Does Monetary Policy Narrow or Widen the Racial Gap in the U.S.? Evidence From the Housing Market *

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Abstract

We study the effects of conventional and unconventional monetary policy shocks on racial inequality in housing related markets. Using detailed data on housing transactions and mortgage records across the United States merged with regulatory data with racial information, we find that in most cases tightening monetary policy shocks increase foreclosure rate and home purchase price, while decrease mortgage origination interest rate for minority households relative to white households. Our findings are consistent with a comparatively low prepayment risk associated with minority borrowers in a high interest rate environment resulted from their refinance behavior being less responsive. More generally, we use the survey data to demonstrate that minority households tend to fare less well in financial literacy and overestimate the prevailing mortgage interest rate, which may help to explain why they do not refinance after expansionary monetary policy shocks .

Keywords: Racial inequality, monetary policy, housing price, mortgage rate, foreclosure
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*The views expressed herein are those of the authors and not necessarily those of the Bank of Canada.

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The racial income and wealth inequality in the United States is substantial and persistent. In past few years, there is a push from Congressional representatives and grass roots organizations to make the Federal Reserve more cognizant of its impact on racial inequality.[1] [2] Central bank leaders have recently suggested that monetary policy may be used to reduce these inequalities but are worried that their tools might be limited[3].

Despite policy interests in the interaction of racial inequality and monetary policy, the economic literature on the effect of monetary policy on racial inequality is less developed. To our knowledge, this paper is the first one that comprehensively documents how various monetary policy shocks (fed funds rate, forward guidance and large-scale asset purchase) affect minority groups' experience in housing-related markets in the US, relative to non-Hispanic white households. We focus on housing markets because housing is the biggest component of wealth for a large percentage of households in the US. Specifically, we look at various stages of individuals' involvement in the housing market including mortgage application, mortgage origination, home purchase, refinance, home sales or foreclosure, using granular data on housing transactions and mortgage records. We also document racial differences in financial literacy and perceptions of monetary policy using a variety of survey data, which can explain the racial differences in responses to monetary policy shocks.

The conventional monetary policy tool of central bank is to set the short-term nominal interest rate. However, in recent years, many central banks have been constrained by the zero lower bound and turned to a variety of unconventional instruments to provide stimulus to the economy. Forward guidance (FG) is to communicate the likely future path of the federal funds rate[4], and large-scale asset purchases (LSAP) is the purchase of longer-term securities issued or guaranteed by government or government-sponsored agencies[5]. The two unconventional policy tools affect interest rate at different maturities. To separately identify the effect of various monetary policy instruments on

[1] https://www.washingtonpost.com/business/2020/08/05/fed-racial-inequality-democrats/

[2] https://nextcity.org/features/the-federal-reserves-reckoning-on-racial-equity

[3] For example, during the press conference on September 22, 2021, Federal Reserve Chair Powell said "first of all, ideally, there would't be any gap (between Black unemployment and overall unemployment) ... This is a persistent gap, and it's very hard to explain based on typical metrics. It's just, it's quite troubling, but it really is—you know, we have, you know, famously broad and blunt tools. I think eliminating inequality and racial discrimination and racial disparities and that kind of thing is really something that fiscal policy and other policies—frankly, education policies and that kind of thing—are better at focusing on. I think we've identified the part that we can do, and we'll do that part. But I've always been clear that it's going to take policies broadly across society to work on these problems."

[4] https://www.federalreserve.gov/faqs/what-is-forward-guidance-how-is-it-used-in-the-federal-reserve-monetary-policy.htm

[5] https://www.federalreserve.gov/faqs/what-were-the-federal-reserves-large-scale-asset-purchases.htm

racial inequality in the housing market, we use the monetary policy shocks constructed by Swanson (2021), and look at all three types of shocks: federal funds (FF), forward guidance (FG), and large-scale asset purchase (LSAP).

Using mortgage interest rates, foreclosure and home prices from Corelogic-HMDA linked data, we find that monetary policy has heterogeneous effects across different race and ethnicity groups. On one hand, monetary tightening disproportionately increases the foreclosure rate for minority groups, exacerbating racial inequality. On the other hand, tightening reduces the mortgage interest rate and increases the home price of minority households relative to white households, reducing racial inequality, at least on impact.

Our finding that monetary tightening causes both an relative increase in foreclosure rate and a relative decrease in mortgage interest rate in minority groups seems counter intuitive. Since minority borrowers are more likely to default in a tightening monetary cycle, lenders that serve minority borrowers should require a larger credit risk premium. So why is that mortgage interest rate relatively declines for minority borrowers? To rationalize finding, we turn to another important risk factor in determining mortgage interest rate: prepayment risk. The compensation for prepayment risk depends on the propensity of refinance and how it comoves with monetary policy.

We then look at how various monetary policy shocks affect racial gaps in mortgage application and originations, especially for refinance mortgages. We found that minority borrowers are less likely to apply and obtain mortgages compared to white household during monetary easing. For example, a quarter after a one-standard-deviation LSAP easing shock, the total number of mortgage applications in a city with 100% white residents will increase by 0.08 percent, while the total number of mortgage applications in a city with 100% Black residents only increases by less than 0.04 percent. We find that this difference comes mostly from refinance mortgage applications instead of the purchase mortgage applications, and a similar pattern holds for mortgage originations.

Finally, we try to understand the racial difference in refinance patterns with survey data. Using the New York Fed's Survey of Consumer Expectations (SCE) Housing survey, we find minority tend to overestimate the average interest rate on a new 30-year fixed-rate mortgage compared to white household, no matter whether they are homeowners or renters. Using National Survey of Mortgage Originations (NSMO), we find that minority borrowers are less familiar with available mortgage rate, the different types of mortgages available as well as the process of taking out a mortgage. The racial gap in interest rate perceptaion and financial literacy can explain the previous finding that minority borrowers are less likely to refinance than the white borrowers after an expansionary monetary policy shock.

Our first contribution to the literature is to quantify the the effects of monetary policy on racial inequality with a focus on housing market. Romer and Romer (1999) investigate the monetary policy's influence on poverty and income inequality. Coibion et al. (2017) find contractionary monetary policy shocks increase income and consumption inequality. Using Survey of Consumer Finances, Bartscher et al. (2021) find that a expansionary monetary policy increases employment of black households more than white households by a small margin, but greatly exacerbates the wealth difference between black and white households. Bergman et al. (2022) find that the employment of Blacks, high school dropouts, and women is more responsive to expansionary monetary policy, especially when labor markets are tight. Gerardi et al. (2022) show that minority borrowers are less likely to prepay their fixed-rate mortgages than white borrowers, and the difference exaggerates post 2008. Lee et al. (2021) find that expansionary monetary policy both reduces Black unemployment rate and increases Black inflation, and overall benefit black households as long as inflation expectations are well anchored.

Our paper is also related to the racial inequality literature. Bayer et al. (2017) find that Black and Hispanic homebuyers pay premium of around 2% on home purchase. Bayer et al. (2018) document that Black and Hispanic borrowers are 103% and 78% more likely to receive high-cost mortgages for home purchases. Kermani and Wong (2021) show that Black and Hispanic homeowners are both more likely to experience a distressed sale and to live in neighborhoods where distressed sales erase more house value. Our contribution is that we look at how racial gaps in home purchase price, mortgage interest rate and foreclosure are affect by monetary policy shocks, which can be used to calibrate and differentiate between different classes of heterogeneous agent models.

The remainder of the paper proceeds as follows. Section 1 describes the data. We then present our empirical analysis: the effects of monetary policy shocks on racial gap in individual level mortgage origination interest rate, foreclosure and home purchase price are presented in Section 2, and the effects on mortgage applications and originations are presented in Section 3. Section 4 provides evidence from two household surveys. Finally, Section 5 concludes. Appendix provides further details.

1 Data

In this section, we describe the data and provide summary statistics.

1.1 HMDA

Our mortgage application dataset is based on public Home Mortgage Disclosure Act (HMDA) data between 1993 and 2019.[6] Fields such as race, ethnicity, gender, loan type (conventional or government sponsored), loan purpose (home purchase, home improvement, refinance), the property location (state, county, census tract), lender and the lender's action on the application (e.g., origination, denial), loan amount, applicant income are available in all years. We restrict our data to the approved and accepted mortgage applications.[7]

We also use the number of home purchase and refinance mortgage applications and originations at the county-month level. These data is derived from 1994–2016 confidential HMDA data and restricted to the top 500 counties in a given year in terms of total originations. Data are obtained at Neil Bhutta's website [8].

We follow Scharfstein and Sunderam (2013) to construct the county-level lender competitiveness data, measured as the share of the mortgages by the top 4 lenders in each area. This measure is obtained at county-year level.

1.2 Corelogic

Corelogic tracts 152 million residential and commercial property in the United States for up to 50 years and collect information on housing and mortgage transactions.

