Do Lower Mortgage Rates Benefit First-Time Homebuyers? *

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Abstract

This paper investigates the mortgage channel of monetary policy transmission to home purchasing behaviors of first-time home buyers and incumbent homeowners. Between 2009 and 2019, the first-time home buyer share of home purchases fell from 35% to 22%, a period in which mortgage rates fell from nearly 7% to 3.5%. First, I construct a new mortgage rate-specific monetary policy shock to use as an IV for mortgage rate changes which predicts future mortgage rates better than existing monetary policy shocks. Next, I provide empirical evidence for three new findings: 1) transacted house prices respond to monetary policy-induced mortgage rate changes within a matter of weeks, indicating a rapid housing demand response to mortgage rates; 2) a negative 25 basis point mortgage rate shock lowers the first-time buyer share of home purchases by 77 b.p. in the first three months after the shock; 3) these results are more pronounced in areas with higher shares of high LTV-constrained borrowers which tend to be areas with more severe housing crises. Finally, I construct a lifecycle model with a housing ladder, heterogeneous agents, and a system of housing-related taxes calibrated to my empirical findings. I find that a one-time unanticipated negative one p.p. transitory shock to mortgage rates causes potential first-time home buyers to face 0.05% consumption-equivalent welfare losses.

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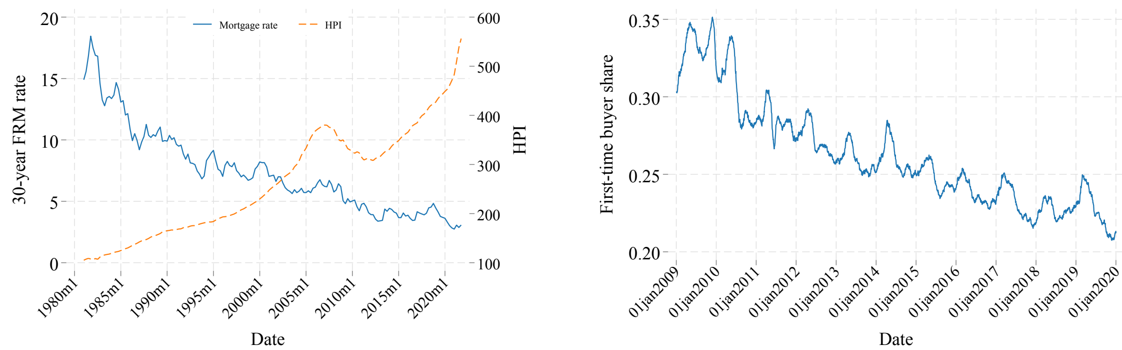
1 Introduction

US house prices have increased by a factor of five between 1981 and 2021 and tripled since 2000, while at the same time the median age of first-time home buyers increased by four years (NAR (2024)). During that time, average mortgage rates have drastically fallen from a high of 17 percent in the early 1980s to a trough of under 3 percent in 2020 and 2021. Lower mortgage rates, indicating lower borrowing costs, alleviates the debt-to-income (DTI) constraint for households which leads to a surge in demand for home purchasing and boosts house prices, consequently increasing the down payments necessary to obtain a mortgage. This inverse relationship between mortgage rates and prices holds strongly when the impact that mortgage rates have on housing demand exceeds their impact on supply, which is historically the case. In fact, since 2000, the bulk of the growth in house prices occurred in the years 2000–2006 and 2013–2021, when mortgage rates were at their respective historic lows.

At the same time, the first-time homebuyer share of home purchases has fallen from 35% to 22% between the years of 2009 and 2019 as shown in Figure 1 Panel (B). This figure tells us that fewer first-time home buyers are purchasing homes relative to incumbent homeowners, despite the lower mortgage rates. Additionally, this figure indicates that incumbent households are steadily increasing the amount of housing in their financial portfolios. Overall, the combination of increased prices, increased age at the time of the first purchase of a home, and fewer potential first-time home buyers purchasing homes suggests that the path to homeownership is not as easy as it was in previous generations. This brings rise to the question: do low mortgage rates benefit or harm the path to home ownership?

The main contributions of the paper are as follows. First, I construct a new mortgage-rate specific monetary policy shock to use as an instrument for mortgage rate changes. Existing monetary policy shocks that capture the longer end of the yield curve fail to accurately predict mortgage rate movements. Factor-driven approaches such as Gürkaynak et al. (2005), Acosta et al. (2024)'s update of the Gürkaynak et al. (2005) factors, and Swanson (2021), all use a variety of financial assets which serve well for giving us an understanding of the expected path of the federal funds rate, but provide an incomplete picture for mortgage markets. The longest duration

Figure 1: House prices, mortgage rates, and first-time home buyers



(a) House prices and mortgage rates

(b) First-time home buyer share of home purchases

Notes: Panel (a) plots the S& P Corelogic Case-Shiller US National House Price Index and the mean, national realized mortgage rate level at the month date level from January 1981 through 2020. Both data are downloaded via FRED. Panel (b) plots daily national-average first-time homebuyer purchase shares from January 1st, 2009 through December 31st, 2019 using the data sample created using the Fisher Center data described in Section 2. The first-time homebuyer purchase share trends observed in this time series are very similar to those observed in NAR (2024).

asset Acosta et al. (2024) tracks movements for are one-year Treasury futures yields, while Swanson (2021)'s data sample includes 30-year Treasuries among many other securities. Neither of their data samples include mortgage-backed securities (MBS). Although the methodology is the same, my monetary policy shock series outperforms these existing factors due to the selection of financial assets. By focusing only on 10-year Treasuries and MBS, I am able to capture the surprise movements in mortgage rates without adding confounding movements from other financial assets.

I focus on 10-year Treasuries and MBS because they directly influence mortgage rate setting. 30-year fixed rate mortgage rates are often tied to 10-year Treasury yields because they have a similar duration due to the high frequency of mortgage prepayment and the less-frequent occurrence of mortgage default. As for MBS, high demand for MBS in the secondary market raises MBS prices implying that mortgage originators may sell their mortgages at a higher price, incentivizing lenders to lower mortgage rates in the hopes of originating more mortgages to sell. Consequently, using intraday 10-year Treasury futures and MBS transactions data, I construct a new monetary policy factor which contains price shocks within 30 minute intervals before and after each Federal Open Market Committee (FOMC) meeting from December

2012 through December 2024.

Second, I provide new empirical evidence that monetary policy-induced mortgage rate changes impact transacted house prices within a matter of weeks. I estimate that on average, a 25 basis point (b.p) fall in mortgage rates yields a 0.42 percent *increase* in transaction prices relative to the their listed. To the best of my knowledge, this is the first paper that demonstrates a high-frequency response in transaction house prices to monetary policy.

Third, I provide novel evidence on how monetary policy affects the composition of homebuyers—specifically, comparing renters, who I observe purchasing their first homes, and incumbent homeowners. The positive relationship between mortgage rates and the first-time buyer share of home purchases observed in Figures 1 does not imply causality. There exist several potential confounders such as growing income or wealth inequality. Additionally, mortgage rates are quite endogenous—suggesting the need for an instrumental variable approach. Consequently, I use the new mortgage-rate specific monetary policy shock as an instrument for mortgage rates. With the new shock in hand, I take this question to the data and demonstrate a positive relationship between mortgage rates and the first-time buyer share of home purchases. I find that a negative 25 basis point (b.p.) mortgage rate shock yields an 77 b.p. *decrease* in the first-time home buyer share of home purchases in the first three months after the shock. This result provides strong evidence that monetary policy transmission through the mortgage channel directly impacts first-time home buyers.

The intuition behind this empirical finding is that when interest rates fall, house prices increase and consequently, downpayments increase as well. On the one hand, incumbent homeowners who want to purchase a home already have housing wealth, so they are hedged from downpayment increases. Thus, they are more able take advantage of the opportunity of lower borrowing costs. On the other hand, renters or potential first-time homebuyers who do not have housing wealth are not hedged from the price increases. This implies that renters must save more in order to overcome this higher downpayment friction, pushing their home purchase further into their life-cycle and delaying the point that they are able to purchase a home and receive all of the benefits that homeownership provides. I argue that these are the two mechanisms driving the empirical results. Importantly, I provide direct evidence for the downpayment mechanism by showing that CBSAs with higher shares of loan-to-value (LTV)-constrained purchases prior to a mortgage rate shock exhibit a larger response in first-time purchase shares than CBSAs with lower shares of LTV-constrained purchases. Lastly, I show that these effects are more pronounced among lower-income first-time homebuyers.

For the final contribution of this paper, I construct a lifecycle model with heterogenous agents, a housing ladder, a negatively-skewed income process, and a system of housing-related taxes to quantify the disparate welfare impact of lowering mortgage rates between potential first-time home buyers (renters) and incumbent home owners. The housing ladder consists of four states: a renter state, a starter-home state, a large home state, and a state where the household owns both a large home and an a vacation home which from this point on will be referred to as a second-home. The inclusion of a state where the household owns both a primary home and a second-home is crucial to generate the empirical results in the model. Like much of the recent macro-housing literature, the model exhibits nonlinear dynamics. When I calibrate the model to the main empirical findings and apply an unanticipated transitory negative one p.p. "MIT" shock with low persistence to mortgage rates, prices and down payments rise while, the first-time home purchase shares fall. I find that households who were renters at the time of the shock face lower consumption-equivalent welfare of 0.05% relative to their pre-shock stationary equilibrium versions.

This paper contributes to several strands of macroeconomic and housing literatures. First, I provide a new monetary policy shock series specifically constructed for mortgage rates which predicts future mortgage rate changes better than existing monetary policy shocks aimed towards the longer end of the yield curve. This shock contributes to the existing monetary policy shock literature which uses high-frequency identification, such as to construct policy shocks Gürkaynak et al. (2005), Swanson (2021), Nakamura and Steinsson (2018), Bauer and Swanson (2023), and Acosta et al. (2024). Xu et al. (2012) finds that the 30-year fixed mortgage rate is slow-moving in response to monetary policy surprises, whereas I show that daily mortgage rates respond immediately within one day. This mortgage rate-specific monetary policy shock can be used in virtually any empirical setting for studying monetary policy transmission through the mortgage channel.

The empirical results in this paper contribute to large empirical literature on the mortgage channel of monetary policy transmission, such as Di Maggio et al. (2017), Di Maggio et al. (2020), Bhutta and Ringo (2021), **?**, Indarte (2023), Ahn et al. (2024), Bosshardt et al. (2024), Gorea et al. (2025). Like Gorea et al. (2025), I find empirical evidence that monetary policy-induced changes to mortgage rates affect house prices within a matter of weeks. My paper serves as a complement to theirs, which only finds a response in listed home prices, by showing that transaction prices respond to mortgage rate changes within a matter of weeks. Like many of these papers, I find that mortgage credit constraints play a vital role in explaining the dynamics found in the empirical analysis. **?** show that when local house prices rise, homebuyer income rises and argue that lower-income buyers are priced-out, particularly among first-time homebuyers. My empirical results complement theirs by demonstrating that first-time homebuyer purchase shares fall when mortgage rates fall, with more pronounced effects in LTV-constrained areas and among lower-income households, complimenting those in Mabille (2023). Overall, this paper adds to the literature by providing direct evidence of the disparate impact of monetary policy on first-time and incumbent home buyers.

This paper relates to several papers with quantitative macro models that focus on the mortgage channel of monetary policy transmission and credit frictions, such as Beraja et al. (2019), Berger et al. (2021), Eichenbaum et al. (2022), Favilukis et al. (2017), Greenwald (2018), Gariga and Hedlund (2020), Gariga et al. (2017), Guren and Greenwald (2025), Guren et al. (2021a), and Guren et al. (2021b). As in Greenwald (2018), the constraint switching effect is present in the transition dynamics of the lifecycle model. When mortgage rates fall, causing housing demand and consequently house prices to rise, the lower borrowing costs alleviates the DTI constraint while the higher prices tightens the LTV constraint. However, renters are more likely to be priced out of purchasing a home due to the tightening LTV constraint and their lack of housing wealth—meanwhile, incumbent homeowners are hedged by the price effects. **?** show a similar mechanism in their stylized model. Additionally, as in Favilukis et al. (2017), Greenwald (2018), Guren and Greenwald (2025), and Guren et al. (2021a) financial frictions play a large role in explaining house price movements. This paper also shows that the differential impact of financial frictions on those who have and do not have housing wealth matters in understanding price movements and first-time home purchasing.

Although this paper is not the first to have a macro model with a housing ladder, others include Attanasio et al. (2012), Fonseca et al. (2024), Ortalo-Magné and Rady (2006), to the best of my knowledge it is the first to investigate the disparate impact in the dynamics of a mortgage rate shock comparing potential first-time home buyers and incumbent homeowners. Similar to Attanasio et al. (2012), I find that house price increases caused by a negative shock to mortgage rates increases downsizing because the gains from selling are larger for owners with multiple homes, however unlike their model, I find an increase in housing demand which is a key driver of the price increase. Like their paper, I find that taxes have a large impact on welfare. A key difference is that my paper allows for a third housing state where homeowners own both a large two-unit primary home and a one-unit second-home. The reason for this lies in what we learn from the data, that falling mortgage rates prompt incumbent homeowners to increase their quantity of housing units owned. Including a second-home state in the housing ladder allows the model to better match the empirical results with more reasonable parameters.

Finally, a subset of the empirical results speak to the urban literature documenting heterogeneity across space and types of movers. I find a larger impact in first-time purchase shares in CBSAs with larger housing markets. This result is largely related to the fact that such CBSAs tend to have higher shares of LTV-constrained borrowers. Additionally, I find that results almost entirely come from within-CBSA movers rather than households moving across CBSAs. Finally, I find that the results are not driven by CBSA-level housing supply elasticities.

The rest of the paper is organized as follows. Section 2 describes the data, the data sample construction, and the monetary policy shock construction. Section 3 describes the empirical methodology and presents the results. Section 4 describes the theoretical model, presents the results, and provides a further discussion connecting the model to recent literature along with next steps. Section 5 concludes.

2 Data

2.1 Constructing the data to estimate the price response

To construct the sample, I start by obtaining arms-length, full consideration property transactions records from ATTOM, a proprietary data provider that compiles national data from county deed and assessor records. For each property transaction, I observe the transaction date, property type, transaction type, and location. Sales involving non-household sellers (e.g., those made by banks or firms) as well as distressed sales (e.g. foreclosures and short sales) are excluded from the sample.

I use national property listing data between January 2011 and December 2020 from Altos Listing Intel. The property listing data provides weekly updates on the listing price, close price, and days on market. Occasionally, a house on the market may post multiple listings. For these cases, I combine listings for the same property if they are no more than 60 days apart.

I then merge the listing data to the property transaction records using the property address, price, and sale date. This leaves me with a sample of nearly two million housing transactions where I observe the transaction price, the last listing price made prior to sale, the transaction date, the last listing price setting date, and time on market at the time of the last listing price setting date.

2.2 Constructing the panel

In order to conduct my main empirical analysis, I construct a CBSA-month date panel with the composition of home purchases, national month-averages of daily bank offered mortgage rates, and CBSA characteristics. To the best of my knowledge, this is the first data sample that decomposes the types of home purchases between first-time and incumbent homeowners at a CBSA-month date level of granularity.

To construct the sample, I again start by obtaining arms-length, full consideration property transactions records from ATTOM, a proprietary data provider that compiles national data from county deed and assessor records. For each property transaction, I observe the transaction date, property type, buyer names, transaction type, and location.

