Fifty-Year-Olds and the Housing Demand Channel of Monetary Policy

Tereza Ranošová*†

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Abstract

The response of housing demand to changes in interest rates is a key mechanism of monetary policy. This paper shows that the effect of monetary policy shocks, identified through high-frequency event studies, on housing markets depends on the age-structure of the population in a non-trivial way. Both across U.S. metro areas and across states, local housing prices drop more after monetary policy tightens whenever the share of population between 50 and 65 years of age is higher. If the share of population in a metro area 50-55 years old increases by one percentage point, a one standard deviation monetary policy shock depresses housing prices by an additional 0.413 percent after 3 quarters. A stronger investment motive in the demand for real estate by this age group is a possible mechanism. This differential reaction of housing prices is already detectable by the quarter of the shock, and is followed by a differential response in employment starting about four quarters after the shock.

*Deutsche Bundesbank. Email: tereza.ranosova@bundesbank.de.

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1 Introduction

The volatility of the housing market is key to the understanding of business cycles and the response of the housing market is a key mechanism of monetary policy (Leamer, 2015). In this paper, I study the variation in the effect of national monetary policy on local housing markets. I show that the pass-through from a monetary policy shock to housing prices depends on the age structure of the economy. Specifically, I provide evidence that housing markets with a high share of population in their fifties react most to monetary policy. I test this hypothesis with both cross-state and cross-metro-area variation within the United States, confirm robustness across several dimensions and discuss possible mechanisms.

A large body of work shows that monetary policy tightening puts a downward pressure on housing prices. Jorda et al. (2015) provide robust evidence linking short-term rates, mortgage lending and house prices over 140 years and several countries, using monetary policy shocks identified based on the fact that countries with fixed exchange regimes often see fluctuations in short-term interest rates unrelated to home economic conditions. Paul (2020) provides recent evidence for the U.S. showing that high-frequency surprise jumps in short-term interests rates depress house price growth, and that this effect is time varying and especially low before the 2007-09 financial crisis.

Several papers study the geographic variation in the effects of monetary policy on housing markets. Fuss and Zietz (2016) show that local population growth is a key demand side factor and the percentage of undevelopable land a primary supply side factor that determine how national monetary policy impacts house price inflation rates at the MSA level. Congruently, Aastveit and Anundsen (2018) and Fischer et al. (2021) show that strict local regulatory environments and low housing supply elasticities are associated with larger housing price responses to monetary policy shocks, as quantities cannot adjust to the demand pressure. I propose a new factor that differentiates local markets in how reactive they are to shocks.

A long tradition in housing economics relates the demographic structure of the economy to housing demand. Mankiw and Weil (1989) argued that the baby boom of 1960s caused a housing boom in the 1980s, as a large cohort entering house-buying age pushed demand up. More recently Takats (2012) uses cross-country variation to show that higher shares of young adults motivate construction. Hiller and Lerbs (2016) come to the same conclusion using variation across German cities. I show that the age-structure also affects the sensitivity of demand to shocks.

Overall, this paper contributes to the growing literature arguing that the economy exhibits time-varying and place-varying responses to aggregate shocks, which depend on the microeconomic distribution of agents. Several papers study how the economy overall reacts to monetary policy shocks depending on the age structure of the population. The evidence so far is mixed. The most closely related of these is Leahy and Thapar (2022) who use a similar strategy to show that private employment and personal income respond most to a monetary policy shock in states with a high share of the population between 40 and 65 years of age. In section 6, I examine in detail how the effect on housing markets and the effect on employment are most likely linked. In contrast with Leahy and Thapar (2022), Berg et al. (2021) show that consumption expenditures for older households are more responsive to monetary policy shocks than for young or middle-aged households, while Sterk and Tenreyro (2018) find that the durable consumption of the young is more responsive than that of the middle aged and old. Wong (2018) also argues that consumption of the young is more sensitive to monetary policy, driven by the behavior of young homeowners. Similarly, Cloyne et al. (2020) shows that people holding a mortgage adjust consumption the most and those are typically younger. More generally, several papers have recently restarted the theoretical work on the role of lifecycle forces in the transmission of shocks. For example, Beaudry et al. (2024) argues that a stronger motivation to save for retirement mutes the response of monetary policy. Bardoczy and Velasquez-Giraldo (2024) study monetary policy in a model combining HANK features with an overlapping generations structure and lifecycle dynamics.

2 Data

I measure variation in house price appreciation using the Federal Housing Finance Agency Housing Price Index, on U.S. state and metro-area level. The FHFA (purchase only) index is a weighted, repeat-sales index, measuring average price changes in repeat sales on the same properties. This information is obtained by reviewing repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac. The baseline index is available for 100 largest metropolitan areas since 1990. I supplement the data on housing price growth with state-level data on employment in construction, and in real estate, rental and leasing services. State level employment data is available beginning in 1990, provided by the Current

Employment Statistics program conducted by the Bureau of Labor Statistics.[1] Lastly, I study the responses of housing permits (all and single-family). State-level data on new private housing units authorized by building permits is collected in the Building Permits Survey and provided by U.S. Census.

To study the responses to monetary policy shocks as dependent by age structure, I collect shares of population of metro areas by age in the 2013-2017 ACS as provided by the NHGIS progam (Manson et al., 2021). Population estimates by age for each year and state were retrieved directly from the U.S. Census website.[2] Shares of population in each age group are multiplied by 100, to be interpreted as percentage points.

I use monetary policy shocks identified using a high-frequency event-study approach, as pioneered by Kuttner (2001). Gurkaynak et al. (2005) study the responses of a range of asset prices around FOMC announcements in a narrow window (10 minutes before and 20 minutes after), so that one can be reasonably certain that any change is caused by the monetary policy change only. Gurkaynak et al. (2005) show that the effects on a variety of asset prices can be well summarized by 2 factors: one that captures variation related to current short-term interest rates (especially current and next month federal funds futures) and a second one that is constrained to only load on future or longer-term interest rates (labeled the 'target' factor and the 'path' factor, respectively). Swanson (2021) extends this analysis to the post great-recession period (capturing 241 FOMC announcements from July 1991 to June 2019), adding a third factor to account for quantitative easing. I use the 'target' factor as identified by Swanson (2021) as the monetary policy shock in this paper, and sum over the quarter to aggregate the high-frequency shocks to a quarterly frequency.[3] This shock is designed to reflect variation in a variety of asset prices, aggregating more information than pure jumps in the federal funds rate, yet is primarily identified from movements of short-term interest rates (stripping away the forward guidance aspect of monetary policy)[4]. This is important, as Paul (2020) shows that the target factor does not suffer from being contaminated with the 'information effect' (as discussed by Nakamura and Steinsson (2018) and others). Later I show that the results

[1]Construction employment is available for 45 states. Employment in real estate, rental and leasing services is available for 47 states.

[2]https://www2.census.gov/programs-surveys/popest/datasets/ retrieved in January 2021.

[3]As is standard in the literature, I exclude the FOMC announcement on September 17, 2001, which took place before markets opened but after financial markets had been closed for several days following the 9/11 terrorist attacks.

[4]Including federal funds futures contracts of different maturities, Eurodollar futures contracts of different maturities, and the 2-, 5-, and 10-year Treasury yields.

are robust to many alternative definitions of a monetary policy shock.

The final sample covers 1991Q3-2019Q2 and is determined by data availability of the monetary policy shock. The monetary policy shock is rescaled to have a standard variation of 1 within the sample. Table 7 provides summary statistics of the metro-area sample and figure 2 plots the monetary policy shock.

3 Metro-area-level analysis

This section presents the main result of the paper. In metro-areas with a higher share of population in their fifties tightening of monetary policy slows down house price growth more.

In principle, I treat the metropolitan area over time as a panel of housing markets. The primary advantage of focusing on markets within the US (as opposed to a cross-country comparison) is that it is a monetary union so that all are subject to the same monetary policy. This means that I can remove the first-order common effect of monetary policy using time fixed-effects and focus on the interaction of shocks with local demography, without worrying about differential monetary policy rules or differential feedback from housing markets to monetary policy. On the other hand, the precise quantitative interpretation of this analysis is not straightforward, due to the missing intercept problem (see Wolf (2023), AdĂŁo et al. (2019), Guren et al. (2021), Huber (2023), **?**).

To identify differential impact of monetary policy I regress the log-difference of a metro-area specific housing price index $p_{m,t}$ on a set of time and metro-area fixed effects and the share of population in a specific age range interacted with a monetary policy shock $\tilde{\epsilon}_t$.

$$log(p_{m,t+i}) - log(p_{m,t-1}) = \gamma_m + \delta_t + \alpha^{i,a} \cdot \tilde{\epsilon}_t \cdot s^a_{m,2010} + u_{m,t} \tag{1}$$

I run this regression separately for horizons $i = 0, ...6$ quarters and age ranges $a = 20 - 25, ..., 70 - 75, 75+$. Notice that in this specification $s^a_{m,2010}$ (the share of population of area m in an age range a) varies only crosssectionally, while the monetary policy shock $\tilde{\epsilon}_t$ varies over time. Thus while the baseline effect of $\tilde{\epsilon}_t$ is subsumed in the time fixed effects and the baseline effect of $s^a_{m,2010}$ is subsumed in the metro-area fixed effect, a differential response by a varying age-structure can be identified. The left-hand side $log(p_{m,t+i}) - log(p_{m,t-1})$ captures the cumulative change between $t-1$ and a horizon of i quarters, to trace down the effect on an impulse response as in Jorda (2005). The coefficients of interest $\alpha^{i,a}$ captures how much more a 1 standard deviation monetary policy tightening affects the impulse response of the log of housing prices if the share of population in the age range a is 1 percentage point higher. The sample of metro areas is weighted by 2010 population and the coefficients are rescaled by one hundred, so the results can be interpreted in percentage point changes.