We assemble a dataset that links approved and accepted mortgages in HMDA data with mortgage record on single-family residence in Corelogic. Linking HMDA and Corelogic has two benefits. First, Corelogice records mortgage interest rate information for a subset of mortgage record, allowing us to analyse the effect of monetary policy shocks on racial gap in cost of housing finance. Secondly, Corelogic contains property information and housing transaction data that can be used to study how monetary policy shocks affect housing prices and foreclosure of minority groups compared to non-hispanic whites.

Our linking procedure resembles that of Bayer et al. (2016). For each mortgage record in Corelogic, we look for the set of mortgage applications in HMDA that match exactly in origination year, census tract, loan amount and loan type (conventional, FHA or VA). Then we select the best

[6] 1990 is the earliest year in which application-level records are reported in HMDA. Prior to that year, the data are only available as aggregate summaries at the Census tract level. Due to the changes of census tracts definitions, we start the sample from 1993.

[7] Other actions are deny, withdraw, incomplete, approve but not accepted.

[8] https://sites.google.com/site/neilbhutta/data

match based on a textual similarity of lender names in both datasets and only keep high quality matches. Our overall matching rate varies by state and year. For example, in California, the matching rate increases from 36% in 1993 to 51% in 2017. Table 1 provides the summary statistics of the matched data. We can see that minority mortgage borrowers on average are more likely to be single female, buy smaller houses, have lower income but higher loan-to-value and loan-to-income ratios and higher interest rate.

1.3 Survey data

We use the National Survey of Mortgage Originations. It is a quarterly mail survey jointly funded and managed by the Federal Housing Finance Agency (FHFA) and the Consumer Financial Protection Bureau (CFPB). NSMO draws its sample from newly originated mortgages that are part of the National Mortgage Database, which is a 1-in-20 sample of closed-end first-lien residential mortgages newly reported to one of the three national credit bureaus.[9] The data is available from 2013 to 2020.

We also utilize the mortgage expectations data from the Federal Reserve Bank of New York's Survey of Consumer Expectations (SCE) Housing survey. The SCE survey is conducted over the internet and includes a nationally representative set of rotating household heads. The SCE core survey is conducted every month while the Housing survey is fielded in February every year. The data is available from 2014 to 2020.

1.4 Monetary policy shocks

We use the monetary policy shock series constructed by Swanson (2021). There are three types of shocks: federal funds (FF), forward guidance (FG), and large-scale asset purchase (LSAP). The advantages of the shock series are that, first, they span a long history of time, from 1991 to 2019, which allows us to study the time varying effects of monetary policy. Second, the shock series separately identify the unconventional monetary policies – forward guidance and LSAP. It allows us to compare the effects unconventional monetary policy tools. Swanson (2021) found that forward guidance rate affects term structure at the medium term, while LSAP shock affects term structure at the 30 years. The benefit of using Swanson (2021) MP shocks is that we can

[9] https://www.fhfa.gov/DataTools/Downloads/Pages/National-Survey-of-Mortgage-Originations-Public-Use-File.aspx

separately identify the effect of various monetary policy instruments on racial inequality in the housing market.

Swanson (2021)'s shock series are constructed using the change in a number of asset prices in a 30-minute window bracketing each FOMC announcement from July 1991 through June 2019. The first three principal components of the asset price responses are extracted. Then the principal components matrix is rotated to identify the three types of monetary policy shocks. The underlying assumptions are that, first, forward guidance and LSAP have no effect on the current federal funds rate, and second, the variance of the LSAP factor is as small as possible over the sample from 1991 to 2008.

Each shock series is then normalized to have a unit standard deviation. Positive values correspond to interest rate increases.

We follow the literature, to obtain monthly frequencies, we assign each shock to the month in which the corresponding Fed announcement occurs. If there are two announcement days in a month, then we sum the shocks. If there are no meetings in a month, then we record the shock as zero for that month. To obtain quarterly frequency, we sum the monthly shocks for that quarter.

In Swanson (2021), LSAP shock is omitted from all the regression using the data from the pre-2008 period, since the changes in LSAP shocks are small and have insignificant effects on intra-day asset prices. We also omit changes in the federal funds rate for the post 2008 period due to its small magnitude. Thus, in the empirical analysis below, we set FF to be 0 after 2008 and LSAP to be 0 before 2009. The quarterly shock series are plot in Figure 1.

We also use alternative measure of monetary policy shocks. In particular, we take the first principal component of the following high frequency shocks constructed in e.g., Gürkaynak et al. (2005) and Nakamura and Steinsson (2018): the 30-minute window changes in current month federal funds rate (MP1, adjusted by the date of the month), three month ahead federal funds futures (FF4), Eurodollar futures two-, three- and four-quarter ahead, two-year Treasury yields, five-year Treasury yields and ten-year Treasury yields around FOMC announcement. The shocks are normalized to have unit standard deviation at the quarterly frequency. The details are in Appendix A.

1.5 Aggregate data

Our county level population by race, and Hispanic origin is obtained through the Survey of Epidemiology and End Results (SEER)[10]. The data is observed at the annual frequency. We follow Kermani and Wong (2021) and look at three minority groups: Non-Hispanic black, Non-Hispanic white, and Hispanic of any race, henceforth Black, white, and Hispanic.[11]

We obtain county-level unemployment rates from the U.S. Bureau of Labor Statistics under their Local Area Unemployment Statistics (LAU) program. The county-level nominal per capita income is from the U.S. Bureau of Economic Analysis.

We obtain aggregate time-series variables, including forecasts of unemployment, inflation and GDP from the Survey of Professional Forecasters (SPF).

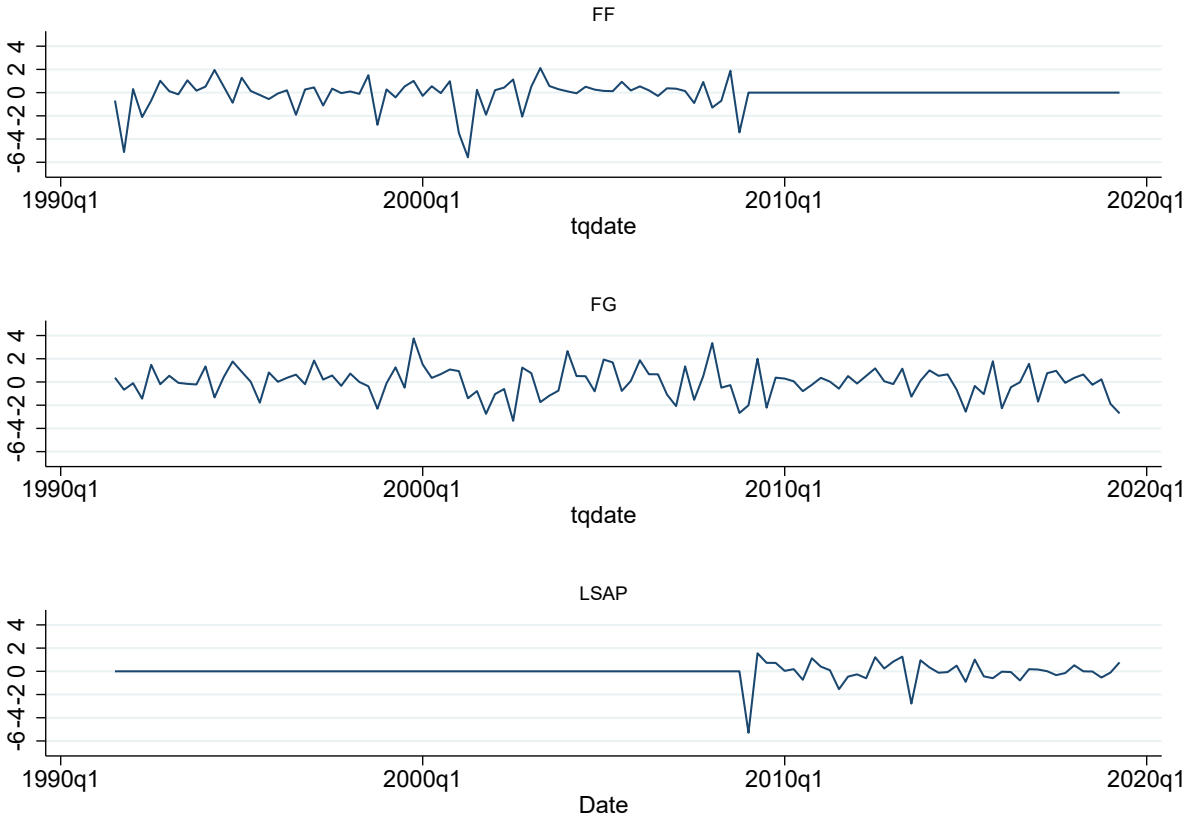
[10] https://seer.cancer.gov/popdata/

[11] As in Kermani and Wong (2021), our focus is on historically disadvantaged minorities, the main results excludes Asian homeowners.

