Refinancing Windows and Monetary Policy in Periods of Credit Expansion

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Abstract

This paper investigates the regional heterogeneity of monetary policy transmission through the refinancing channel. Utilizing comprehensive mortgage loan origination data from the Home Mortgage Disclosure Act (HMDA) database spanning 1990 to the present, we identify five distinct periods of heightened refinancing activity ("refinancing windows"). By analyzing these periods as quasi-natural experiments, we examine the relationship between refinancing activity and key regional characteristics, including house prices, per capita income, and employment levels. Our findings demonstrate that regions with higher initial house prices and per capita income exhibit greater refinancing activity, highlighting the importance of regional housing market conditions and income levels in determining the effectiveness of monetary policy transmission through this channel. The interest rate effect from monetary policy is followed by a second wave of refinancing as house prices also react and bring additional equity to the homeowners. The economic impact of refinancing can be measured in employment and consumption dynamics. Regions with more pronounced employment contractions exhibit lower refinancing levels. This research contributes to a nuanced understanding of how monetary policy impacts the real economy at the regional level.

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1 Introduction

Monetary policy exerts a direct influence on mortgage interest rates, as these rates adjust to reflect the incentives established by central banking authorities. When individuals secure mortgage loans, they lock in interest rates based on prevailing market conditions. A reduction in the Federal Reserve's policy rate—such as the federal funds rate—often leads to a decrease in mortgage rates, creating an environment where refinancing becomes advantageous.

For borrowers, declining interest rates present a strategic opportunity to refinance under more favorable terms, thereby reducing monthly payments and the overall cost of borrowing. As households respond to these altered incentives by refinancing, they effectively increase their disposable income, which can stimulate economic activity. This behavioral response reinforces the intended effects of monetary policy through enhanced household spending and investment, illustrating the aggregation of individual decisions into broader economic outcomes.

In this paper, we utilize comprehensive mortgage loan origination data from the Home Mortgage Disclosure Act (HMDA) database spanning from 1990 to the present. We identify five distinct periods of heightened refinancing activity—referred to as "refinancing windows"—characterized by sustained volumes of refinancing loan originations surpassing those of home purchase loans. These periods provide a natural experiment to examine the differential regional effects of monetary policy transmitted through the refinancing channel.

Housing markets are locally segmented, and the presence of a mortgage adds an additional layer of segmentation. Monetary policy induces asymmetric effects on the real economy via the refinancing channel, with distinct responses to interest rate hikes and cuts. The mechanism is straightforward: when interest rates adjust, borrowers face the decision of whether to refinance their mortgages. When rates rise, borrowers typically retain their existing mortgages, as the original terms remain more favorable. Conversely, when rates fall, borrowers with above-market rates have the opportunity to refinance at lower rates, provided they meet certain conditions. This window remains open until the central bank raises rates again, at which point borrowers are effectively locked into their existing mortgages—a phenomenon known as the "lock-in" effect.

Our analysis examines the last five refinancing windows since the 1990s and investigates the factors contributing to regional differences in refinancing levels. We find a significant relationship between contemporaneous house prices and per capita income at the onset of the refinancing window. Specifically, regions with higher house prices and higher per capita income exhibit greater refinancing activity.

While house price appreciation plays a role, its impact is secondary. Following the 2008 financial crisis, we observe that some regions with substantial refinancing activity experienced significant house price increases, while others with similar refinancing levels saw house prices decline. This suggests that factors beyond house price appreciation contribute to refinancing decisions.

By employing cumulative log house prices since the 1980s, we account for long-term

appreciation trends that influence the lock-in effect, wherein changing residences would necessitate new mortgages at potentially less favorable terms. Our findings provide evidence that monetary policy has heterogeneous effects across regions, transmitted through the refinancing channel.

Furthermore, we present a framework that simplifies data utilization to demonstrate that interest rate cuts have exhibited similar patterns over the last five refinancing periods. Notably, during the Great Recession, house prices decreased overall, whereas in other periods, house prices increased. Despite these differences, the fundamental aspects influencing the refinancing channel remain consistent: house prices and per capita income at the time of the refinancing window are key determinants of refinancing activity.

Our results align with those of Beraja et al. (2018), who utilize home equity in their analysis but indicate that regional disparities arise primarily from variations in house prices rather than outstanding debts. In essence, regions with higher house prices and higher per capita income also exhibit higher numbers of refinancing transactions.

Regarding employment dynamics, we observe that refinancing windows do not necessarily correspond with periods of employment decline. However, in regions where employment contraction is more pronounced, refinancing levels tend to be lower. Overall, employment and income reactions appear relatively flat during and after the refinancing windows.

This study contributes to the understanding of how monetary policy affects the real economy through the refinancing channel, highlighting the importance of regional housing market conditions and income levels. By shedding light on the heterogeneous regional effects, we offer insights into the transmission mechanisms of monetary policy and their implications for economic stabilization efforts.

Literature Review

A substantial body of research examines the relationship between housing wealth, consumption, and mortgage markets. Estimating the elasticity of consumption with respect to housing wealth is challenging due to the endogeneity between house prices and economic activity. Pioneering work by Saiz (2010) used satellite data to estimate developable land in U.S. metropolitan areas, providing new instruments for supply elasticities. Building on this, Graham and Makridis (2023) introduced a novel instrumental variables approach to estimate the causal effect of house prices on consumption, reinforcing the significant role of housing wealth in driving consumer spending.

Moreover, Guren et al. (2020) offered a long-term perspective on housing wealth effects, finding that the elasticity of consumption to house prices has remained relatively stable over decades. This suggests that larger price movements, rather than increased sensitivity, drove the significant role of housing during the 2000s. Utilizing these instruments, Mian et al. (2013) investigated the consumption consequences of the 2006–2009 housing collapse, finding limited consumption risk-sharing and highlighting the roles of debt and wealth shocks. Kaplan et al. (2020) replicated and extended their analysis using accessible data on non-durable goods.

In related work, Stroebel and Vavra (2019) demonstrated that local house price increases lead to higher retail markups, particularly in areas with many homeowners. This effect arises from reduced price sensitivity among wealthier consumers, indicating that housing wealth can influence local inflation dynamics. Over a historical span, Òscar Jordà, Schularick and Taylor (2015) explored how low-interest rates fuel real estate lending and house price bubbles, heightening the risk of financial crises.

The interplay between mortgage refinancing and monetary policy is examined by several studies. Beraja et al. (2018) found that regions with lower housing equity respond less to interest rate cuts, diminishing aggregate stimulus and increasing regional disparities. Berger et al. (2021) analyzed how mortgage prepayment behavior creates path-dependent effects on monetary policy transmission. Subsequently, Berger et al. (2024) developed a mortgage pricing model showing that refinancing frictions lead to cross-subsidies among borrowers, affecting pricing and credit access. Additionally, Gerardi et al. (2023) highlighted racial disparities in refinancing, with minority homeowners refinancing less frequently, leading to higher interest rates and unequal benefits from monetary expansions.

This paper contributes by bridging these themes, examining how house price fluctuations affect consumption—using retail employment as a proxy—through the refinancing mechanism. As house prices rise, collateral values increase, enhancing refinancing opportunities, which can reduce payments or allow cash-out, potentially stimulating consumption.

In theoretical contributions, Berger et al. (2017) showed that models with incomplete markets and borrowing constraints predict large consumption responses to house price changes, aligning with empirical observations. Similarly, Aruoba et al. (2022) quantified the significant role of heterogeneity in households' financial constraints in consumption declines.

Finally, this article also contributes to methodologies for identifying monetary policy effects. Nakamura and Steinsson (2018) and Swanson (2021) used high-frequency data around Federal Reserve announcements to distinguish between policy shocks and information effects. Christiano et al. (1999) provided a comprehensive review of methods for identifying monetary policy shocks. Employing their identification strategy combined with the local projections method by Jordà (2005), we adopt a flexible alternative to traditional vector autoregressions.

2 Mortgage Channel of Monetary Transmission

The transmission mechanism of monetary policy through long-term debt contracts, particularly residential mortgages, has gained prominence in developed economies. As the relative size of credit markets (both private and public) to the economy has expanded, the influence of these contracts on economic activity has intensified. Mortgages, in particular, due to their significant size and direct link to the real economy, play a crucial role in this transmission mechanism (e.g., see Garriga, Kydland, and Sustek 2017, 2020 for a comprehensive analysis). These contracts are long-duration (15 to 40 years) nominal obligations with a rigid repayment structure.

There are three important channels that monetary policy affects with respect to nominal mortgages: First, it influences the *real value of existing mortgage payments* on oustanding loans. When inflation rises, it reduces the real burden of fixed-rate mortgages (the value of the loan increases for the borrower), stimulating consumption and investment. The opposite happens when the borrower has an adjustable-rate mortgage and the interest rate resets, depressing consumption and investment. Second, it also influences the *financing cost of new house purchases*, with lower interest rates stimulating housing demand and residential investment, while higher rates dampen it. This channel is particularly potent in areas with very liquid housing markets, characterized by frequent trades and tenure transitions. This channel operates through the flow of new credit but can also reduce the size of the stock of credit as proceeds from house sales can be used to liquidate pre-existing mortgage balances against the transacted housing unit.

The refinancing of existing loans constitutes a third channel through which the current stock of mortgages is influenced, primarily in the context of fixed-rate mortgages. When interest rates decline, homeowners with either adjustable or fixed-rate mortgages may refinance to lower their monthly payments. Beyond a decline in interest rates, homeowners may consider refinancing for additional reasons. One key reason is to adjust the loan term, either shortening it to accelerate payoff or lengthening it to lower monthly payments. Additionally, refinancing can provide access to home equity, which can be utilized for various purposes, such as home improvements, debt consolidation, or large purchases. Another strategic reason is to switch between fixed-rate and adjustable-rate mortgages. In all these cases, the change in disposable income can stimulate consumption and investment.

In the context of this channel, a *refinancing window* is a period where the majority of the mortgage originations are tied to refinancing as opposed to home purchases. These windows typically emerge when the central bank lowers the interest rates in a way that leads to a decrease in mortgage rates. These episodes can be particularly interesting to understand the transmission mechanism that allows homeowners with mortgages change their monthly payments, pay off their mortgage faster, or access the equity in their homes. However, the effectiveness of monetary policy during these refinancing windows depends on factors such as refinancing costs, lender willingness to lend (measured by the expected value of the housing collateral), and borrower eligibility (in terms of the quality of their credit score, and repayment ability).

Persistent shifts in monetary policy, such as extended periods of low (high) interest rates and inflation, can result in substantial wealth transfers between borrowers and lenders. Homeowners with fixed-rate mortgages benefit from lower real interest rates (or higher inflation), while savers and lenders may be disadvantaged. Conversely, with adjustable-rate mortgages, the wealth transfer operates in the opposite direction. These redistributions can influence real estate transactions, house price movements, new residential investment, and credit expansion through financial intermediation. The potential macroeconomic implications of monetary policy transmission through long-term debt contracts are multifaceted and present complex measurement and identification challenges that the paper attemps to overcome by exploring the cross-sectional and time-series data across US counties.