Table 1 shows the results for horizons of 0-6 quarters and age ranges of 50-55 and 55-60. In areas where the share of population 50-55 years old is 1 percentage point higher, a one standard deviation shock decreases housing prices by a further 0.41 percentage points after 3 quarters and 0.64 percentage points by 6 quarters. Figure 1 plots $\alpha^{i,a}$ for a variety of age ranges and a horizon of 3 quarters. Similarly, figure 1 plots $\alpha^{i,a}$ for a variety of age ranges and a horizon of 6 quarters. Overall, a clear pattern emerges. Housing markets with a large share of residents in their fifties react substantially more to monetary policy. Metro-areas with a high share of population 35-45 years of age react less than average (though this could be because this share is negatively correlated with the share in their 50s). Other age groups do not show a significant effect.

4 State-level analysis

Next, I show that also across states higher share of population in their fifties is associated with a stronger housing market reaction to monetary policy with the following specification:

$$log(y_{s,t+i}) - log(y_{s,t-1}) = \gamma_s + \delta_t + \alpha^{i,a} \cdot \tilde{\epsilon}_t \cdot s^a_{s,t} + \phi^{i,a} \cdot s^a s, t + \beta X_{s,t-1} + u_{s,t} \tag{2}$$

$X_{s,t-1}$ includes 4 quarter population growth.[5] First I confirm that the pattern observed across metro areas for house price growth also holds across states. Figures 2 plot $\alpha^{i,a}$ for $y_{s,t}$ being a state-level housing price index, a variety of age ranges and a horizon of 3 quarters and 6 quarters respectively. Across states it also holds that higher shares of population between 50 and 60 years old is associated with stronger responses of housing prices to monetary policy. When studying variation across metro-areas it seems that housing markets with a higher share of population between 35-40 responds less to monetary policy shocks. This pattern is not robust to using state-level variation. If anything, it seems that higher shares of population in their twenties is possibly associated with a weaker response to monetary policy.

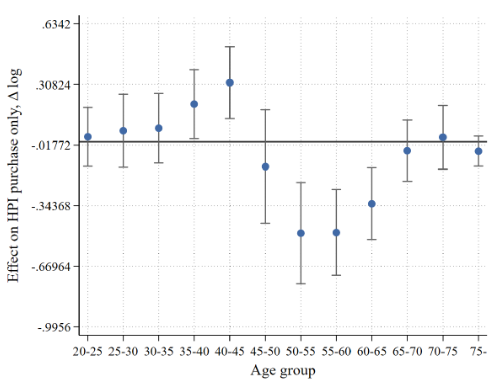
A stronger reaction in house prices can be caused by a stronger housing demand response or

[5] 4-quarter growth is chosen, because population estimates are only available annualy.

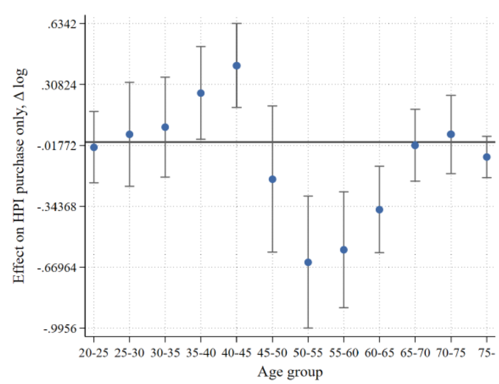
Figure 1: Differential response of metro-area housing prices to monetary policy shocks based on the local age structure

	$\Delta_i \log(p_{m,t+i})$						
	$i=0$	$i=1$	$i=2$	$i=3$	$i=4$	$i=5$	$i=6$
$s_{m,2010}^{50-55} \cdot \tilde{\epsilon}_t$	-.096	-.210	-.292	-.413	-.492	-.572	-.643
	(.032)	(.066)	(.093)	(.107)	(.139)	(.160)	(.180)
	$\Delta \log(p_{m,t+i})$						
	$i=0$	$i=1$	$i=2$	$i=3$	$i=4$	$i=5$	$i=6$
$s_{m,2010}^{55-60} \cdot \tilde{\epsilon}_t$	-.102	-.236	-.324	-.406	-.488	-.542	-.577
	(.027)	(.054)	(079)	(.094)	(.117)	(.138)	(.158)
N	11200						
N clusters	100						
Sample	1991Q3 - 2019Q2						

Standard errors in parentheses, clustered at the MSA level.



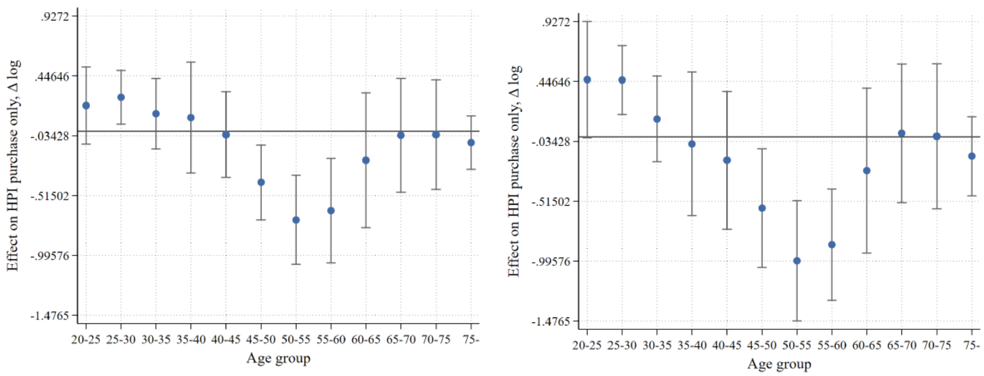
Lag 3



Lag 6

Sample of 100 largest MSAs and metropolitan divisions, weighted by population. Source of price indices: FHFA HPI ©.

Figure 2: Differential response of state-level housing prices to monetary policy shocks based on the local age structure



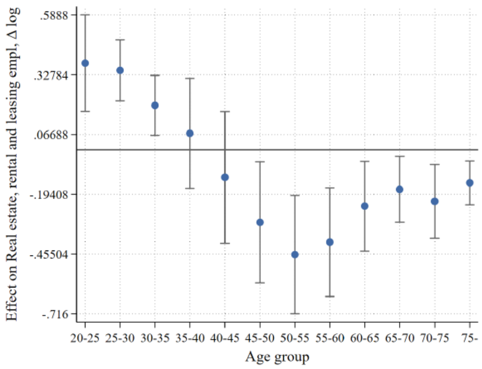
Lag 3 Lag 6

Sample of US states, weighted by population. Source of price indices: FHFA HPI ©. Figures plot the point estimates and 95% confidence intervals of $\alpha^{3,a}$ and $\alpha^{i,6}$ for a variety of age ranges.

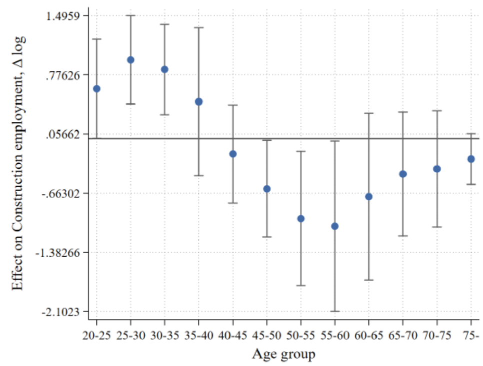
a weaker housing supply response. Thus I next study a set of quantity-related variables associated with the housing market. There is no publicly available data on the number of sales disaggregated by state or metro-area for a long enough time horizon. However, state-level employment by sector is available since 1990. I study two sectors especially associated with activity in the housing market: employment in real estate, rental and leasing services and employment in construction. Figures 3 show the results for a horizon of 6 quarters. Real estate, rental and leasing services employment does react more to a monetary policy shock in states with a lot of people in their fifties. However, unlike with prices other age-groups show up as having a significant impact as well. Younger states are associated with weaker monetary policy responses in real estate employment, while older states have a stronger response. The results are similar for construction employment. States with a higher share of population bellow 35 years of age have their construction employment less affected by national monetary policy, while states with a lot of people in their fifties react the most.

Last, I study the behavior of new housing permits to build single-family housing. Figures 4 show that housing permits react more to monetary policy in older states and less in younger states. However, unlike with housing prices and sectoral employment the share of population in their fifties does not have a significant effect on the sensitivity of housing permits to monetary policy. Still, the

Figure 3: Differential response of state-level housing-related employment to monetary policy shocks based on the local age structure



Real estate, rental and leasing emp, lag 6



Construction employment, lag 6

Sample of US states, weighted by population.

