) "The Housing Boom and the Decline in Mortgage Rates," Federal Reserve Bank of New York Liberty Street Economics, Sept 2021, https://libertystreeteconomics.newyorkfed.org/2021/09/the-housing-boom-and-the-decline-in-mortgage-rates.

Manganelli Benedetto, Pierluigi Morano and Francesco Tajan (2014) *WSEAS Transactions on Business and Economics* 11(1):219-226, January

Poterba, James M (1984) "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach", *The Quarterly Journal of Economics* 99, no. 4: 729–52.

Saunders Trent and Peter Tulip (2019) "A Model of the Australian Housing Market" Reserve Bank of Australia, Research Discussion Paper, 2019-01

Verbrugge, Randal (2008) "The Puzzling Divergences of Rents and User Costs, 1980 – 2004", *Review of Income and Wealth*, 54(4): 671 – 699.

Verbrugge, Randal, and Joshua Gallin (2017) "A Theory of Sticky Rents: Search and Bargaining with Incomplete Information" Federal Reserve Bank of Cleveland, Working paper 17-05.

Appendix

Table 2. Mean Summary Statistics					
Jan-13 to Sep-23					
	HPA, YOY %chg	**RRA**, YOY %chg	**RVB**, Ratio	**LLORD**, % %shr	**VAC**, rate
Albuquerque, NM	0.06	0.04	1.20	32.8	5.58
Baltimore, MD	0.04	0.03	1.33	32.6	7.84
Boston, MA	0.06	0.04	1.08	39.1	4.84
Chicago, IL	0.06	0.03	1.29	34.4	7.08
Dallas, TX	0.10	0.05	1.36	39.2	8.01
Denver, CO	0.09	0.06	1.17	37.7	5.13
Houston, TX	0.08	0.04	1.41	NA	9.27
Indianapolis, IN	0.08	0.04	1.46	33.1	8.68
Las Vegas, NV	0.11	0.05	1.17	44.7	8.47
Los Angeles, CA	0.08	0.05	1.02	51.5	4.93
Memphis, TN	0.08	0.04	1.52	39.2	8.54
Miami, FL	0.10	0.06	1.35	40.8	5.63
Milwaukee, WI	0.06	0.02	1.11	40.6	5.09
Minneapolis, MN	0.07	0.04	1.26	29.2	5.92
New York, NY	0.05	0.04	1.04	49.6	5.05
Phoenix, AZ	0.11	0.07	1.15	35.2	7.22
San Francisco, CA	0.09	0.05	0.82	45.0	4.23
Seattle, WA	0.09	0.06	0.96	39.7	5.24
Tulsa, OK	0.06	0.04	1.36	34.2	7.74
Washington, DC	0.05	0.03	1.14	35.0	4.63

Sources: Altisource.com, Zillow.com, Census, Transunion, Corelogic, IRS, CHTR

A.1 Replicating Dias and Duarte (2019)

Dias and Duarte (2019) use monthly data to estimate the SVAR model and select the number of lags, p, in the SVAR model to be 12. They also use quarterly data to estimate the SVAR model and use 4 lags. Their policy shock is identified by high-frequency surprises on federal funds 3-month futures around policy meetings. They use rent of primary housing rents from the Consumer Price Index for All Urban Consumers (CUSR0000SEHA) for rents nationally. They use Consumer Price Index for All Urban Consumers: All Items (CPIAUCSL) for national home price. They find that house prices contract and housing rents increase after a contractionary monetary policy shock.[9]

If the Federal Reserve engages in quantitative tightening it shrinks its monetary reserves by either selling government bonds, or mortgage back securities or letting them mature and removing them from its cash balances. Gorea et al. (2023) find that the response to a surprise about future interest rates, captured by their instrument variables, is that mortgage rates increase by around 4 basis points within a month. By contrast, the response of mortgage rates to the level surprise is close to zero. Based on data through 2006, Hamilton (2008) demonstrates that changes in information about the level and slope of the federal funds rate are positively correlated with 30-year mortgage rates, with slope effects 2.6 times stronger than level effects. Hamilton argues that the mortgage rate response materializes as soon as markets realize the changes in the path of the federal funds rate. So, mortgage rates do capture the policy motives of the Federal Reserve.