2.1 The Mechanics of the Mortgage Channel

The formulation follows Garriga, Kydland, and Sustek (2017,2020), and for simplicity abstracts from taxation, and mortgages are modeled as first mortgages, as opposed to home equity loans, which allow homeowners to draw new credit against the value of their existing housing stock. Home equity loans are a widespread phenomenon in the United States, but they are less prevalent in other countries. Each period, the homeowner with a loan faces a budget captured by

$$c_t + \frac{m_t}{p_t} = w_t + (1 + i_{t-1} + \Phi_{t-1})\frac{b_{t-1}}{p_t} - \frac{b_t}{p_t} + p_t^h(h_{t-1} - h_t), \tag{1}$$

The term, c_t represent consumption expenditures,[1] the term m_t denotes the nominal mortgage payments on outstanding debt where p_t represents the price level, w_t represent labor earning, b_{t+1} represents the holdings of the one-period illiquid nominal bond between periods t and $t+1$, and Φ_{t-1} controls the transaction cost of adjusting financial assets.[2] The addition of housing wealth allows to capture the potential effect of equity gains on consumption, especially if the homeowner has accrued sufficient capital gains and expect to transact the property in the foreseeable future. One can think about the current price as a summary statistic of the changes in value since the purchase in period τ where δ_t captures all the cumulative price appreciation, $p_t^h = \delta_t p_\tau^h$. Therefore, even when $h_{t-1} = h_t$, there can be a housing wealth effect coming from changes in b_t/p_t as explained by Guren et al. (2018).

Mortgages: The focus here is on changes in the value of mortgage payments, either directly or through refinancing. The mortgage payment, m_t, encompasses both interest payment and principal amortization, $m_t = (R_t + \gamma(d_{t-1}))d_{t-1}$ where R_t is the current interest rate on the loan, and $\gamma(d_{t-1})$ is the amortization rate of the outstanding principal, d_{t-1}. The loan balance decreases with amortization, $d_t = (1 - \gamma(d_{t-1}))d_{t-1}$.[3] At the beginning of the loan, the amortization rate is very close to zero, and it gradually increases over time to compensate for the decreasing principal balance, eventually converging to one. Note that

[1] The notation abstracts from using durable goods, but these are an important part of consumer spending. It is direct to include durable purchases and the stock of durables

[2] It is convenient to include transaction costs via a function $\Phi(.)$ controls the extent to which the homeowner can use a short-term nominal financial asset to engage in intertemporal trade in response to fluctuations in current and future values of mortgage payment, housing, and income. Setting $\Phi_{t-1} = 0$ for all real balances $\widetilde{b}_t$ allows the homeowner to be fully flexible in terms of moving resources intertemporally, and it would act as a fully permanent income hypothesis consumer. In the other extreme, setting $\Phi_{t-1} = \infty$ implies that the homeowner cannot react to changes in valuation other than discrete choices such as adjusting the mortgage balance, or transacting the house, hence, the homeowner acts as a complete hand-to-mouth consumer. For intermediate values of $\Phi_{t-1} \in (0, \infty)$, the homeowner has some flexibility to use allows for costly access to financial markets.

[3] Why not simply assume a constant amortization rate, $\gamma(d_{t-1}) = \gamma$ for all t? Such an assumption would imply that mortgage payments would decrease exponentially over time. This means that the largest payments would occur at the beginning of the loan term, with substantially smaller payments towards the end. This is contrary to the typical structure of standard mortgage contracts, which generally involve evenly distributed payments throughout the loan's duration, unless interest rates fluctuate.

one-period loans are a special case where $\gamma(d_t) = 1$ for all t, meaning homeowners roll over their balances until the loan is fully repaid. In the case of a *fixed-rate loan*, the nominal payments are constant, $m_t = m_{t-1} = ... = m$ for all t, as the interest rate is fixed at origination, $R_t = i_\tau^m$. For a *variable-rate loan*, the interest rate fluctuates with the market rate, $R_t = i_t^m$.

Using the definition of the mortgage payment and consolidating all wealth variables (short-term financial positions and real estate), the budget constraint can be rewritten as...

$$c_t = w_t + \Omega_t - \frac{(R_t + \gamma(d_{t-1}))}{1 + \pi_t} \widetilde{d}_{t-1}, \tag{2}$$

where real loan balances are $\widetilde{d}_{t-1} = d_{t-1}/p_{t-1}$, the inflation rate is $1 + \pi_t = p_t/p_{t-1}$, and $\Omega_t = (1 + i_{t-1} + \Phi_{t-1})b_{t-1}/p_t - b_t/p_t + p_t^h(h_{t-1} - h_t)$. Changes in consumption, Δc_t, have to result from changes (current/future) real wages, Δw_t, wealth, $\Delta\Omega_t$, or the real value of mortgage payments, $\Delta\widetilde{m}_t$.

$$\Delta c_t = \Delta w_t + \Delta\Omega_t - \Delta\widetilde{m}_t, \tag{3}$$

These can come from inflation deflating the real value of the payments, refinancing that can reset the maturity by adjusting $\gamma(d_{t-1})$ closer to zero, or adjusting the principal (e.g., cash-out, home improvement loans, or pre-payment).

Changes in monetary policy, such as fluctuations in inflation or interest rates, can affect the outstanding stock of mortgage debt (ignoring changes in house prices and refinancing). This impacts the value of mortgages for borrowers by altering their cash flow and disposable income. The magnitude of this *income effect* is determined by the timing of mortgage payments. For the outstanding debt of a borrower, what matters are the payments over the remaining term of existing loans, as captured by the amortization rate. A value near zero indicates a newly originated loan, while a value approaching one signifies a loan nearing maturity or termination.

2.2 The Mechanics of Refinancing

Refinancing a loan involves replacing an existing mortgage with a new one, often to secure a lower interest rate, adjust the loan term, or access the equity built up in the property. This process typically applies to fixed-rate mortgages, where the interest rate remains constant throughout the loan term. A fixed-rate mortgage is a type of loan that requires borrowers to make equal monthly payments over a specific period, such as 15 or 30 years. The key characteristic of a fixed-rate mortgage is that the interest rate remains unchanged during the entire loan term.

The formula to calculate the monthly payment, M, is derived from the present value of an annuity formula of duration N (or total number of loan payments each months) where the payment, $M \equiv M_1 = ... = M_N$, is consistent with the condition that the present value

of mortgage payments repays the original loan D_0:

$$M = \frac{D_0 \cdot r \cdot (1+r)^N}{(1+r)^N - 1} = \frac{D_0 \cdot r}{1 - \frac{1}{(1+r)^N}}$$

where r is the monthly interest rate (annual interest rate / 12). The principal of the loan, $D = \lambda p^h \cdot H$, is tied to the fraction λ of the value of the housing property $p^h \cdot H$.

Interest rate refinancing: Using the definition of the mortgage payment, it is straightforward to see that when the interest rate drops ($\Delta r = r - r^{'} > 0$), the implied monthly mortgage payment for roughly the same principal amount ($\Delta D = D_0 - D_0^{'} \approx 0$) amount decreases ($\Delta M = M - M^{'} > 0$).

$$M = \frac{D_0 \cdot r}{1 - \frac{1}{(1+r)^N}} > \frac{D_0^{'} \cdot r^{'}}{1 - \frac{1}{(1+r^{'}))^N}} = M^{'}$$

$$\frac{M}{M'} = \frac{D_0 \cdot r}{D_0^{'} \cdot r^{'}} > \frac{1 - \frac{1}{(1+r)^N}}{1 - \frac{1}{(1+r^{'}))^N}}$$

If the refinancing costs are sufficiently low, it can be optimal for the borrower to refinance the loan.

Maturity extension refinancing: It is less trivial to argue that it can also be beneficial to refinance to a higher rate, ($\Delta r = r - r' < 0$), even when there is no cash-out refinancing, and the main reason is maturity extension, $\Delta = N - N' < 0$. For the payment to decrease after refinancing to a higher interest rate than the old mortgage, it must be the case

$$\frac{D_0' \cdot r' \cdot (1+r')^{N'}}{(1+r')^{N'} - 1} < \frac{D_0 \cdot r \cdot (1+r)^N}{(1 + r^{N-1}}$$

Assuming no cash-out refinance, but allowing the new balance to be the same or lower due to positive principal repayment (i.e., $D_0' = \gamma D_0$) where $\gamma \leq 1$, Simplifying by canceling out the principal P:

$$\frac{\gamma r' \cdot (1+r')^{N'}}{(1+r')^{N'} - 1} < \frac{r \cdot (1+r)^N}{(1+r)^N - 1}$$

While this inequality is complex to solve analytically, it intuitively shows that by extending the loan term (increasing N'), we can reduce the monthly payment, even if the interest rate r' is higher than the original rate r.

3 Data

The primary sources for this article are the Home Mortgage Disclosure Act (HMDA) dataset, the McDash Database from Black Knight, and the Credit Risk Insight Servicing McDash (CRISM) dataset. Each offers granular insights essential for understanding mortgage origination, performance, and associated consumer behaviors over the past decades.

The HMDA dataset, instituted in 1975, serves as a foundational resource for analyzing mortgage origination patterns. It captures the universe of U.S. mortgage applications—originated, rejected, purchased, or incomplete—since 1990. This dataset allows me to construct a historical series of mortgage originations and rejections at any frequency down to the county level. The richness of HMDA data facilitates a nuanced examination of lending practices, credit access, and the evolution of mortgage markets over time.

To delve into mortgage performance and refinancing behaviors, we utilize the McDash Database. This loan-level dataset includes monthly updates on millions of active loans, covering delinquencies, foreclosures, prepayments, refinancing activities, and loan modifications. With approximately 226 million individual loans and 9.5 billion records of monthly performance history dating back to April 1992, McDash enables the construction of time series on active mortgages, new originations, completions, refinancing rates, and interest rates. This granularity permits a detailed analysis of borrower responses to macroeconomic conditions and policy changes, shedding light on default risks and repayment behaviors across different demographics.

The CRISM dataset represents a significant advancement by merging McDash mortgage servicing data with Equifax consumer credit information. This integration provides loan-level mortgage performance data alongside detailed borrower credit profiles, including credit scores and outstanding debts. Utilizing CRISM, we construct an equity series for each individual, tracking monthly changes in mortgage debt balances and property values. Property values are separated into book value and monthly appreciation, the latter estimated using zip code-level house price indices. This approach allows for precise assessment of household leverage and equity positions, critical for understanding consumption behavior and financial stability.

Supplementary datasets enhance the analysis by providing broader economic context. The CoreLogic House Price Index offers repeat-sales measures of property values, controlling for regional housing market fluctuations. The Nielsen Consumer Panel contributes insights into household consumption patterns, enabling the study of consumption dynamics in response to changes in housing wealth and credit conditions. Vacancy rates from the United States Postal Service (USPS) and labor force statistics from the Bureau of Labor Statistics (BLS) add layers of information on local economic conditions, such as housing supply dynamics and employment trends. Personal income and wage data from the Bureau of Economic Analysis (BEA) further augment the analysis by incorporating regional income variations.