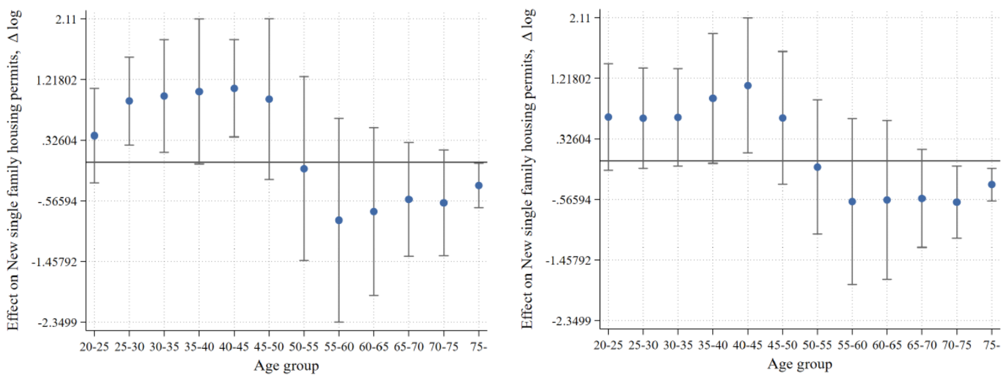
pattern is broadly in line with the behavior of prices. Importantly, there is no evidence suggesting that the the supply of housing reacts less to monetary policy in states with a lot of people in their fifties. This implies that the price responses identified above are likely driven by a difference in demand behavior, not supply. Moreover, the inconclusive behavior of permits suggests that the price responses are coming from the market for existing houses and less so for new construction.

5 Robustness

Fuss and Zietz (2016), Aastveit and Anundsen (2018) and Fischer et al. (2021) all show that monetary policy affects housing prices more in metro areas that have a low elasticity of housing supply. If the age structure of the population correlates with housing supply elasticity, this effect could confound the mechanism estimated in this paper. Following Aastveit and Anundsen (2018), I use the metro-area housing supply elasticity measure developed by Saiz (2010). Figures 9 and 9 repeat the metro-area analysis while adding $\tilde{\epsilon}_t \cdot \mathit{Saiz\ elasticity}_m$ as an additional control, showing that if anything the effects are more pronounced.

Next I test how robust the results are to using different measures of monetary policy shocks.

Figure 4: Differential response of state-level housing starts to monetary policy shocks based on the local age structure



Lag 3, 1-Unit Structures

Lag 6, 1-Unit Structures

Sample of US states, weighted by population.

First, I show that the results are broadly robust to using alternative monetary policy shocks not reliant on high-frequency event studies as identified in Romer and Romer (2004), Aruoba and Drechsel (2024) and Bu et al. (2021) (see figure **??**). Next I check the robustness to using different versions of the high-frequency identified monetary shocks. In figure **??**, I show that using raw jumps in the current month federal funds futures implied rate, as in Gorodnichenko and Weber (2016) extended with the replication data provided by Paul (2020), gives almost the same results but with less precision. The last figure shows that the overall results are robust to using the 'target factor' identified on data excluding unscheduled FOMC meetings, though the effect of the 50-60 ages share are slightly smaller.

The strategy of using high-frequency surprises as monetary policy shocks has come under some scrutiny since its inception. Several papers have documented that even this very targeted measurement method leads to a series of shocks that likely measure more than the change in monetary policy orthogonal to the current economic conditions. Specifically, the shocks can still be predictable and autocorrelated (Ramey (2016), Cieslak (2018)) and can correlate with central banks' private macroeconomic forecasts (Barakchian and Crowe (2013), Gertler and Karadi (2015), Ramey (2016)). This can be either because the Fed is revealing some of its private information through their policy action (as in Nakamura and Steinsson (2018)) or that the Fed is reacting with a surprising intensity compared to what the markets expect (as argued by Bauer and Swanson (2023a) and labeled the 'Fed response to news' channel). To deal with these potential issues several authors have proposed strategies to orthogonalize the series of high-frequency surprises in asset prices around FOMC meetings with respect to the information effect. Jarocinski and Karadi (2020)'s approach uses the information-processing power of the markets and identifies central bank information shocks from the high-frequency co-movement of interest rate and stock market surprises (based on the intuition that if a monetary policy tightening also has a signaling content about an improving economy, stock prices would increase, despite the contractionary effects of the tightening itself). Figure **??** shows the baseline results are robust to using this series of shocks. Bauer and Swanson (2023b) project the standard high-frequency surprises in the federal funds rate on publicly available macroeconomic and financial news. Similarly, Miranda-Agrippino and Ricco (2021) orthogonalize the surprises with respect to central bank's economic projections as well as with past market surprises (purging the serial correlation as well). Figure **?** shows the comparison between the baseline result with using the monetary policy shocks series proposed by Bauer and Swanson (2023a). The first line shows that using this alternative series of shocks does not lead to the same conclusion. However, the second line reveals that the discrepancy is driven almost entirely by how the methods interpret the monetary policy actions of the Fed during the Great Recession. Specifically, if we replace the value of the shock for both our baseline series and the Bauer and Swanson (2023a) series during the quarters of the great recession with its sample mean excluding the great recession (completely neutralizing the shocks during this time), the results are very comparable across the two series.[6] Figure 13 shows why, plotting the baseline, Bauer and Swanson (2023a) and Miranda-Agrippino and Ricco (2021) series. While the baseline shock series interprets the cutting of interest rates during the Great Recession as an easing of monetary policy, the other series 'overcorrect' and interpret it as severe tightening. When I treat these actions as neutral, variation from the rest of the sample supports the baseline conclusion. Paul (2020) suggests that asset price jumps around unscheduled FOMC meetings before 1995 or after 2007 exhibit more of an information effect. Moreover, only after 1995 did the FOMC began issuing press releases following every meeting. Figure 10 presents the baseline results starting the sample in 1995. Since

[6]This conclusion is the same when comparing to Miranda-Agrippino and Ricco (2021) who also correct for the 'information effect'.

the Great Recession starting in 2008 was associated with a major housing market correction, I check that the results are not driven by the post 2008 sample in figure 10.

Next I argue that the housing market differences observed in this paper are not a pure consequence of the labor market differences observed by Leahy and Thapar (2022). Leahy and Thapar (2022) show that employment and personal income in states with a high share between 40 and 65 years of age respond more to monetary policy. A natural question is then whether the differential impact on housing markets is purely a result of differential impact on the whole economy, employment and income, that consequently prompts a shift in demand for housing through an income effect. I rerun the baseline state-level specification with the housing price index controlling for the proximate changes in state level non-farm employment $E_{s,t}$

$$log(p_{s,t+i})-log(p_{s,t-1}) = \gamma_s+\delta_t+\alpha^{i,a}\cdot\tilde{\epsilon}_t\cdot s^a_{s,t}+\phi^{i,a}\cdot s^a s,t+\beta X_{s,t-1}+\beta\cdot(log(E_{s,t+i})-log(E_{s,t-1}))+u_{s,t} \quad (3)$$

Table 1 presents the baseline state-level results for $a = 50 - 55$ and horizons of 0-6 quarters contrasted with the results from running the specification 3. At shorter-term horizons (0-2 quarters) the housing price results are essentially unaffected by controlling for changes in employment. Thus I conclude that the proximate cause of the differential reaction in the housing market is not a differential change in overall employment. At longer-term horizons the independent effect on housing prices diminishes and ultimately becomes subsumed with the variation in employment. This suggests that a stronger reaction in housing prices is ultimately followed by an effect on the whole economy.

6 Response of employment: the role of the housing market channel

In this section I show that the housing market plays a key role in why employment in states with a large late-middle-aged population reacts most to monetary policy.

To study the interaction between the effect on housing markets and the reaction in employment I run the following specification.

$$log(L_{s,t+i})-log(L_{s,t-1}) = \gamma_s+\delta_t+\alpha^{i,a}\cdot\tilde{\epsilon}_t\cdot s^a_{s,t}+\phi^{i,a}\cdot s^a s,t+\beta X_{s,t-1}+\beta\cdot(log(p_{s,t+i})-log(p_{s,t-1}))+u_{s,t} \quad (4)$$

Table 1: Differential response of state-level housing prices: with and without netting the effect on state-level employment

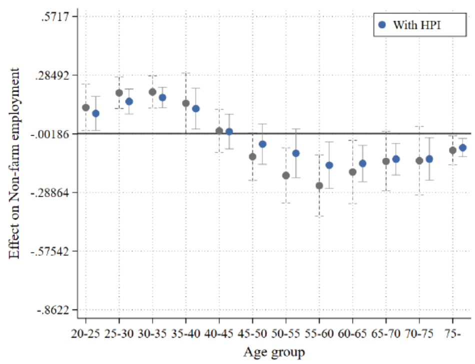
	$\Delta_i \log(p_{s,t+i})$						
	$i=0$	$i=1$	$i=2$	$i=3$	$i=4$	$i=5$	$i=6$
$s_{s,t}^{50-55} \cdot \tilde{\epsilon}_t$	-.188	-.438	-.595	-.710	-.863	-.927	-.992
	(.054)	(.124)	(.177)	(.183)	(.207)	(.230)	(.247)
$s_{s,t}^{50-55} \cdot \tilde{\epsilon}_t$	-.193	-.443	-.419	-.307	-.527	-.541	-.128
	(.052)	(.118)	(.133)	(.132)	(.183)	(.214)	(.304)
$\Delta_i \log(L_{s,t+i})$	x	x	x	x	x	x	x
N	5264						
N clusters	47						
Sample	1991Q3 - 2019Q2						

Standard errors in parentheses, clustered at the state level.