I am able to identify whether a buyer is a renter or an incumbent homeowner household using USPS change-of-address tracking data from Data Axle InfoGroup. The data provider tracks households and identifies when a household moves from one location to another based on their submission of a USPS change-of-address form which forwards their mail from their old home to their new home. Importantly, the data provider also includes a key variable which identifies whether a household is a renter or a homeowner. The data is well-populated starting in 2009. With latitude, longitude, and property address information, I am able to match properties from this data to properties in ATTOM. Using the name of the head of household from the tracking data and the name of the buyer from the transactions data, I am able to merge households' mobility and rental-ownership status with the housing transactions data. However, it is important to note that these housing transactions likely excludes many non-primary housing transactions because the tracking data reports moving from one primary home to another.

Finally, I obtain loan-level mortgage origination characteristics from Black Knight McDash and borrower credit file information from Equifax. I combine the borrower ID from Black Knight McDash with the borrower ID from the Equifax borrower credit files using a crosswalk provided by Black Knight McDash. I rely on the borrower identifier to check if a renter purchasing a home has previously purchased a home on their credit file. This check is crucial to ensure that households identified as a renter are indeed a first-time home buyer. Importantly, I can identify whether the originated mortgage for a home is reported to be the owner's primary home or non-primary second-home. I use this as an additional check to ensure that households identified as a first-time buyer are purchasing their primary home. Separately, I am able to obtain origination LTV and DTI ratios for each housing transaction. I construct a CBSA-month date panel containing the shares of borrowers with high LTV and high DTI originations, which is used to demonstrate the downpayment mechanism in Table 3.

To merge in the mortgage origination and borrower credit history data I rely on a crosswalk following the same procedure used in Issler et al. (2023) and Kermani and Wong (2024). The matching algorithm uses a set of property and transaction attributes such as loan amount, loan purpose, and interest rate to find the k-nearest neighbors. I then keep the matches from the merge with the transactions matched with the tracking data. In an attempt to include non-primary home purchases, I expand the data sample to include additional property purchases identifed in the transactions data that did not match tracking data using the borrower identifier. This allows me to have a dataset that contains property purchases by first-time buyers as well as primary and non-primary purchases made by incumbent homeowners. The merge is available for housing transactions through 2019, giving me a CBSA-month date panel from January 2009 through December 2019.

Although the mortgage origination data contains the mortgage rate for borrowers, this may not resemble the true mortgage rate offered by banks at the time of origination, given that many home buyers lock in their mortgage for up to 30 days. Additionally, a borrower's mortgage rate is impacted by many factors such as their credit score, LTV, DTI, any points paid, and the loan product. Consequently, I obtain daily offered mortgage rates from Bankrate downloaded via a Bloomberg Terminal. These data are overnight averages of offered mortgage rates for 30-year fixed rate mortgages among all banks surveyed by Bankrate.com.

I obtain CBSA-month date level unemployment rates, house price indices, and rent price indices from BLS via FRED as well as national month date-averages of the effective federal funds rate from FRED. Lastly, I obtain month date-averages of the CBOE: Volatility Index Overview (VIX) from Wharton Research Data Services (WRDS). The unemployment rates, policy rates, and VIX are used as controls in the regression specification.

2.3 Monetary policy shock construction

I construct the mortgage rate-specific monetary policy shock using a factor approach similar to Gürkaynak et al. (2005), Swanson (2021), and Acosta et al. (2024). This data-driven method relies on observing price changes for a set of financial assets between narrow time windows before and after each FOMC announcement and extracting a single factor from the observed changes for each FOMC date. In order to construct a factor that is relevant for mortgage rate changes, my data sample consists of intraday trades for 10-year Treasury futures and MBS. This is the first monetary policy shock that uses MBS price movements in its construction. The inclusion of

MBS is vital to study mortgage rate movements given the effects that forward guidance and quantitative easing have in the secondary mortgage market, **?** and **?**.

I obtain intraday 10-year Treasury futures trades from CME Group via DataBento, a data platform that supplies real-time and historical financial data. The data platform provides intraday transaction prices on trades at the nanosecond-level since June 2010.

I obtain intraday 30-year To-Be-Announced (TBA) MBS price and coupon data since December 2012 and 30-year TBA uniform MBS (UMBS) price and coupon data since March 2019.[1] The data are reported to FINRA and downloaded from TRACE via WRDS. TBA MBS and UMBS mortgage pools are not known at the time of trade, but their characteristics such as maturity, coupon, and settlement date are known. I use UMBS when available because they are more liquid FHFA (2020).

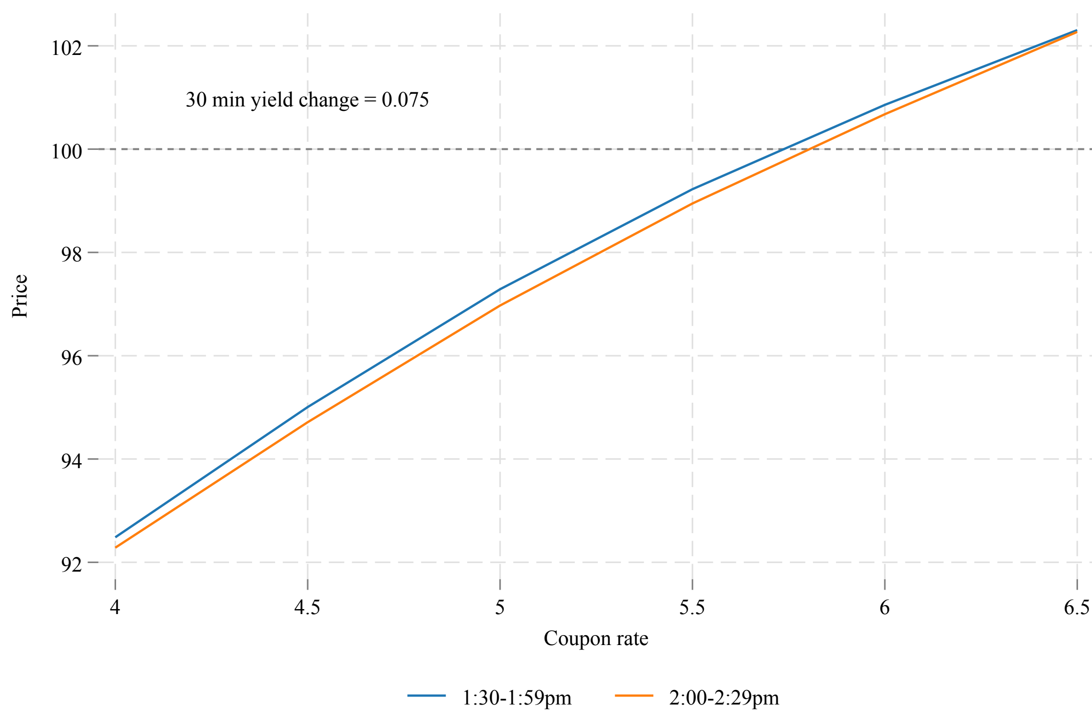
Alternatively, one could use 10-year Treasury futures and MBS yields instead of prices. One way to interpolate MBS yields is to extrapolate the hypothetical coupon rate that sells at par from a curve which compares prices to coupon rates. However, there exist FOMC announcement dates when it is impossible to find two such MBS with coupon rates that trade above and below par, such as May 1, 2013, which adds measurement error. For that reason, I focus on percent changes in prices. Figure 2 provides a graphical example with LOWESS plots comparing prices and coupon rates for TBA UMBS trades in 30 minute windows before and after the 2 pm FOMC announcement on December 18, 2024.

The December 18, 2024 monetary policy announcement included a largely expected 25 basis point decrease in the Federal Funds Rate and reduction in LSAPs. However, the announcement also included a large unexpected forward guidance message in the closely watched "dot plots" suggesting that fewer rate decreases were forecasted than previously expected.[2] In line with the Expectations Hypothesis, the higher expected future short-term rates led to an increase in 10-year Treasury note future yields, implying lower prices, as seen in Figure 3 and an increase in MBS yields

[1] Prior to December 2012 I observe very few or no trades.

[2] See Figures 2 from the projection materials for September 2024 and December 2024: `https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20240918.pdf` and `https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20241218.pdf`

Figure 2: MBS Prices December 18, 2024



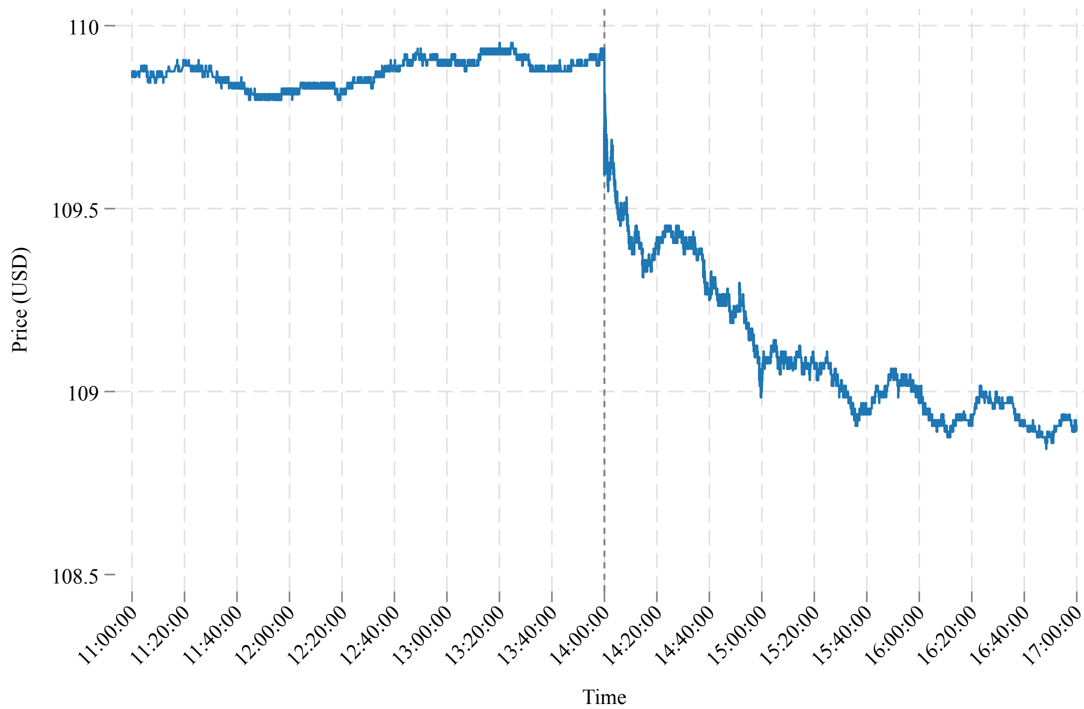
Notes: The figure provides LOWESS plots comparing prices and coupon rates for TBA UMBS trades in 30 minute windows before and after the Federal Open Market Committee's 2pm EST monetary policy statement release on December 18th, 2024. The plots provide a graphical explanation for the coupon rate, and consequently the yield, for a hypothetical TBA UMBS which sells at par. The data are downloaded from WRDS's TRACE database.

as seen in Figure 2.

With the price data in hand for each scheduled and unscheduled FOMC meeting from December 12, 2012 to December 18, 2024, I calculate the average price for 10-year Treasury futures and TBA MBS's in the thirty minutes immediately before the announcement and the thirty minutes immediately after the announcement. This allows me to calculate the average price percent change for both asset types. With these two sets of price responses for each FOMC date, I extract a single factor to serve as the shock. The factor is scaled to equate to one unit standard deviation shock to 1 p.p. ten-year Treasury yield change.

Assuming no outside confounders impact the assets within these narrow time windows, the changes in prices demonstrate the responses to FOMC announcements.

Figure 3: 10-year Treasury Note Prices December 18, 2024

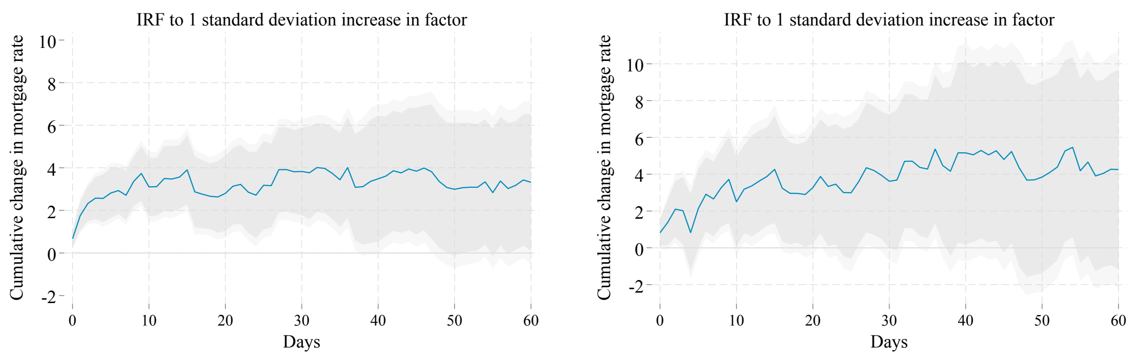


Notes: The figure plots intraday prices in Panel (a) and yields in Panel (b) for 10-year Treasury Note futures from the Chicago Mercantile Exchange on December 18th, 2024 before and after the Federal Open Market Committee's 2pm EST monetary policy statement release. The data are downloaded from DataBento's CME Group database.

Thus, the single factor I extract serves as a monetary policy shock that is specific for mortgage rate setting.

Figure 4 demonstrates relevance of the new mortgage rate monetary policy factor for predicting future mortgage rate changes for a sample period that contains FOMC announcements from December 2012 to December 2019 which matches the sample period for the main empirical results. I regress the cumulative change in daily mortgage rates on the factor for horizons of 0 to 60 business days and plot the estimated impulse response function estimated from a local projections approach where the shock is the only right-hand side variable. Panel (A) plots the impulse response function (IRF) for the new factor and Panel (B) plots the IRF for the existing path factor from Acosta et al. (2024). Both factors have mean zero, but to improve comparability, the path factor is rescaled to match the variance of the mortgage rate factor. The light gray

Figure 4: Monetary policy factor relevance



(a) Mortgage rate monetary policy factor

(b) GSS path factor Acosta et. al 2024 update

Notes: The figure plots the estimated coefficient of regressing cumulative difference in mortgage rate change between horizon h=0,...,60 business days and the mortgage rate the day before the FOMC announcement on the factors with 90% and 95% confidence bands. The sample period runs December 2012 through December 2019, which matches the same time period from the empirical analysis in Table 2.

area plots the 95% confidence band and the dark gray area plots the 90% confidence band. Though the estimated coefficients are quite similar over the 60 business day horizon, the new mortgage rate-specific monetary policy factor is much less noisy as it is statistically significant for approximately three months. Notably, the Zero-Lower Bound (ZLB) period makes up much of the time frame. When expanding the sample to March 2025, mortgage rates are more responsive to monetary policy shocks and the persistence of the effects are statistically significant for one year as seen in Appendix Figure A1.

Separately, I run a horse-race between the 10-year Treasury future and the MBS price shocks on one-day and ten-day cumulative mortgage changes after FOMC announcements to determine which shocks primarily drive mortgage rate movements. During the ZLB period prior to 2016, I find that MBS shocks dominate Treasury shocks in explaining future mortgage rate movements. However after the ZLB period, mortgage rate movements almost entirely load on Treasury shocks.