It is likely that policy makers have some concern about individual local markets, but each individual mortgage market is not their target. Stated differently, the 30-year FRM (as a policy variable) is not reacting to the movements of the other variables. The data is too granular. And although market forces (supply and demand for homes, supply and demand for mortgage backed securities) certainly have some feedback back into mortgage rates, the degree to which other variables in the model then feedback into the FRM is probably small and that changes mortgage rates are plausibly exogenous to each local housing market.

I reproduce the findings of Dias and Duarte using a non-weighted average of the log of home prices for three bedroom homes from Zillow.com on three bedroom properties for 20 CBSAs. Using the same variables in **Z** of Equation 5. My instrument for policy shock is the 30-year FRM. Directly following the notation from Dias and Duarte (2019) and Stock

[9] Manganelli, Morano and Tajan (2014) find that rent appreciation falls in response to a contractionary monetary policy.

and Watson (2012) , let Y_t be an n × 1 vector of observable time series variables. A SVAR with p lags is given by:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + H\varepsilon_t, \quad \text{(A1)}$$

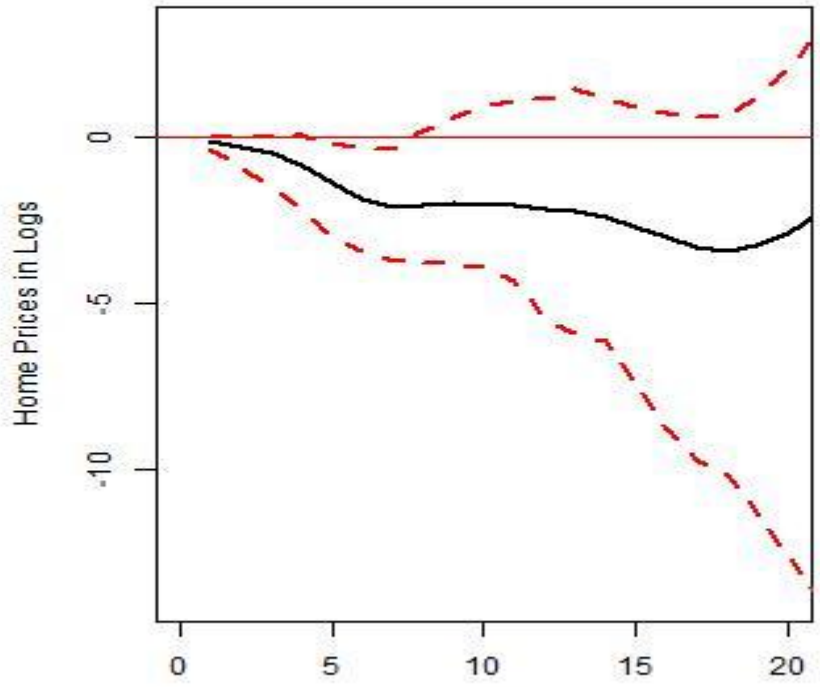
where I_n, A_i for i = 1, ..., p and H are n × n matrices, and ε_t a vector of n structural shocks. Equation 1 can be rewritten with lag-operator notation in a compact representation as

$$A(L)Y_t = H\varepsilon_t, \quad \text{(A2)}$$

In the SVAR, the A matrix is built so that home prices do not feedback onto mortgage rates in the first period. I am imposing the condition that demand shocks do not affect mortgage rates in the long run. To do this, I assume that the monetary policy shock (captured by the 30-year FRM) corresponds to the first column of H, denoted here as H_1. The impulse response function (IRF) of Y_t with respect to a monetary policy shock is then given by

$$\partial Y_t / \partial_{\varepsilon 1t} = A(L)^{-1} H_1 \quad \text{(A3)}$$

Chart A1. Twenty CBSA Average Home Price



95 % Bootstrap CI, 100 runs

The data used by Dias and Duarte (2019) is monthly data which runs from Jan-1983 to Dec-17, and also quarterly data run from 1981:Q1 to 2017:Q4. My data extends from Jan-13 to Sep-23. The period of my sample is a period of time with very few declines in home prices and rents. So, we would expect slightly different results. I select the number of lags, p, in the SVAR model to be 16. My result for the twenty CBSA average is presented in Chart A1. In line with Equation 5, I am concerned only with the near-term – what happens to rent appreciation when lease rates expire. I project out only 20 months. This is a short-horizon view. I find that a policy contraction which moves the 30-year FRM up 100 bps results in lower home prices 2.5 percent lower home prices after one year.[10]