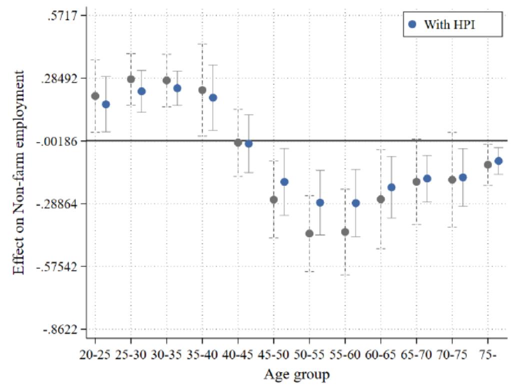
State-level variation. Results from specifications 2 and 3. The second line of the table shows the differential effect on house prices when accumulative effects on state-level employment are netted out.

On the left hand side is a cumulative log-change in non-farm employment as in Leahy and Thapar

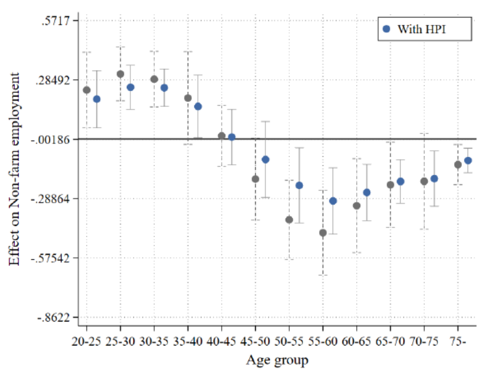
Figure 5: Differential response of state-level employment based on local age structure: with and without netting the effect on state-level housing prices



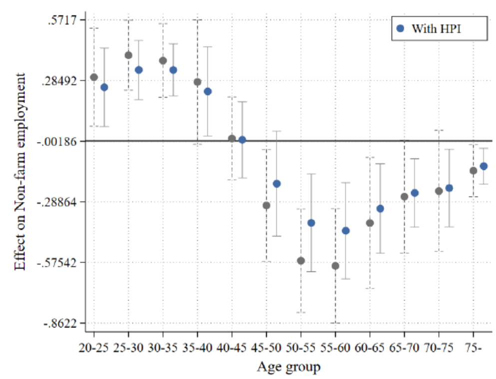
Lag 4



Lag 6



Lag 8



Lag 10

State-level, weighted by population. Source of price indices: FHFA HPI ©. Estimates of equation 4. Gray dots and dashed confidence interval replicate the results from Leahy and Thapar (2022), extended to match the sample and monetary policy shock used in this paper. Blue dots and solid confidence intervals add the cumulative log-change in housing prices as an additional control.

(2022). As a control I add the cumulative log-change in housing prices. Figures 5 show the results for a variety of age groups and horizons, with blue markers and solid confidence intervals. In each figure, gray markers represent results without adding $(log(p_{s,t+i}) - log(p_{s,t-1}))$ for comparison. Overall, the effect of age structure on the effectiveness of monetary policy is broadly similar with or without controlling for the reaction of the housing market, confirming this is not the only channel.

However, the exception is precisely in the effect of shares of population between 50 and 60 years of age. At all horizons, controlling for the cumulative log-change in housing prices diminishes the difference between the 50-60 age range and older groups. With or without an effect on housing prices age structure has a significant effect on how much monetary policy affects employment. Yet, when the effect on the housing market is regressed out, the conclusion simplifies. Younger states (with a high share of population bellow 40) react less than older states (with a high share of population above 50). A possible explanation is that the results in Leahy and Thapar (2022) are a combination of two mechanisms. A stronger housing market reaction by people of 50-60 years of age resulting in an overall slowdown in demand and employment, and an unknown mechanism that limits the response of employment whenever the share of population bellow 40 is high.

Interestingly, the results in figures 5 are essentially unchanged if only the cumulative effect on house prices by the second quarter is used:

$$log(L_{s,t+i}) - log(L_{s,t-1}) = \gamma_s + \delta_t + \alpha^{i,a} \cdot \tilde{\epsilon}_t \cdot s^a_{s,t} + \phi^{i,a} \cdot s^a s, t + \beta X_{s,t-1} + \beta \cdot (log(p_{s,t+2}) - log(p_{s,t-1})) + u_{s,t}$$

This reinforces the conclusion that the housing market mechanism operates sequentially. First housing demand reacts more in locations with a high share of population between 50 and 60 years of age. Next, after several quarters, this change propagates to a stronger reaction in employment.

7 Consumption versus savings in housing as a possible mechanism

The response of housing markets to monetary policy depends on the age structure of the market in a non-trivial way. It is neither the young places nor the older places that stand out. Prices respond the most in places with a high share of the population in their fifties. It thus begs the question – what makes 50-year-olds special?

One of the salient features that distinguishes this group from others is that they are at the peak of their life-cycle savings behavior. Their incomes are high and their retirement is getting close, motivating them to save more. This also translates in their housing market behavior. They are the most likely to be owners and their housing wealth is at their life-cycle peak. This is documented in the existing literature, for example in Iacoviello and Pavan (2013).

I hypothesize that a possible mechanism explaining the results in this paper stems precisely from this savings motivation. Intuitively, housing serves two purposes to individuals: it provides an immediate consumption value, but it is also a savings vehicle. Since people in their fifties have already accumulated a lot of housing, they might not care as much about the additional unit for immediate consumption. However, they are still very interested in acquiring more to save up. This dichotomy can be illustrated with a simple first order condition for housing stemming from a standard life-cycle model with consumption, housing (with a price p_t) and a savings/borrowing rate on a safe asset r_t:

$$\frac{MBH_t}{p_t} + \left(\frac{p_{t+1}}{p_t}\frac{1}{1+r} - 1\right) = 0 \tag{5}$$

The two terms in equation 5 are demonstrating the two aspects of housing demand. The first term represents the within-period marginal value of obtaining an additional unit of the housing good in consumption terms. In the simplest version of the model, $MBH_t = \frac{MU_{housing}}{MU_{consumption}}$. The second term represents the present value of an investment in one unit of housing. If MBH_t is lower for people in their fifties than for people of other ages, their demand for housing is more driven by the investment motive and thus more sensitive to the interest rate. On the aggregate, housing demand will be more sensitive to monetary policy when the share of fifty-year-olds is high.

There are several reasons why the marginal within-period benefit of a unit of housing might have a U-shape. First, as discussed above the value of housing an owner lives in has a reverse-U-shape over the lifecycle (see figure 6). Assuming the utility from housing is concave, as long as the life-cycle profile of consumption is flatter (or utility from housing more concave), $\frac{MU_{housing}}{MU_{consumption}}$ is lower for people in their fifties. Intuitively, people in their fifties have already accumulated a high value home, so an additional marginal improvement is not important to their period utility.

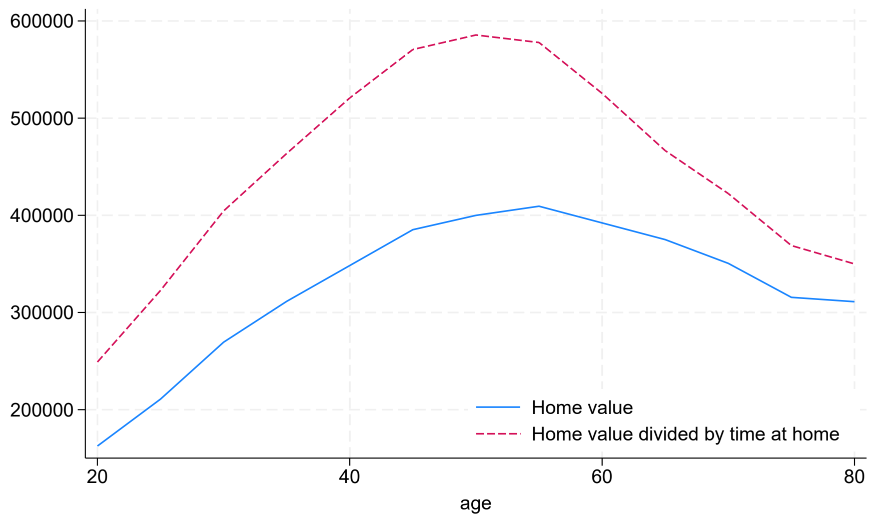
Other factors can be at play. For example, younger households are likely credit constrained and thus limited in how much housing they can buy. The first order condition does not hold, so the investment benefit of housing does not play a role in their decision. Moreover, for credit constrained households there is an additional immediate benefit to housing – serving as a collateral for additional loans. This additional immediate benefit diminishes the response to interest rates just as a high marginal utility from housing consumption does, providing an additional reason for low sensitivity to interest rates of the young as they are most likely to be credit-constrained.