4 The Mortage Market in the United States - 1990 - 2024

In this section, we will describe how the mortgage market in the United States has evolved since the 1990s, using a variety of data sources to provide a comprehensive view. Figure 1 provides an overview of U.S. mortgage origination trends from 1990 to 2022, contrasting home purchase loans (left panels) and refinancing loans (right panels). The top panels show the number of loans originated, while the bottom panels display the percentage breakdown of loans that were originated, denied, or unprocessed.[4]

Home purchase loans exhibit a relatively stable trend, with modest growth during economic expansions and declines during recessions (grey shaded areas). This stability reflects the consistent demand for homeownership, driven by demographic and socio-economic factors. The composition of approvals and denials remains fairly constant, indicating that credit criteria for purchase loans do not fluctuate dramatically through the business cycle.

Refinancing loans, by contrast, show pronounced cyclicality, with significant spikes during periods of declining interest rates—particularly during the early 2000s, the Great Recession, and the COVID-19 pandemic. These spikes reflect the strong response of borrowers to interest rate cuts, seeking to refinance at better terms or extract home equity. The red shaded areas indicate periods when refinancing makes up more than 50% of total originations, often coinciding with monetary easing.

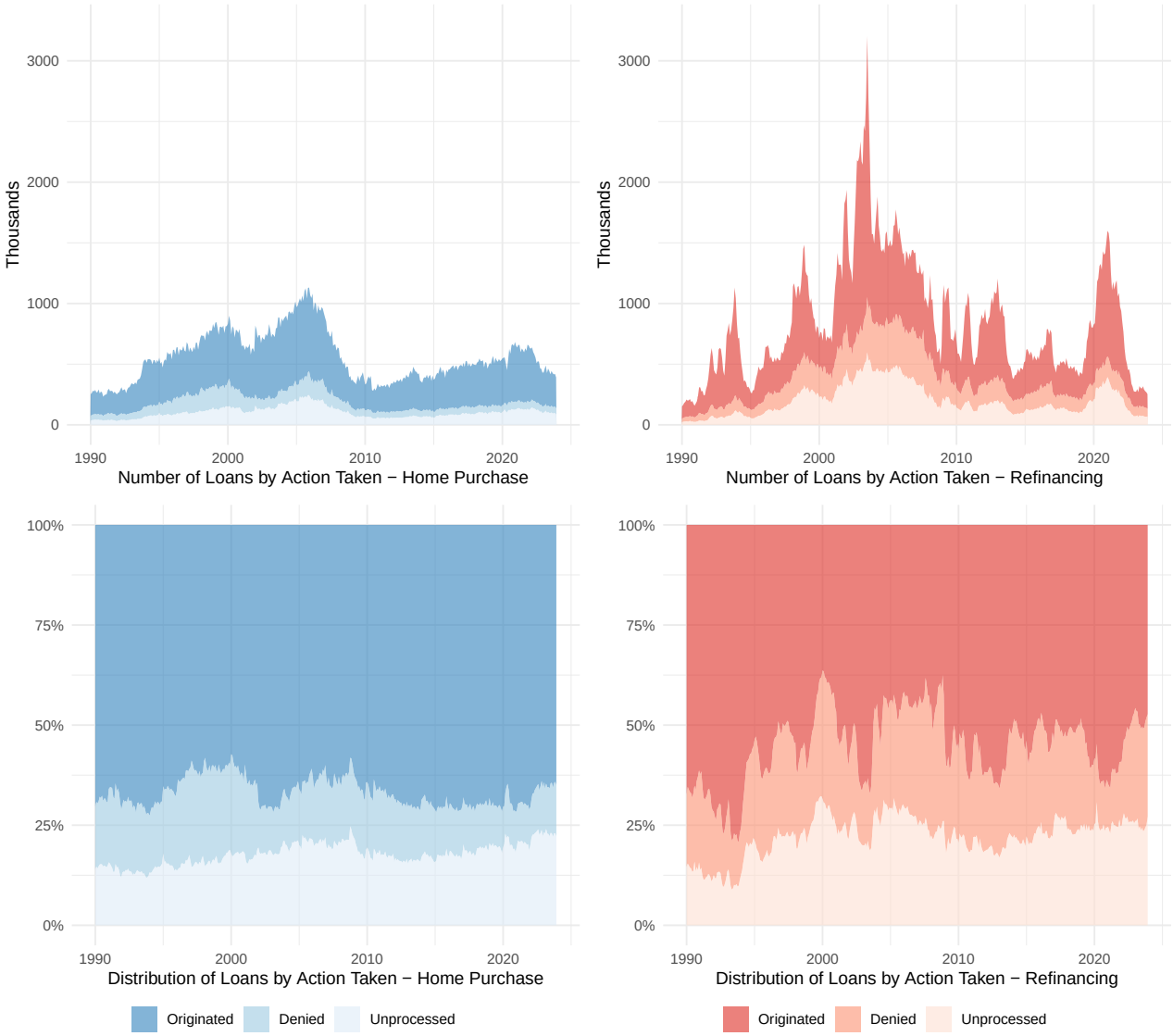
The composition of refinancing applications reveals that approval rates increase during rate cuts, reflecting looser effective credit conditions. Overall, these figures highlight the asymmetric sensitivity of refinancing to interest rate changes, compared to the steadier demand for home purchase loans, illustrating the distinct roles these segments play in the monetary policy transmission mechanism.

Figure 2 shows the monthly number of mortgage loans originated in the United States from 1990 to 2023, split into home purchase loans (blue line) and refinancing loans (red line). The data provides an extensive overview of mortgage market dynamics over more than three decades, with shaded areas indicating economic recessions. These trends reveal significant shifts in borrowing behaviors over time, particularly in response to macroeconomic conditions and monetary policy interventions.

Refinancing activity, as depicted by the red line, is highly cyclical, characterized by pronounced peaks during periods of declining interest rates. These spikes coincide with episodes of monetary easing by the Federal Reserve, such as during the early 2000s, the 2008-2009 financial crisis, and the COVID-19 pandemic. The figure highlights how borrowers tend to respond strongly to reductions in interest rates, refinancing to secure lower costs or extract equity from increased property values. This suggests a critical channel of monetary policy transmission: refinancing surges, spurred by lower interest rates, provide households with more favorable borrowing terms and additional liquidity.

[4] I define unprocessed loans as those that, while not explicitly rejected, ultimately do not result in an origination. These include loans that are approved but not accepted, withdrawn by the applicant, or closed for incompleteness

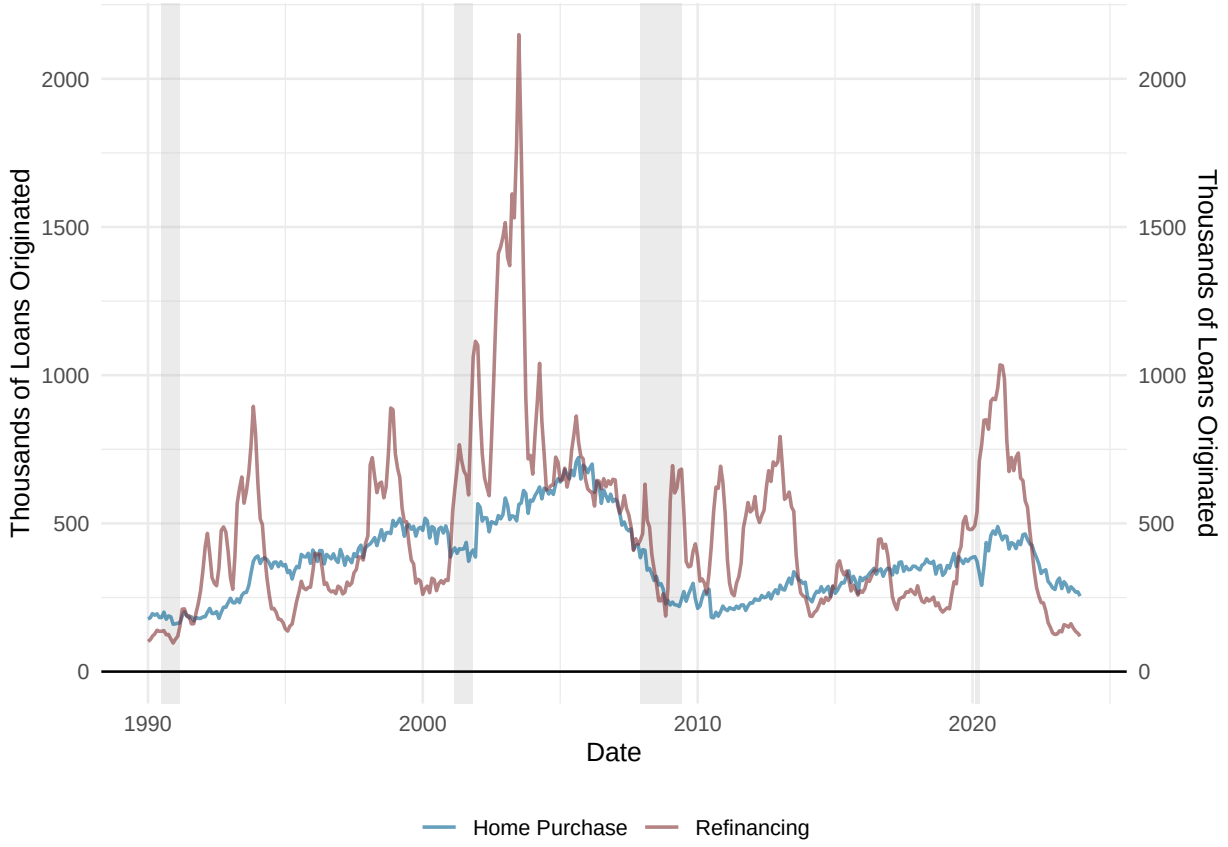
Figure 1: Refinancing Periods Comparison - 1990-2022.



Source: FRED. Notes: The grey shaded areas indicate recession periods, while the red shaded areas represent months when refinancing of existing mortgages constitutes more than 55% of new mortgage originations.

In contrast, the home purchase loan series (blue line) displays a far more stable trajectory. The home purchase market exhibits a steady trend with moderate growth during favorable economic periods, such as the late 1990s and the post-Great Recession recovery. Unlike refinancing, home purchase activity appears less sensitive to short-term interest rate fluctuations, reflecting its dependence on longer-term factors such as income growth, demographic shifts, and housing market supply. During economic recessions, refinancing often experiences a sharp increase as rates are reduced to stimulate the economy, while home

Figure 2: Number of Loans Originated - 1990-2023.



Source: cHMDA. The shaded areas correspond to recession periods.

purchase originations tend to stagnate or decline, reflecting weaker consumer confidence and tightened credit conditions. For instance, during the 2008 financial crisis, refinancing volumes surged as the Federal Reserve cut rates to historically low levels, while home purchases dropped substantially, highlighting a divergence in household behavior driven by credit supply constraints.