Table 1: Summary Statistics of Matched Corelogic-HMDA Data

	All			Black			Hispanic		
VARIABLES	N	mean	sd	N	mean	sd	N	mean	sd
White	7.244e+07	0.828	0.377						
Black	7.244e+07	0.0699	0.255						
Hispanic	7.244e+07	0.102	0.303						
Year	7.244e+07	2,007	5.794	5.066e+06	2,007	5.606	7.385e+06	2,007	5.564
Mortgage Rate	1.287e+07	5.782	1.771	1.266e+06	6.596	1.810	1.725e+06	6.257	1.779
Foreclosure	3.184e+07	0.0655	0.247	2.359e+06	0.143	0.350	4.089e+06	0.114	0.318
Female	7.232e+07	0.275	0.447	5.056e+06	0.461	0.498	7.363e+06	0.278	0.448
Co-borrower	7.244e+07	0.536	0.499	5.066e+06	0.303	0.460	7.385e+06	0.424	0.494
Loan Amount (log)	7.099e+07	4.935	0.744	4.990e+06	4.786	0.727	7.303e+06	4.912	0.720
House Price (log)	2.633e+07	12.19	0.640	2.040e+06	11.98	0.615	3.335e+06	12.12	0.624
Income (log)	6.789e+07	4.347	0.671	4.595e+06	4.109	0.606	6.855e+06	4.122	0.597
LTV	2.685e+07	284.2	9,007	2.075e+06	307.9	7,693	3.368e+06	294.5	8,625
LTI	6.789e+07	2.249	2.987	4.595e+06	2.345	2.185	6.855e+06	2.653	2.557
Jumbo	7.244e+07	0.0693	0.254	5.066e+06	0.0361	0.186	7.385e+06	0.0549	0.228
Junior	3.434e+07	0.275	0.446	2.550e+06	0.259	0.438	4.030e+06	0.257	0.437
Land sq ft (log)	7.234e+07	9.382	1.074	5.060e+06	8.968	0.899	7.380e+06	8.940	0.748
Bldg sq ft (log)	6.857e+07	7.518	0.415	4.926e+06	7.444	0.396	7.184e+06	7.353	0.365

Figure 1: Monetary policy shock at quarterly frequency



Notes: This figure plots the quarterly series of the monetary policy shocks: FF (top), FG (middle) and LSAP (bottom). Positive number means a contractionary monetary policy shock. Each shock series is originally constructed at the daily frequency and normalized to have a unit standard deviation at the daily frequency. The red line is based on the original data from Swanson (2021). The blue lines in the FF panel and LSAP panel are the shocks that set FF to be zero after 2009 and LSAP to be zero before 2009.

2 Mortgage rate, foreclosure and home price

In this section, we present the empirical results from linked Corelogic-HMDA data at the transaction level. Transaction data allows us to control for census tract/month fixed effect, and really focus on the heterogeneous effects of monetary policy shocks on different racial groups within a

neighborhood at a given time. Our baseline empirical specification takes the following forms:

$$\begin{aligned}\text{Outcome}_{i,t} = {} & \beta^{(h)}_{Black*FF}\text{Black}_i * \text{FF}_{t-h,t-1} + \beta^{(h)}_{Hispanic*FF}\text{Hispanic}_i * \text{FF}_{t-h,t-1} \\ & + \beta^{(h)}_{Black*FG}\text{Black}_i * \text{FG}_{t-h,t-1} + \beta^{(h)}_{Hispanic*FG}\text{Hispanic}_i * \text{FG}_{t-h,t-1} \\ & + \beta^{(h)}_{Black*LSAP}\text{Black}_i * \text{LSAP}_{t-h,t-1} + \beta^{(h)}_{Hispanic*LSAP}\text{Hispanic}_i * \text{LSAP}_{t-h,t-1} \\ & + \text{controls}_{it} + \text{error}^{(h)}_{it}\end{aligned} \tag{1}$$

The regressions are at monthly frequency, and the key outcome variables are mortgage interest rate, foreclosure and home price. $\text{Outcome}_{i,t}$ is the outcome variable for individual i in month t, Black_i and Hispanic_i are dummy variables equal to 1 if individual i's self reported race and ethnicity is Black and Hispanic, respectively. $\text{FF}_{t-h,t-1}, \text{FG}_{t-h,t-1}$ and $\text{LSAP}_{t-h,t-1}$ are the FF, FG and LSAP monetary policy shocks accumulated from month $t-h$ to month $t-1$, respectively. We include the following controls: race and ethnicity of the homewoner, an indicator of whether co-borrower exists, log of loan amount, log of income, an indicator of whether the loan is a subordinate loan, an indicator or whether the loan is jumbo, census tract$\times$month fixed effects, lender fixed effects, loan-to-income and loan-to-value bins.

Our coefficients of interest are $\beta^{(h)}$s, which measure the effects of one standard deviation monetary policy shocks, accumulated over the past h months, on the outcome variable for a given race/ethnicity group j, relative to the baseline group of white households.

2.1 Mortgage rate

We first investigate how mortgage interest rates vary with race and ethnicity of the borrower in different monetary policy environment. We focuses on 30-year fixed rate home purchase mortgages. . Table 2 shows the results with 1, 3, 6 and 12-month lags. At 3-month or 6-month lags, Fed fund rate shocks have either negative or insignificant effects on mortgage interest rate of minority groups compared to white households. Forward guidance shocks have consistently negative effects on the mortgage interest rate of minority groups compared to white households. For example, a standard deviation change in Fed funds rate shock in the past 6 months decreases mortgage interest rate by 1.6 basis point for black households and 1.4 basis point for hispanic households, relative to white households. LSAP shocks do not have significant effects on racial gap in mortgage interest rate at 3-month or 6-month lags.

Table 2: Monetary Policy on Racial Gap in Mortgage Interest Rate

MP Lags	**1**	**3**	**6**	**12**
Black	0.161***	0.164***	0.175***	0.182***
	(0.004)	(0.005)	(0.005)	(0.005)
Hispanic	0.042***	0.046***	0.063***	0.065***
	(0.004)	(0.004)	(0.004)	(0.004)
Female	0.009***	0.009***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
Co-borrower	-0.076***	-0.076***	-0.076***	-0.076***
	(0.002)	(0.002)	(0.002)	(0.002)
Loan Amount (log)	-0.366***	-0.366***	-0.366***	-0.366***
	(0.006)	(0.006)	(0.006)	(0.006)
Income (log)	0.061***	0.061***	0.060***	0.060***
	(0.006)	(0.006)	(0.006)	(0.006)
Junior	0.290***	0.291***	0.291***	0.291***
	(0.009)	(0.009)	(0.009)	(0.009)
Jumbo	0.098***	0.098***	0.098***	0.098***
	(0.004)	(0.004)	(0.004)	(0.004)
Black*FF	0.032***	0.008	-0.003	-0.005*
	(0.010)	(0.006)	(0.004)	(0.003)
Black*FG	-0.015***	-0.010***	-0.014***	-0.012***
	(0.005)	(0.003)	(0.002)	(0.002)
Black*LSAP	-0.029*	-0.003	-0.002	0.021***
	(0.018)	(0.012)	(0.010)	(0.007)
Hispanic*FF	0.004	-0.006	-0.016***	-0.009***
	(0.009)	(0.005)	(0.003)	(0.002)
Hispanic*FG	-0.017***	-0.009***	-0.016***	-0.013***
	(0.004)	(0.002)	(0.002)	(0.001)
Hispanic*LSAP	0.020	0.007	-0.004	0.010
	(0.015)	(0.010)	(0.009)	(0.006)
Constant	7.693***	7.693***	7.693***	7.692***
	(0.019)	(0.019)	(0.019)	(0.019)
Observations	1,893,654	1,893,654	1,893,654	1,893,654
R-squared	0.757	0.757	0.757	0.757

Sample includes 30-year conventional mortgages on single-family residential properties. Purchase loans only. Cumulative monetary policy shocks with 1,3,6,12 months of lags are used. Other controls include census tract×month fixed effects, lender fixed effects, loan-to-income and loan-to-value bins. Standard error is clustered at census tract×month level. *** p<0.01, ** p<0.05, * p<0.1.

2.2 Foreclosure

We then study how foreclosure rates vary with race and ethnicity of the borrower in different monetary policy environment. Table 3 shows the results of linear probability models. Contractionary monetary policy shocks increases the foreclosure rate for minority households compared to the white household consistently across regressions using different monetary policy lags. For example, a standard deviation change in the Fed funds rate or forward guidance shock in the past 6 months increases the foreclosure rate for black households by 30 basis point, relative to white households, while a standard deviation change in the LSAP shock in the past 6 months increases the foreclosure rate for black households by 20 basis point, relative to white households.