Lastly, another aspect of housing demand that changes over the life-cycle is the time spent at home. As people retire, they spend more time in their homes and thus their marginal utility of another unit of housing likely increase. This is one of the plausible explanations for why the decline in home value with old age is only timid. To illustrate this point, assume utility from housing is given by $\log(H) \cdot T^{home}$, where T^{home} is the time spent at home. In this case the marginal utility from housing is given by $\frac{T^{home}}{H}$. Figure 6 plots the inverse of this quantity–value of own house per time spent in it–over the lifecycle, showing a strong inverted-U shape peaking around age 50. This suggests that fifty-year-olds are living in high value homes despite not spending that much time in them, consistent with the intuition that their marginal within-period value from an additional unit of housing is likely the lowest out of all age groups and their housing market behavior is dominated by the investment motive.[7] Overall, the life-cycle profile of housing consumption is a plausible

[7] The argument so far is based on the incentives of owners. The housing demand for renters pins down the market rent at $\frac{MU_{housing}}{MU_{consumption}} = R_t$ and those who operate in the housing market purely as investors have a demand equation $\frac{R_t}{p_t} + \left(\frac{p_{t+1}}{p_t}\frac{1}{1+r} - 1\right) = 0$, which collapses to equation 5 except what matters are the preferences of renters. However, if a rental market is present and the behavior of 50-year-olds is driven by their investment motive, they can consider participating in the housing market as downright investors renting out additional properties. Thus, to preserve the argument that a low marginal utility of housing consumption $MU_{housing}$ makes the demand of 50-year-olds for housing more sensitive to interest rates, there has to be a barrier for them as individuals to become investors or to get the same rents as large investors. This is not hard to imagine – with the fixed costs of acquiring an additional property, the agency issues of being a landlord, the institutional knowledge of the market that an individual investor is lacking and the often higher property taxes paid on properties that are not a first residence, it is no wonder a 50-year-old saver would opt for investing more in the home they live in (or vacation themselves)

mechanism for the aggregate results presented in this paper. Section C in the Appendix presents a toy model with the above mentioned mechanisms that matches the life-cycle profile of housing consumption and implies that the responsiveness of housing demand to the interest rate has an inverted-U shape in the share of the middle-aged in the population.

Figure 6: Value of own house over the life-cycle (raw and per time spent home)



The solid line plots the average value of owner-occupied residential homes H_a over the lifecycle, computed from the Survey of Consumer Finances (poling waves 1992 to 2022, excluding 2008 to 2012 due to the financial crisis and normalizing to 2022 dollars using the CPI). The dashed line plots the ratio of two averages $\frac{H_a}{T_a^{home}}$ over the lifecycle, where T^{home} is the share of time a person spends at home computed from the American Time Use Survey base on waves 2003-2019 of the Integrated Public Use Microdata Series (Flood et al., 2023).

8 Conclusion

In this paper I provide evidence that local housing markets are more sensitive to monetary policy if their population is more middle-aged. Specifically, the higher the share of population who are between 50-65 years old, the more housing prices fall (rise) after monetary policy tightens (loosens). This conclusion is true both across U.S. states and metropolitan areas and is robust to alternative sub-samples, alternative monetary policy shocks and to controlling for housing supply elasticity. I

rather then branching out into the wild west of owning and renting out additional properties.

also show that employment in housing-related sectors (real estate and construction) falls most after a monetary policy tightening in states with a high share of 50-65 year-olds, while housing permits do not show a clear pattern. This suggests that the differential effect of housing prices is a result of a differential response in demand, not supply.

The effects on employment relate this paper directly to Leahy and Thapar (2022) who show a similar conclusion across U.S. states for overall employment. In this paper I provide evidence that the differential effect on housing prices precedes that on employment but after several quarters they coincide. Moreover, when the effect on housing prices is netted out, the results for employment resemble more a simpler pattern where older places react more strongly to monetary policy than younger places. This suggests the effects on employment in Leahy and Thapar (2022) are a combination of a mechanism where the economy reacts more when its population is older with a mechanism where the housing market (and then consequently the rest of the economy) reacts most when middle-aged. Future research should unpack why employment in older states reacts more to monetary policy. Lastly, I suggest a possible mechanism that could generate the presented results in the housing market. A fruitful area for future research is to look for supportive microeconomic evidence for this mechanism, or to explain the pattern with an alternative one.

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Table 2: Monetary policy shock from Swanson (2021)

	mean	sd	count
HPI % Δ	0.9	2.1	11200
Share of 50-55 in msa	7.0	0.5	100
Share of 55-60 in msa	6.7	0.6	100
Population in msa	2029769.1	1972484.8	100
HF shock	0.0	1.0	112

A Appendix: Descriptive statistics of the sample

Table 7 presents the summary statistics of the baseline sample. Figure 7 plots the monetary policy shocks used in the baseline analysis. Figure 8 shows the shifting age composition in the U.S. over the last century.

Figure 7: Descriptive statistics of the sample

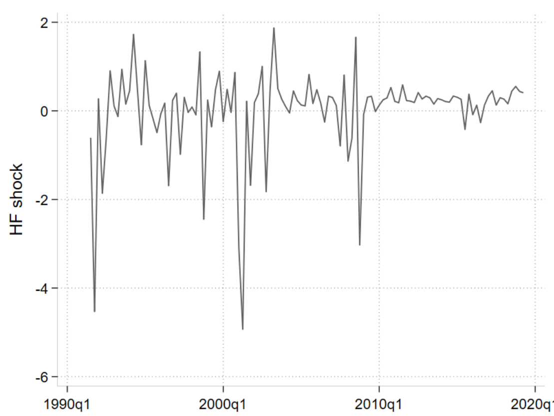
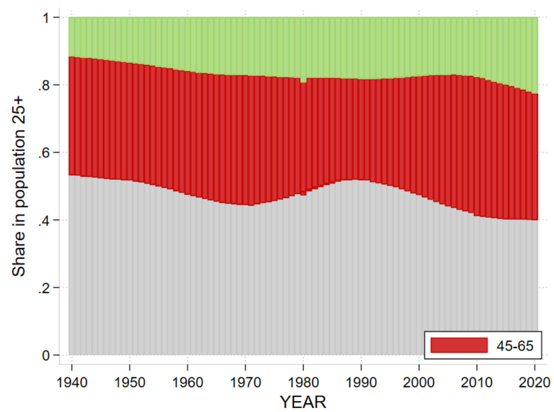


Figure 8: Shifting age composition

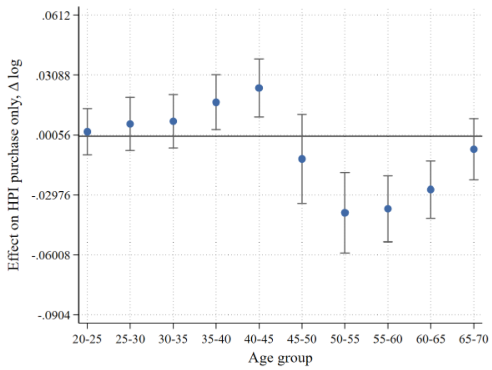


Source: U.S. Census.

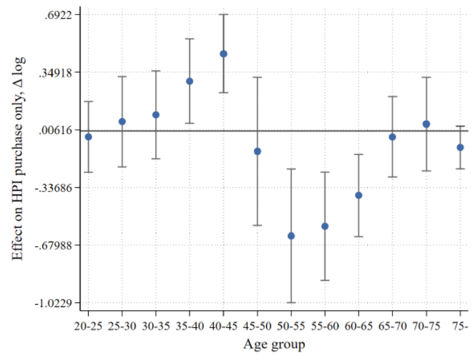
B Appendix: Robustness checks

This section presents several robustness checks, as described in the text. Figures 9 show the results of controlling for local housing supply elasticity in how much monetary policy shocks affect housing prices. Figures 10 show the results are robust to alternative time subsamples. Figures **??** show the robustness to using alternative measures of monetary policy shocks available in the literature.

Figure 9: Differential response of metro-area housing prices: controlling for local housing supply elasticity



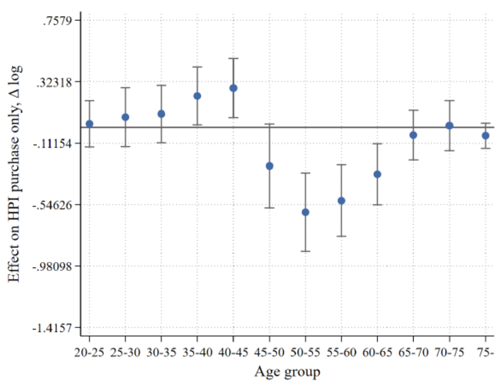
Lag 3



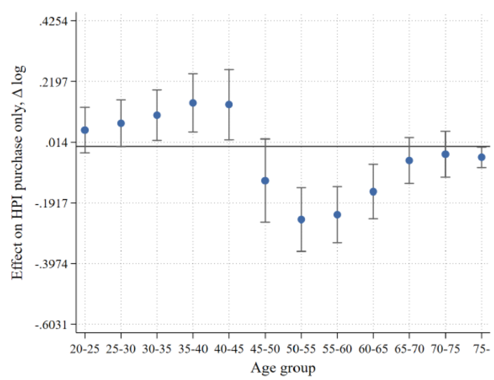
Lag 6

Adding $\alpha^{el} \cdot \tilde{\epsilon}_t \cdot$Saiz elasticity$_s$ as an additional control. Metro-level, weighted by population. Lag 3. Source of price indices: FHFA HPI ©.