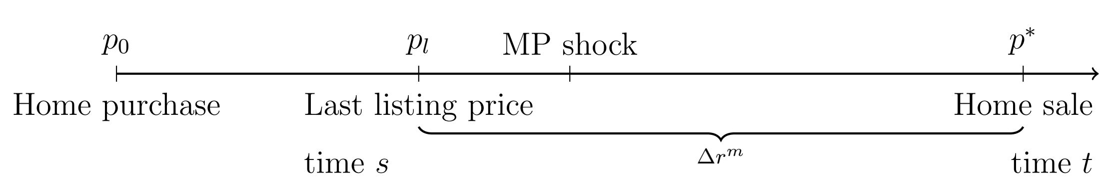
3 Empirical results

3.1 House price impact of monetary policy

First, I establish that monetary policy-induced mortgage rate changes pass through to transaction house prices more quickly than previously believed by the prior literature. Some of existing literature tells us no, Kuttner (2013) and Williams (2015), largely due to their data being aggregated and having a low frequency. However, more recent papers such as Gorea et al. (2025) find that listed home prices respond in a matter of weeks. In fact, they find that an exogenous 0.25 p.p. increase in mortgage rates lowers house prices 1.4 percent in two weeks using Swanson (2021)'s forward guidance monetary policy shock and provide evidence that the impact is asymmetric with the bulk of the response coming from expansionary monetary policy. Although Gorea et al. (2025) demonstrates passthrough to listing prices within a matter of weeks, they fail to find this pattern for transaction prices. Showing passthrough to transacted prices is the first empirical contribution of this paper. Figure 5 presents the empirical strategy.

Consider a home that was purchased at price p_0, is later listed on the market with a most-recent listing price of p_l set on date s, and is sold on date t at price p^*. Between dates s and t, there is a monetary policy shock that impacts mortgage rates. I will regress the log price change between the listed and transaction prices on the change in mortgage rates between dates s and t instrumented by the monetary policy shock. The estimated coefficient will inform us how mortgage rate changes impact the price changes. Effectively, this is a repeat-sales approach but substituting the purchase price with the listing price. The relatively high-frequency approach allows us to more cleanly estimate the impact that mortgage rate changes have on individual transaction prices.

Figure 5: Price growth empirical strategy



Equation 1 describes the exact specification. For a home i on the market, estimate log growth between the transaction price at date t and the last listed price at date s in response to the instrumented change in mortgage rates between dates s and t using the mortgage rate-specific monetary policy shock. Controls include the mortgage rate for date s, time on market at date s, the effective federal funds rate for date s, and Census Tract-level fixed effects. β is the estimated coefficient of interest.

$$\ln(p^*_{i,t}) - \ln(p^l_{i,s}) = \beta\widehat{\Delta^{t-s} r^m} + \boldsymbol{\theta_{i,s} X_{i,s}} + \phi\delta_k + \varepsilon_{i,t} \quad (1)$$

Including the national average offered mortgage rate and effective federal funds rate allows us to control for the state of the economy at the time of the price listing. Controlling for time-on-market allows us to control for homes with different listing experiences—for instance, homes on the market for a longer period of time may be more willing to sell their home at a larger discount—and the Census Tract fixed effects can be though of as a control for neighborhood-level characteristics. The time period of the sample runs from December 2012 through December 2020, though the results are similar if the year 2020 is excluded. The sample excludes homes that were owned for less than two years to remove home flippers and excludes homes extreme transaction values, i.e., homes with sales prices outside of the 1st and 99th percentiles and where the log growth between the last listing price and the transaction price lie outside of the 1st and 99th percentiles.

There are two candidates to select as the sale date t. One date is the transaction date recorded by the county assessor's office observed in the ATTOM data. Though this date is typically after a home deal is finalized which may come after a price is agreed between the two parties. While closing a home may only take a few days for cash buyers, it may take weeks for homes purchased with mortgages. Thus, the other candidate date is the last observed listing date which can be inferred as the last date prior to matching with a buyer at an agreed price. Due to the higher-frequency setting of this empirical framework, using the last observed listing date may give a closer estimate for the actual change in mortgage rates between the last price setting date and the date of price negotiating between the buyer and seller. However, both dates give very similar results.

Table 1: Price impact from monetary policy-induced mortgage rate changes

	All transactions			Days< 14	Days∈ [14, 28)	Days∈ [29, 42)	All transactions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	IV	IV	IV	IV
Δ Mortgage rt	-0.0009**	-0.0015***	-0.0126***	-0.0185***	-0.0136***	-0.0101***	-0.0054	-0.0194***
	(0.0003)	(0.0005)	(0.0022)	(0.0070)	(0.0033)	(0.0031)	(0.0035)	(0.0038)
Δ Mortgage rt × 90+ LTV shr							-0.0108**	
							(0.0047)	
90+ LTV shr							0.0010***	
							(0.0003)	
Δ Mortgage rt × Supply elas								0.0125***
								(0.0047)
Observations	643793	643793	643793	36772	116401	136891	560078	356422
Tract FEs	Y	Y	Y	Y	Y	Y	Y	Y
Interest rate controls	Y	Y	Y	Y	Y	Y	Y	Y
Time-on-mkt control		Y	Y	Y	Y	Y	Y	Y
K-P Fstat			276.46	278.00	289.40	178.54	135.72	113.04

The table provides estimates of the log price change between the listed and transaction prices in response to mortgage rate changes between the time of setting the last listing price and the transaction date. Controls include the mortgage rate and effective federal funds rate at the time of listing, time on market at the time of listing, and Census Tract fixed effects. The data sample excludes homes owned for less than two years, extreme transaction values, and extreme price growth between listing and sale, and runs from December 2012 through December 2020. Kleibergen-Paap (Kleibergen and Paap (2006)) F-statistics are reported. Clustered standard errors at the transaction date-level reported in parenthesis

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Table 1 presents the results using the last listed date as the sale date. All regressions include the interest rate controls and Census Tract fixed effects. Standard errors are clustered at the sale date level and Kleibergen-Paap (Kleibergen and Paap (2006)) F-statistics are reported. Columns (1) and (2) estimate the price response to mortgage rate changes using an OLS approach without and with the time-on-market control, respectively. Column (3) presents the results using the IV approach described above. The estimated coefficient tells us that a one percentage point reduction in mortgage rates, raises the transaction price by about 1.26% relative to the listing price. Given the short time-horizon between listing and finalizing sales, this estimate is quite large. To get a better sense of the response for different time horizon Columns (4), (5), and (6) present the results for pooled $t - s$ horizons of less than 14 days, between 14 and 28 days, and between 28 and 42 days, respectively. For each of these columns, a statistically significant negative coefficient is estimated. The magnitude of these estimates demonstrate that transacted prices show a significant response to mortgage rate changes almost immediately. We can interpret from these results that home buyer demand responds to monetary policy-induced mortgage rate changes within a matter of days or a couple of weeks.

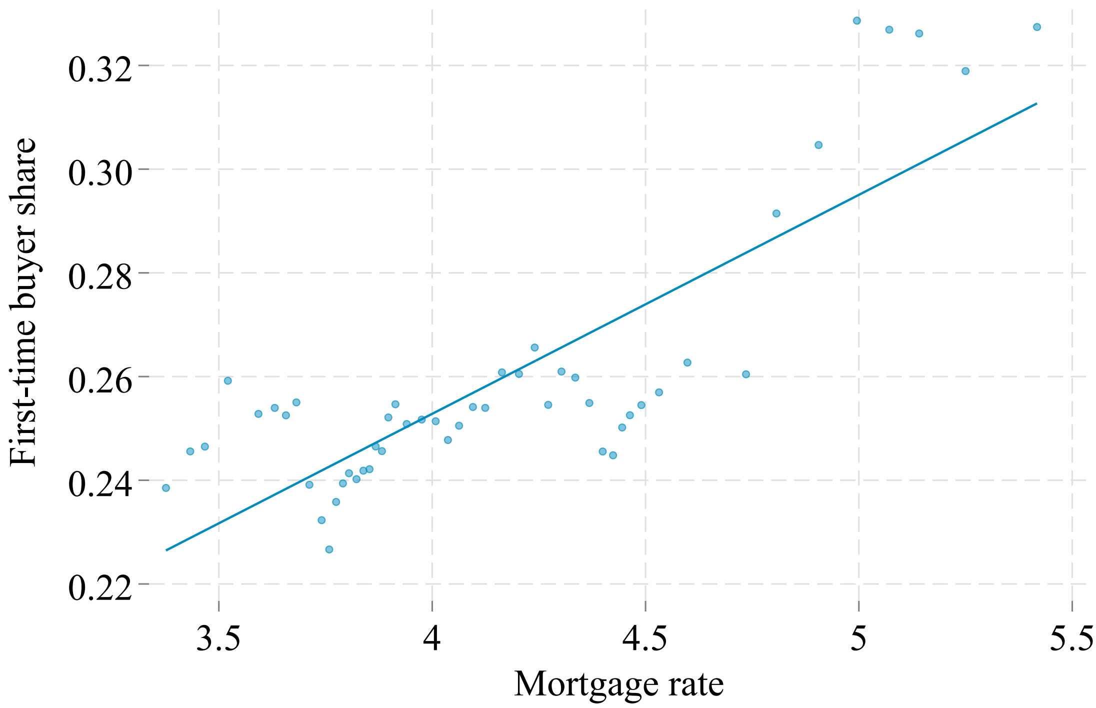
The estimates presented in Column (7) use a similar specification but interacts the instrumented mortgage rate change with the share of origination LTVs greater than 90% in home i's Census Tract for the quarter prior to setting the listing price. The sign of the estimated coefficient tells us that transaction prices grow more in response to falling mortgage rates in neighborhoods where buyers face more binding LTVs. This result is inline with Gorea et al. (2025)'s findings that listing prices in low-income and low house price zip codes are more responsive to mortgage rate changes. While this benefits sellers in neighborhoods with higher shares of LTV-constrained homebuyers, it makes entering the homeownership state more difficult, particularly for LTV-constrained buyers. As a robustness check, I perform the same exercise but with defining the transaction date as the sale date t in Table A1. The estimated coefficients in the table are very similar to those in Table 1 demonstrating that these empirical findings are not sensitive to sale date choice.

3.2 Main results

Figure 6 presents binned scatter plots showing first-time homebuyer purchase shares against the level of mortgage rates. The figure demonstrates a positive relationship between the first-time purchase share of housing purchases and mortgage rates. This implies a negative relationship between the total incumbent homeowner purchase share, which includes incumbent primary home purchases and secondary home purchases, and mortgage rates as well.

These binscatter plots provide suggestive evidence. Mortgage rates are endogenous and impacted by both primary and secondary market demand for mortgages, the financial state of mortgage originators, and other factors. Thus, we cannot conclude that outside factors are not behind the patterns we observe from the binscatter plots. Consequently, we will use a Two-Stage Least-Squares Instrumental Variables approach with the newly constructed monetary policy shocks specifically constructed for mortgage rates as the instrumental variable.

Figure 6: First-time home purchase shares and mortgage rates



Notes: Data are at the CBSA-month date level between 2009 and 2019. CBSAs with fewer than 50 transactions are dropped.

The specification is slightly different from a local projections approach with an IV, though a local projections approach gives very similar estimates. Instead of instrumenting for the mortgage rate or the mortgage rate change at the time of the shock, I instrument for the cumulative mortgage rate change with the monetary policy shock. This specification allows me to use the relevant mortgage rate change for longer horizons. Equation 2 shows IV specification. i denotes a CBSA, t denotes the month date of the monetary policy shock, and h denotes the horizon after the shock.

$$\Delta^{12} Y_{i,t+h} - \Delta^{12} Y_{i,t-1} = \alpha_{2,h} + \hat{\beta}_h \widehat{\Delta^h r_t^m} + \boldsymbol{\theta_{2,h} X_{i,t}} + \phi_{2,h}\delta_i + \varepsilon_{i,t,h} \tag{2}$$

The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t+h$ and the annual change in purchase shares for time $t-1$. I focus on changes in annual differences of purchase shares to account for seasonality in housing markets (Case and Shiller (1989), Goodman (1993), Ngai and Tenreyro (2014)) which is demonstrated in Figure 1. The main purchase shares variable of interest is the first-time buyer share of home purchases. The main coefficient of interest is $\hat{\beta}_h$ which tells us the response in the purchase shares to the instrumented change in mortgage rates. The set of controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). We control for the levels of mortgage rates because households behave differently in periods of low and high mortgage rates. Including the EFFR and VIX allows us to control for contemporaneous macroeconomic conditions, and including local unemployment rates gives us an additional control for the state of the local metropolitan area. Because the specification controls for twelve lags of monthly changes in annual differences of first-time purchase shares, I need to ensure that these variables are properly estimated, minimizing measurement error. Thus, I remove any CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions (roughly 3 transactions per day). Finally, to account for common autocorrelated disturbances, Driscoll-Kraay standard errors (Driscoll and Kraay (1998)) are included with four lags.

Table 2 reports the estimates of the impact of mortgage rate changes on annual changes in the first-time home buyer share of home purchases for one, two, and three month horizons. Kleibergen-Paap (Kleibergen and Paap (2006)) F-statistics are reported. Mortgage rate shocks are monthly averages, and months without a mortgage rate shock are never counted as a period receiving a monetary policy shock of zero. The sample in the table consists of 2,032 CBSA-month date observations containing 50 total CBSAs.

The main result with the IV estimate is presented in Column (2) showing that a negative 1 percentage point change in the mortgage rate between the month before and after the mortgage rate shock yields a negative 3.59 percentage point change in the annualized first-time buyer share of home purchases in the month after the shock compared to the month before the shock. The estimated coefficient is statistically

Table 2: First-time buyer share of home purchases regressions

	$h = 1$		$h = 2$		$h = 3$	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
Δ Mortgage rate	0.0096**	0.0359**	0.0141***	0.0298***	0.0134***	0.0270**
	(0.0038)	(0.0140)	(0.0033)	(0.0080)	(0.0030)	(0.0128)
Observations	2032	2032	2032	2032	1989	1989
K-P Fstat		16.84		27.67		15.65
Number of transactions	3066813	3066813	3088425	3088425	3030114	3030114

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t+h$ and the annual change in purchase shares for time $t-1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

significant at the 5% level. Finally, the total number of housing transactions used in the calculation of the LHS variable is reported at over 3 million. Column (1) shows a qualitatively similar and statistically significant coefficient for the OLS specification.

Columns (4) and (6) present the estimated coefficients using the IV approach for the two-month and three-month horizons, respectively. The IV regression results in Column (4) reports a similar coefficient estimate of 0.0298 to that in Column (2) which is statistically significant at the 1% level. The reported F-statistic is much higher at 27.67 demonstrating stronger validity of the mortgage rate shock as an instrument. The estimated coefficient in Column (6) drops to 0.0270 and maintains statistical significance at the 5% level; however, the F-statistic also falls to 15.65. The fall in the magnitude of the coefficient, the statistical significance, and the F-statistic are not surprising given that there are likely 2-3 FOMC meetings by the third month horizon which likely diminish the impact of the original shock. Columns (3) and (5) present the OLS estimated coefficients for the two and three-month horizons, respectively, reporting statistically significant coefficients of similar magnitude to that in reported in Column (1). Appendix Figure A3 plots the estimated coefficients of the IRF using a local projections approach (Jordà (2005)) with the mortgage rate shock IV with the same set of controls. The figure shows that the effects are persistent and statistically significant for six months after the monetary policy shock.