A.2 What should we expect about the relationship between mortgage and rents?
There are two important differences between renters and homebuyers:

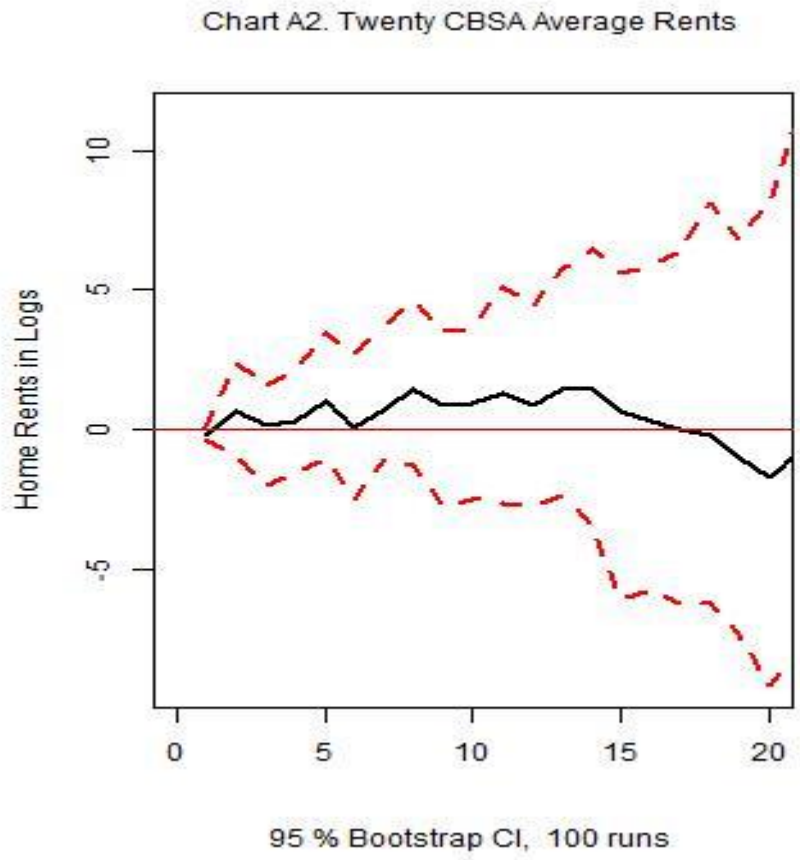
- Renters often sign rent contracts that limit their ability to move in the current time period.
- Renters do not take out a mortgage.

It is widely accepted that the rental payment on a single-family detached rental property is governed by the rules of the rent contract. Each contract is negotiated when the tenant moves into the property. If the tenant signs a one-year lease, then the tenant is guaranteed to be required to pay only the agreed upon amount for 12 months. Rents for single-family properties in which tenants have recently vacated (the spot rate) can go up if vacancies are low and the market is tight. A landlord must evaluate the cost/benefit to raising the rent on a house to a new tenant. For each CBSA, Altisource.com combines the rents on new leases with the rents on existing leases which yields the contract rental rate (an average or the mean of all new and static rent payments). We might expect the average contract rate for a CBSA to be pretty stable since the average rent payment for 3 bedroom properties for any CBSA is going to consist of rent payments heavily weighted by people who cannot (or do not want to leave).

But the reality is not simple. Not all tenants of single-family properties sign leases, and a lease agreement might be negotiable. Landlords recognize that constant rents amid higher home prices mean that their rate of return on that property is declining. Thus, higher home prices today, might be followed almost immediately by higher rents as landlords try to shore up earning. Although the reverse might not be true, lower home prices might be followed by lower rents. What pattern would govern how FRM influences rents?