Figure 10: Differential response of metro-area housing prices: early and late sub-samples



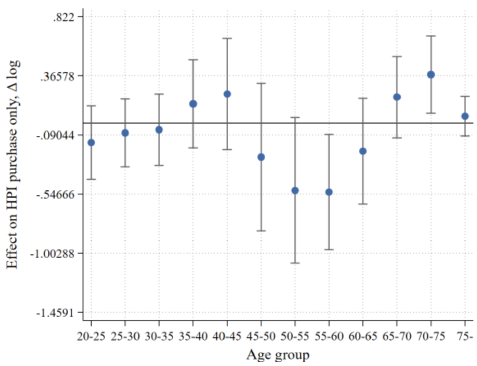
$t \geq 1995$



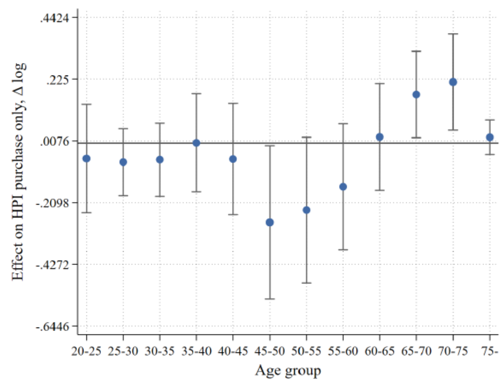
$t \leq 2007$

Metro-level, weighted by population. Lag 3. Source of price indices: FHFA HPI ©.

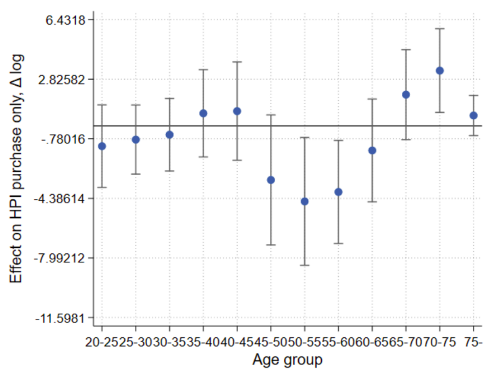
Figure 11: Differential response of metro-area housing prices: alternative monetary policy shock measures



Romer and Romer (2004)



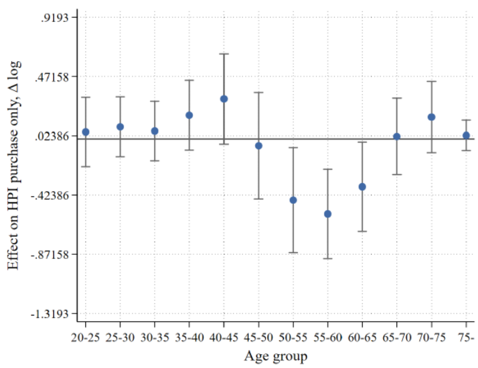
Bu et al. (2021)



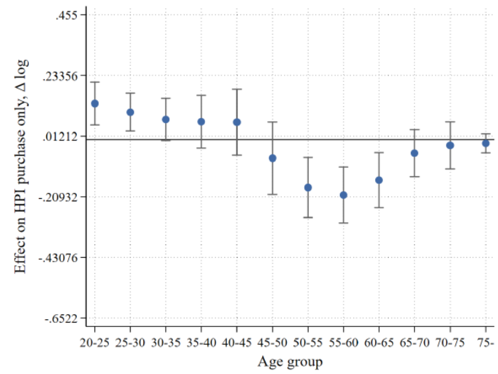
Aruoba and Drechsel (2024)

Metro-level, weighted by population. Lag 3. Source of price indices: FHFA HPI ©. (a) Romer and Romer (2004) shock series, extended by Johannes Wieland and Max Breitenlechner (1991Q1 - 2012Q4). (b) Aruoba and Drechsel (2024) shock series (c) MP shocks constructed by Bu et al. (2021) (1994Q1 - 2019Q3).

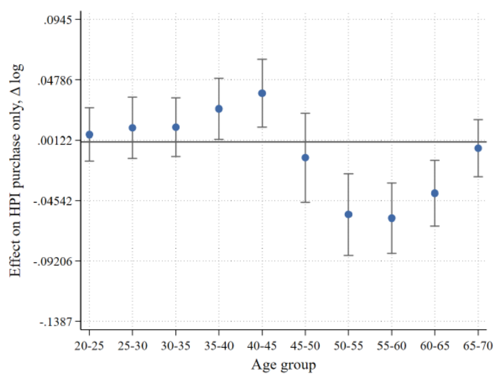
Figure 12: Differential response of metro-area housing prices: tweaks to the high-frequency measures



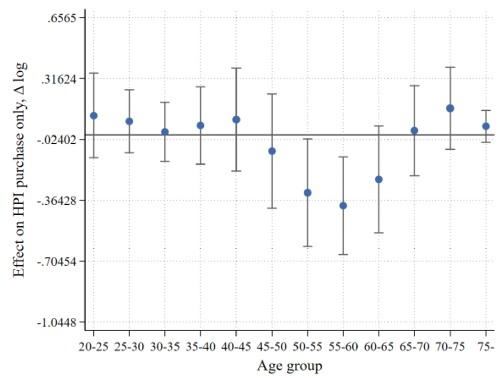
Gorodnichenko and Weber (2016) extended.



Jarocinski and Karadi (2020)



Swanson (2021), reweighted.



Gurkaynak et al. (2005) as in Paul (2020)

Metro-level, weighted by population. Lag 3. Source of price indices: FHFA HPI ©. (a) Raw 30-minutes window jumps in the price of federal funds rate current month futures around FOMC meetings from Gurkaynak et al. (2005), Gorodnichenko and Weber (2016) and Paul (2020) (Sample: 1991Q1 - 2017Q3). (b) MP shocks constructed in Jarocinski and Karadi (2020) (1991Q1 - 2016Q4). (c) Baseline MP shock, from Swanson (2021), aggregated using a weighted moving average as in Ottonello and Winberry (2020) (Sample: 1991Q4 - 2019Q2) (d) Target factor from Paul (2020) extracted according to the Gurkaynak et al. (2005) methodology, but excluding all unscheduled FOMC meetings (Sample: 1991Q1 - 2017Q3)

Figure 13: Comparison between baseline, Miranda-Agrippino and Ricco (2021) and Bauer and Swanson (2023a) shocks.

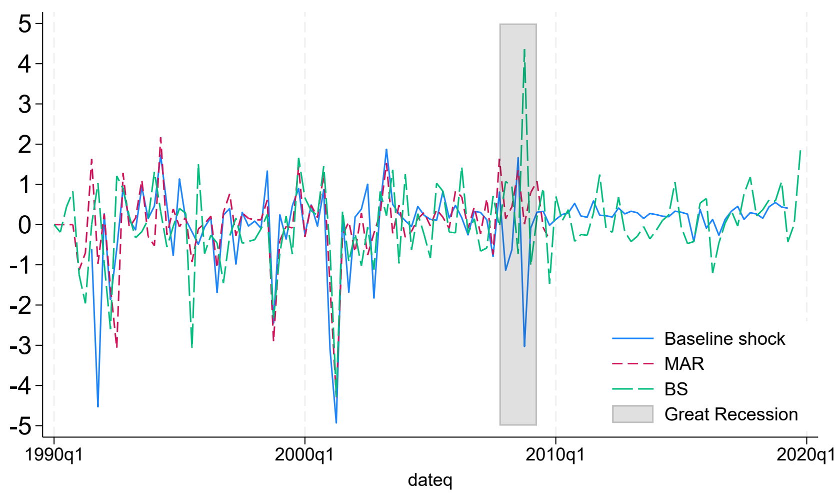
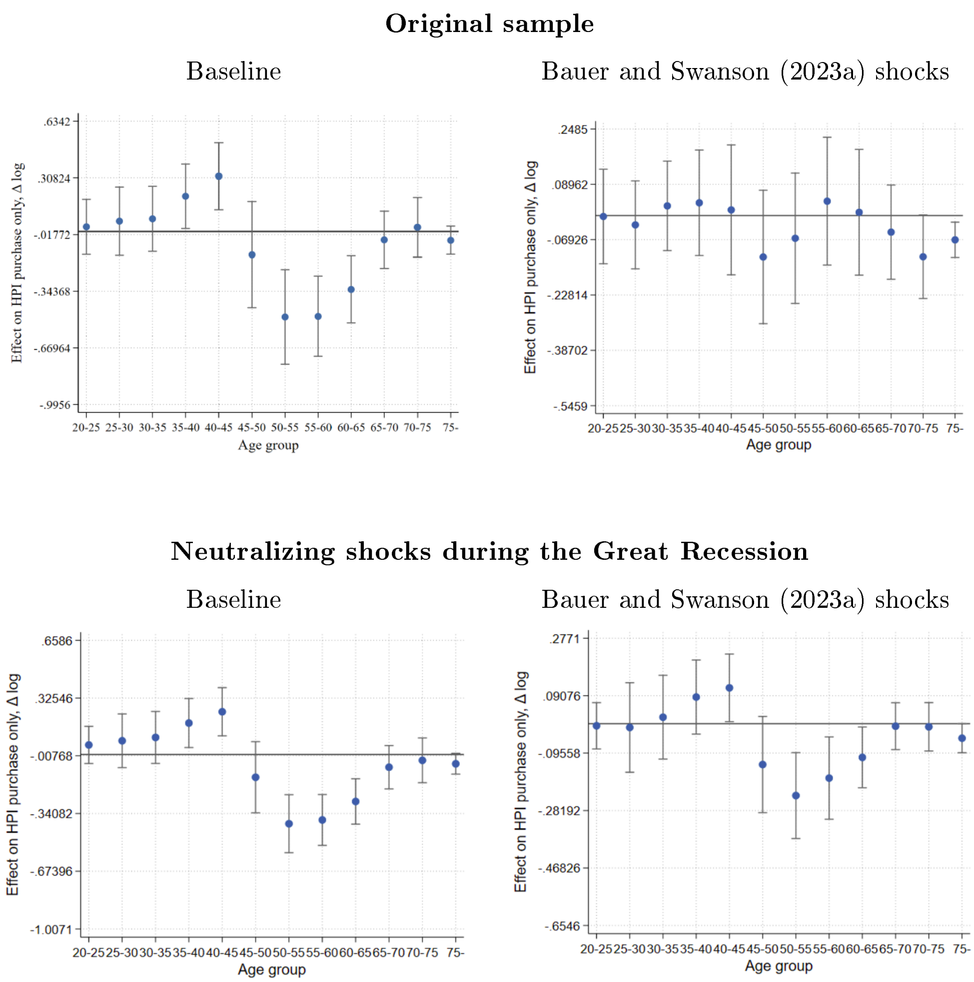