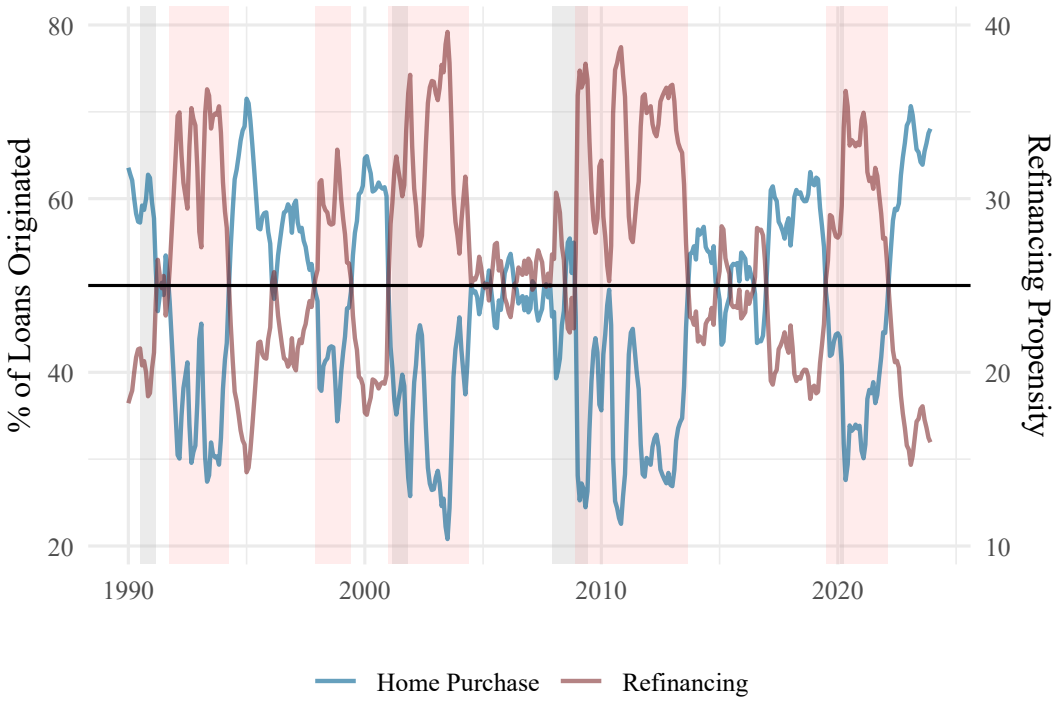
The most recent period, from 2020 onward, captures the economic response to the COVID-19 pandemic. A dramatic surge in refinancing occurred amid swift interest rate cuts, reaching levels not seen since the early 2000s. However, as the Federal Reserve began to increase rates again in 2022, refinancing activity sharply declined, underscoring the sensitivity of refinancing to monetary conditions. In comparison, home purchase originations experienced a moderate increase in the low-interest environment, followed by a slight decline as rates began to rise, illustrating the distinct channels through which interest rates affect different segments of the mortgage market.

Overall, Figure 2 underscores the asymmetric responses of refinancing and home purchase loans to macroeconomic shocks and monetary policy changes. Refinancing is highly

sensitive to interest rate movements, with borrowers seizing opportunities to refinance at lower costs or extract equity when rates decline. On the other hand, home purchase activity remains more stable and is driven by broader economic conditions rather than immediate changes in interest rates. This dynamic illustrates the differentiated channels through which monetary policy transmits into the real economy, with refinancing providing a direct mechanism for households to adjust their leverage in response to changing financial conditions.

Figure 3 presents the evolution of home purchase and refinancing loans as a share of total mortgage originations in the United States from 1990 to 2023. The blue line indicates the share of home purchase loans, while the red line shows the share of refinancing loans. By construction, these shares always sum to 100%. The observed oscillatory pattern in these shares highlights the influence of external macroeconomic conditions, particularly changes in monetary policy.

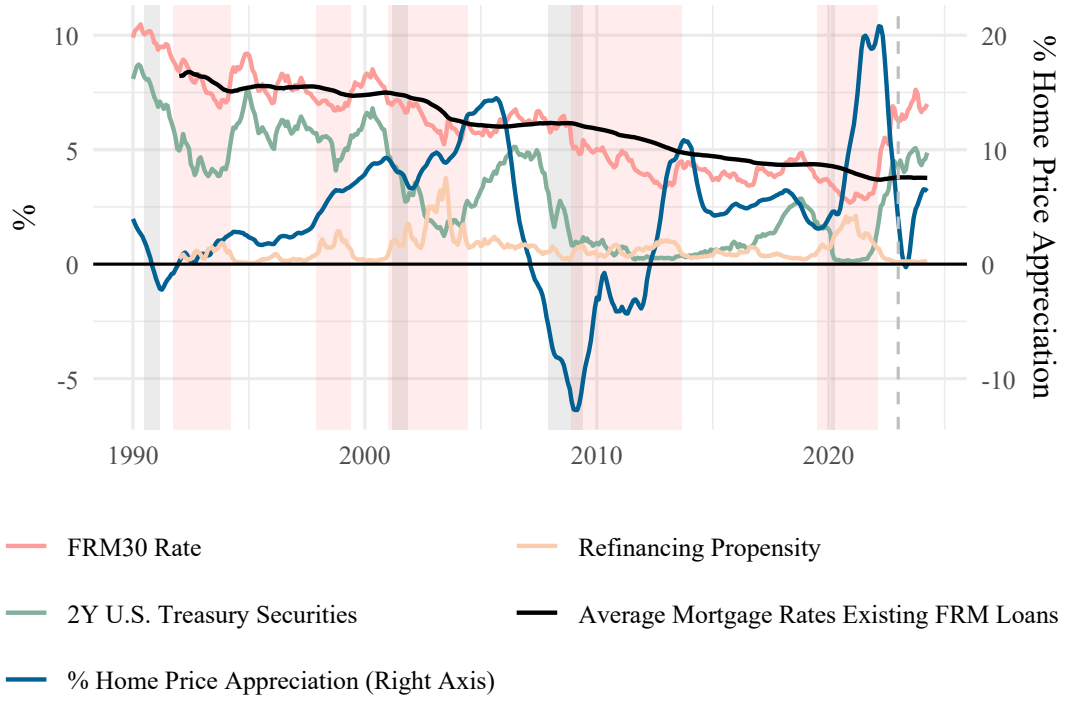
Figure 3: Share of Loans Originated - 1990-2023.



Source: cHMDA. Notes: The grey shaded areas indicate recession periods, while the red shaded areas represent months when refinancing of existing mortgages constitutes more than 50% of new mortgage originations.

The cyclical behavior evident in these series suggests a useful framework for viewing the mortgage market as a helix—one that alternates between periods dominated by home purchase activity and those driven by refinancing, which we refer to as "refinancing windows." These refinancing windows align with phases of monetary policy easing, where reductions

Figure 4: Refinancing Periods Comparison - 1990-2023.



Source: FRED. Notes: The grey shaded areas indicate recession periods, while the red shaded areas represent months when refinancing of existing mortgages constitutes more than 50% of new mortgage originations.

in interest rates make refinancing particularly advantageous for borrowers. During such periods, homeowners respond to lower interest rates by refinancing to secure more favorable borrowing terms or to extract equity from their properties. This behavior is especially pronounced during episodes such as the early 2000s, the Great Recession, and the COVID-19 pandemic, where aggressive rate cuts by the Federal Reserve triggered waves of refinancing activity.

The helix representation of the mortgage market provides an insightful perspective on the dynamics of credit markets. Peaks in refinancing represent clear instances of how monetary policy can open windows of opportunity, temporarily shifting market focus toward optimizing existing mortgages rather than new purchases. As interest rates rise or stabilize, these refinancing windows close, and home purchase activity becomes the dominant form of mortgage origination once again. Although these cyclical shifts are largely endogenous to changes in monetary policy, they are essential for understanding how the broader impact of interest rate adjustments affects housing leverage and economic behavior at the household level. The helix metaphor aptly captures the recurring and alternating nature of these opportunities, emphasizing how macroeconomic conditions, particularly interest rate movements, shape the mortgage market over time.

Figure 4 provides a detailed comparison of key macroeconomic variables affecting refinancing activity in the U.S. mortgage market from 1990 to 2023. The plot includes the 30-year fixed mortgage rate (FRM30) in red, the 2-year U.S. Treasury yield in green, the average mortgage rates on existing fixed-rate loans in black, and the refinancing propensity in orange. The blue line, plotted on the right axis, represents the percentage of home price appreciation. The grey shaded areas denote economic recessions, while the red shaded areas indicate months when refinancing accounts for more than 50% of all new mortgage originations.

This figure captures the critical factors influencing refinancing activity and complements the dynamics explained in Figure 3. The cyclical behavior observed in Figure 3, where refinancing and home purchase shares alternate over time, is driven by changes in the broader macroeconomic environment—specifically interest rate movements and housing market dynamics, which are shown here in detail.

Refinancing Propensity in orange provides a measure of the level of interest in refinancing across different periods. It clearly follows an inverse relationship with interest rate levels, particularly the 30-year fixed mortgage rate (FRM30) and the average mortgage rates of existing loans. During periods of declining interest rates, such as the early 2000s, the Great Recession, and the COVID-19 pandemic, refinancing propensity spikes as homeowners seek to capitalize on lower rates, refinancing existing mortgages to reduce their monthly payments or extract equity. This behavior is reflected in the red shaded areas of the plot, where refinancing exceeds half of all mortgage originations.

The 2-year U.S. Treasury yield in green provides an indication of short-term rate expectations, often influenced directly by Federal Reserve policy actions. A decline in the Treasury yield often signals a period of monetary easing, which contributes to the decline in mortgage rates, subsequently spurring refinancing activity.

The blue line, representing home price appreciation, also plays an essential role in refinancing dynamics. Periods of significant home price appreciation provide households with increased equity, which can further motivate refinancing, particularly in cash-out refinancing scenarios where homeowners tap into increased property values. For instance, during the housing boom leading up to 2007, rising home prices contributed to higher refinancing activity as homeowners leveraged their increased equity. Conversely, during the financial crisis, negative home price appreciation reduced refinancing opportunities for many households, as declining home values eroded equity and limited the ability to refinance.

The interaction between interest rates, refinancing propensity, and home price appreciation highlights how external macroeconomic factors shape the evolution of the mortgage market. The helix metaphor introduced in Figure 3 is further substantiated by Figure 4, as we observe the alternating periods where refinancing opportunities arise—what we term "refinancing windows"—as a direct consequence of monetary policy shifts and housing market trends. These windows reflect times when both interest rates and home price movements align to create favorable conditions for refinancing, shifting the focus away from new home purchases to optimizing existing mortgage terms. Conversely, as interest rates

rise or home price appreciation slows, refinancing activity falls, and home purchase loans regain prominence. Together, these figures depict the dynamic interplay of interest rates, housing prices, and monetary policy in driving mortgage market behavior.

Figure 5 presents the relationship between the share of refinancing in total mortgage originations and median home prices (top row) as well as home price changes (bottom row) during distinct refinancing windows from 1990 to 2022. Each column corresponds to a specific refinancing window, defined as periods when refinancing constituted more than 50% of all new mortgage originations nationwide. The data is based on county-month observations, derived from CoreLogic and cHMDA, with median prices and changes normalized to mean zero and one standard deviation.

The top row illustrates a positive relationship between median home prices and the share of refinancing during refinancing windows. Higher median home prices are generally associated with increased refinancing activity, which is consistent across most windows, reflecting the importance of accumulated home equity as a driver of refinancing decisions. During periods such as 2008-2013, despite a significant decrease in home prices during the financial crisis, refinancing activity persisted in regions with sufficiently high historical appreciation, indicating that accumulated equity from previous gains enabled continued refinancing despite falling current prices.