[10] This is very close to 2.0% reported by Liu Haoyang et.al (2021) after 5 quarters using a irf with local projections approach (i.e., a semi-elasticity of 2). Dake, Plagborg-Møller and Wolf (2022) argue that there is no meaningful between an irf from a VAR or local projections model if interest centers on short horizons.

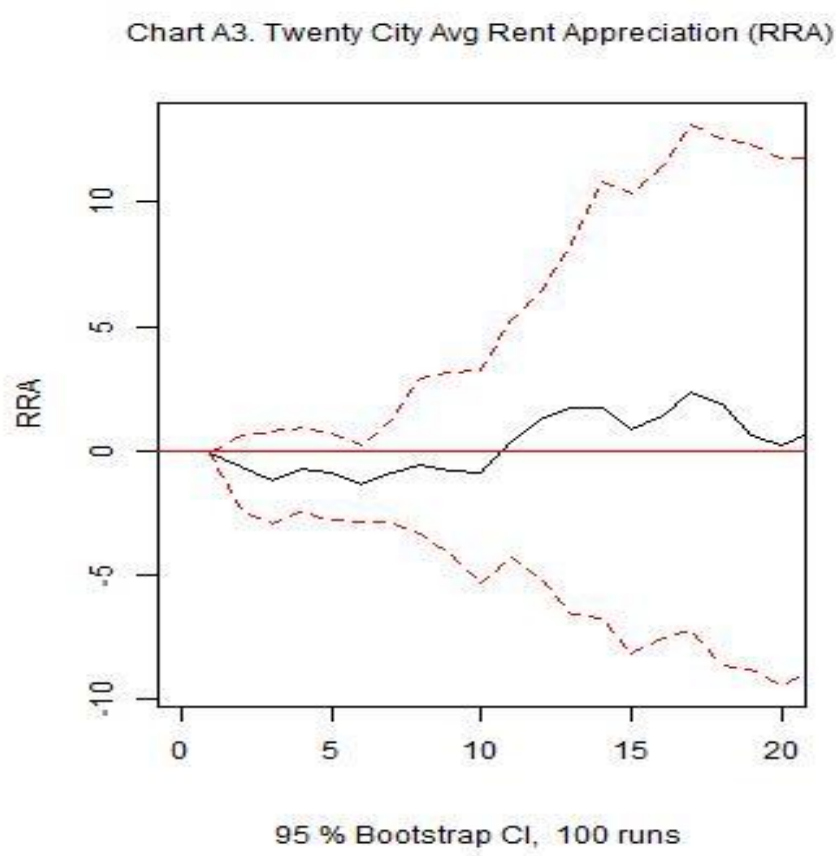
Let my response variable be the average of the log of rents for 20 CBSAs. Chart A2 shows that the impact of higher mortgage rates on average rent appreciation, for the 20 CBSAs in my sample. Rents are higher (similar to Dias and Duarte) during the first 16 months and then after that point rents fall (unlike their finding). The evidence supports the hypothesis that high mortgage rate cause home prices to fall and rent to rise.



A.3 Relationship between mortgage rates and rent appreciation (RRA)

Equation 5 above is test that relative prices (RVB) impact rent appreciation in the short run, say some period specified as 12 months. During the period of my sample (Jan-13 to Sep-23) home prices and rents generally increased. Looking at rent appreciation rather rent levels over this time period makes sense. We saw from Equation 5 that each CBSA responds differently. I can use a similar SVAR approach on rent appreciation rather than the levels since it is a short-horizon study. The results of the irf are in Chart 3.

We see in Chart 3, a small decline, or a delay to the point at which rent appreciates quickly. Why might there be a delay? It is reasonable to assume that that most renters of SFR properties are protected by the lease to external shock and that most landlords cannot respond quickly to the now higher mortgage rates and home prices slowing. Tenants on the other hand, because leaving is difficult, also need time to adjust to this new disequilibrium. It can take time to find a suitable new dwelling. For those tenants that do have a lease, as each individual tenant's lease expires, the tenant can then exercise his option to move. At that point, both the tenant and the landlord reconsider recent home price changes and the relative monthly costs of renting-versus-owning (RVB) and rental demand changes.