2.3 Housing price

Finally, we look at property transaction prices and how they are affected by the race and ethnicity of buyers in different monetary policy environment. Here we focus on arm-length transactions of single-family residential properties. Table 4 presents the result. We can see that contractionary monetary policy shocks increase the home purchase price for Hispanic households relative to white households, but have mixed effects on black households. Across regressions with various monetary policy lags, Hispanic households buy at a higher price during monetary tightening compared to the non-Hispanic white group. For example, a standard deviation change in the fed fund rate or LSAP shock in the past 3 months increases the home price for Hispanic households relative to white households by 0.2%, and a standard deviation change in the forward guidance shock in the past 3 months increases the home price for Hispanic households relative to white households by 0.1%. For black households, the effect of monetary policy shocks varies: fed fund rate shocks increase the (relative) home purchase price for Black households, LSAP shocks decrease the (relative) home purchase price for Black households, while forward guidance shocks have muted effects.

2.4 Discussion

Overall, contractionary monetary policy shocks make foreclosure more likely for minority groups relative to a baseline group of white households. The exacerbated racial gap in foreclosure during monetary tightening can be explained by the heterogeneous labor market effect of monetary policy. For example, Bergman et al. (2022) documents that the employment of minority groups are more sensitive to monetary policy. Monetary tightening causes job loss of minority households,

Table 3: Monetary Policy on Racial Gap in Foreclosure

MP Lags	**1**	**2**	**3**	**6**
Black	0.034***	0.034***	0.033***	0.032***
	(0.001)	(0.001)	(0.001)	(0.001)
Hispanic	0.025***	0.025***	0.024***	0.023***
	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.004***	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Co-borrower	-0.014***	-0.014***	-0.014***	-0.014***
	(0.000)	(0.000)	(0.000)	(0.000)
Loan Amount (log)	0.005***	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Income (log)	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Junior	0.036***	0.036***	0.036***	0.036***
	(0.001)	(0.001)	(0.001)	(0.001)
Jumbo	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Black*FF	0.000	0.002***	0.003***	0.002***
	(0.001)	(0.001)	(0.000)	(0.000)
Black*FG	0.002***	0.003***	0.003***	0.003***
	(0.001)	(0.000)	(0.000)	(0.000)
Black*LSAP	0.004***	0.002***	0.002***	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)
Hispanic*FF	0.003***	0.003***	0.004***	0.003***
	(0.001)	(0.000)	(0.000)	(0.000)
Hispanic*FG	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.000)	(0.000)	(0.000)
Hispanic*LSAP	0.000	0.001***	0.001*	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)
Constant	0.064***	0.064***	0.064***	0.064***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	11,201,066	11,201,066	11,201,066	11,201,066
R-squared	0.417	0.417	0.417	0.417

Sample includes 30-year conventional mortgages on single-family residential properties. Purchase loans only. Cumulative monetary policy shocks with 1,3,6,12 months of lags are used. Other controls include census tract×month fixed effects, lender fixed effects, loan-to-income and loan-to-value bins. Standard error is clustered at census tract×month level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Monetary Policy on Racial Gap in Home Price

MP Lag	**1**	**3**	**6**	**12**
Black	0.002***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Hispanic	-0.016***	-0.016***	-0.016***	-0.016***
	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.008***	-0.008***	-0.008***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
Co-borrower	0.025***	0.025***	0.025***	0.025***
	(0.000)	(0.000)	(0.000)	(0.000)
Land sq ft (log)	0.077***	0.077***	0.077***	0.077***
	(0.000)	(0.000)	(0.000)	(0.000)
Bldg sq ft (log)	0.675***	0.675***	0.675***	0.675***
	(0.001)	(0.001)	(0.001)	(0.001)
Black*FF	0.001	0.001*	0.001***	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)
Black*FG	0.001	0.000	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Black*LSAP	-0.003**	-0.002**	-0.001**	-0.001
	(0.001)	(0.001)	(0.001)	(0.000)
Hispanic*FF	0.003***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Hispanic*FG	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Hispanic*LSAP	0.001	0.002***	0.001	0.001**
	(0.001)	(0.000)	(0.000)	(0.000)
Constant	6.445***	6.445***	6.445***	6.445***
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	13,214,979	13,214,979	13,214,979	13,214,979
R-squared	0.908	0.908	0.908	0.908

Notes: Sample includes arm-length transactions of single-family residential properties. Cumulative monetary policy shocks with 1,3,6,12 months of lags are used. Other controls include census tract×month fixed effects. Standard error is clustered at census tract×month level. *** p<0.01, ** p<0.05, * p<0.1.

which in turn may lead to deterioration of their financial health and ultimately foreclosure.

Another important observation is that the increase in credit risk associated with minority households during monetary tightening is not necessarily priced in. In most cases, contractionary monetary policy shocks either does not affect or reduces the mortgage interest rate for minority households relative to the baseline. One possible explanation is that contractionary monetary policy increases the prepayment risk of white households, who are more likely to refinance or sell their homes when monetary policy reverses in the future, and thus reduces the racial gap in mortgage interest rate.

Finally, consistent with relative decrease in home financing cost, home purchase price of minority households mostly increases during monetary tightening compared to the baseline group. One exception is LSAP shock for black households.

3 Mortgage applications and originations

In this section, we look at the extensive margin of the mortgage market. We ask the question that, after an expansionary monetary policy shock, will the regions with more minority population apply for more mortgages or have more mortgages originated, compared with areas with less minorities?

Our empirical approach follows the local projections method of Jordà (2005). In particular, we employ the following specification:

$$\begin{aligned}\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1} = & \sum_{j\in\{\text{White,Black,Hispanic}\}} \beta^{(h)}_{j*FF}\text{Pop}_{i,j,t-1} * \text{FF}_t \\ & + \sum_{j\in\{\text{White,Black,Hispanic}\}} \beta^{(h)}_{j*FG}\text{Pop}_{i,j,t-1} * \text{FG}_t \\ & + \sum_{j\in\{\text{White,Black,Hispanic}\}} \beta^{(h)}_{j*LSAP}\text{Pop}_{i,j,t-1} * \text{LSAP}_t \\ & + \text{controls}_{it} + \text{error}^{(h)}_{it} \end{aligned} \tag{2}$$

Here $\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1}$ is the cumulative change in Outcome variable in county i from $t-1$ to $t+h$; $\text{Pop}_{i,\text{White},t-1}$, $\text{Pop}_{i,\text{Black},t-1}$ and $\text{Pop}_{i,\text{Hispanic},t-1}$ are percentage of White, Black and Hispanic population in county i at quarter $t-1$ and they sum up to 1; FF_t, FG_t, and LSAP_t are

three monetary policy shocks in quarter t. The control variables include FF_t, FG_t, and LSAP_t, the race/ethnicity population ratio $\text{Pop}_{i,j,t-1}$, 4 lags of the following variables – first difference of the Outcome variable, county level unemployment rates, county level nominal per capita income and county level lender competitiveness, and county fixed effects. We follow Eichenbaum et al. (2022) and include the average forecast of the SPF for the following variables: the two-year ahead real GDP growth, the two-year ahead civilian unemployment rate, and the one and two-years ahead CPI inflation rate. Following Ramey (2016), we also include one lag for each monetary policy shock and one lag for each of their interaction terms to purge serial correlations of the independent variables.

Specification (2) is estimated by fixed-effects panel regression. The standard errors are clustered at the county by year level. Estimated coefficients $\beta^{(h)}_{j*MP}$, where $j \in \{\text{White}, \text{Black}, \text{Hispanic}\}$, and $MP \in \{FF, FG, LSAP\}$ are our parameters of interests. For example, $\beta^{(h)}_{White*FF}$ measures the effect on the $\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1}$ when FF_t increases from 0 to 1 if a county i has 100% white population, i.e., $Pop_{\text{i, White, t-1}} = 1$.