At a high level, by comparing the volume response between first-time and incumbent buyers it appears that the results are largely explained by an immediate response from incumbent homeowners rather than first-time buyers as seen in Appendix Table A3. Again, due to high seasonality in housing markets, the dependent variable is log changes in annual log differences of purchase volumes. I do not find a statistically significant response in total volumes one month after the mortgage rate shock—though as we know from Table 2 the difference between first-time and incumbent buyers is statistically significant. However, I do estimate statistically significant total and incumbent volume increases in response to a mortgage rate decline for the second and third month horizons. The lack of a negative statistically significant coefficient for first-time buyer volumes in the first two months after the shock is an important result. While incumbent homeowners adjust the amount of housing in their portfolio within the first two months after the shock, we fail to provide evidence of first-time buyers doing the same until three months after the shock, which is still a lower response compared to incumbent homeowners. It is important to note that the composition of first-time buyers can change as well. Specifically, I discuss how the actual first-time buyer response depends on the first-time buyers' liquidity constraints in the following subsection.

Appendix Table A5 reports the estimated coefficients using the same specification from Table 2 but with the Acosta et al. (2024) update of the Gürkaynak et al. (2005) path factor as the IV. Though qualitatively similar, the IV regression coefficients in Columns (2), (4), and (6) lack statistical significance. This is likely due to the lack of validity the path factor serves as an instrument which is observed from the reported F-statistics and from Figure 4 Panel (B).

The mechanism argued in the paper is one that lowering mortgage rates increases house prices and consequently increases down payments. This downpayment increase differentially affects renters (potential first-time home buyers) and incumbent homeowners LTV constraints. Incumbents already have housing wealth, so their housing wealth co-moves with downpayments, allowing them to take advantage of the opportunity of lower mortgage borrowing costs. However, renters who were on the margin of overcoming the down payment friction are suddenly more LTV-constrained and may need to forgo the house purchase to save more, despite the lower borrowing costs. Recent papers such as Gorea et al. (2025) and the analysis shown in Table 1, tell us that house prices respond to monetary policy-induced mortgage rate changes within a matter of weeks. Applying a back-of-the-envelope calculation of a 0.25 p.p. mortgage rate cut to a $400,000 dollar house with a 20% downpayment would raise the downpayment by over one thousand dollars with the Table 1 Column (3) estimate of average house price response, which is not an insignificant impact.

To get a sense of the impact that monetary policy-induced mortgage rate changes have on house prices at an annual frequency, I perform a similar exercise to that of Gorea et al. (2025) estimating local projections (Jordà (2005)) with this paper's new mortgage-rate specific monetary policy shock as the instrument. Appendix Figure A4 plots house price IRF. I estimate the cumulative changes in annual log differences of CBSA-level house prices and house price to rent ratios on the mortgage rate change instrumented with the mortgage rate-specific monetary policy factor. The specification is the same as above except that the instrumented variable of interest is the change in average mortgage rates one month before and after the shock instead of the cumulative change. I do this because house prices are typically very persistent as opposed to purchase shares.

Not surprisingly, the immediate response is slow. The data sample is monthly with house price indices aggregated at the CBSA-level. The important takeaways are twofold. First, the twelve-month response to an exogenous 1 p.p. decrease in mortgage rates yields a 4% increase in annualized house price growth. Second, the response persists and increases to 10% two years after the shock.

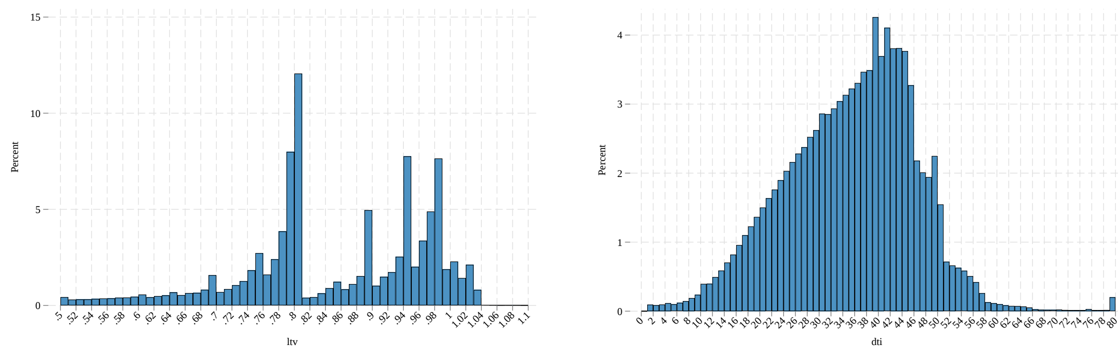
3.3 LTV and DTI

To understand the mechanism behind the main results, I explore how the results vary when focusing on CBSAs with more constrained borrowers. In particular, I examine the role that LTV and DTI constraints play in explaining these results. First, I examine the LTV and DTI distributions for mortgages in my sample period as shown in Figure 7.

Although, there are many different types of loan products, in Panel (A) find LTV bunching around the 80% level as well at several levels at and above 90%. Over 20% of mortgages originate with an LTV between 79 and 81% while over 30% are between 90 and 100%. The bunching around the 80% level indicates many households are up against the LTV mortgage constraint which avoids paying private mortgage insurance (PMI). The large mass with LTVs between 90 and 100% tells us that many households are up against the LTV constraint to obtain a mortgage. CBSAs are very heterogeneous in their shares of home purchases with mortgage originations that have high LTVs. In the data sample for Table 2, the mean share of high LTV originations between 90 and 100% is 47% with a standard deviation of 12. If the mechanism behind the main regression results is that higher prices and consequently higher down payments cause the LTV constraint to bind or fail to be satisfied, we would expect starker results in magnitude among CBSAs with a history of more LTV constrained buyers. Table 3 Columns (1)–(4) demonstrates this exact pattern in its results.

In Panel (B) I find that the DTI distribution largely resembles that shown in Bosshardt et al. (2024) in that there are steep cliffs after the 45% and 50% DTI levels. One might expect to see a cliff at the 36% level given Fannie Mae's default DTI maximum limit; however, Fannie Mae allows a maximum limit of 45% if the borrower provides a higher level of credit worthiness. Additionally, Fannie Mae allows a higher DTI limit of 50% for mortgages underwritten using their Desktop Underwriting automated process if the full set of the borrower's characteristics (application data, income, financial assets, credit history, and employment history) satisfies their eligibility model. Approximately 20% of mortgages originated in the data have a DTI greater than 45%. One might expect that CBSAs with higher shares of high

Figure 7: LTV and DTI Distributions



LTV Distribution

DTI Distribution

Notes: Data sample consists of 10 million purchase loan originations between 2009 and 2019. Mortgages with LTVs higher than 1.1 and DTIs higher than 80% are excluded.

DTI mortgages originated would strongly react with higher first-time home purchase shares in the event of a mortgage rate decrease. The results in Table 3 Columns (5)–(8) show that this is not the case.

Table 3 presents the regression results using the same specification from Table 2 but interacting the instrumented mortgage rate change with the CBSA share of high LTV buyers in Columns (1)–(3) and the share of high DTI buyers in Columns (4)–(6) from the month prior to the monetary policy shock. I define a CBSA's share of constrained LTV borrowers as the share of mortgages originated with an LTV between 90 and 100% in that month. Similarly, I define a CBSA's share of constrained DTI borrowers as the share of mortgages originated with a DTI greater than 45% in that month.

The results in Columns (1)–(3) indicate that CBSAs with higher constrained LTV shares in the prior month faced larger decreases in first-time home purchase shares when mortgage rates fall relative to their less-constrained counterparts. These results provide direct evidence for the mechanism behind the Table 2 results that the increased downpayment friction which binds the LTV constraint impedes potential first-time home buyers abilities to purchasing their first home—thus lowering the first-time home purchase share. Appendix Table A6 further supports this by showing similar results by interacting the instrumented mortgage rate change with the CBSA

Table 3: First-time purchase shares by LTV and DTI shares

	LTV shares			DTI shares		
	(1)	(2)	(3)	(4)	(5)	(6)
	$h = 1$	$h = 2$	$h = 3$	$h = 1$	$h = 2$	$h = 3$
Δ Mortgage rate $\times$ L.LTV 90s shr	0.0919**	0.0757***	0.0564**			
	(0.0355)	(0.0245)	(0.0275)			
Δ Mortgage rate $\times$ L.DTI 45+ shr				0.1695**	0.1529***	0.1099*
				(0.0701)	(0.0455)	(0.0575)
Observations	2032	2032	1989	2032	2032	1989
K-P Fstat	15.89	28.23	15.28	20.83	26.84	15.88
Number of transactions	3066813	3088425	3030114	3066813	3088425	3030114

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes interacted with CBSA-level shares of high origination LTVs (Columns (1)–(3)) and of high origination DTIs (Columns (4)–(6)) for the month prior to the shock instrumented by the mortgage rate-specific monetary policy shock. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t+h$ and the annual change in purchase shares for time $t-1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10, ^{**} p < 0.05, ^{***} p < 0.01$.

share of high combined LTV (CLT) buyers.

When borrowing costs fall, one might expect previous DTI-constrained borrowers to have a higher ability to obtain a mortgage and thus we would expect that the impact of the mortgage rate changes to be lower for CBSAs with higher DTI-constrained borrowers given that first-time buyers would be more responsive. Surprisingly, the results in Columns (4)–(6) are contrary to what was initially hypothesized with the estimated coefficients telling a similar story to those in Columns (1)–(3). The rationale behind these results lies in the data. First, borrowers who are DTI-constrained tend to be LTV-constrained as well. So CBSAs with higher shares of LTV-constrained borrowers also tend to have higher shares of DTI-constrained borrowers. Second, the

DTI distribution in Figure 7 Panel (B) tells us that borrowers seem to have relatively little difficulty in overcoming Fannie Mae's lower 36% DTI limit by providing evidence of credit worthiness and by searching for non-conventional mortgage products, while a sudden increase in a down payment caused by higher house prices may be a more difficult barrier to overcome.

Table A4 regresses log changes in annual log differenced-volumes for first-time buyers with FHA loans to instrumented mortgage rate changes by the CBSA's high LTV share quartile the month prior to the mortgage rate shock. The results are telling, particularly in the one month horizon. In Column (4), I estimate a statistically significant coefficient indicating that a one percentage point mortgage rate drop yields a 37.9% decrease in first-time purchases by buyers with high LTVs. As previously discussed, typically when mortgage rates fall, housing demand rises which causes house prices rise. Given that I do not estimate an statistically significant increase in purchase volumes for these types of home buyers in response to lowering mortgage rates, the empirical evidence suggests that many first-time buyers are relatively priced out of the home purchasing market.

Combined with the prior results, the empirical results indicate that most of the initial increased buyer demand for housing that causes prices to rise comes more from incumbent homeowners and less from first-time buyers. Additionally, the less-affluent high LTV first-time home buyer purchase volumes actually decrease in the one month horizon in CBSAs with higher shares of LTV-constrained buyers. Overall, the results tell a stark story that when mortgage borrowing costs fall, the "haves" (households that own housing) buy more of the housing shock relative to the "have-nots" (potential first-time homebuyers).

3.4 Additional Heterogeneity

This subsection explores the heterogenous impact of mortgage rate changes on the first-time homebuyer share by income groups, by housing market size, and by original location prior to purchasing a home.

A natural question to ask after seeing how first-time homebuyer purchase share results depend on mortgage constraints is how do the results vary by income. Given the results from Table 3, one would expect that lower income first-time homebuyers' purchasing behaviors are more sensitive to price shocks than higher-income first-time homebuyers' purchasing behaviors because they tend to be more liquidity-constrained. Table 4 demonstrates evidence showing this is likely the true story.

I estimate homebuyer income in two ways. First, I use the income reported from homebuyers' credit records estimated from their personal income model (PIM). Second, I impute income by dividing a homebuyer's total liabilities by the DTI ratio at origination. Total liabilities are calculated as the sum of all monthly mortgage and non-mortgage debt payments observed in the credit records and the monthly property tax payment the year prior to the home purchase. Miscellaneous liabilities such as child support payments are not included, though these types of liabilities are not typical. Homebuyers are arranged into low, moderate, upper, and highest income groups if their income is less than 50% of their county's median household income, between 50 and 80% of their county's median household income, between 80 and 120% of their county's median household income, and over 120% of their county's median household income, respectively. The first-time homebuyer purchase shares by income group relate the number of first-time homebuyers for an income group by the total number of homebuyers for whom I estimate their income.

Table 4 presents the analysis using the same specification for the IV regressions in Table 2 home buyer income group at the one-month horizon. Columns (1)–(4) display the estimates for the Iow, moderate, upper, and highest income groups, respectively, using the DTI-inferred income. Columns (5)–(8) display the estimates for the Iow, moderate, upper, and highest income groups, respectively, using the PIM-inferred income. Qualitatively, the results are consistent across both income estimates. Columns (1) and (5) indicate that when mortgage rates fall, low-income first-time homebuyer purchase shares fall by more compared to all other income groups, agreeing with the hypothesis that credit constraints matter. The estimated coefficients are lower for higher-income first-time buyers. Columns (4) and (8) indicate that when mortgage rates fall, the highest-income first-time homebuyer purchase shares actually increase, a result that we observed for incumbent homebuyers in the main table regressions. These households are less liquidity constrained, and therefore less sensitive to house price shocks caused by mortgage rate changes. These results complement those in **?**

Table 4: First-time buyer share of home purchases regressions—Income

	Income via DTI				Income via PIM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low	Moderate	Upper	Highest	Low	Moderate	Upper	Highest
Δ Mortgage rate	0.0917***	0.0214***	-0.0004	-0.0115**	0.0314***	0.0185	0.0159***	-0.0038**
	(0.0309)	(0.0074)	(0.0058)	(0.0055)	(0.0096)	(0.0199)	(0.0054)	(0.0017)
Observations	1568	1568	1568	1568	2032	2032	2032	2032
K-P Fstat	18.34	19.13	18.78	19.14	15.46	16.60	16.44	16.72
Number of transactions	2629613	2629613	2629613	2629613	3066814	3066814	3066814	3066814

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock by income groups. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t+1$ and the annual change in purchase shares for time $t-1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 25 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis $^*p < 0.10,^{**} p < 0.05,^{***} p < 0.01$.

by showing that lower mortgage rates price-out lower-income first-time homebuyers.

Alternatively, one may ask how these results vary over different types of metropolitan areas—specifically, those with smaller and larger housing markets. Larger cities typically have larger housing markets that are more liquid and have higher prices. They also tend to have a higher liquidity supply or inflow rate of buyers (Jiang et al. (2024)). Consequently it is not surprising that that CBSAs with larger housing markets have more sensitive first-time homebuyer share rates as shown in Table 5. I define the size of a CBSA's housing market based on the number of housing transactions between 2009 and 2019, and divide the data sample into three groups: large market CBSAs with a top ten market size, medium market CBSAs that rank between 11 and 50, and small market CBSAs outside of the top 50. The same specification from Table 2 is used; however, I reduce the restriction on the minimum number of transactions from 150 to 25 to include the smaller CBSAs. This allows the sample sizes to be large enough for each sub-sample.