The bottom row shows the relationship between home price changes and the refinancing share during these periods. In the 2007-08 financial crisis, home prices experienced considerable declines across many regions, resulting in a negative relationship between price changes and refinancing. This suggests that, while recent price declines generally reduced refinancing opportunities, the persistence of refinancing activity seen in the top row can be attributed to the accumulated gains from prior years.

These findings illustrate that refinancing activity is not uniformly distributed but instead exhibits substantial regional heterogeneity, heavily influenced by local housing market conditions. Counties that experienced either higher median prices or significant accumulated appreciation were more likely to refinance, especially during windows of monetary easing. This highlights the role of long-term home value appreciation in maintaining refinancing viability, even when short-term market conditions are adverse. As such, the impact of monetary policy on the refinancing channel is moderated by regional housing dynamics, with differing effects across various parts of the country based on historical home price trajectories and current economic conditions.

Figure 5: Regional Heterogeneity in Refinancing Activity Across Refinancing Windows: The Role of Home Prices and Appreciation (1990-2022).



Source: CoreLogic and cHMDA. Notes: Median prices and Price Increases are normalized to mean zero and 1 sd. Each figure represent periods when refinancing of existing mortgages constitutes more than 55% of new mortgage originations.

5 Decomposition of Leverage Dynamics: Debt and Property Value Contributions

To evaluate borrower equity using CRISM data, we employ two methodologies. The first calculates equity by taking the sum, over each property, of the difference between the original house value and the current total mortgage debt, divided by the original house value. The second method uses the estimated current house value in place of the original value, calculating equity as the sum of the estimated current house value minus the current mortgage debt, divided by the estimated current house value. In both cases, equity is defined as one minus the current loan-to-value ratio (CLTV), that is, equity = 1 - CLTV.

Let the *combined loan-to-value ratio* (CLTV) of an individual *we* at time t be defined as follows. Denote by M_{it} the total outstanding mortgage balance on all properties owned by the individual, and by V_{it} the aggregate value of these properties. The CLTV is then given by:

$$\text{CLTV}_{it} = 1 - \frac{M_{it}}{V_{it}}$$

where V_{it} can represent either the *book value* or the *market value* of the properties.

This metric captures the individual's remaining equity as a fraction of the property value, adjusted by the degree of leverage represented by M_{it}. When V_{it} reflects current market valuations, the measure offers a dynamic view of leverage that adjusts with market fluctuations, whereas using the book value yields a more conservative, static perspective.

The analysis of monthly changes in the Loan-to-Value (LTV) ratio provides a precise view of how individual leverage adjusts over time, driven by debt repayments or fluctuations in property values. We decompose the LTV change for each individual by calculating the contributions of debt (mortgage balance changes) and property value changes (market or appraisal variations).

The debt component reflects adjustments in outstanding liabilities, offering insights into how borrowing or repayment behaviors influence leverage month by month. By contrast, the property value component reveals how market dynamics, reflected in property value shifts, alter the LTV independently of an individual's direct financial actions.

Analyzing these decompositions reveals clear patterns. In periods of stable or rising property values, LTV changes are typically driven by debt adjustments, reflecting deliberate decisions by individuals. However, in times of volatile market conditions, property value changes often dominate, amplifying leverage risk or, conversely, building equity unexpectedly.

This decomposition allows us to observe the primary economic forces at play in individual leverage dynamics. Debt repayments reduce leverage predictably, while market fluctuations introduce uncertainty in leverage, underscoring the role of asset price stability in financial security. This analysis thus demonstrates how individual leverage is influenced not merely by personal financial decisions but by broader economic forces, yielding a robust framework for understanding leverage behavior and its macroeconomic implications.

Regional disparities in property prices can lead to widening economic inequality through the mechanism of differential wealth accumulation and leverage. In high-growth regions, property values appreciate rapidly, reducing homeowners' Loan-to-Value (LTV) ratios and enabling them to accumulate wealth more quickly. This increased equity creates opportunities for further investment, access to credit, and improved financial stability. These individuals gain the ability to leverage their assets into productive investments, further enhancing their economic status.

Figure 6 illustrates the distribution of borrowers' equity in real estate across counties with the highest (blue lines) and lowest (red lines) house price growth during at the beginning of the last two refinancing windows: December 2008 and July 2019. The left-hand plots represent equity as a percentage of the original home value, while the right-hand plots depict equity relative to the estimated current home value. Equity is measured as $1 - CLTV$, representing the proportion of the property value that exceeds the outstanding mortgage debt.

The left-hand plots, which assess equity relative to the original home value, show relatively similar distributions between high-growth and low-growth regions. This suggests that when considering the original purchase value, regional disparities in equity are less pronounced. Regardless of whether a county experienced high or low house price growth, equity distributions tend to be more clustered, indicating that using original values does not capture the divergence caused by recent market changes.

In contrast, the right-hand plots, which use estimated current home values, reveal more pronounced regional differences in equity distribution. The blue lines (representing high-growth counties) are shifted towards higher levels of equity compared to the red lines (low-growth counties), highlighting that current market conditions amplify disparities in accumulated home equity. This divergence is particularly evident in July 2019, where homeowners in high-growth areas have accumulated significantly more equity than those in stagnant regions, emphasizing the role of recent house price appreciation in enhancing wealth accumulation.

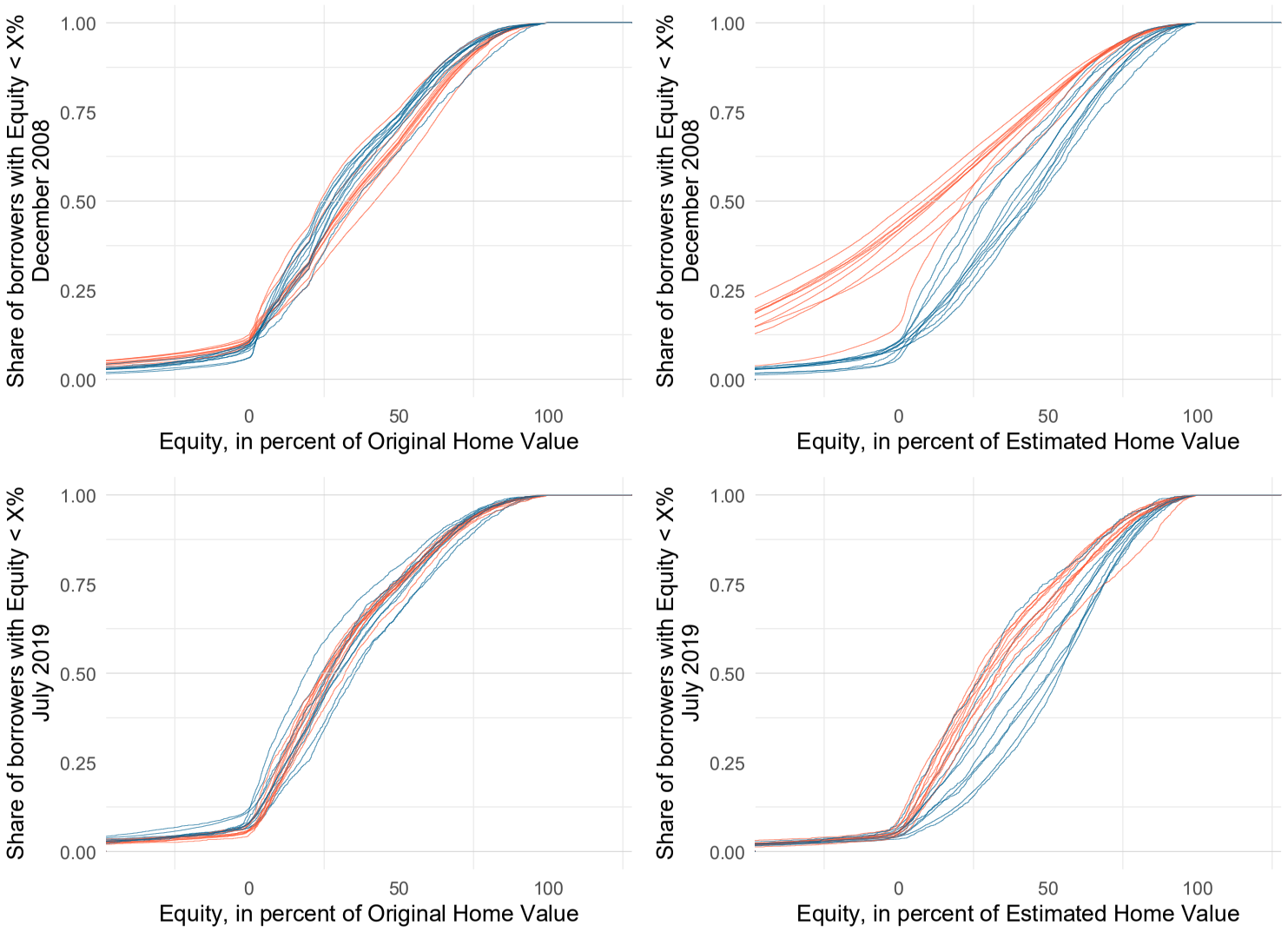
The top right panel (December 2008, estimated value) also highlights that some borrowers experienced negative equity during the financial crisis—particularly in counties with negative price growth. As property values fell during this period, many homeowners found themselves with mortgage debt that exceeded the current value of their homes, reflecting the vulnerability of borrowers in regions that did not experience significant price appreciation before the crisis. This negative equity scenario underscores the financial strain faced by households in these regions, limiting their ability to refinance or leverage their property for other financial purposes.

These regional differences in equity have significant implications for refinancing opportunities. In high-growth regions, the accumulation of equity due to rising property values enhances the ability of homeowners to access favorable refinancing terms. Lower Loan-to-Value (LTV) ratios enable these homeowners to reduce their borrowing costs, engage in cash-out refinancing, or reinvest in other wealth-building activities, creating a cycle of economic advantage.

In contrast, homeowners in low-growth regions face higher LTV ratios and are therefore more constrained in their ability to refinance. The inability to access equity limits their financial flexibility and reduces their ability to respond to economic shocks. During downturns, such as the 2008 financial crisis, these households are at greater risk of financial instability, including foreclosure, due to their inability to refinance effectively or accumulate sufficient equity.

Figure 6 shows that regional house price dynamics fundamentally influence the distribution of home equity and thereby impact the ability of households to refinance and build wealth. The divergence in equity distribution observed in the right-hand plots highlights that current market conditions play a significant role in creating and reinforcing regional economic disparities. Homeowners in high-growth regions are better positioned to benefit from rising property values, enhancing their financial resilience and wealth accumulation, while those in low-growth regions are left with fewer opportunities, contributing to growing economic divergence.

Figure 6: Distribution of Borrowers' Equity in Real State for Counties with the Highest and Lowest House Price Growth.



Source: CRISM and Corelogic. Notes: The red lines represent the 10 counties with the lowest house price growth, while the blue lines represent the 10 counties with the highest house price growth. The fourth and fifth refinancing windows identified in this paper begin in December 2008 and November 2019, respectively. Borrower equity from CRISM is evaluated as 1 - CLTV, using either original or estimated current house values in two approaches: original house value minus current mortgage debt, or estimated current value minus current mortgage debt, both relative to the respective house value.