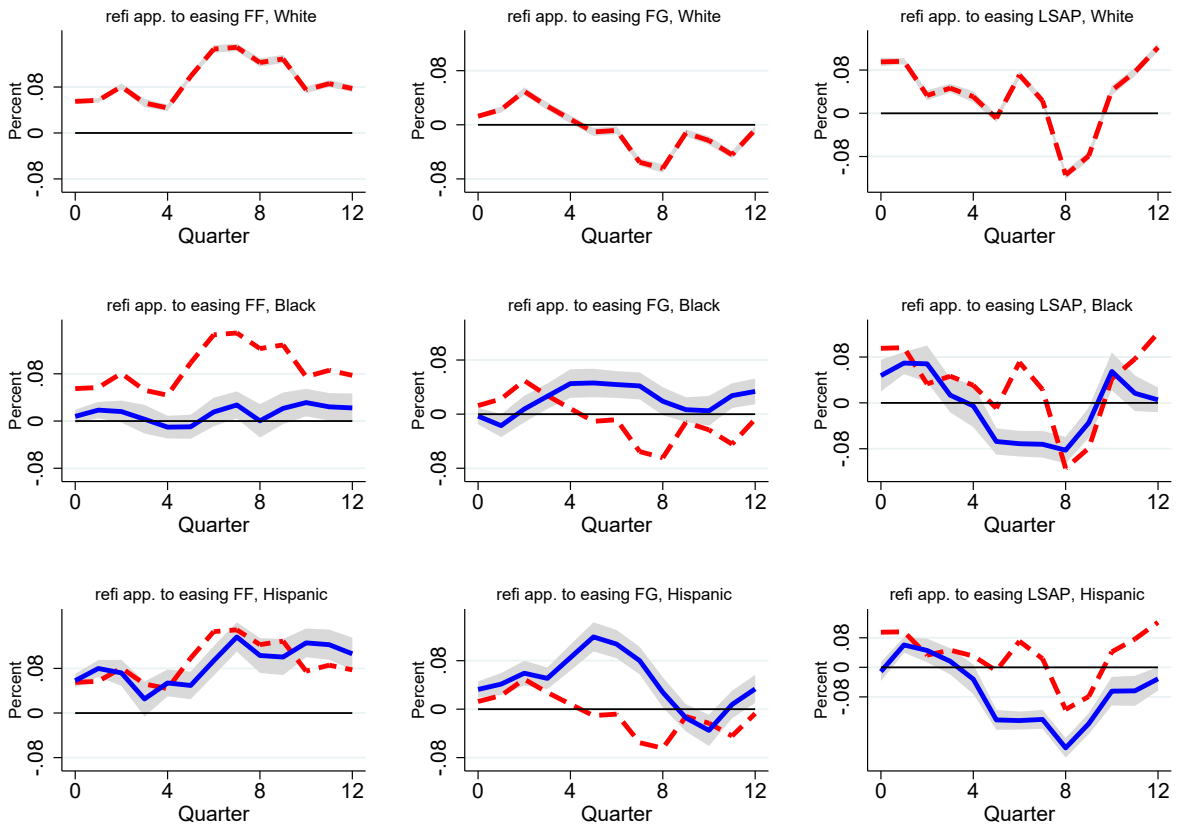
We start by looking at the effects of monetary policy on the total numbers of refinance mortgage application growth at the county-quarter level. The estimated results are shown in Figure 2. For a 100% white county, shown in the top panel, after a one-standard-deviation of FF easing, the total refiannace mortgage application in mortgage increases by 0.06%. The response to FG shock is small, but the initial response to a drop in LSAP shock is more than 0.08%. The middle panel of Figure 2 shows the responses for a 100% black county. The responses to FF and FG shocks are almost 0, and the responses to LSAP shock is slightly smaller than that of a white county in the short run and quite lower than the white county after four quarters. The lower panel plots the responses for a 100% hispanic county. The responses to LSAP at the first quarter and after four quarters are very small compared to a white county.

We then check whether the negative racial gaps in refinance applications after monetary easing turns into a negative racial gaps in refinance mortgage originations. As shown in Figure 3 , the answer is yes. The most striking result from this figure is that after a one-standard-deviation easing LSAP shock, counties with 100% white residents react very quickly and the magnitude of response is significantly higher than that of Black and Hispanic counties at almost all horizons.

In the Appendix Section A, we repeat the same exercise using the alternative monetary policy measure. The results are robust. In the Appendix Section B, we present the estimation results of the effects on total mortgage application and originations and home purchase mortgage application and originations. In most case, monetary policy shocks affect racial gaps in total mortgage

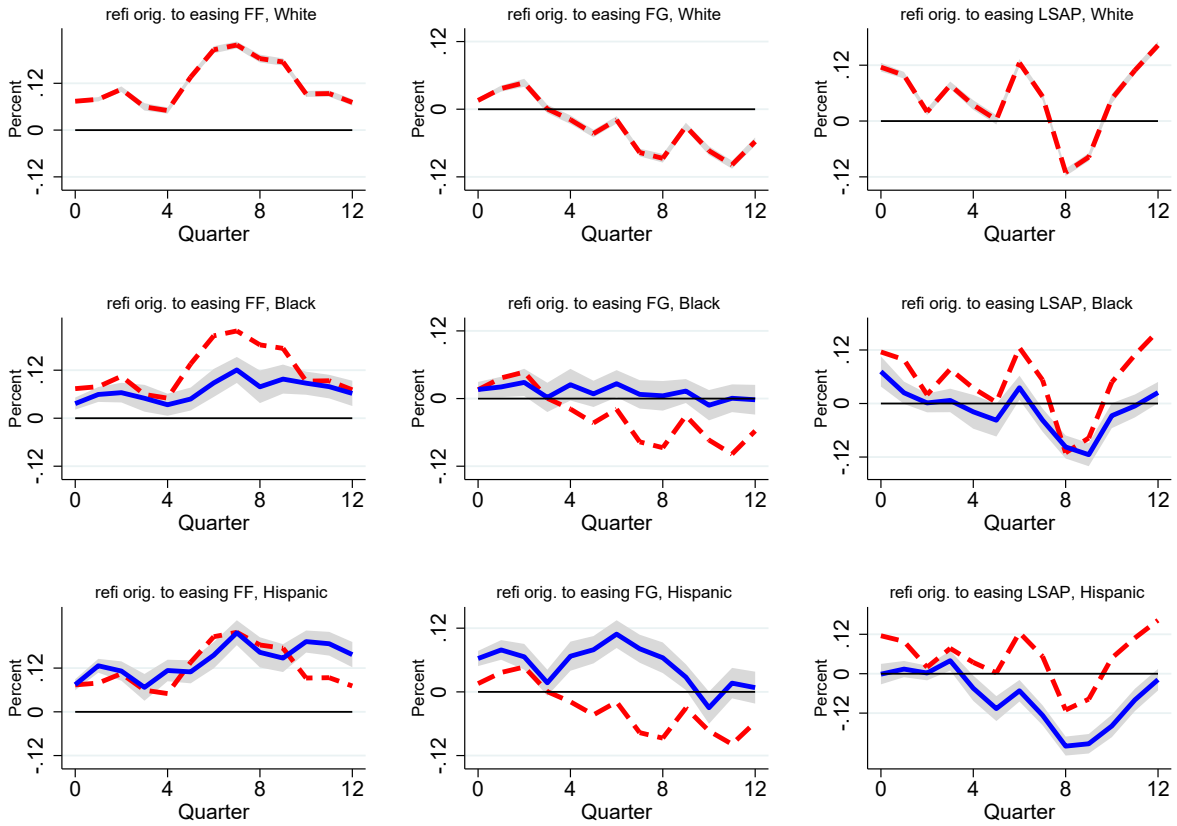
applications and originations, and the majority of the effects comes from refinance mortgage applications and originations other than home purchase mortgage. In the Appendix Section C, we conduct a robustness check by looking at MSA-level refinance propensities computed from the Freddie Mac loan level dataset. We find that after an expansionary monetary policy, the minority MSAs refinance ratio is smaller than the white MSAs.

Figure 2: Total refinance application responses to a one-standard-deviation easing MP shock



Notes: The figure provides the cumulative growth in refinance mortgage applications in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Figure 3: Total refinance originations responses to a one-standard-deviation easing MP shock



Notes: The figure provides the cumulative growth in refinance mortgage originations in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

4 Survey evidence on mortgage knowledge and mortgage rate perception

In this section, we use the National Survey of Mortgage Originations (NSMO) to document how mortgage market knowledge differs among different race and ethnicity groups, and we use New York's Survey of Consumer Expectations (SCE) Housing survey to measure the perception of mortgage rate among different race and ethnicity groups. In both cases, our findings align well with our earlier results.

In NSMO, the households are asked:

> "When you began the process of getting this mortgage, how familiar were you (and any co-signers) with each of the following?"
>
> - mortgage interest rates available at that time (x05a)
> - The different types of mortgages available (x05b)
> - The process of taking out a mortgage (x05c)

For each of them, a respondent can say he/she is "very familiar", "somewhat familiar", or "not at all". We plot the fraction of each answer category by race and ethnicity groups in Figure 4. Gauging from answers to all three familiarity questions, white borrowers has better mortgage market knowledge than minority borrowers. For example, 55% of the white borrowers state that they are very familiar with different types of mortgages, while only 42% of Black borrowers and 45% of of Hispanic borrowers are in the same category.