Renters, every month, in each CBSA, in the twelve to sixteen months following the identical (nationwide) monetary policy change look at relative prices (RVB) -- the central conclusion of both this paper and Dias and Duarte (2019) in their tenure choice.

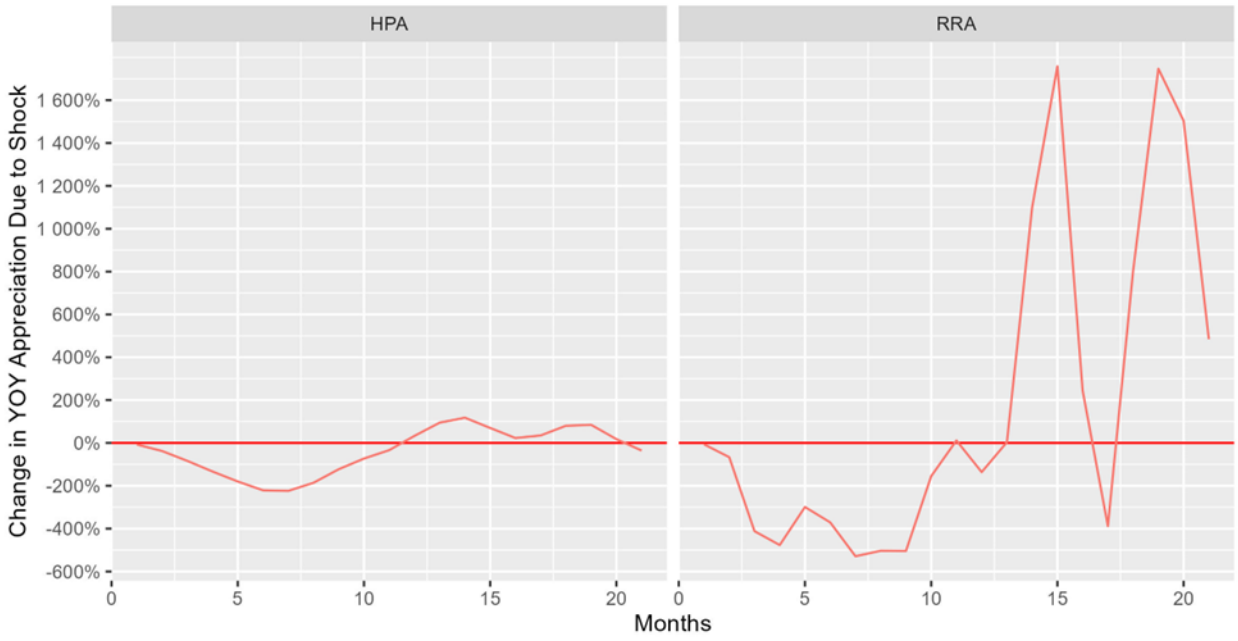
A.3 Individual Markets

However, each CBSA is different. We can see this more vividly in Charts A4 and A5 using the same SVAR approach. In those CBSAs, rent appreciation falls slightly immediately following the shock and then accelerates near month 12 as demand for shelter shifts to renting rather than owning. If we consider the results of Equation 5 (Table 1), the β_3

coefficient for both CBSAs is negative and significant -- rent appreciation falls as RVB drops.