6 Identifying the Effect of Monetary Policy on Refinancing Originations

In this section, we aim to understand the impact of monetary policy surprises on mortgage refinancing. Para hacer esto, by applying an identification approach similar to Christiano et al. (1999). In their paper, they use Vector Autoregressions (VARs) to estimate impulse responses—essentially measuring how an economic variable reacts over time to a shock in another variable, such as a monetary policy shock. The VAR approach captures complex interdependencies between multiple macroeconomic variables, and their model is often applied with quarterly data, making it suitable for understanding the effects of monetary policy at a low frequency (i.e., over quarters or years).

However, the VAR methodology typically requires certain assumptions, such as the imposition of identifying restrictions to separate the monetary shock from other influences, and it also assumes a specific functional form for the dynamics between variables. This means that impulse responses from a VAR are often sensitive to these modeling choices and may impose rigid structures on the relationships among variables.

In contrast, our use of local projections, as proposed by Jordà (2005), offers a more flexible alternative for estimating the dynamic effects of monetary policy shocks. The local projection method allows for a direct estimation of the impact of monetary policy surprises on refinancing activity at each future time horizon, without imposing the same strong parametric structure required by VARs. This approach is less restrictive in terms of model specification and can provide more robust estimates of impulse responses, especially when there is uncertainty about the correct specification of dynamic relationships.

By applying local projections, we can directly model the effects of monetary policy surprises (derived from the residuals of a regression of the federal funds rate on key economic indicators) on refinancing activity across different time horizons. This allows us to capture both the short-term and medium-term effects of policy changes on refinancing decisions, while also accounting for local heterogeneity through the inclusion of regional fixed effects and control variables. Moreover, the flexibility of local projections allows us to include lags of relevant variables, which helps in capturing persistent effects without assuming the specific lag structure of a VAR.

Thus, while the VAR approach of Christiano et al. (1999) is a powerful tool for examining the broader macroeconomic effects of monetary policy, our local projection framework offers a more adaptable and direct means of exploring how unanticipated monetary policy shocks translate into changes in refinancing behavior. This flexibility is particularly valuable when focusing on a specific channel, such as the refinancing channel, and when trying to understand how households adjust their borrowing behavior in response to unexpected changes in monetary policy at a regional level.

6.1 Linear Projections Framework

Using the local projections method with instrumental vsariables, introduced by Òscar Jordà, Schularick and Taylor (2015), we derive the monetary policy surprises as the residuals of a first-stage regression that models the federal funds rate as a function of key macroeconomic indicators. Specifically, the federal funds rate at time t is regressed on GDP, CPI, and a commodity price index, following the specification:

$$\text{Federal Funds Rate}_t = \delta_0 + \delta_1 \text{GDP}_t + \delta_2 \text{CPI}_t + \delta_3 \text{Commodity Price Index}_t + u_t$$

where δ_0 is the intercept, $\delta_1, \delta_2, \delta_3$ are coefficients representing the relationships between the federal funds rate and each macroeconomic variable, and u_t represents the residual term. The residuals, u_t, capture the unexpected component of monetary policy—that is, the part of the federal funds rate that cannot be explained by economic fundamentals such as GDP, CPI, and commodity prices. These residuals serve as our measure of monetary policy surprises.

We use this approach to isolate the unanticipated component of policy actions, allowing us to assess how unexpected changes in monetary policy influence refinancing conditions. Specifically, by capturing the component of policy that is not systematically driven by the economic environment, we can accurately measure how shifts in policy rates translate into changes in refinancing activity. To improve the robustness of the analysis, we also include 6 lags of all the variables in the model, which helps to account for the dynamics of the relationships over time.

The local projection model used for this analysis is specified as follows:

$$\text{Refinance}_{i,t+h} = \alpha_{i,h} + \beta_h \, \text{Surprise}_t + \sum_{k=0}^{6} (\gamma_{h,k} X_{i,t-k}) + \epsilon_{i,t+h},$$

where $\text{Refinance}_{i,t+h}$ represents the refinancing rate or volume in region i at time $t+h$, with h indicating the horizon after the policy shock. $\alpha_{i,h}$ represents region-specific fixed effects, capturing unobserved heterogeneity, while β_h measures the effect of the monetary policy surprise on refinancing activity. The term $\sum_{k=0}^{6} (\gamma_{h,k} X_{i,t-k})$ includes 6 lags of the control variables $X_{i,t}$ (such as mortgage rates, housing prices, income levels, and credit supply factors), where $\gamma_{h,k}$ represents the coefficients of the lagged control variables, helping to capture the dynamic relationships over time. $\epsilon_{i,t+h}$ is the error term.

By applying this framework, we aim to understand how monetary policy surprises—as derived from unexpected deviations in the federal funds rate—affect mortgage refinancing behavior over multiple time horizons. This approach provides insight into how households adjust their refinancing decisions in response to monetary shocks, ultimately influencing household leverage and aggregate economic activity.

The sequence of estimated coefficients $\{\beta_h\}$ for $h = 0, 1, \ldots, H$ constitutes the impulse response function of refinancing activity to a monetary policy shock. Plotting β_h against the horizon h reveals the temporal dynamics of the policy's impact on refinancing behavior.

An unexpected easing of monetary policy (a negative Surprise_t) should, in theory, lower mortgage interest rates, thereby incentivizing borrowers to refinance existing mortgages at more favorable terms. A positive and significant β_h would indicate that refinancing activity increases following a policy surprise, validating the transmission of monetary policy through the refinancing channel. Conversely, if β_h is insignificant or negative, this may suggest frictions or constraints—such as credit market imperfections, borrower creditworthiness issues, or operational lags—that impede the effective pass-through of policy changes to refinancing decisions.

Furthermore, to explore the heterogeneity in the effect of monetary policy during specific periods of heightened refinancing activity, we include interaction terms for all variables with a dummy variable for the refinancing windows. The refinancing windows are defined as periods in which the volume of refinancing consistently surpasses that of home purchase loans, indicating times of active refinancing. These interaction terms allow us to capture any differential impact of monetary policy surprises during these refinancing windows, highlighting how the refinancing channel may behave differently in periods of elevated refinancing activity compared to more typical periods.

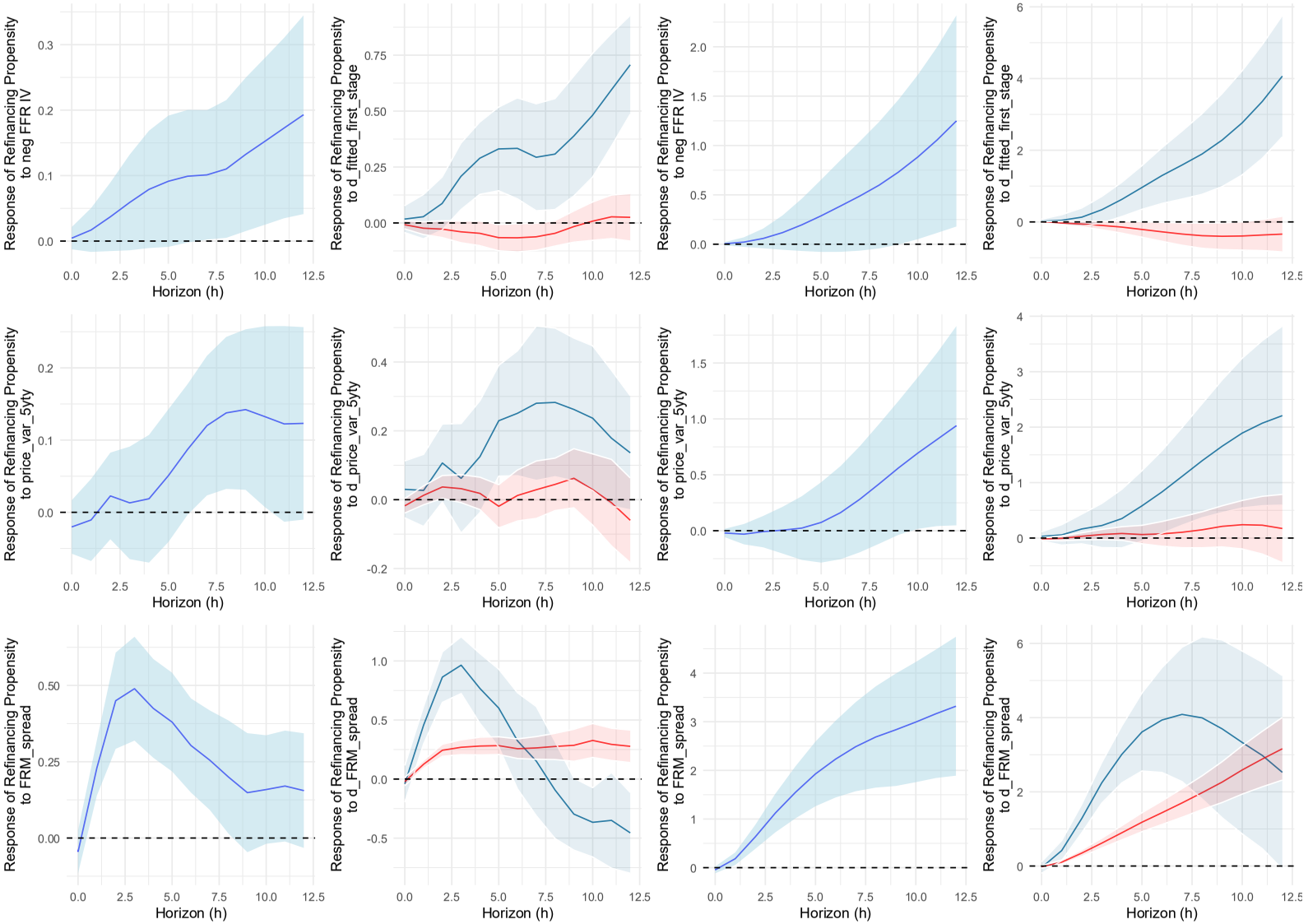
The local projection model used for this analysis is specified as follows:

$$\begin{aligned}\text{Refinance}_{i,t+h} = \alpha_{i,h} + \beta_h \,\text{Surprise}_t + \sum_{k=0}^{6} \left(\gamma_{h,k} X_{i,t-k}\right) \\ + \delta_h \left(\text{Surprise}_t \times D_{\text{ref},t}\right) + \sum_{k=0}^{6} \left(\theta_{h,k} (X_{i,t-k} \times D_{\text{ref},t})\right) + \epsilon_{i,t+h},\end{aligned} \tag{4}$$

where $\text{Refinance}_{i,t+h}$ represents the refinancing rate or volume in region i at time $t+h$, with h indicating the horizon after the policy shock. $\alpha_{i,h}$ represents region-specific fixed effects, capturing unobserved heterogeneity, while β_h measures the effect of the monetary policy surprise on refinancing activity. The term $\sum_{k=0}^{6} \left(\gamma_{h,k} X_{i,t-k}\right)$ includes 6 lags of the control variables $X_{i,t}$ (such as mortgage rates, housing prices, income levels, and credit supply factors), where $\gamma_{h,k}$ represents the coefficients of the lagged control variables, accounting for persistent effects over time. $\delta_h(\text{Surprise}_t \times D_{\text{ref},t})$ and $\sum_{k=0}^{6} \left(\theta_{h,k} (X_{i,t-k} \times D_{\text{ref},t})\right)$ represent the interaction terms between the monetary policy surprise, the lagged control variables, and the dummy variable for refinancing windows ($D_{\text{ref},t}$), allowing us to explore the differential effects during these periods.