Columns (1)–(3), Columns (4)–(6), and Columns (7)–(9) report the coefficient

Table 5: First-time buyer share of home purchases regressions—Market size

	Mkt rank > 50			Mkt rank 11–50			Mkt rank ≤ 10		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$h=1$	$h=2$	$h=3$	$h=1$	$h=2$	$h=3$	$h=1$	$h=2$	$h=3$
Δ Mortgage rate	-0.0011	0.0067	0.0137	0.0306**	0.0301***	0.0216*	0.0390***	0.0352***	0.0571***
	(0.0123)	(0.0098)	(0.0180)	(0.0140)	(0.0096)	(0.0126)	(0.0142)	(0.0119)	(0.0190)
Observations	4610	4610	4508	1961	1961	1924	636	636	624
K-P Fstat	15.19	24.72	12.79	15.63	26.64	14.31	17.71	28.10	14.19
Num. of trans	927289	932643	915964	1590605	1602805	1571324	1657077	1669421	1637211

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock by housing market size. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t+h$ and the annual change in purchase shares for time $t-1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 25 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01.$

estimates for small, medium, and large housing markets respectively. The estimated coefficients for the large market CBSAs are the greatest in magnitude and statistically significant for all three horizons with the reported F-statistic meaningfully large for the first two months post-shock. Similarly, the estimated coefficients for CBSAs with housing markets that rank 11–50 are economically significant in magnitude and statistically significant for the first two post-shock months. Finally, the estimated coefficients for the small market CBSAs are lower in magnitude and are not statistically significant. These results are not very surprising given that CBSAs with larger housing markets tend to have higher house prices and more constrained LTV borrowers. Overall, the results from this table suggest that the positive relationship between mortgage rates and the first-time buyer share is largely driven by characteristics in metropolitan areas with larger housing markets.

There is a stark difference in the first-time homebuyer response when comparing households who purchase their first home within the CBSA they currently inhabit and

Table 6: First-time buyer share of home purchases regressions—Migration

	Within CBSA			Into CBSA		
	(1)	(2)	(3)	(4)	(5)	(6)
	$h = 1$	$h = 2$	$h = 3$	$h = 1$	$h = 2$	$h = 3$
Δ Mortgage rate	0.0387**	0.0274***	0.0254**	-0.0028	0.0030	0.0014
	(0.0146)	(0.0076)	(0.0124)	(0.0032)	(0.0031)	(0.0042)
Observations	2032	2032	1989	2032	2032	1989
K-P Fstat	17.08	29.32	16.75	17.36	28.29	16.01
Number of transactions	3066813	3088425	3030114	3066813	3088425	3030114

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock by whether home buyers are moving within their CBSA or into a new CBSA. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t + h$ and the annual change in purchase shares for time $t - 1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

those who move to a different CBSA. Table 6 reports the estimated IV coefficients for the different migration populations. The IV specification is the same from Equation 2, but changes the numerator of the dependent variable to buyers who move within their CBSA and to buyers who move into a different CBSA. Columns (1)–(3) report the estimated coefficients for the within-CBSA buyers and Columns (4)–(6) report the estimated coefficients for the buyers who move into their new CBSA.

One might expect a stark difference when comparing CBSAs with different levels of supply elasticities, since, we would observe larger effects in areas with lower supply elasticities, i.e., areas with a lower housing quantity increase in response to a price increase. Surprisingly, this is not exactly the case. Table A7 presents the results where the sample is divided between CBSAs with above and below median housing supply elasticities from Baum-Snow and Han (2024). The housing supply elasticities used are those aggregated at the MSA-level. To convert the geography level to the CBSA-level, I merge in the county using a data crosswalk from the Centers for Medicare and Medicaid Services, and merge in the CBSA using a data crosswalk available via the NBER. The results are mixed given that the estimated coefficients are larger for high supply elasticity CBSAs for the one and two-month horizons, while we observe the expected result for the three-month horizon. These results may be explained in that the regressions focus on a short-run horizon rather than a long-run horizon. Additionally, the results in the table confirm that the impact of mortgage rate changes on first-time home buyer shares is not driven by housing supply elasticities.

4 Model

I construct a quantitative life-cycle model with a housing ladder, a system of housing-related taxes, a negatively-skewed income process with uninsurable income risk, and long-term mortgage debt. Interest rates are exogenous and house prices clear the market at each point in time.

4.1 Environment

Time is discrete and indexed by t while age is indexed by a. Households live for T periods, with one period equating to one year, and have preferences over non-durable consumption C and illiquid housing H

$$U(C_{a,j,t}, H_{a,j,t}) = \frac{C_{a,j,t}^{1-\gamma}}{1-\gamma} + \phi H_{a,j,t}$$

where γ is the risk aversion parameter and ϕ is the housing taste parameter. In each period, households receive working or retirement income and make consumption, savings, and housing decisions to maximize utility over their remaining life. Households are heterogeneous in their age, wealth, income state, moving state, housing state, and the age at which they purchased their most recent house. Without loss of generality, denote a household's state with j. The economy is made up of a unit mass of overlapping generations of these j heterogeneous households.

At the beginning of each period, new working households are born, shocks are realized, and then income is earned. Households then make consumption and housing decisions, which clears the housing market, and realize utility. The period ends with households aging one year—those who lived for T periods with terminal wealth A_j and housing H_j realize utility with a bequest benefit

$$\frac{B_0}{1-\gamma}\left(A_j + p_t H_j + B_1\right)^{1-\gamma}$$

where p_t is the housing price, B_0 is the bequest motive multiplier, and B_1 is the bequest motive shifter. The housing portion a household's bequest benefit is sold at market price p_t. Households begin their working life as a renter with no ownership of housing, zero liquid wealth, at a random income state, and no desire to move. Only after their first working year are moving shocks realized. In each period t, age a, and state j, households maximize expected remaining lifetime utility

$$E_t\left[\sum_{k=a}^{T} \beta^{k-a} U(C_k, H_k) + \beta^{T-k} B(A_T, H_T)\right].$$

In each working period, households earn an exogenous time-varying wage depending on their age and income state, choose how much to consume and save liquid wealth at an exogenously given risk-free rate $r = \{r^{rf}, r^b\}$. Households with positive liquid wealth earn interest $r^{rf} > 0$, while those who carry liquid debt borrow at rate r^b. Households begin working at age 25, retire at age 61, and reach their end of life at age 65.

4.1.1 Housing

The set of housing outcomes $\mathcal{H}$ comprises of four states: a renter state, a starter homeowner state, a large homeowner state, and a second-homeowner state. The aggregate stock of non-rental housing is fixed, i.e., there is no housing construction or depreciation, and non-rental housing is owned entirely by households. Following the results from Guren and Greenwald (2025), rental markets are perfectly segmented and, for simplicity, I further assume that the stock of rental housing perfectly matches rental demand and is owned by outside landlords who charge a fixed per-period rental price q. Given the empirical results shown in Appendix Figure A4 that the majority of the response to changes in the house price-to-rent ratio from mortgage rate shocks are due to house price movements and not rent price movements, I only solve for house prices and assume rental prices are exogenously set. In each period, homeowners pay property taxes on the number of total housing units they own at the current market price and tax rate τ^p. Households have the option to change their housing state if they receive a Calvo moving shock with probability ξ. Upon receiving a moving shock, households in the renter state may choose to obtain a mortgage in order to purchase a one-unit starter home, owners of a starter home may choose to pre-pay their mortgage and sell their home in order to obtain a new mortgage to purchase a two-unit large home, owners of a large home may choose to pre-pay their large home mortgage in order to obtain a new mortgage to purchase an additional starter home to treat as their second-home, and second-home owners may choose to "downsize" by selling both their large and second-homes and obtain a new mortgage to purchase a new large home. Mortgages originated in time t at age b with an initial balance of M_0 amortize over the course of a household's remaining life with interest rate $r^m_t > r^{rf}$ and fixed payments

$$x = \left(\frac{M_0}{T-b} \sum_{a=b}^{T} (1 + r^m_{t-(a-b)})^{a-b+1} \right)^{-1}.$$

Moving households are subject to a variable moving cost c_m, and pre-paying a mortgage entails paying off the remaining balance plus c_p percent of the remaining balance. Any housing returns are also subject to a capital gains tax of τ^{cg}. Houses are homogenous in all but their unit size and provide flow utility of ϕ times the total number of units owned. For simplicity, I abstract away from any additional consumption benefits that typical owner-occupied housing may provide over rental housing and assume that rental units provide the same consumption utility as a starter home.

When originating a mortgage for a home of unit size H and price p, households make a downpayment $\theta^{LTV} pH$, borrow $M_0 = (1 - \theta^{LTV})pH$, and must satisfy a debt-to income (DTI) ratio

$$\frac{M_0 r^m + \mathbb{I}(A < 0) \cdot |A| r^b + \tau^p p H^{total}}{Y} \leq \theta^{DTI}$$

where Y is the households pre-tax income, τ^p is the property tax rate, H^{total} is the total number of housing units owned, and θ^{DTI} is the maximum DTI ratio. The DTI constraint tells us that the household's financial obligations relative to their pre-tax income cannot be too high. To satisfy the DTI constraint, the sum of household's mortgage payment, liquid debt payment, and total property tax payments scaled by their income must not exceed θ^{DTI}.

4.1.2 Income process

Pre-tax income follows a simplified and discretized version of the benchmark process recommended in Guvenen et al. (2021). Income follows a Markov process which varies by age. As shown in Equation 3, age a income for household j consists of a lifecycle component $g(a)$, discretized states combining the persistent z_a^j and transitory shocks ϵ_a^j, and an additional individual time-varying transitory effect β_a^j drawn from $\mathcal{N}(0, \sigma_\beta)$. The persistent component z_a^j follows an AR(1) process (Equation 4) with shock η_a^j drawn from a mixture of normals (Equation 5). The transitory component ϵ_a^j is an innovation also drawn from a mixture of normals (Equation 6). First, I discretize the persistent and transitory shocks into three bins each using quadrature methods. I apply Tauchen's method (Tauchen (1986)) over the mixture-quadrature nodes to create the transition matrix for the persistent shocks. I then use K-means clusters to collapse the joint income distribution of persistent and transitory shocks for each working year into three bins. Transitioning between the income states across time follows a Markov process which varies over time.

$$Y_{a,j} = \exp\{g(a) + \beta_a^j + z_a^j + \epsilon_a^j\} \tag{3}$$

$$z_a^j = \rho^p z_{a-1}^j + \eta_a^j \tag{4}$$

$$\eta_a^j \sim \begin{cases} \mathcal{N}(\mu_{\eta 1}, \sigma_{\eta 1}) & \text{with prob. } p_z \\ \mathcal{N}(\mu_{\eta 2}, \sigma_{\eta 2}) & \text{with prob. } 1 - p_z \end{cases} \tag{5}$$

$$\epsilon_a^j \sim \begin{cases} \mathcal{N}(\mu_{\epsilon 1}, \sigma_{\epsilon 1}) & \text{with prob. } p_\epsilon \\ \mathcal{N}(\mu_{\epsilon 2}, \sigma_{\epsilon 2}) & \text{with prob. } 1 - p_\epsilon \end{cases} \tag{6}$$

For simplicity, I do not include non-employment shocks nor do I include individual fixed effects which are present in the benchmark process in Guvenen et al. (2021). I am able to generate negative skewness and high kurtosis in my discretized version of the process without them. Secondly, if one were to include the time-varying component in the model, one would need to track this in the backward induction code, which would add to the already significant state space. Finally, one could discretize the persistent and transitory innovations separately, but that would increase the state space to more than what is necessary to generate the income process with negative skewness and high kurtosis.

Income is taxable following a progressive tax function 7 as in Heathcote et al. (2017) and Guren et al. (2021a). Additionally, households with mortgages deduct mortgage interest payments from their current mortgage balance $M_{a,b}$ (where a is their current age and b is their age at origination) from their taxable income. Once households reach retirement age, their remaining income stream is a constant fraction of the income from their last working age. Specifically, I set retirement log income to the last working age income minus ρ. Finally, income is scaled so that mean post-tax income, absent any mortgage interest deduction, is one.

$$\text{Post-tax income} = \begin{cases} \tau(Y_{a,i}) = Y_{a,i} - \tau_0 Y_{a,i}^{1-\tau_1}, & H = 0 \\ \tau(Y_{a,i} - M_{a,b} r^m) = (Y_{a,i} - M_{a,b} r^m) - \tau_0 (Y_{a,i} - M_{a,b} r^m)^{1-\tau_1}, & H > 0 \end{cases} \tag{7}$$

4.2 Household decisions

Every period, households make consumption and housing decisions. The exogenous state variables for households are their age, income state, and their moving state, and the endogenous state variables are their liquid wealth, housing state, and age at which they purchased their current house. Consequently, the latter two along with the household's age imply the level of their mortgage balance and their constant mortgage payments.

First, consider a renter at age a who enters time t with liquid savings $A_{a-1,i_{t-1},h=0,t-1}$ and income state i who earns pre-tax income $Y_{a,i}$. If they choose to stay as a renter, they pay rent q to live in a one-unit home owned by some outside landlord and choose consumption $C_{a,i,h=0,t}$ to maximize flow and remaining lifetime utility subject to their budget constraint

$$C_{a,i,h=0,t} + A_{a,i,t} = \tau(Y_{a,i}) - q + A_{a-1,i_{t-1},t-1}(1 + r).$$

If the renter receives a moving shock, is able to satisfy the DTI constraint, and chooses to climb the housing ladder, they make a downpayment θ^{LTV} to originate a fixed-rate mortgage with mortgage rate r_t^m where they will make constant annual payments $x_{a,b}^{h=1}(r_{t-(a-b)}^m)$ over the course of their remaining life to purchase a one-unit home at price p_t.[3] They will pay a one-time moving cost $c_m p_t$ and start paying property taxes every period. Finally, they choose consumption $C_{a,i,h=1,b,t}$ to maximize flow and remaining lifetime utility subject to their budget constraint

$$\begin{aligned} C_{a,i,h=1,b,t} + A_{a,i,h=1,b,t} = {} & \tau(Y_{a,i} - M_{a,b} r_t^m) + A_{a-1,i_{t-1},t-1}(1 + r) \\ & - \theta^{LTV} p_t - x_{a,b}^{h=1}(r_{t-(a-b)}^m) - c_m p_t - \tau^p p_t. \end{aligned}$$

Next consider an age a household who enters period t owning a starter home purchased at age b with liquid savings $A_{a-1,i_{t-1},h=1,b,t-1}$ and in income state i. If they choose to stay as a starter owner, they continue to pay down their mortgage and choose consumption $C_{a,i,h=1,b,t}$ to maximize flow and remaining life utility subject to their budget constraint

$$\begin{aligned} C_{a,i,h=1,b,t} + A_{a,i,h=1,b,t} = {} & \tau(Y_{a,i} - M_{a,b} r_{t-(a-b)}^m) + A_{a-1,i_{t-1},h=1,b,t-1}(1 + r) \\ & - x_{a,b}^{h=1}(r_{t-(a-b)}^m) - \tau^p p_t. \end{aligned}$$

If the household receives a moving shock, satisfies the DTI constraint for a large, two-unit home mortgage, and chooses to purchase a new two-unit home, they will pre-pay their original mortgage and face a prepayment penalty c_p,sell their starter home and pay a capital gains tax on their housing returns, pay a moving cost, and obtain a new mortgage in order to purchase their new home while choosing consumption $C_{a,i,h=2,b,t}$ to maximize flow and remaining lifetime utility subject to their budget constraint

[3]Note that b is the age of mortgage origination, so the household's reference mortgage rate is $r_{t-(a-b)}^m$.

$$
\begin{aligned}
C_{a,i,h=2,b,t} + A_{a,i,h=2,b,t} = {} & \tau(Y_{a,i} - M_{a,b}^{h=2} r_{t-(a-b)}^{m}) + A_{a-1,i_{t-1},h=1,b,t-1}(1+r) \\
& - 2\theta^{LTV} p_t - x_{a,b}^{h=2}(r_{t-(a-b)}^{m}) \\
& - M_{a,b}^{h=1}(1+c_p) + (p_t - \tau^{cg}(p_t - p_{orig})) - 2c_m p_t - 2\tau^p p_t.
\end{aligned}
$$