Chart 3. Memphis, TN

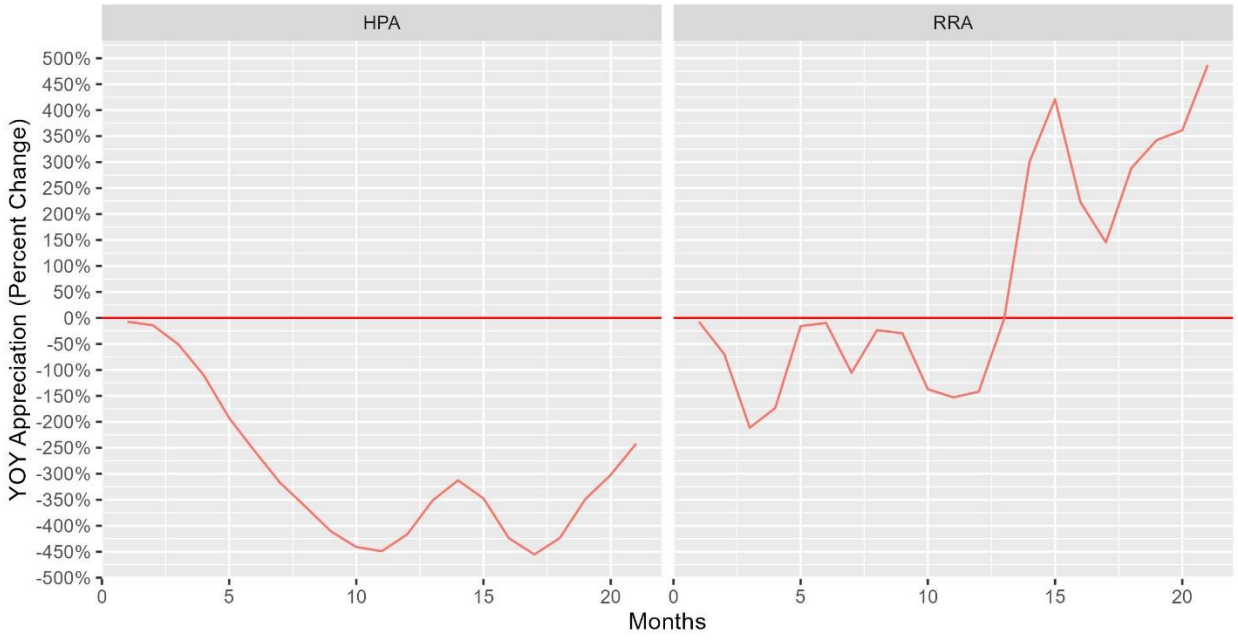
An 100 bps higher mortgage rate results in HPA slowing and RRA increasing



Source: Zillow.com, Altisource.com, Freddie Mac and CHTR

Chart A5. Denver, CO

An 100 bps higher mortgage rate results in HPA slowing and RRA increasing



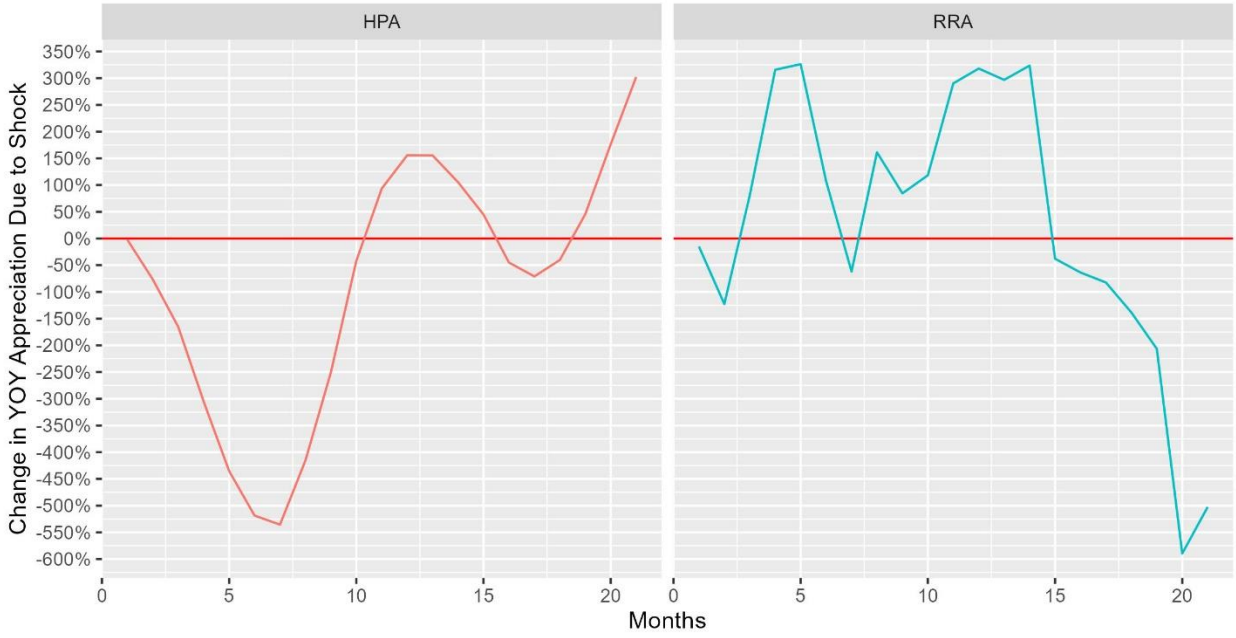
Source: Zillow.com, Altisource.com, Freddie Mac and CHTR