We then utilize the mortgage expectations data from the Federal Reserve Bank of New York's Survey of Consumer Expectations (SCE) Housing survey. The SCE survey is conducted over the internet and includes a nationally representative set of rotating household heads. The SCE core survey is conducted every month while the Housing survey is fielded in February every year. The data is available from 2014 to 2020. The households are asked:

> "What do you think is the average interest rate (for all borrowers) on a new 30-year fixed-rate mortgage as of today? (Q5b)"

Respondents provide answers to both questions as a percentage. We obtain the prevailing monthly 30-year fixed rate from the Primary Mortgage Market Survey (PMMS).[12] Each week,

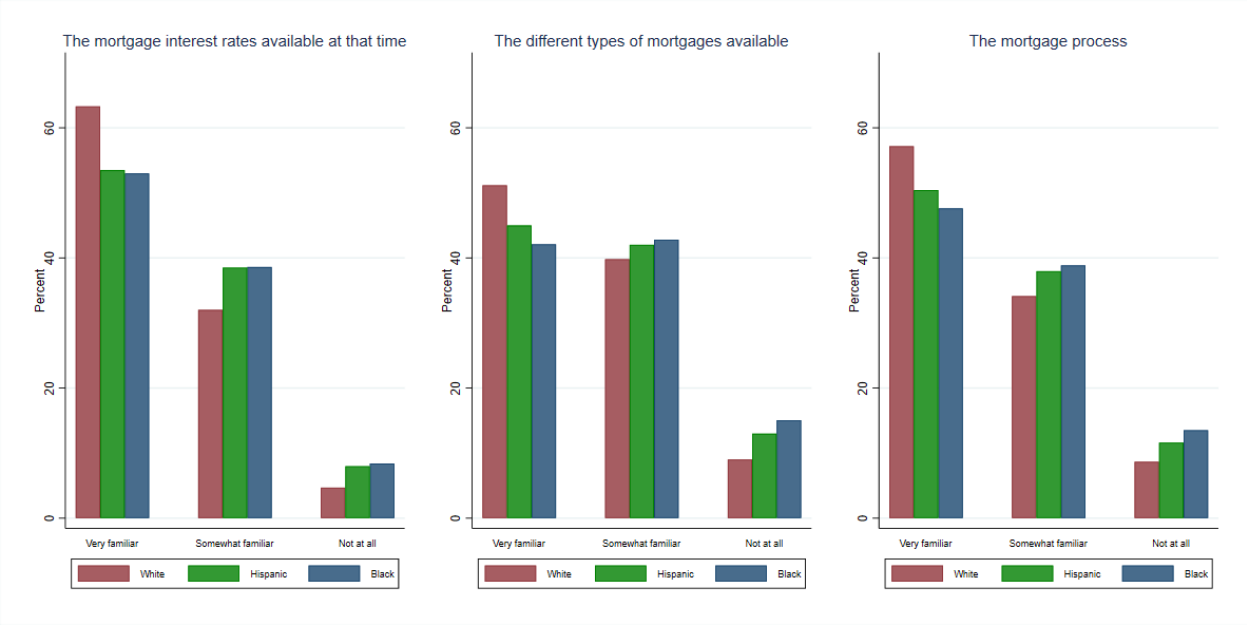
[12] https://www.freddiemac.com/pmms/pmms_archives.

Freddie Mac surveys lenders for their most popular rate. The survey is based on first-lien prime conventional conforming home purchase mortgages with a loan-to-value of 80 percent.

We then compute the perception error of each household in SCE housing survey by subtracting the realized monthly average PMMS rate from the answer to the perception question.

The mean, median, 25th and 75th quartiles, minimum and maximum of the perception errors by race and ethnicity group is plotted in Figure 5. We find that the distribution of minority households' perception error is wider and has a higher mean and median. As shown in the Appendix, this result is robust if we further split the sample into renter and homeowner. If borrowers perceive a higher mortgage rate that what it actually is, they are less likely to refinance their mortgages. Thus, racial difference in mortgage interest rate perception might explain why we see the less refinance applications and originations in minority counties after an expansionary monetary policy shock.

Figure 4: Mortgage market knowledge by race and ethnicity groups



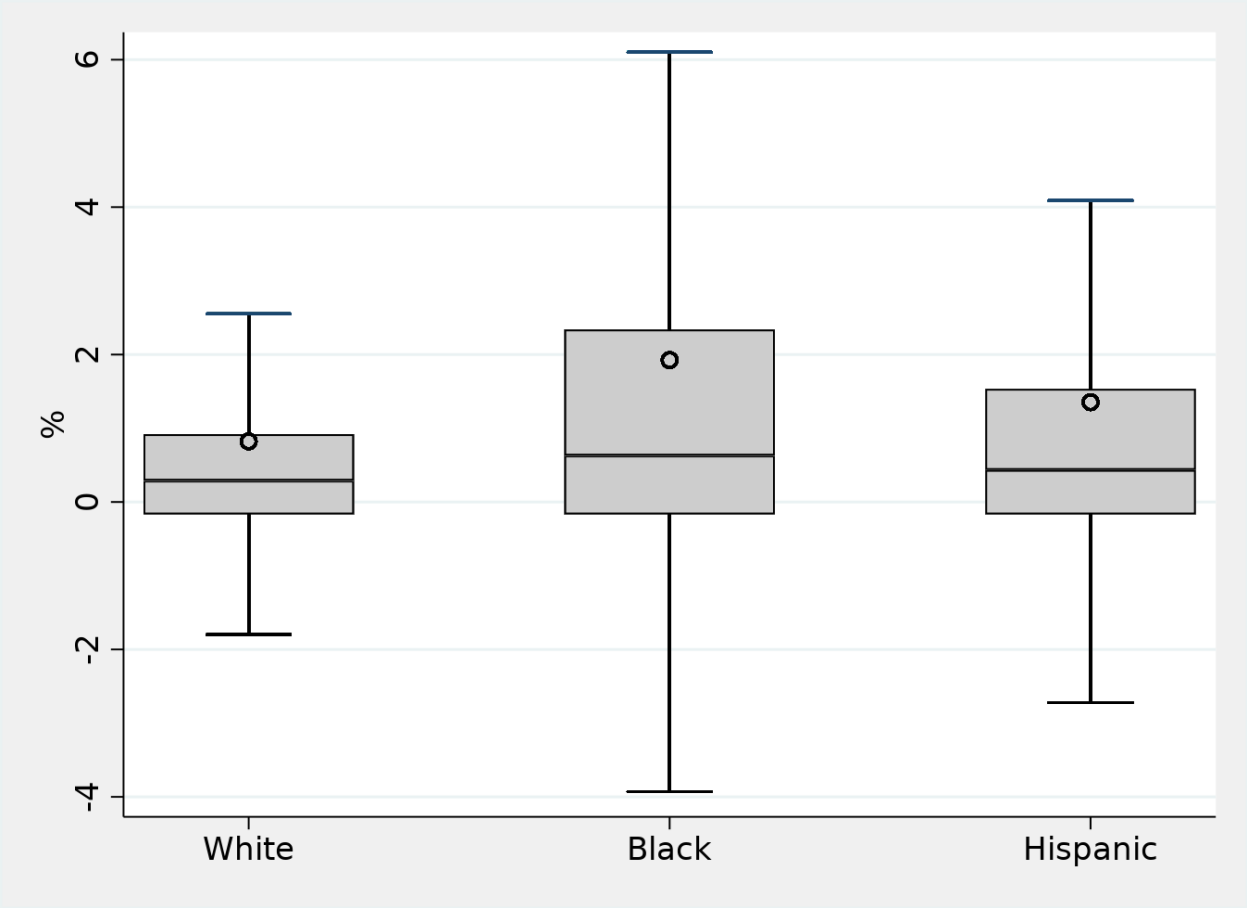
Notes: The figure provides the fraction of three categories of mortgage market familiarity by race and ethnicity groups.

5 Conclusion

In this paper, we study the effects of conventional and unconventional monetary policy shocks on racial inequality with a focus on housing market. Overall, we find that, on one hand, monetary tightening disproportionately increases the foreclosure rate for minority groups, exacerbating racial inequality; while on the other hand, tightening reduces the mortgage interest rate and increases the home price of minority households relative to white households, reducing racial inequality, at least on impact.

The tension between foreclosure rate going up and mortgage interest rate going down can be explained by a widening racial difference in prepayment risk during monetary tightening, which is in turn due to relative low refinance propensity from minority borrowers. The racial difference in refinance patterns are consistent with survey data: we find minority households tend to overestimate the prevailing average interest rate and are less familiar with mortgage markets.

Figure 5: Mortgage rate perception error by race and ethnicity groups



Notes: The distribution (median, 25th and 75th quartiles, minimum and maximum) of mortgage rate perception error by race and ethnicity group is shown in the boxplot. The shallow dot marker is the sample mean. The unit is percentage. Source: New York Fed's Survey of Consumer Expectations Housing survey.