Next consider an age a household who enters period t owning a large home purchased at age b with liquid savings $A_{a-1,i_{t-1},h=2,b,t-1}$ and in income state i. If they choose to stay as a large home owner, they continue to pay down their mortgage and choose consumption $C_{a,i,h=2,b,t}$ to maximize flow and remaining life utility subject to their budget constraint

$$
\begin{aligned}
C_{a,i,h=2,b,t} + A_{a,i,h=2,b,t} = {} & \tau(Y_{a,i} - M_{a,b} r_{t-(a-b)}^{m}) + A_{a-1,i_{t-1},h=2,b,t-1}(1+r) \\
& - x_{a,b}^{h=2}(r_{t-(a-b)}^{m}) - 2\tau^p p_t.
\end{aligned}
$$

If the household receives a moving shock, satisfies the DTI constraint for a one-unit home mortgage, and chooses to purchase a one-unit home to be their vacation (second) home, they will pre-pay their original large home mortgage and obtain a new mortgage in order to purchase their secondhome. The second-home owners will make property tax payments for both of their homes and also list their home for short-term rentals for a part of their receiving an income of w_{2nd}. Given this action, they will choose consumption $C_{a,i,h=3,b,t}$ to maximize flow and remaining lifetime utility subject to their budget constraint

$$
\begin{aligned}
C_{a,i,h=3,b,t} + A_{a,i,h=3,b,t} = {} & \tau(Y_{a,i} - M_{a,b}^{h=1} r_{t-(a-b)}^{m}) + A_{a-1,i_{t-1},h=1,b,t-1}(1+r) \\
& - \theta^{LTV} p_t - x_{a,b}^{h=1}(r_{t-(a-b)}^{m}) \\
& - M_{a,b}^{h=2}(1+c_p) - 3c_m p_t - 3\tau^p p_t + w_{2nd}
\end{aligned}
$$

Finally, consider an age a household who enters period t owning a large home and a home purchased at age b with liquid savings $A_{a-1,i_{t-1},h=3,b,t-1}$ and in income state i. If they choose to stay as an large home owner, they continue to pay down their mortgage and choose consumption $C_{a,i,h=3,b,t}$ to maximize flow and remaining life utility subject to their budget constraint

$$C_{a,i,h=3,b,t} + A_{a,i,h=2,b,t} = \tau(Y_{a,i} - M_{a,b} r^m_{t-(a-b)}) + A_{a-1,i_{t-1},h=2,b,t-1}(1+r)$$
$$- x^{h=2}_{a,b}(r^m_{t-(a-b)}) - 3\tau^p p_t + w_{2nd}.$$

If the household receives a moving shock, satisfies the DTI constraint for a two-unit home mortgage, and chooses to downsize from a large home and second home to a new large, two-unit home to be their second-home, they will pre-pay their second-home mortgage, sell both of their homes, and obtain a new mortgage in order to purchase their new two-unit home. Given this action, they will choose consumption $C_{a,i,h=2,b,t}$ to maximize flow and remaining lifetime utility subject to their budget constraint

$$C_{a,i,h=3,b,t} + A_{a,i,h=3,b,t} = \tau(Y_{a,i} - M^{h=1}_{a,b} r^m_{t-(a-b)}) + A_{a-1,i_{t-1},h=1,b,t-1}(1+r)$$
$$- 2\theta^{LTV} p_t - x^{h=2}_{a,b}(r^m_{t-(a-b)})$$
$$- M^{h=1}_{a,b}(1+c_p) - 3c_m p_t - 2\tau^p p_t.$$

4.3 Stationary Equilibrium

Given an exogenous set of interest rates $\{r^{rf}, r^b, r^m\}$ and tax rates $\{\tau^p, \tau^{cg}, \tau_0, \tau_1\}$, a fixed stock of housing, a stochastic income process with an initial income distribution, and a set of moving shocks, a competitive equilibrium consists of house prices $\{p_t\}$, aggregate allocations $\{H_t\}$, and decision functions $\{\sigma_C(C_t(a,w,h,m)), \sigma_H(H_t(a,w,h,m))\}$ such that households optimize, housing markets clear, and cross-sectional distributions are consistent with household behavior.

4.4 Solution method

All households are forward-looking and have perfect foresight. I first use backward induction to calculate a household's consumption and housing policy function at each given state and age for some house price. I then simulate the model 250,000 times over the entire course of their working and retired lives. I define each simulation-age pair as an instance. Given the large number of simulations and that the model is in a stationary equilibrium, I treat each instance as an individual household in the economy with each household receiving equal weight, although some instances occur many times, such as the first-working age instance where households wake up as renters with zero liquid wealth and divided equally across the different income states.

A simulation-age pair instance or household that lives in a starter home owns one unit of housing, a household that lives in a large home owns two units of housing, and a household that lives in a large home and owns a second-home owns three units of housing. Renters own zero units of housing. I calculate the total stock of owned housing units per household by summing the number of total units owned in the economy across simulation-age pair instances and divide by the number of simulations times the total number of years households live to calculate the total stock of homes per household in the economy.

By construction, the intra-temporal demand for housing equals the intra-temporal supply of housing because for each simulation-age pair that increases the amount of housing they own, there exists another simulation-age pair (later on in that simulation's "life") that sells or dies with that same amount of housing—a feature one would expect within a stationary equilibrium. However, the total stock of owned housing units in the model changes in response to the house price. Thus, to solve for the equilibrium house price, I solve for the price which matches the calibration target of 1.14 units of owned housing per household. Note that by targeting the total number of homes per household, I allow the homeownership rate to vary. Alternatively, the homeownership rate can be targeted instead.

The solution method for the model where I apply a negative 1 p.p. "MIT" shock to the mortgage rate with low persistence is similar to the solution method for the stationary equilibrium. First, I solve the model for the stationary equilibrium prior to the mortgage rate shock. Then I take the exogenously given mortgage rate path and guess a corresponding house price for some horizon T_h and use backward induction again to calculate a household's consumption and housing policy function at each given state, age, and post-shock time period. I then do a forward sweep and simulate the model again for both existing households prior to the mortgage rate shock and new households who are born after the shock. Each newborn household "replaces" a household who dies and faces the same set of lifecycle shocks without *ex ante* knowledge of receiving them. By doing this, I am able to compare households in the post-shock state to their counterfactual pre-shock stationary equilibrium versions.

4.5 Calibration

Table 7 reports the parameters for the model. Each period in the model represents one year so the discount factor is set to 0.96. The risk-free rate for positive liquid wealth saving is 2% and the borrowing rate is 25%—similar to that of a credit card for revolving debt. The tax function is calibrated as in Heathcote et al. (2017) and Guren et al. (2021a) where the scalar is set to $\tau_0 = 0.8$ and the parameter guiding the curvature of the function is set to $\tau_1 = 0.18$. The parameter that guides log income decline in retirement ρ is set to 0.35 as in Guren et al. (2021a).

Table 7: Calibration of Main Parameters

Parameter	Value	Description	Parameter	Value	Description
β	0.96	Discount factor	ϕ	0.4	Housing taste
γ	2	CRRA	θ^{DTI}	0.45	Maximum Debt-to-Income
r^f	2%	Risk-free rate	θ^{LTV}	20%	Downpayment
r^b	25%	Borrowing rate	τ^p	1%	Property tax
ρ	0.35	Log income decline in retirement	c_m	3%	Variable moving cost
τ_0	0.8	Constant in tax function	c_p	1%	Variable pre-payment cost
τ_1	0.18	Curvature in tax function	τ^{cg}	15%	Capital gains tax on home sales
B_0	85	Bequest multiplier	rent	0.1021	Minimum pre-tax income value
B_1	1.75	Bequest additive scalar	w_2	rent/24	Income from 2nd home
	36	Working years	ξ	50%	Moving shock
	5	Years retired		1.14	Total house supply per household
Stationary equilibrium targets			**Transition target**		
	Value	**Description**		**Value**	**Description**
	62.4%	Homeownership rate		3%	Initial 1st-time buyer purchase shr. change
	8.5%	Incumbent homeowner moving rate			

Notes: Benchmark parameter values used in the baseline calibration.

Rent is set to the lowest working-age pre-tax income value before accounting for any time-varying individual heterogeneity, implying that low income retired renters will need to save to account for rent exceeding their retirement income. ρ which governs retirement income is taken from Guren et al. (2021a). The LTV constraint parameter θ^{LTV} is set to 20% which is the most common LTV ratio used, implying that households face the same mortgage rate and do not make additional payments for PMI, and the DTI constraint parameter θ^{DTI} is set to 0.45 given the bunching observed in Figure 7. Although, this parameter is different from that set in Greenwald (2018) which sets the maximum DTI to 36% and compares the model results to a maximum DTI of 43%, it does not affect the results by much—however, like in Greenwald (2018) the model confirms that higher DTI maximums work well as a countercyclical tool. The variable moving and prepayment penalty costs are also taken from Guren et al. (2021a). The bequest multiplier B_0 and bequest shifter B_1 parameters guide the utility weight and the motive for bequests, respectively. Increasing B_0 incentivizes additional bequest saving and increasing B_1 raises the luxury status of bequests, lowering the incentives to make smaller bequests. The parameters are set to values from the lifecycle model in Guren et al. (2021b). The median net-worth for households age 60 relative to households age 45 is 2.4, similar to the 2.1 value in Guren et al. (2021a).

Finally, the housing taste parameter ϕ, the Calvo moving shock parameter ξ, and the constant income from short-term rentals of a second-home parameters are jointly used to calibrate the model to match a homeownership rate of 62% in the stationary equilibrium absent the MIT shock, the homeowner moving rate who moves once every twelve years according to Redfin data,[4] and to match the main empirical results. I choose to estimate the model with an equilibrium mortgage rate set at 5%. The homeownership rate target and the mortgage rate chosen match the U.S. national average in the beginning of 2010. Though housing taste parameter is high compared to the values used in Guren et al. (2021b) and Guren et al. (2021a), the reason for this is to encourage large homeowners to purchase additional housing. The higher housing taste parameter raises the flow utility from housing, overcoming the financial burden of purchasing an additional housing unit at the end of a household's life which could instead be used for additional consumption. In this model, low housing taste parameter values are sufficient to encourage starter and large home purchases, but they lower the incumbent homeowner moving rate and provide insufficient incentives to encourage purchasing second-homes which are typically purchased closer to a

[4] `https://www.redfin.com/news/homeowner-tenure-2022/`

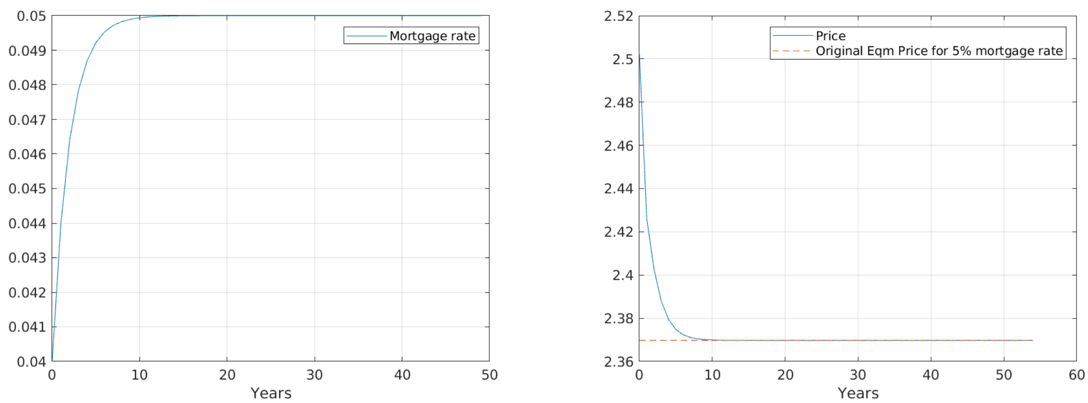
household's end of life. On the other hand, a housing taste parameter that is too high incentives too much additional, non-primary home purchases and lowers the homeownership rate. An untargeted moment, the price-to-rent ratio, is about 23 which is comparable to Austin, Texas in the mid-2010s.

I calibrate the income process to match the second and third moments of five-year income growth for median income earners using data provided in the Guvenen et al. (2021)'s supplementary files as shown in Appendix Table A9. As mentioned in their paper, discretizing their process is difficult because the nonnormalities raises the possibility of needing irregular placement for the grid points. In an attempt to overcome this, I adjust the width of the state space for the persistent shock to be 1.18 standard deviations of the stationary distribution. Although this is small, it can be enlarged when increasing the number of income states. I also adjust the probability of receiving the transitory shock p_ϵ to 0.353 and the standard deviation of the first set of normals governing the transitory shock $\sigma_{\epsilon 1}$ to 0.35. The rest of the parameter values are taken from Guvenen et al. (2021)'s recommended Model 6 values, though the process is robust to values taken from the other models in their paper. $\mu_{\eta 2}$ and $\mu_{\epsilon 2}$ are calculated such that the innovations have mean zero. Appendix Table A8 reports all of these values.

4.6 Model results

Assuming a pre-shock stationary equilibrium mortgage rate of 5%, I apply a negative 1 p.p. shock to the mortgage rate with low persistence following the process $\eta_t = 0.6^{t-1}\eta_0$ where $\eta_0 = -1$. After the initial shock period, mortgage rates quickly converge back to their stationary equilibrium level of 5% as shown in Figure 8 Panel (a). All households have perfect foresight, so the mortgage rate and house price paths are known. Panel (b) plots the price path dynamics which are the market prices setting demand equal to supply for each post-shock period. Knowing that mortgage rates will rise after the initial shock, household demand for housing increases which raises prices as shown in Panel (b). We can see that housing demand at the time of the shock is higher than housing demand in the stationary equilibrium with a 4% mortgage rate because the initial house price level is higher than the stationary equilibrium price level with a 4% mortgage rate.

Figure 8: Mortgage rate and price paths



(a) Mortgage rate path

(b) Price path

Notes: Panel (a) plots the mortgage rate path and Panel (b) plots the price path for post-mortgage rate shock horizons 0 to 55 years.