Figure 14: Comparison with using the Bauer and Swanson (2023a) shocks.



Comparing the baseline results with using the monetary policy shocks series proposed by Miranda-Agrippino and Ricco (2021). In the second line, we replaced the values of the shock in quarters 2007q4-2008q4 with its sample mean in the period before the Great Recession (neutralizing the values of the shocks during the Great Recession).

Lastly, I examine the variation in the share of 50-60 year olds across U.S. metropolitan areas. In figure 15 I visualize the variation on a map. Clearly, a considerable portion of the variation is across-regions. This gives room to the suspicion that the measured differential response of housing prices to monetary policy shocks does not arise from the differences in age-structure itself, but from other broad differences across regions. In table 3 I test how well the results hold up when cross-regional variation is netted out, zooming in at the role of 50-60 year olds and also specifically 55-60 year olds and a lag of 3 quarters. Controlling for a Census region fixed effect dummy one at a time affects the results only marginally. Therefore, I can conclude that the results are not driven by a specific region. However, when netting out all cross-region differences in the response to a shock reduces the baseline result to almost zero, suggesting cross-regional differences in some form are necessary to draw the conclusions of the paper. Upon further investigation, one of the reasons for this is that the within-region variation in the share of 50-60 year olds correlates closely with the within-region variation in the share of an older population in general. Figure 16 illustrates this point visually. The second map in 15 also shows that when within-region differences as well as the variation in the share of the population older than 50 is netted out, there is still plenty of variation left. The last column of table 3 shows that when I net out the differential response in older vs younger areas (including a share of population 50 plus interacted with the shock), the baseline results is robust to including Census region fixed effects interacted with the shock and is thus not driven purely by cross-regional differences.

Table 3: Differential response of metro-area housing prices: the role of regional and within-regional differences

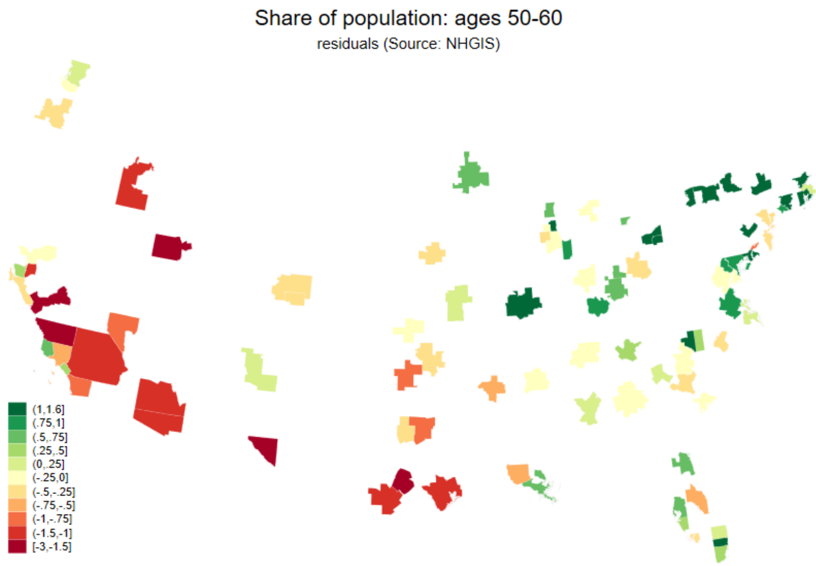
	$\Delta \log(p_{m,t+i})$, $i = 3$					
$s_m^{50-60} \cdot \tilde{\epsilon}_t$	-.387	-.245	-.409	-.204	-.058	-.147
	(.108)	(.105)	(.112)	(.092)	(.094)	(.094)

	$\Delta \log(p_{m,t+i})$, $i = 3$					
$s_m^{55-60} \cdot \tilde{\epsilon}_t$	-.378	-.274	-.405	-.240	-.087	-.430
	(.092)	(.094)	(.106)	(.077)	(.071)	(.140)
region 1 $\cdot \delta_t$	x				x	x
region 2 $\cdot \delta_t$		x			x	x
region 3 $\cdot \delta_t$			x		x	x
region 4 $\cdot \delta_t$				x		
$s_m^{50-} \cdot \tilde{\epsilon}_t$						x
N	11200					
N clusters	100					
Sample period	1991Q3 - 2019Q2					

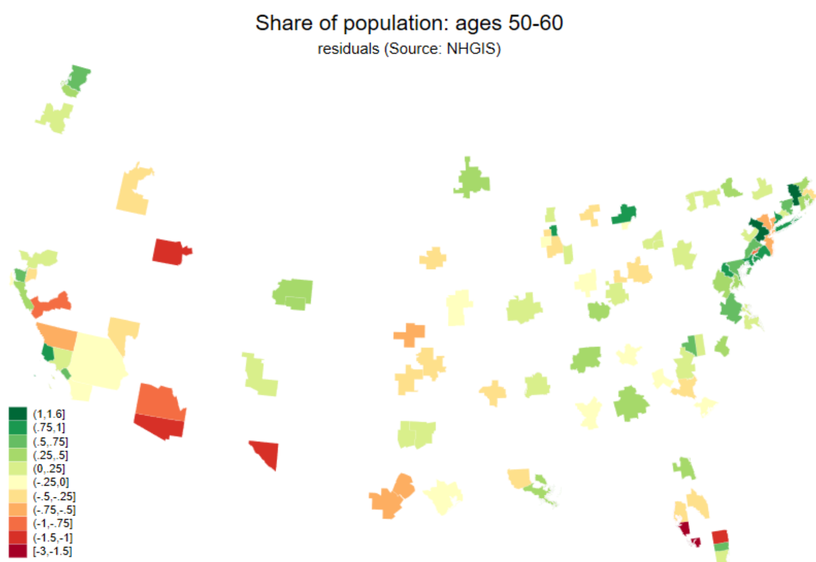
Standard errors in parentheses, clustered at the MSA level.

Sample of 100 largest MSAs and metropolitan divisions, weighted by population. Source of price indices: FHFA HPI ©. Column 1 reproduces the main result from 1 with age groups 50-60 and 55-60 and lag of 3 quarters. Columns 2-4 add an interaction of a particular Census region's dummy with the shock. Column 5 adds all of regions 1-3 (adding all regions would result in colinearity). Column 6 adds the region dummies interacted with a shock as well as a share of population 50+ interacted with the shock.