The pattern changes for both Los Angeles, CA and Washington, DC, (Charts 5 and 6) HPA slows and RRA quickens. Higher rates, reduce property demand, increase rental demand

and RRA quickens (almost immediately following a FRM rate change). In the case of strong demand for rental properties when housing to purchase becomes more expensive due to higher mortgage rates.

Chart 3. Los Angeles, CA

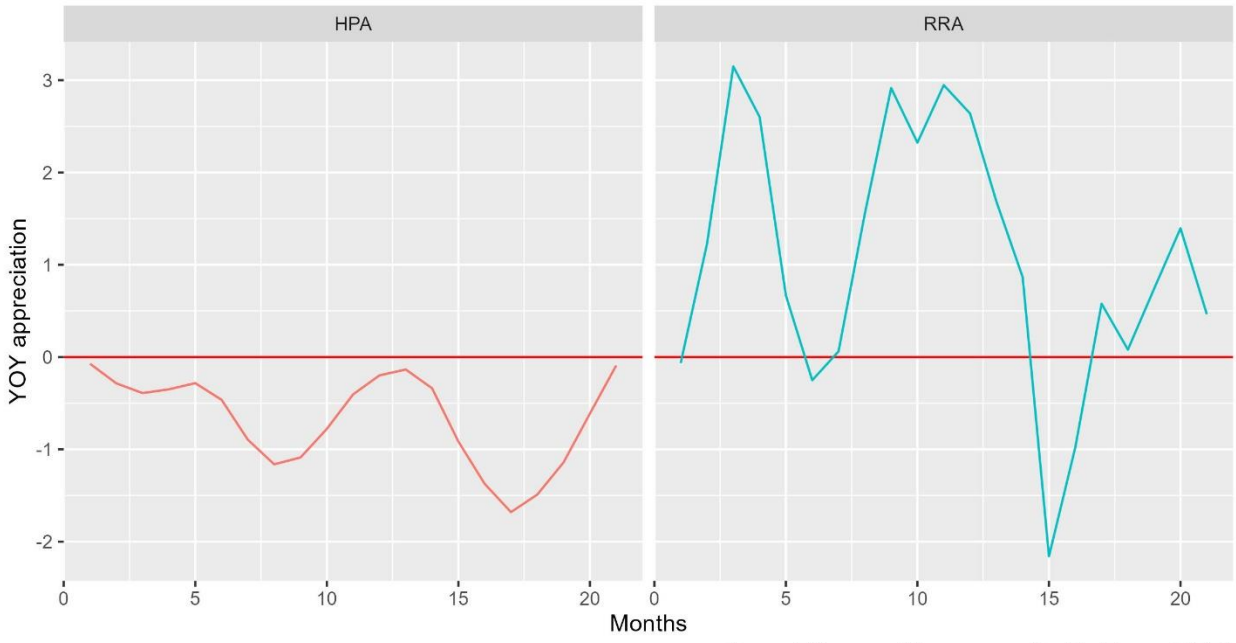
An 100 bps higher mortgage rate results in HPA slowing and RRA increasing



Source: Zillow.com, Altisource.com, Freddie Mac and CHTR

Chart 4. Washington, DC

High mortgage rates result in HPA slowing and RRA increasing



Source: Zillow.com, Altisource.com, Freddie Mac and CHTR