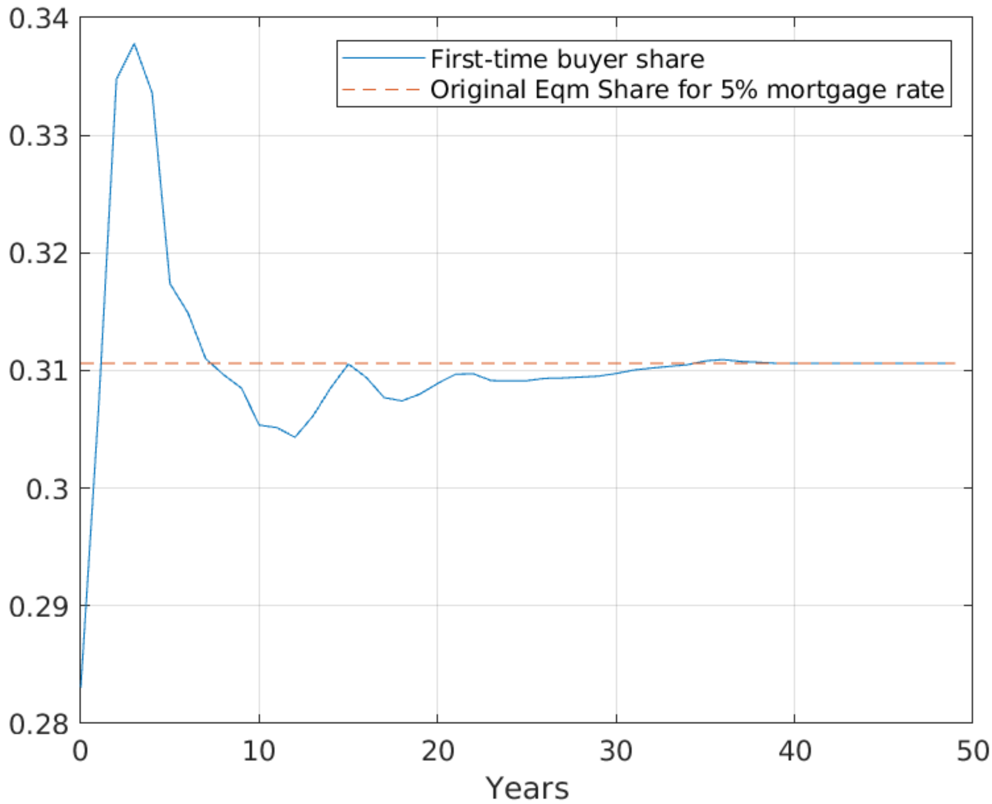
Figure 9 plots the transition path of the first-time buyer share of home purchases. In the initial shock year, the first-time buyer share falls by 2.8%, in line with the empirical results. The rebound in first-time home purchases three years after the shock reflects the increase of first-time homebuyers entering the market relative to incumbent homeowners. This spike occurs because many incumbent homeowners their next home purchase earlier in their lifecycle to take advantage of the low mortgage rates. As mortgage rates rise and prices fall back to their pre-shock levels, we see that the renter share rises back to its pre-shock level as well.

Following Chatterjee et al. (2007), I calculate consumption-equivalent welfare by finding the percent change to consumption in all periods in the no shock scenario such that households are indifferent between the no shock scenario and the shock scenario. I do this by housing status prior to the shock and denote λ as the consumption change scalar

$$\frac{\sum_i \sum_{a=1}^{T} \sum_{s=a}^{T} \beta^{s-a} U\left((1+\lambda) \cdot C_{i,a,s}, H_{i,a,s}\right)}{\sum_i \sum_{a=1}^{T} \sum_{s=a}^{T} \beta^{s-a} \cdot U\left(C'_{i,a,s}, H'_{i,a,s}\right)} = 1.$$

Figure 10 below compares the mean post-shock welfare of households by pre-shock housing status relative to the no-shock world. I define a household's welfare as their

Figure 9: First-time buyer share impulse response



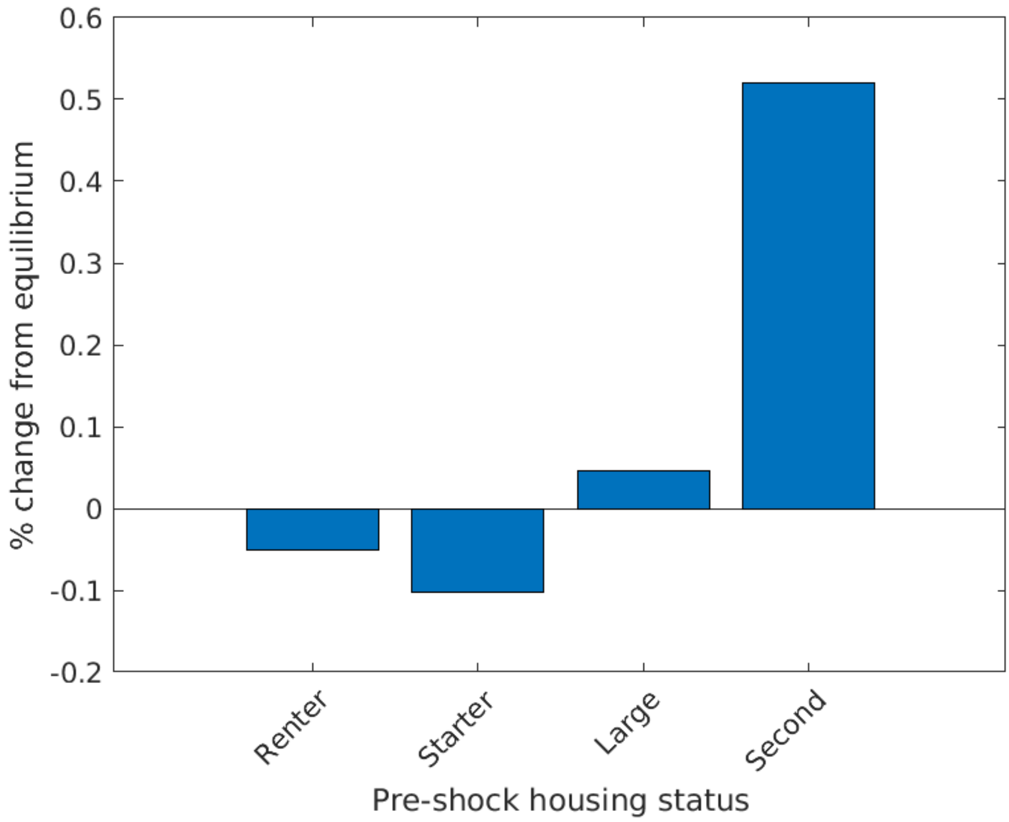
Notes: The figure plots the transition path of the first-time buyer share of home purchases for post-mortgage rate shock horizons 0 to 50 years

lifetime's remaining utility at the time of the shock (happy to discuss welfare definitions more). Renters are -.05% worse off relative to renters in the no-shock world. The real winners are households who own large homes and households who own large and multiple homes who receive welfare gains of 0.05% and 0.52%, respectively. Surprisingly, starter homeowners receive welfare losses of -0.1%. These types of households, like renters, have lower wealth relative to large and multiple homeowners. So the increase of house prices disparately impacts them as well.

4.7 Counterfactual policies

In this subsection, I explore a set of tax-related and subsidy-related counterfactual policies. The tax-related policies explored raise the relative cost of housing for second-home owners which dampens their demand for additional housing and mutes the price

Figure 10: Relative welfare to pre-shock stationary equilibrium



Notes: The figure plots the consumption-equivalent gains and losses for households of different housing status (prior to the mortgage rate shock) relative to their no-shock stationary equilibrium versions.

effects from mortgage rate decreases. I find that raising property taxes on non-primary homes reduces equilibrium prices and mutes the price response to mortgage rate shocks. Raising the capital gains tax for second home sales has similar, but smaller price effects. Note that due to the construction of the model, prices are constant in equilibrium, implying that capital gains on housing are zero in equilibrium. If price dispersion were introduced, capital gains tax policy may be more effective in lowering house prices. Removing mortgage interest deduction for second homes has the lowest impact on prices. Overall, these price results are similar to those in **?**.

In future versions of this paper, I will explore subsidy-related counterfactual policies. Providing a downpayment subsidy for first-time buyers, such as those proposed by recent presidential candidates, will increase potential first-time buyers' abilities to purchasing their first home—though their increased housing demand will generate a price increase, lowering their future consumption. I suspect that raising property taxes and capital gains tax rates for second-homeowners will generate higher welfare gains for potential first-time home buyers in the event of a mortgage rate decrease relative to providing the equivalent of a \$10,000 subsidy for downpayment assistance.

4.8 Discussion

This paper attempts to capture as many of the benefits and nuances of housing as feasibly possible. A home provides many benefits for its owners, since it is a unique financial asset which is also consumed. On the consumption side, households derive flow utility from living in their dwelling. A key feature in the model is that households derive additional utility from larger homes and from vacation homes. Unfortunately, due to limits in working with a feasible state space, the model leaves out housing quality which is left for future work—though this is not believed to be of first-order importance.

On the financial side, paying down a mortgage in the US, which typically has a fixed mortgage rate and monthly payments, is not subject to rental market price increases. Mortgage amortization schedules also serve as a savings plan critical for wealth building (Bernstein and Koudijs (2024)). Once a mortgage is paid off, the owners essentially receive a dividend payment in the form of a \$0 rental payment. Finally, homes are unique as a financial asset with many tax benefits. First, primary and second-home mortgage payers may deduct up to \$750,000 of mortgage interest payments from their taxes—increasing the flow returns from "saving" into their housing wealth. Second, selling a home often yields capital gains subject to capital gains taxes. However, there exist tax exemptions for sales on primary homes. Single filers are exempt from capital gains taxes on the first \$250,000 , while married filers are exempt on the first \$500,000. Additionally, occupying a second-home for over two weeks allow owners to claim the home as their primary residence—enabling them to take advantage of the capital gains tax exemption as well.

Though this paper studies the welfare impact of capital gains taxes, it does not look at capital gains tax exemptions. To include this feature in the model, one would need to add price dispersion in the model. Unfortunately, this greatly increases the state space because one would need to keep track of prices for both primary and secondary homes that are purchased and sold—making it difficult to study when looking at transition dynamics. However, when comparing stationary equilibrium with high and low mortgage rates and calibrating the exemptions to pre-Covid levels I find that removing exemptions for second-homes is welfare improving for renters because equilibrium prices fall, easing the path to homeownership. Finally, when a homeowner passes away and their home is bequeathed, the cost-basis is reset to the market value at time of death instead of the original purchase price. The model assumes that homes are sold immediately upon death and thus no capital gains taxes are paid.

This paper ignores the existence of trusts which are a useful tool for passing down wealth to future generations with large tax benefits, because to study them properly, one would need to adjust the lifecycle model to allow for legacy households who inherit properties and wealth at some point in their lifetime—further complicating the model. Additionally, this paper has an income process that does not vary as mortgage rates change. Accounting for the increasing income gap would likely augment the model results as renters would face increased sensitivity to the LTV constraint, suggesting that the welfare implications are in fact a lower bound.

The main model results compare outcomes from a stationary equilibrium to the transition dynamics caused by applying a transitory MIT shock to mortgage rates—however, in reality, we likely are never in a true stationary state. Just as Eichenbaum et al. (2022) and Berger et al. (2021) demonstrate a strong state and path-dependency in the consumption response to a fall in mortgage rates, further research is needed to understand the state-dependent nature of the disparate impact monetary policy transmits to first-time and incumbent home buyers.

Finally, the constructed model is tailored to answer questions for contexts when the demand impact of mortgage rate changes exceeds the impact on supply—a feature which on average is consistent with the data as seen from the empirical results. As a result, we are able to study periods such as the early 2020s when we observed record-low mortgage rate levels leading to high house price growth. However, when mortgage rates rose in 2022 and 2023, prices did not fall, a feature the current calibrated model does not capture. This is likely a result of several economic forces. First, households' expectations matter. Households may have expected only a short period of high mortgage rates with the hope that the high federal funds rate would cause inflation to quickly fall—consequently causing a fall in the short rate and a fall in the longer end of the yield curve. If households were to assume high mortgage rates for a short period of time, they may believe that the option value to not selling in a high rate period and waiting to sell in a low mortgage rate period exceeds the value of selling in the high mortgage rate period. If households were aware of the long high mortgage rate period *a priori* we would likely have observed lower prices. Though I am not aware of any paper that demonstrates this, the model in this paper can be adjusted to show this by adding an additional "sell option state" where incumbent home buyers have the option to wait on selling their previous home—effectively limiting the housing supply. I plan to investigate this further in future research. This phenomenon of higher vacancy levels and higher prices is contrary to Wheaton (1990) because it is a transitory outcome not an equilibrium outcome. Second, Fonseca et al. (2024) argue that high housing demand during low mortgage rate periods "lock-in" households during high rate periods, consequently lowering mobility. The lower mobility decreases downsizing and exits from homeownership, which raises net demand for housing and, as a result, prices.

5 Conclusion

In this paper, I first establish that that transacted house prices respond to monetary policy-induced mortgage rate changes within a matter of weeks, indicating that housing demand and transacted house prices respond to mortgage rate changes faster than previously believed in the literature. Then I show a positive relationship between mortgage rates and the first-time homebuyer share of home purchases estimating that an exogenous negative 0.25 b.p. shock to mortgage rates reduces the first-time home buyer share by 77 b.p.s. These results are more pronounced in areas with higher shares of high LTV buyers, suggesting that a very responsive incumbent homeowner demand and higher down payment frictions due to lower mortgage rates relatively price-out potential first-time home buyers. The link demonstrates the direct impact of monetary policy transmission through the mortgage channel to first-time home buyers. To estimate these results, I construct a new mortgage rate-specific monetary policy shock using intraday 10-year Treasury and MBS transactions data.

To quantify the welfare impact from an exogenous mortgage rate reduction, I construct a quantitative lifecycle model with heterogenous agents that incorporates a housing ladder and a negatively-skewed income process. Agents differ in their housing, income, wealth, age, and age of home purchase states. I find that applying a negative one p.p. transitory MIT shock to mortgage rates with low persistence to my calibrated model lowers potential first-time buyers' consumption-equivalent welfare by 0.05%. The model results indicate that 1) large homeowners and multiple homeowners benefit much more from mortgage rate reductions than first-time buyers, and 2) lower mortgage rates fail to provide consumption-equivalent welfare benefits for first-time homebuyers due to the house price increases caused by increased housing demand from lower mortgage rates.

Overall, my results suggest that central banks should be aware of the power that forward guidance and Quantitative Easing pass-through have on housing demand through the mortgage channel and its direct implications on growing housing wealth inequality. Policies that mitigate incumbent homeowner demand swings relative to first-time buyers are solutions that likely rebalance the relative welfare outcomes between incumbent homeowners and first-time buyers.

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A Appendix

Figure A1: Monetary policy factor relevance

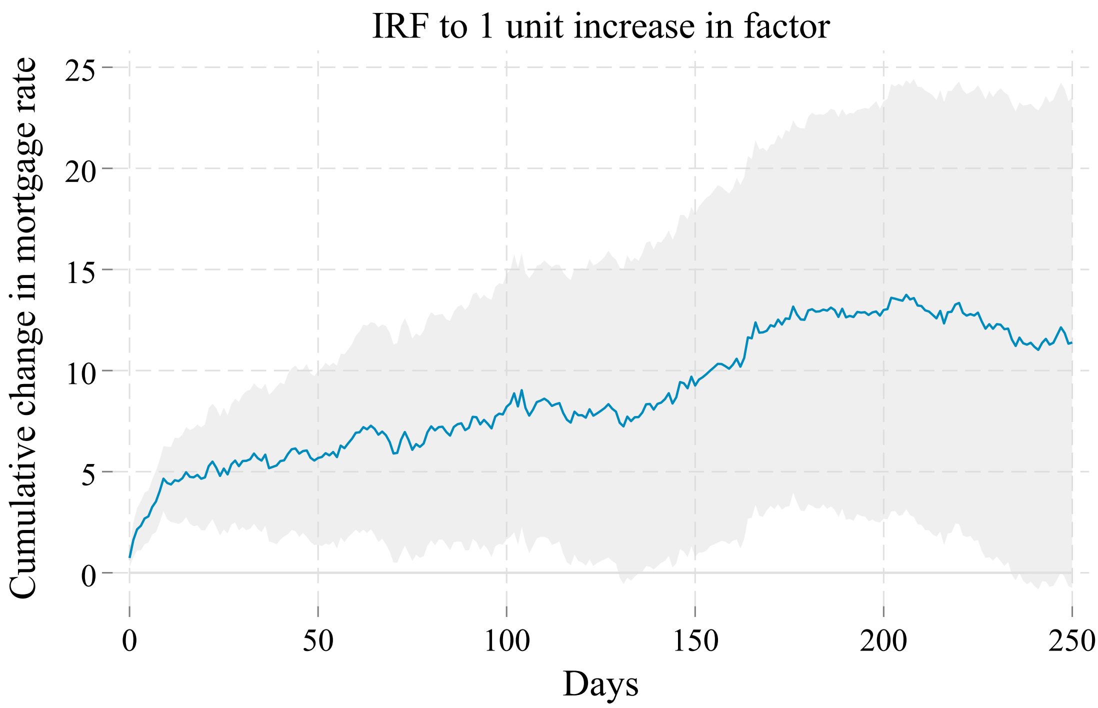


Figure A2: Mortgage rate monetary policy factor

Notes: The figure plots the estimated coefficient of regressing cumulative difference in mortgage rate change between horizon h=0,...,250 business days (approximately one year) and the mortgage rate the day before the FOMC announcement on the factors with 95% confidence bands. The sample period runs December 2012 through March 2025.