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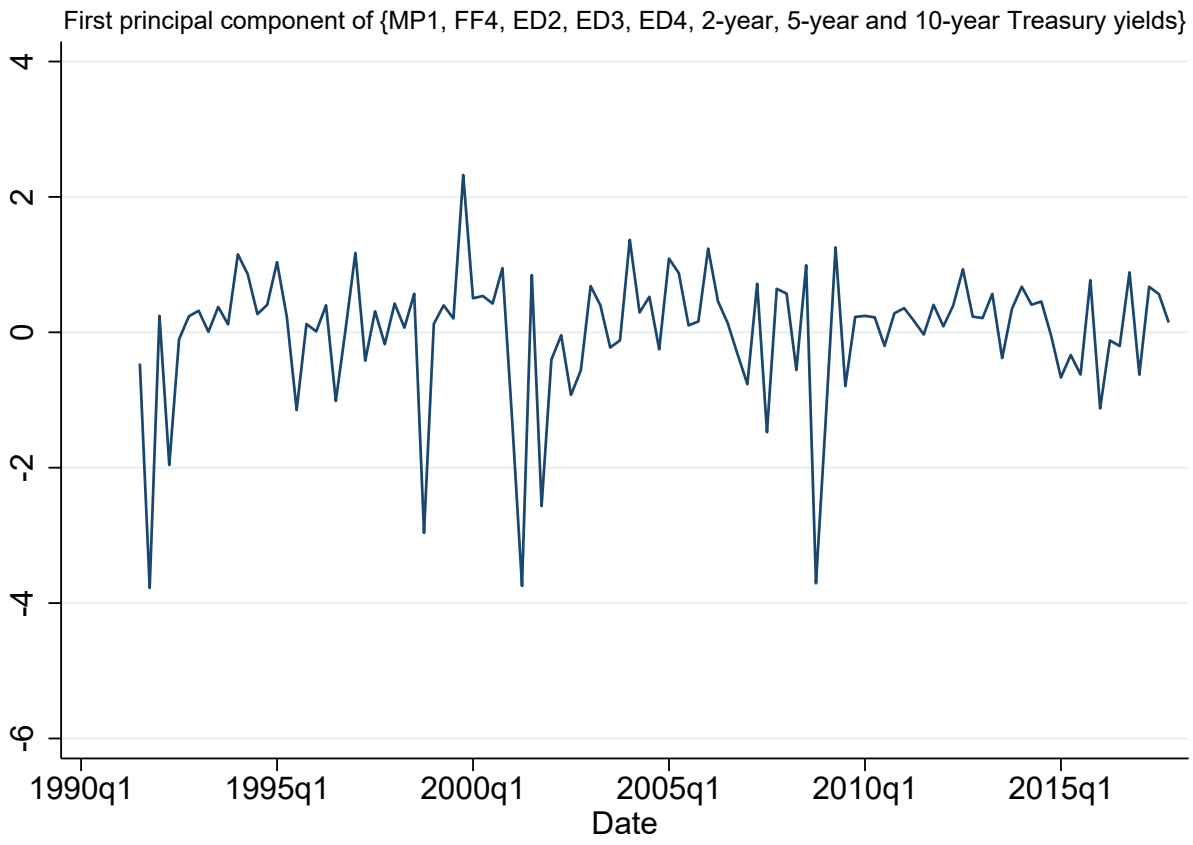
A Alternative measures of monetary policy shocks and the robustness

In this section, we show that our results are robust if we use first principal component of the following interest rate surprises as our monetary policy shock: the 30-minute window changes in current month federal funds rate (MP1, adjusted by the date of the month), three month ahead federal funds futures (FF4), Eurodollar futures two-, three- and four-quarter ahead, two-year Treasury yields, five-year Treasury yields and ten-year Treasury yields around FOMC announcement. The data is plotted in Figure 1.

Appendix Figure 1: Alternative Monetary policy shock at quarterly frequency



Notes: This figure plots the quarterly series of the alternative monetary policy shocks.

We then repeat the same exercise as in Section 3. In particular, we employ the following specification:

$$\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1} = \sum_{j \in \{\text{White,Black,Hispanic}\}} \beta^{(h)}_{j*MP} \text{Pop}_{i,j,t-1} * \text{AltMP}_t + \text{controls}_{it} + \text{error}^{(h)}_{it} \tag{3}$$

Here $\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1}$ is the cumulative change in Outcome variable in county i from $t-1$ to $t+h$; $\text{Pop}_{i,\text{White},t-1}$, $\text{Pop}_{i,\text{Black},t-1}$ and $\text{Pop}_{i,\text{Hispanic},t-1}$ are percentage of White, Black and Hispanic population in county i at quarter $t-1$ and they sum up to 1; AltMP_t is the alternative measure of monetary policy shocks in quarter t.

As shown in Appendix Figures 2 and 3, using the alternative monetary policy measure, we still find that the minority county refinance less than the white county.

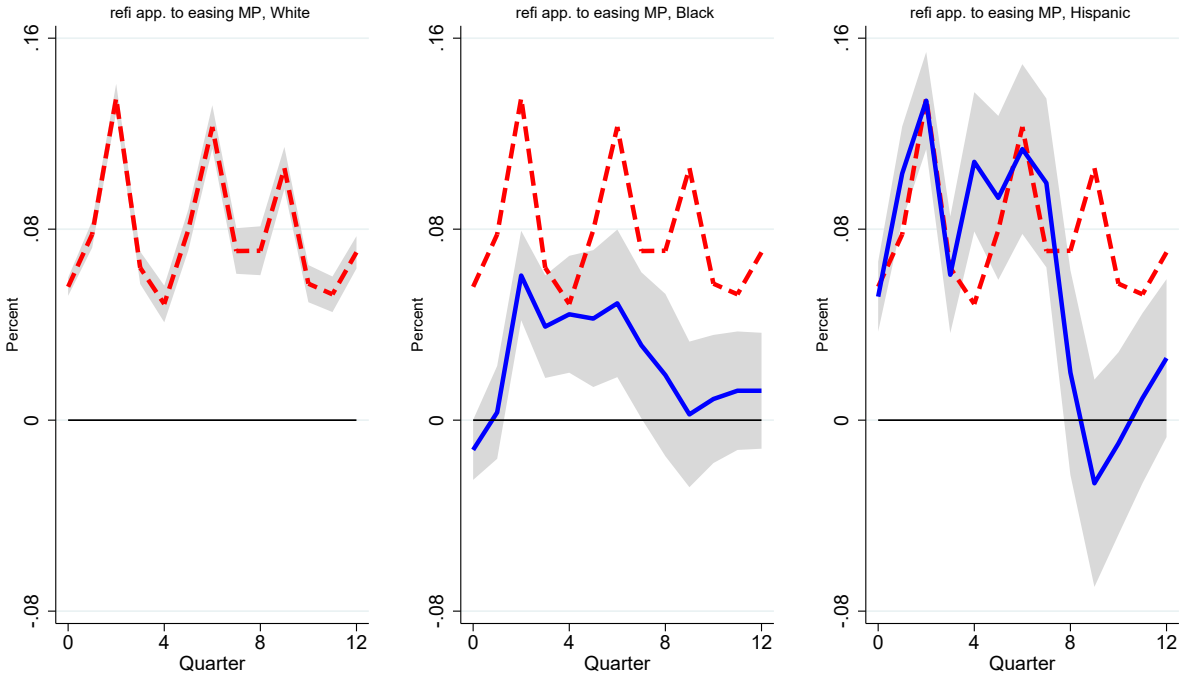
We also estimate the following instrument variable regression:

$$\text{Outcome}_{i,t+h} - \text{Outcome}_{i,t-1} = \sum_{j \in \{\text{White,Black,Hispanic}\}} \beta^{(h)}_{j*PMMS} \text{Pop}_{i,j,t-1} * \triangle\text{PMMS}_t + \text{controls}_{it} + \text{error}^{(h)}_{it} \tag{4}$$

where the endogenous variables are, $\triangle\text{PMMS}_t$, the change of PMMS rate in quarter from the end of quarter $t-1$ to the end of quarter t and its interaction terms with the population ratios. The instruments are the alternative monetary policy shock AltMP_t and its interaction terms with the population ratios.