By incorporating control variables $X_{i,t}$ and fixed effects $\alpha_{i,h}$, we aim to isolate the effect of monetary policy surprises from other concurrent regional economic factors. This methodology allows us to capture heterogeneous responses across different regions and time horizons, providing a nuanced understanding of the refinancing channel's role in the transmission of monetary policy.

Figure 7: Impulse Response Functions of Refinancing Propensity to Monetary Policy Shocks.



Source: FRED, McDash and Corelogic. Notes: The first two columns show the Impulse Response Functions (IRFs) for refinancing propensity. The first column represents the full sample, while the second interacts with a refinancing window indicator. Red indicates responses outside the window, and blue indicates those within. The third and fourth columns depict the cumulative response over time. Shaded areas correspond to a 95% Confidence Interval.

Figure **?** presents the Impulse Response Functions (IRFs) of the refinancing propensity following a monetary policy shock, observed over a series of horizons (h). The IRFs provide insights into how refinancing behavior evolves dynamically across different time periods after the shock.

The first column represents the IRF for the full sample, capturing the average effect across all observations. The refinancing response, depicted by the blue line, shows a consistent increase over time, indicating that monetary policy shocks induce a positive and gradually strengthening refinancing response.

In the second column, we introduce an interaction with an indicator for refinancing windows. This allows us to distinguish refinancing behavior during periods of heightened refinancing activity—what we refer to as "refinancing windows." The blue line captures the response within these windows, while the red line represents the response outside of such windows. The divergence between these lines indicates that refinancing propensity is substantially more responsive during periods when conditions are favorable for refinancing, emphasizing the amplifying role of favorable monetary conditions.

The third and fourth columns present the cumulative responses over the horizon. These cumulative IRFs summarize the total impact of monetary policy shocks over time, providing an aggregate measure of refinancing response. Within refinancing windows (blue line), the cumulative effect is substantially higher, suggesting that the shocks lead to significantly amplified refinancing activity in these favorable periods compared to the rest of the sample (red line). The shaded regions around the lines represent the uncertainty bands, offering a sense of the variability in responses.

7 The Impact of Housing Market and Economic Factors on Refinancing Behavior

To evaluate the determinants of refinancing activity at the county level, we estimate the following regression model:

$$Y_{it} = \alpha_i + \lambda_t + \mathbf{X}_{it}\boldsymbol{\beta} + \epsilon_{it}$$

where:

In this equation, Y_{it} represents the refinancing propensity in county we at time t. The model includes county-level fixed effects, α_i, which capture unobserved, time-invariant characteristics specific to each county, such as geographic or socio-economic factors that do not change over time. It also incorporates time fixed effects, λ_t, to account for common macroeconomic shocks or time-specific factors that influence all counties simultaneously, such as changes in national interest rates or macroeconomic policy.

All Sample Interacted with Refinancing Window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log HPI*D_ref	0.194***							0.020
	(0.030)							(0.026)
Delta HP*D_ref		0.002***					0.002***	0.002***
		(0.000)					(0.000)	(0.000)
FICO*D_ref			0.006***				0.004***	0.004***
			(0.001)				(0.001)	(0.001)
FRM Spread*D_ref				−0.532***			−0.384***	−0.382***
				(0.029)			(0.035)	(0.035)
Log Income per Capita*D_ref					0.174***		−0.046	−0.049
					(0.040)		(0.039)	(0.040)
Population (logs)*D_ref						−0.070***	−0.076***	−0.076***
						(0.008)	(0.007)	(0.007)
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 370
R-squared	0.726	0.726	0.739	0.742	0.726	0.731	0.753	0.753
Adjusted R-squared	0.725	0.725	0.737	0.741	0.725	0.730	0.752	0.752

* p <0.05, ** p <0.01, *** p <0.001
Standard errors in parentheses. * p¡0.05, ** p¡0.01, *** p¡0.001

The term $\mathbf{X}_{it}$ denotes a vector of county-level explanatory variables at time t. These variables might include economic indicators such as housing prices, credit scores, income per capita, mortgage interest rate spreads, and other local factors that can impact refinancing decisions. The vector of coefficients $\boldsymbol{\beta}$ captures the effect of each of these explanatory variables on the refinancing propensity.

The error term ϵ_{it} represents the residual variation in refinancing propensity that is not explained by the fixed effects or the county-level characteristics. The standard errors are clustered at the county level to account for serial correlation within counties over time, ensuring that the inference is robust to potential within-county dependencies across time periods. This general specification allows us to assess the influence of both regional and temporal factors on refinancing behavior while appropriately controlling for fixed differences across counties and common time trends.

The model includes interactions between the refinancing window indicator ($D_{\text{ref},t}$) and various county-level variables to assess how local economic conditions influence refinancing propensity specifically during periods of heightened refinancing activity. The standard errors are clustered at the county level to provide robust inference against within-county correlation over time. This specification helps us understand both the temporal and regional heterogeneity in refinancing behavior, controlling for fixed differences across counties and time-specific common factors.

Table 7 presents the results of regression models evaluating the effects of housing market conditions and regional economic characteristics on refinancing originations. The dependent variable in each model is a measure of refinancing activity, and the key explanatory variables are interactions between regional economic conditions and a refinancing indicator (D_{ref}), which captures periods of high refinancing activity. The models incorporate different combinations of these interaction terms to isolate the respective impacts of each variable on refinancing.

The coefficient on the interaction between the log of the House Price Index (HPI) and the refinancing indicator in column (1) is 0.194, significant at the 0.1% level. This suggests that, during periods of increased refinancing activity, higher house prices are associated with greater levels of refinancing. This result supports the hypothesis that increased home equity, driven by rising house prices, encourages households to refinance. Additionally, the interaction between the change in house prices (ΔHP) and the refinancing window indicator is positive and significant across multiple specifications (columns (2), (7), and (8)), with a coefficient of 0.002, indicating that changes in housing prices positively influence refinancing behavior. Homeowners are more inclined to refinance their mortgages when they perceive an appreciation in their property value, and this can be explained in two ways. First, an increase in the value of their home boosts the collateral backing their mortgage, which allows them to negotiate a lower interest rate on their debt. Second, when property values appreciate significantly, homeowners also gain the opportunity to "cash out" some of the increased equity—essentially borrowing against the rise in their home's value. This enables them to access additional liquidity, which can be used for other expenditures or investments.

The interaction of FICO scores with the refinancing indicator is also positive and sig-

nificant, with coefficients ranging from 0.004 to 0.006 in columns (3), (7), and (8). This suggests that counties with higher credit scores are significantly more likely to refinance during periods of favorable interest rates. This finding emphasizes the importance of borrower creditworthiness in determining access to beneficial refinancing terms. Conversely, the interaction term for the Fixed-Rate Mortgage (FRM) spread is negative and significant across columns (4), (7), and (8), with coefficients between -0.532 and -0.382. This implies that a higher FRM spread, which indicates less attractive mortgage rates relative to market rates, is associated with reduced refinancing activity.

Column (5) shows a significant positive coefficient of 0.174 for the interaction between log income per capita and the refinancing indicator, indicating that regions with higher income levels are more likely to experience increased refinancing during favorable periods. However, this effect becomes statistically insignificant in columns (7) and (8), suggesting that its influence is diminished when other covariates are included, potentially due to collinearity or interactions with additional factors. Furthermore, the interaction between log population and the refinancing indicator is consistently negative and significant in columns (6), (7), and (8), with coefficients around -0.070 to -0.076. This finding suggests that regions with larger populations exhibit lower levels of refinancing during high refinancing periods, which may reflect greater competition or higher constraints in densely populated housing markets.

8 Real Effects of the Monetary Policy

This section discusses the ways in which refinancing propensities influence broader economic outcomes, particularly retail employment. Following Guren et al. (2020), retail employment is used as a measure of local consumption because it closely correlates with shifts in household spending. The advantage of relying on retail employment data lies in its longitudinal depth; county-level statistics often extend back several decades, which allows for richer historical analysis than is possible with direct consumption data that only became widely available in the early 2000s.

To quantify these effects, we employ a model in which the dependent variable is the log change in per-capita retail employment. The specification accounts for refinancing propensity, house prices, and additional control variables that may shape local retail conditions. Formally, we estimate:

$$\Delta y_{i,r,t} \;=\; \psi_i \;+\; \xi_{r,t} \;+\; \mu\,\Delta \text{Refi}_{i,r,t} \;+\; \beta\,\Delta p_{i,r,t} \;+\; \Gamma\,X_{i,r,t} \;+\; \epsilon_{i,r,t},$$

where $\Delta y_{i,r,t}$ denotes the log change in per-capita retail employment for county i in region r at time t. The term $\Delta \text{Refi}_{i,r,t}$ represents the change in refinancing propensity, while $\Delta p_{i,r,t}$ corresponds to the log change in house prices. We control for unobserved county-specific heterogeneity through ψ_i and account for region-time trends using $\xi_{r,t}$. Any additional factors potentially affecting retail employment are included in the vector $X_{i,r,t}$. The error term $\epsilon_{i,r,t}$ captures all other unexplained variation.

Throughout the analysis, i indexes counties, r indicates census regions comprising multiple counties, and t represents discrete time periods (e.g., quarters). County-level fixed effects, denoted by ψ_i, remove the influence of any permanent differences across counties, such as persistent local policies or geographical traits. Region-time-specific effects, denoted by $\xi_{r,t}$, further control for macroeconomic shocks or regional factors that affect multiple counties simultaneously within a given time frame. When relevant, the term $X_{i,r,t}$ includes additional controls thought to influence retail employment, such as demographic or industry-level variables.

Potential endogeneity arises in two distinct relationships: first, between house prices and retail employment, and second, between refinancing propensity and retail employment. Simultaneity bias can occur if changes in house prices directly affect local consumption patterns and, therefore, retail employment, while rising retail employment and local income levels may, in turn, support higher house prices. A similar feedback loop can emerge around refinancing, where households may refinance more as they accumulate higher incomes, but increased refinancing can itself stimulate consumption and hiring in retail sectors.

Instrumenting House Prices with Housing Supply Elasticity

One approach to mitigating endogeneity is to use housing supply elasticity as an instrumental variable (IV) for house prices. This approach is consistent with Saiz (2010), Mian et al. (2013), Guren et al. (2020), and Graham and Makridis (2023). By exploiting geographical or regulatory constraints on new construction, it becomes possible to isolate exogenous shifts in local house prices that are less likely to be correlated with changes in retail employment. In practice, this method involves measuring county-level housing supply elasticities and leveraging differences in how local prices respond to regional housing market shocks.