Table A1: Price impact from monetary policy-induced mortgage rate changes

	All transactions			Days<20	Days$\in[20,40)$	Days$\in[40,60)$	All transactions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	IV	IV	IV	IV
Δ Mortgage rt	-0.0058***	-0.0056***	-0.0103***	-0.0056	-0.0099***	-0.0079***	-0.0048*	-0.0147***
	(0.0004)	(0.0004)	(0.0019)	(0.0100)	(0.0027)	(0.0017)	(0.0029)	(0.0028)
Δ Mortgage rt × 90+ LTV shr							-0.0086***	
							(0.0032)	
90+ LTV shr							0.0006**	
							(0.0002)	
Δ Mortgage rt × Supply elas								0.0067**
								(0.0031)
Observations	1104497	1104497	1104497	13500	294223	400568	930349	614963
Tract FEs	Y	Y	Y	Y	Y	Y	Y	Y
Interest rate controls	Y	Y	Y	Y	Y	Y	Y	Y
Time-on-mkt control		Y	Y	Y	Y	Y	Y	Y
K-P Fstat			393.04	143.46	145.12	215.83	211.49	196.62

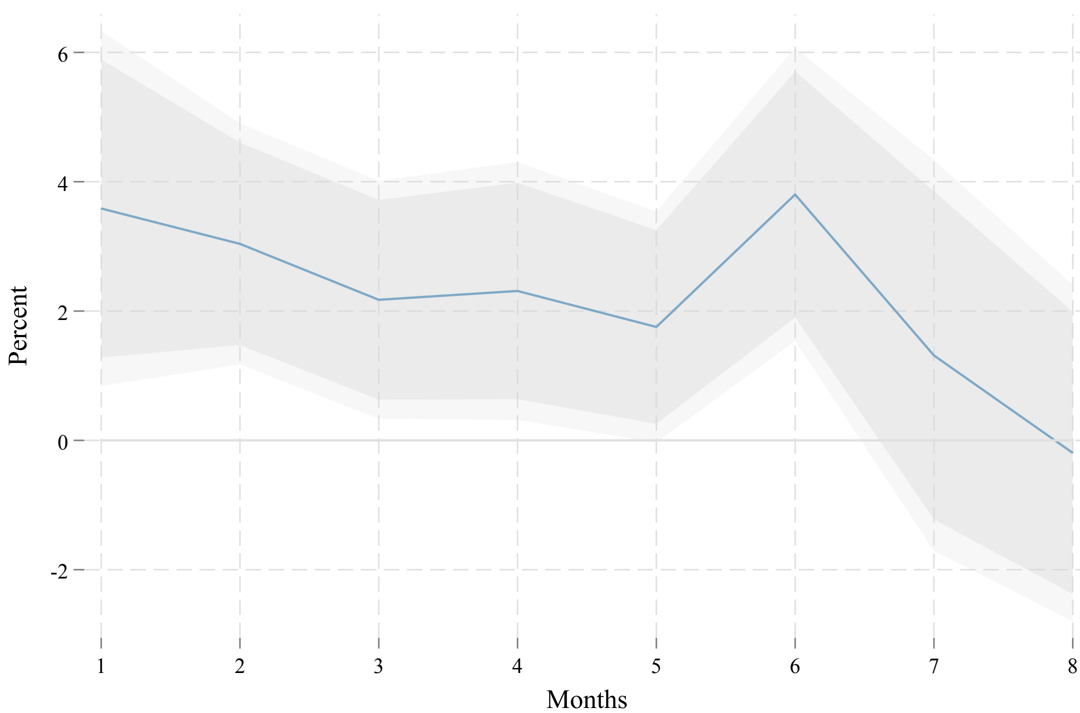
The table provides estimates of the log price change between the listed and transaction prices in response to mortgage rate changes between the time of setting the last listing price and the transaction date. Controls include the mortgage rate and effective federal funds rate at the time of listing, time on market at the time of listing, and Census Tract fixed effects. The data sample excludes homes owned for less than two years, extreme transaction values, and extreme price growth between listing and sale, and runs from December 2012 through December 2020. Kleibergen-Paap (Kleibergen and Paap (2006)) F-statistics are reported. Clustered standard errors at the transaction date-level reported in parenthesis
$^{*}p<0.10,^{**}p<0.05,^{***}p<0.01$.

Table A2: First-time buyer share of home purchases vs mortgage rates 1st stage regressions

	$h=1$	$h=2$	$h=3$
	(1)	(2)	(3)
MP Shock	0.0725***	0.0736***	0.0591***
	(0.0179)	(0.0147)	(0.0154)
Observations	2003	2003	1962

The table provides estimates for the first stage of the Column (2), (4), and (6) regressions in Table 2. Driscoll-Kraay standard errors reported in parenthesis.
$^{*}p<0.10,^{**}p<0.05,^{***}p<0.01$.

Figure A3: First-Time Buyer Share of Home Purchases IRF



Notes: The figure plots the local projection IRF estimated coefficient of regressing changes in annual differences of first-time buyer share in response to a 1 p.p. mortgage rate increase instrumented by the mortgage rate-specific monetary policy shock at the CBSA-month date level. 90% and 95% confidence bands using Driscoll-Kraay standard errors are included. Controls include 12 months of lags of monthly log price changes and the local unemployment rate, the three previous shocks, lags for the month prior to the shock for the effective federal funds rate and month-average VIX level, and CBSA fixed effects. The data sample spans December 2012 through December 2019.

Table A3: Volume regressions

	Total volume			1st-time buyer volume			Incumbent volume		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$h=1$	$h=2$	$h=3$	$h=1$	$h=2$	$h=3$	$h=1$	$h=2$	$h=3$
Δ Mortgage rate	-0.0509	-0.3061**	-0.4191***	0.0799	-0.1731	-0.3525***	-0.0981	-0.3244***	-0.5009***
	(0.1198)	(0.1181)	(0.1287)	(0.1336)	(0.1299)	(0.1101)	(0.1235)	(0.1146)	(0.1538)
Observations	2032	2032	1989	2032	2032	1989	2032	2032	1989
K-P Fstat	24.98	27.76	15.45	20.18	25.85	14.57	24.66	29.24	16.10
Number of transactions	3066813	3088425	3030114	3066813	3088425	3030114	3066813	3088425	3030114

The table provides estimates for changes in home purchase volumes in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock for the one, two, and three month horizons. The left-hand side of the IV regression is the change between the annual differences in purchase volumes for time $t+h$ and the annual change in purchase volumes for time $t-1$. Columns (1)–(3), (4)–(6), and (7)–(9) present the results for all buyers, first-time buyers, and incumbent buyers, respectively. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis. $^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Table A4: First-time FHA volume by LTV share regressions

	$h=1$		$h=2$		$h=3$	
	(1)	(2)	(3)	(4)	(5)	(6)
	Low LTV shares	High LTV shares	Low LTV shares	High LTV shares	Low LTV shares	High LTV shares
Δ Mortgage rate	0.0698	0.3789**	0.0032	-0.0372	-0.2534	-0.1804
	(0.1764)	(0.1700)	(0.1679)	(0.1904)	(0.2062)	(0.2590)
Observations	1029	1001	1029	1001	1006	980
K-P Fstat	21.85	18.72	27.66	25.37	17.49	14.25

The table provides estimates for changes in first-time buyer FHA home purchase volumes in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock for the one, two, and three month horizons restricting the data to above and below-median CBSA shares of high LTV borrowers prior to the shock. The left-hand side of the IV regression is the change between the annual differences in purchase volumes for time $t+h$ and the annual change in purchase volumes for time $t-1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis. $^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Table A5: First-time buyer share of home purchases regressions—GSS path factor

	$h = 1$		$h = 2$		$h = 3$	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
Δ Mortgage rate	0.0050	0.0297	0.0082^{***}	0.0384^{*}	0.0087^{***}	0.0233
	(0.0035)	(0.0186)	(0.0031)	(0.0201)	(0.0030)	(0.0155)
Observations	2129	2129	2129	2129	2086	2086
K-P Fstat		7.39		8.81		9.72
Number of transactions	3179077	3179077	3201048	3201048	3142847	3142847

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the Acosta et al. (2024) update of the Gürkaynak et al. (2005) path factor. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t + h$ and the annual change in purchase shares for time $t - 1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Table A6: First-time purchase shares by CLTV shares

	(1)	(2)	(3)
	$h = 1$	$h = 2$	$h = 3$
Δ Mortgage rate × L.CLTV 90s shr	0.0885**		
	(0.0340)		
Δ Mortgage rate × L.CLTV 90s shr		0.0727***	
		(0.0234)	
Δ Mortgage rate × L.CLTV 90s shr			0.0549**
			(0.0266)
Observations	2032	2032	1989
K-P Fstat	16.35	28.71	15.25
Number of transactions	3066814	3088434	3030128

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes interacted with CBSA-level shares of high origination CLTVs for the month prior to the shock instrumented by the mortgage rate-specific monetary policy shock. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t + h$ and the annual change in purchase shares for time $t - 1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis
$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

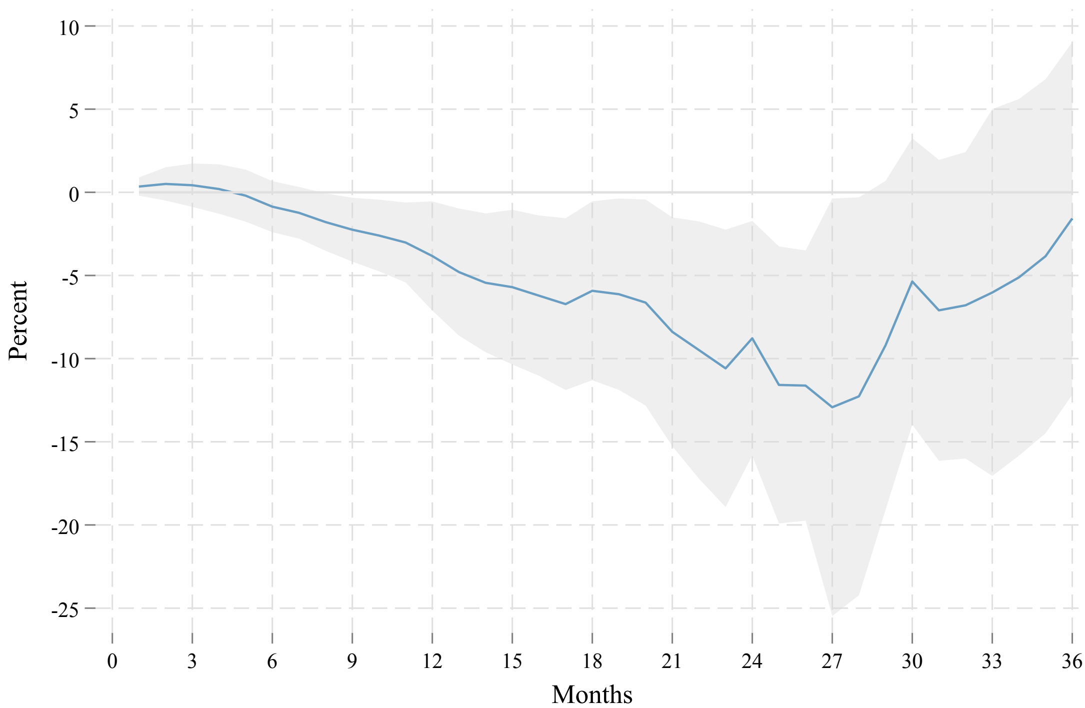
Table A7: First-time buyer share of home purchases regressions by supply elasticity

	Higher supply elasticity			Lower supply elasticity		
	(1)	(2)	(3)	(4)	(5)	(6)
	$h = 1$	$h = 2$	$h = 3$	$h = 1$	$h = 2$	$h = 3$
Δ Mortgage rate	0.0430**	0.0473***	0.0129	0.0295*	0.0168*	0.0395***
	(0.0170)	(0.0138)	(0.0169)	(0.0154)	(0.0089)	(0.0129)
Observations	951	951	931	917	917	897
K-P Fstat	17.45	28.51	16.31	15.31	24.50	13.82
Number of transactions	1116771	1123939	1104245	1761729	1775027	1739654

The table provides estimates for changes in first-time buyer shares of home purchases in response to mortgage rate changes instrumented by the mortgage rate-specific monetary policy shock by above and below median CBSA-level housing supply elasticity. The left-hand side of the IV regression is the change between the annual differences in purchase shares for time $t + h$ and the annual change in purchase shares for time $t - 1$. Controls include lagged values of national offered mortgage rates, local unemployment rates, and monthly changes in annual differences of first-time buyer purchase shares from the previous twelve months, the three previous monetary policy shocks, and the previous month's average effective Federal Funds Rate (EFFR) and CBOE Volatility Index (VIX). The data sample excludes CBSA-month date observations where any of the previous twenty-five months contains fewer than 150 observed transactions, and runs from December 2012 through December 2019. Driscoll-Kraay standard errors reported in parenthesis

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Figure A4: House Price IRF



Notes: The figure plots the local projection IRF estimated coefficients of regressing log price growth in response to a 1 p.p. mortgage rate increase instrumented by the mortgage rate-specific monetary policy shock at the CBSA-month date level. 90% confidence bands using Driscoll-Kraay standard errors are reported. Controls include 12 months of lags of monthly log price changes and the local unemployment rate, the three previous shocks, lags for the month prior to the shock for the effective federal funds rate and month-average VIX level, and CBSA fixed effects. The data sample spans December 2012 through December 2023.

Table A8: Calibration of Income Process Parameters

Parameter	**Value**	**Description**
ρ^p	0.959	Persistence
p_z	0.407	Probability of receiving persistent shock
$\mu_{\eta 1}$	-0.85	Mean of η_1
$\mu_{\eta 2}$		Mean of η_2
$\sigma_{\eta 1}$	0.364	Std dev of η_1
$\sigma_{\eta 2}$	0.069	Std dev of η_1
p_ϵ	0.353	Probability of receiving transitory shock
$\mu_{\epsilon 1}$	0.271	Mean of ϵ_1
$\mu_{\epsilon 2}$		Mean of ϵ_2
$\sigma_{\epsilon 1}$	0.35	Std dev of ϵ_1
$\sigma_{\epsilon 2}$	0.037	Std dev of ϵ_2
σ_β	0.196	Individual heterogeneity in earnings

Notes: Benchmark parameter values used in the income calibration. Largely taken from Guvenen et al. (2021).

Table A9: Moments matched in income calibration

Parameter	Model	GKOS data
St. dev. of 5-year income growth for median income earner	0.76	0.76
Skewness of 5-year income growth for median income earner	-0.67	-0.65

Notes: GKOS moments are taken from the averaging across ages for the median recent earnings values for the data used to produce Figures C9 and C10. Data are obtained from the supplementary file from Guvenen et al. (2021).