Figure 15: Map of metropolitan areas by share of 50-60 year olds

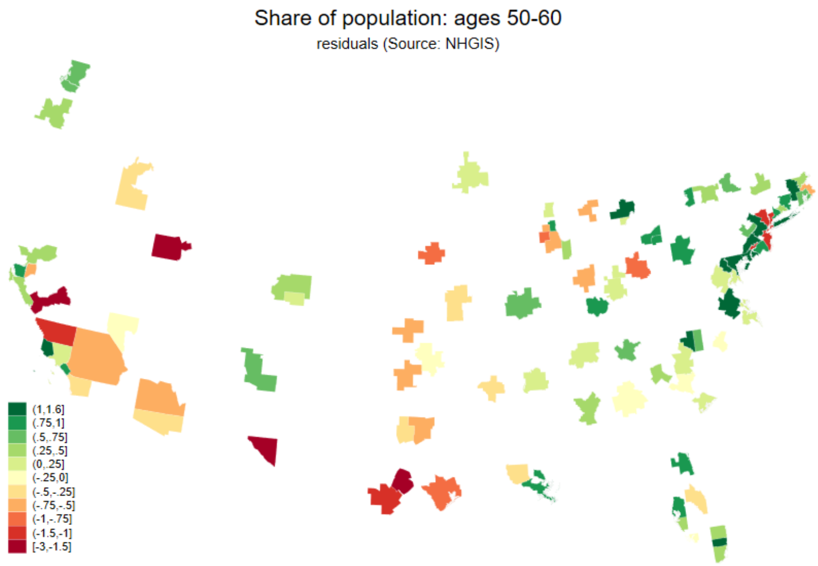


Demeaned share 50-60

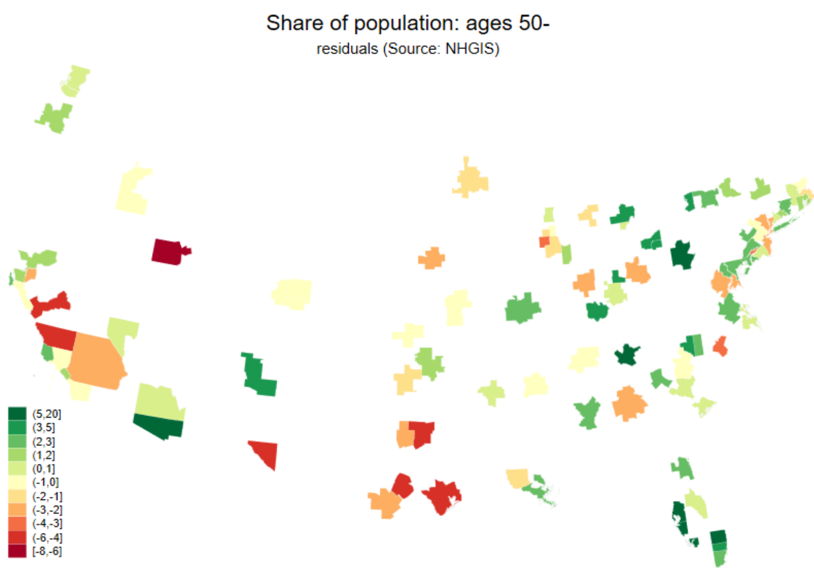


Demeaned share 50-60, within regions & variation in share 50- netted out

Figure 16: Map of metropolitan areas by share of 50-60 year olds: cont.



Demeaned share 50-60, within regions



Demeaned share 50-, within regions

Metro-level, weighted by population. The first map shows the geographic distribution of the share 50-60 years old across US metro areas. The second map shows the geographic distribution of the share 50-60 years old across US metro areas with regional differences netted out. The third map shows the geographic distribution of the share 50-60 years old across US metro areas with regional differences netted out. The fourth map shows the geographic distribution of the share 50+ years old across US metro areas with regional differences netted out.

C Appendix: Toy model

In this section I describe a toy model that rationilizes the hump-shape in responsiveness to monetary policy observed in the data. It does so through the hump-shape in $\frac{p \cdot H}{T^{home}}$. Each agent lives for 3 periods: young, middle and old $(1, 2, 3)$. Over these

$$\max_{c^s, H^s, B^s} \sum_{s=1,2,3} \beta^{s-1} (\log(c^s) + \alpha \log(H^s) \cdot T^s) \tag{6}$$

$$\begin{aligned} \text{s.t. } c^s + p(H^s - H^{t-1}) + \frac{B^s}{1+r} &= B^{t-1} + Y^s \\ T^s = 0.5 \text{ if } s = 1, 2 \text{ and } T^s &= 1 \text{ if } s = 3 \\ Y^s = 0.5 \text{ if } s = 1, \, Y^s = 1 \text{ if } s = 2 \text{ and } Y^s &= 0 \text{ if } s = 3 \\ pH^s &\leq \Theta \text{ if } s = 1 \end{aligned} \tag{7}$$

The housing market clearing (with fixed supply for simplicity) is given by

$$\bar{H} = \omega^1 H^1 + \omega^2 H^2 + \omega^3 H^3$$

First order conditions

$$\frac{1}{c_t^1} = \beta(1 + r_t) E_t \frac{1}{c_{t+1}^2}$$

$$\frac{1}{c_t^2} = \beta(1 + r_t) E_t \frac{1}{c_{t+1}^3}$$

$$\frac{\alpha T^2}{H_t^2} + \frac{1}{c_t^2} \Big(\frac{E_t(p_{t+1})}{1 + r_t} - p_t \Big) = 0$$

Housing in other life periods is given by $H_t^1 = \frac{\Theta}{p_t}$ (as the constraint is calibrated to be binding in and close to the steady state) and $H_t^3 = \frac{B_t^2 + p_t H^2}{p_t} \frac{T^3}{1+T^3}$. For the old generation, we get the consumption function as $c_t^3 = \frac{B_t^2 + p_t H_t^2}{1+T^3}$. Together with the three sequential budget constraints, I solve for the 9 variables (3 choices per life-stage). Together with the housing market clearing, I solve for the price of housing.

The policy functions can be solved recursively (suppressing expectation operators). For $s = 3$ the policy functions are $B^3 = 0$, $H^3 = \frac{B^2+pH^2}{p}\frac{\alpha T^3}{1+\alpha T^3}$ and $c^3 = \frac{B^2+p_tH^2}{1+T^3}$. For $s = 2$

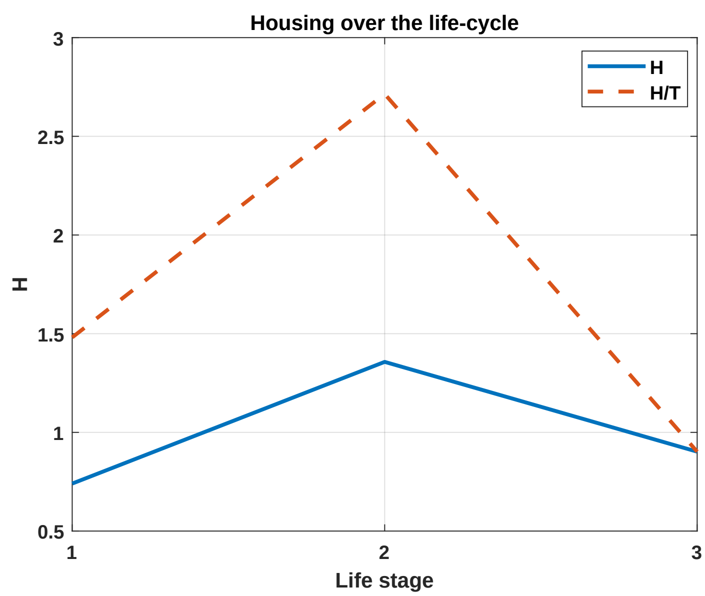
$$B^2 = (p_tH^1 + B^1 + Y^2)\frac{1}{\frac{1+\frac{p_t\alpha T^2}{p_t-p_{t+1}/(1+r_t)}}{(1+\alpha T^3)(1+r_t)\beta-\frac{p_t\alpha T^2}{p_t-p_{t+1}/(1+r_t)}} + \frac{1}{1+r}}$$

$$c^2 = \frac{p_tH^1 + B^1 + Y^2}{1 + \frac{p_t\alpha T^2}{p_t-p_{t+1}/(1+r_t)} + (1+\alpha T^3)\beta - \frac{p_t\alpha\alpha T^2}{(1+r_t)p_t-p_{t+1}}}$$

$$H_2 = \frac{c_2\alpha T_2}{p_t - p_{t+1}/(1+r_t)}$$

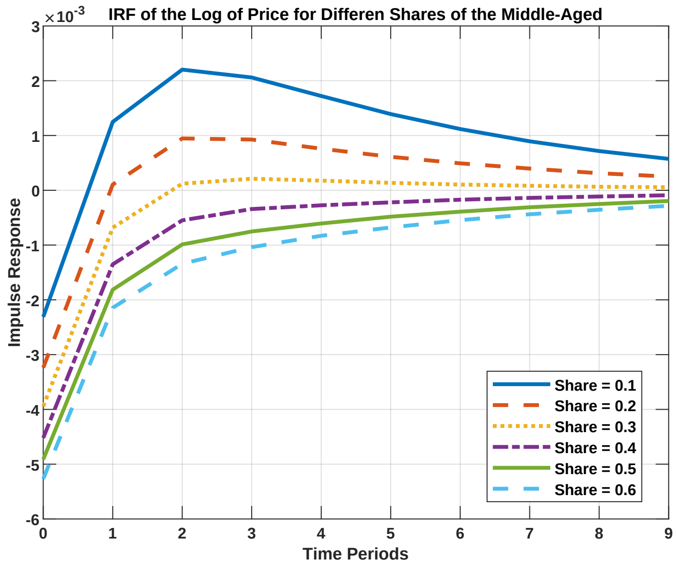
For $s = 1$, I calibrate the housing constraint to be clearly binding, with $H^1 = \frac{\Theta}{p_t}$.

Figure 17: Housing demand over the life-cycle (raw and per time spent home)



The solid line plots the amount of housing H_a over the lifecycle. The dashed line plots the ratio $\frac{H_a}{T_a^{home}}$ over the lifecycle, where T^{home} is the share of time a person spends at home.

Figure 18: Impulse response of the price of housing to an interest rate shock



Impulse responses of the log of p_t for varying levels of ω_2 to a 0.01 increase in the interest rate.