Instrumenting Refinancing Propensity

A similar strategy is used to address endogeneity in refinancing propensity by relying on the spread between existing and current mortgage rates. This spread is shaped by macroeconomic factors and thus tends to be exogenous to local retail employment conditions. The broader idea is to capture the incentive for homeowners to refinance based on the cost differential rather than on regional economic strength. A first-stage regression relates changes in refinancing propensity to this mortgage rate differential while controlling for county and time fixed effects. By doing so, one can identify exogenous variation in refinancing activity and, in the second stage, estimate its causal impact on retail employment with greater accuracy.

9 Conclusions

This paper investigates the regional heterogeneity of monetary policy transmission through the refinancing channel. Utilizing comprehensive mortgage loan origination data from the Home Mortgage Disclosure Act (HMDA) database spanning 1990 to the present, we identify five distinct periods of heightened refinancing activity ("refinancing windows") and examine the factors influencing regional variations in refinancing levels.

Our methodology involves analyzing these refinancing windows as quasi-natural experiments to assess the impact of interest rate changes on regional housing markets. We investigate the relationship between refinancing activity and key regional characteristics, including house prices, per capita income, and employment levels.

The findings demonstrate a significant relationship between contemporaneous house prices and per capita income at the onset of the refinancing window and the level of refinancing activity. Regions with higher initial house prices and higher per capita income exhibit greater refinancing activity. While house price appreciation plays a role, its impact is secondary to the initial conditions. Employment dynamics do not consistently correlate with refinancing windows, but regions with more pronounced employment contractions exhibit lower refinancing levels.

These results highlight the importance of regional housing market conditions and income levels in determining the effectiveness of monetary policy transmission through the refinancing channel. This research contributes to a nuanced understanding of how monetary policy impacts the real economy at the regional level.

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10 Appendix

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
log HPI	0.402***							0.346***
	(0.020)							(0.024)
$Delta HP_{t–t-36}$		0.002***					0.002***	0.001***
		(0.000)					(0.000)	(0.000)
$FICO $			0.002***				0.001***	0.001*
			(0.000)				(0.000)	(0.000)
FRM Spread				−0.265***			−0.190***	−0.095***
				(0.022)			(0.022)	(0.022)
$Log Income_{t}$					0.295***		0.131**	−0.150**
					(0.044)		(0.046)	(0.047)
Population (logs)						0.324***	0.226***	0.233***
						(0.026)	(0.025)	(0.025)
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 370
R-squared	0.737	0.729	0.726	0.728	0.726	0.729	0.735	0.741
Adjusted R-squared	0.736	0.727	0.725	0.727	0.724	0.728	0.734	0.740

* p <0.05, ** p <0.01, *** p <0.001
Standard errors in parentheses. * p¡0.05, ** p¡0.01, *** p¡0.001

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log HPI*(1-D_ref)	0.308***							0.377***
	(0.022)							(0.023)
Delta HP*(1-D_ref)		0.003***					0.003***	0.001*
		(0.000)					(0.000)	(0.000)
FICO*(1-D_ref)			−0.003***				−0.002***	−0.002***
			(0.000)				(0.000)	(0.000)
FRM Spread*(1-D_ref)				0.276***			0.213***	0.264***
				(0.026)			(0.023)	(0.023)
Log Income per Capita*(1-D_ref)					−0.105**		−0.092*	−0.141***
					(0.038)		(0.038)	(0.036)
Population (logs)*(1-D_ref)						0.078***	0.089***	0.083***
						(0.008)	(0.007)	(0.007)
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 370
R-squared	0.731	0.727	0.728	0.730	0.725	0.733	0.744	0.751
Adjusted R-squared	0.730	0.726	0.727	0.729	0.724	0.732	0.743	0.750

* p <0.05, ** p <0.01, *** p <0.001
Standard errors in parentheses. * p¡0.05, ** p¡0.01, *** p¡0.001

Table 1: All Sample Interacted with (1 - d_recession)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log HPI*(1-D_rec)	0.362***							0.313***
	(0.019)							(0.022)
Delta HP*(1-D_rec)		0.002***					0.002***	0.001***
		(0.000)					(0.000)	(0.000)
FICO*(1-D_rec)			0.002***				0.001**	0.000
			(0.000)				(0.000)	(0.000)
FRM Spread*(1-D_rec)				−0.206***			−0.175***	−0.112***
				(0.017)			(0.019)	(0.020)
Log Income per Capita*(1-D_rec)					0.156***		−0.019	−0.129***
					(0.020)		(0.025)	(0.025)
Population (logs)*(1-D_rec)						0.057***	0.048***	0.048***
						(0.004)	(0.004)	(0.004)
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 370
R-squared	0.735	0.728	0.726	0.727	0.725	0.726	0.732	0.737
Adjusted R-squared	0.734	0.727	0.724	0.726	0.724	0.725	0.731	0.736

* p <0.05, ** p <0.01, *** p <0.001
Standard errors in parentheses. * p¡0.05, ** p¡0.01, *** p¡0.001

Table 2: All Sample Interacted with (1 - d_recession) and d_refinancing_window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log HPI*(1-D_rec)*D_ref	0.190***							0.023
	(0.030)							(0.025)
Delta HP*(1-D_rec)*D_ref		0.002***					0.002***	0.002***
		(0.000)					(0.000)	(0.000)
FICO*(1-D_rec)*D_ref			0.006***				0.003***	0.003***
			(0.001)				(0.001)	(0.001)
FRM Spread*(1-D_rec)*D_ref				−0.504***			−0.359***	−0.357***
				(0.027)			(0.032)	(0.032)
Log Income per Capita*(1-D_rec)*D_ref					0.187***		−0.029	−0.032
					(0.037)		(0.036)	(0.037)
Population (logs)*(1-D_rec)*D_ref						−0.059***	−0.066***	−0.066***
						(0.007)	(0.007)	(0.007)
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 370
R-squared	0.726	0.726	0.737	0.740	0.727	0.729	0.748	0.748
Adjusted R-squared	0.725	0.724	0.736	0.739	0.725	0.728	0.747	0.747

Standard errors in parentheses. * p <0.05, ** p <0.01, *** p <0.001

Table 3: All Sample Interacted with (1 - d_recession) and (1-d_refinancing_window)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log HPI*(1-D_rec)*(1-D_ref)	0.296***							0.362**
	(0.022)							(0.023
Delta HP*(1-D_rec)*(1-D_ref)		0.002***					0.002***	0.000
		(0.000)					(0.000)	(0.000
FICO*(1-D_rec)*(1-D_ref)			−0.002***				−0.002***	−0.002*
			(0.000)				(0.000)	(0.000
FRM Spread*(1-D_rec)*(1-D_ref)				0.250***			0.195***	0.242**
				(0.025)			(0.023)	(0.022
Log Income per Capita*(1-D_rec)*(1-D_ref)					−0.095**		−0.087*	−0.134*
					(0.036)		(0.036)	(0.034
Population (logs)*(1-D_rec)*(1-D_ref)						0.075***	0.084***	0.079**
						(0.007)	(0.007)	(0.006
Observations	188 370	188 370	188 370	188 370	188 370	188 370	188 370	188 37
R-squared	0.730	0.727	0.728	0.729	0.725	0.733	0.742	0.748
Adjusted R-squared	0.729	0.726	0.726	0.728	0.724	0.731	0.741	0.747

Standard errors in parentheses. * p <0.05, ** p <0.01, *** p <0.001

Appendix

Mortgage Originations - HMDA

The Home Mortgage Disclosure Act (HMDA), enacted in 1975, aims to bring transparency to the mortgage market. It mandates that financial institutions collect, report, and disclose data on their mortgage lending activities. HMDA covers the entire universe of U.S. mortgages—whether originated, rejected, purchased, or incompleted during the process. It details various loan types, including home purchases, refinancing, and home improvement. There are two versions of the data: public and confidential. The confidential version includes additional information, such as the mortgage date and, in recent years, variables like FICO scores and borrower age.

House Prices - CoreLogic

The CoreLogic House Price Index (HPI) is a key tool for analyzing U.S. housing market dynamics. Using a repeat-sales methodology, it tracks price changes for the same properties over time, offering a true measure of price movement while controlling for property quality variations. With data available at national, state, and local levels, updated monthly, and covering several decades, it provides a detailed view of both short-term fluctuations and long-term trends. CoreLogic's HPI informs economic analysis, risk management, and policy planning by revealing regional price disparities and forecasting future trends, making it essential for real estate and financial decision-making.

Refinancing Propensities

The McDash Database, provided by Black Knight, offers an extensive, loan-level dataset critical for analyzing the U.S. mortgage market. Covering millions of active loans with monthly updates, McDash includes detailed information on delinquencies, foreclosures, prepayments, refinancing activities, and loan modifications. Key variables such as loan balance, interest rate, and borrower credit characteristics enable researchers to examine mortgage performance at a granular level. This dataset is invaluable for understanding how macroeconomic conditions and policy changes impact mortgage default risk, repayment behaviors, and regional variations in loan performance, thus providing a robust foundation for economic research, risk assessment, and policy evaluation.

Nielsen Consumer Panel

We utilize the Nielsen Consumer Panel and Retail Scanner datasets to analyze consumer behavior and its implications for economic theory. These datasets provide detailed insights into U.S. household purchasing patterns and retail sales, offering a robust foundation for studying consumption dynamics. The Nielsen Consumer Panel is a longitudinal dataset tracking the purchasing behavior of a representative sample of approximately 40,000 to 60,000 U.S. households annually since the early 2000s. Households use handheld scanners to

record all in-home purchases of fast-moving consumer goods (FMCGs) like food, beverages, personal care items, and household supplies.

Key features include detailed household demographic information—such as income, family size, age, education level, and geographic location—which enables analysis of consumption patterns over time and across different segments of the population. This rich data allows us to examine consumer behavior across various economic conditions and contributes to a deeper understanding of consumption dynamics in the United States.

Vacancy Rates - United State Postal Service (USPS)

In 2005, the U.S. Department of Housing and Urban Development (HUD) reached an agreement with the U.S. Postal Service (USPS) to obtain quarterly data on addresses identified as "vacant" or "stateless" in the previous quarter. This dataset, encompassing the entire universe of U.S. addresses and updated every three months, is now accessible to researchers and practitioners for tracking neighborhood changes. Under the terms of the agreement, HUD can publicly release this data at the census tract level.

Labor Force Statistics - BLS

To analyze regional labor market dynamics, we utilize data from the U.S. Bureau of Labor Statistics (BLS) Labor Force Statistics. Specifically, we obtain monthly statistics on employment, unemployment, unemployment rates, and labor force at the county level. This granular dataset allows for a detailed examination of local economic conditions and labor market fluctuations across different regions.

Personal Income and Wages - BEA

To enhance the analysis of regional economic conditions, we utilize annual data on Personal Income and Wages from the U.S. Bureau of Economic Analysis (BEA). This dataset provides comprehensive information on income and wage levels at the county level across the United States.

CRISM dataset

The CRISM dataset is a unique and comprehensive resource that merges Black Knight's McDash mortgage servicing data with Equifax consumer credit information. This integration provides granular, loan-level details on mortgage performance alongside detailed borrower credit profiles. From the McDash data, users gain insights into mortgage origination, payment histories, delinquency statuses, and loan modifications. The Equifax component adds depth with credit scores, outstanding debts, credit card balances, and other personal credit behaviors.