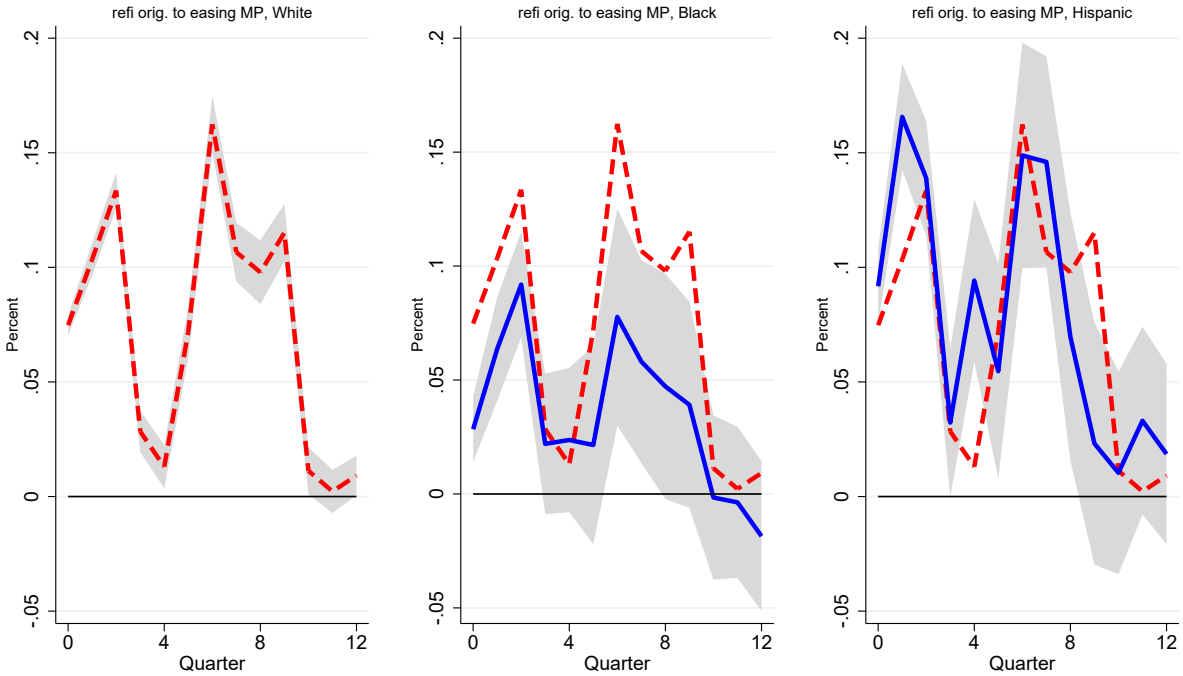
In Appendix Figures 4 and 5, we plot the IV estimates of $\beta^{(h)}_{Black*PMMS} - \beta^{(h)}_{White*PMMS}$ as well as $\beta^{(h)}_{Hispanic*PMMS} - \beta^{(h)}_{White*PMMS}$ in response to an monetary policy shock which lowers the PMMS 30-year fixed rate by 100 basis points. Again, the minority county refinance less than the white county.

Appendix Figure 2: Refinance mortgage application responses to a one-standard-deviation easing MP shock (alternative measure)



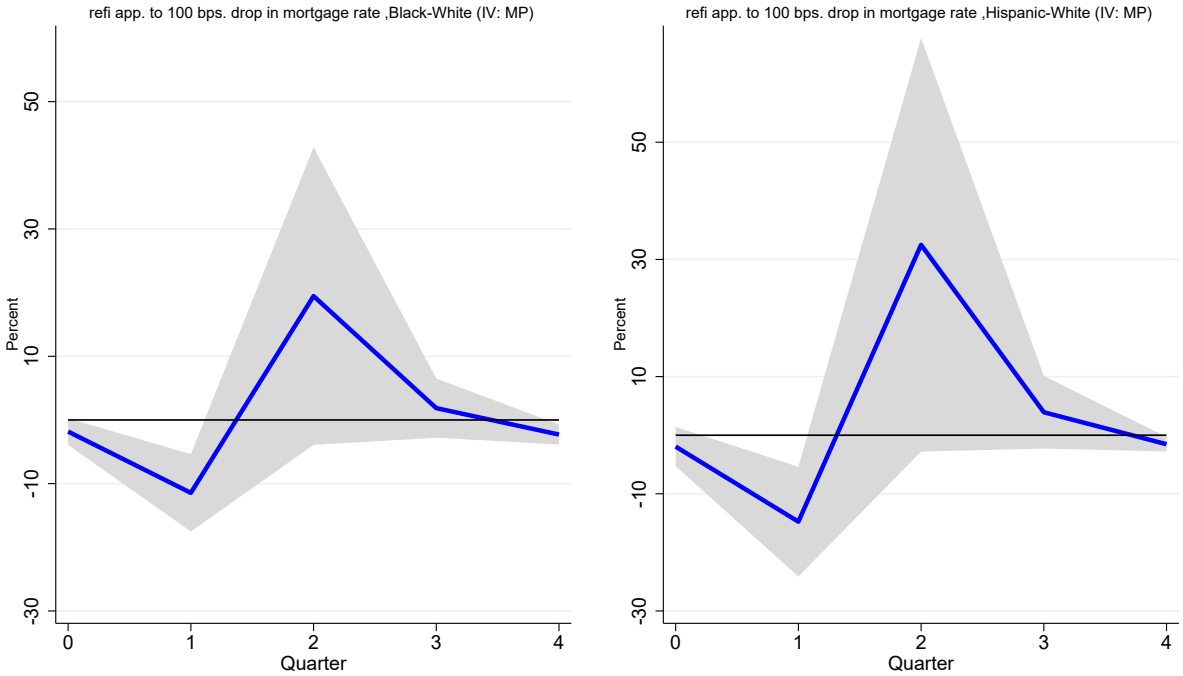
Notes: The figure provides the cumulative growth in refinance mortgage applications in a county with 100% White (left panel) or 100% Black (middle) or 100% Hispanic (right) residents when the alternative measure of monetary policy shock decreases by a one-standard-deviation. Responses are estimated using specification (3). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 3: Refinance mortgage originations responses to a one-standard-deviation easing MP shock (alternative measure)



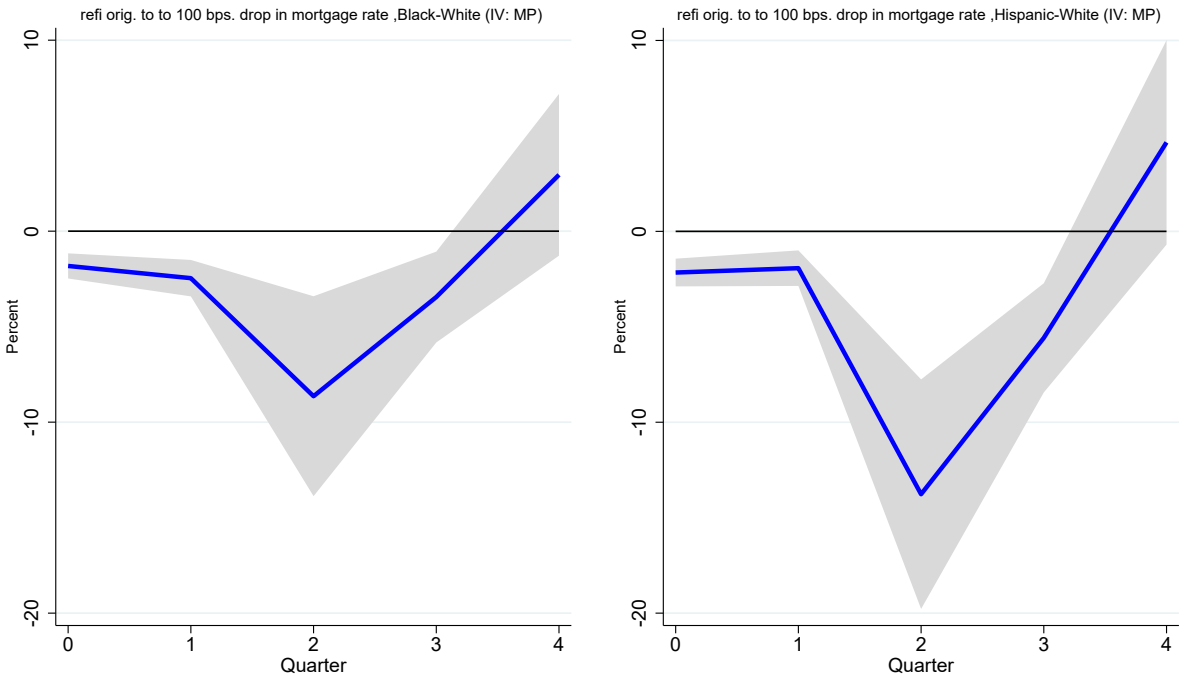
Notes: The figure provides the cumulative growth in refinance mortgage applications in a county with 100% White (left panel) or 100% Black (middle) or 100% Hispanic (right) residents when the alternative measure of monetary policy shock decreases by a one-standard-deviation. Responses are estimated using specification (3). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 4: Total refinance mortgage application responses to a MP shock that lowers the PMMS 30-year fixed rate by 100 basis points, using the alternative monetary policy shock an IV



Notes: Responses are estimated using specification (4). The figure plots $\beta^{(h)}_{Black*PMMS} - \beta^{(h)}_{White*PMMS}$ (left) as well as $\beta^{(h)}_{Hispanic*PMMS} - \beta^{(h)}_{White*PMMS}$ (right) in response to an monetary policy shock which lowers the PMMS 30-year fixed rate by 100 basis points. Again, the minority county refinance less than the white county.Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 5: Total refinance mortgage origination responses to a MP shock that lowers the PMMS 30-year fixed rate by 100 basis points, using the alternative monetary policy shock an IV



Notes: Responses are estimated using specification (4). The figure plots $\beta^{(h)}_{Black*PMMS} - \beta^{(h)}_{White*PMMS}$ (left) as well as $\beta^{(h)}_{Hispanic*PMMS} - \beta^{(h)}_{White*PMMS}$ (right) in response to an monetary policy shock which lowers the PMMS 30-year fixed rate by 100 basis points. Again, the minority county refinance less than the white county.Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

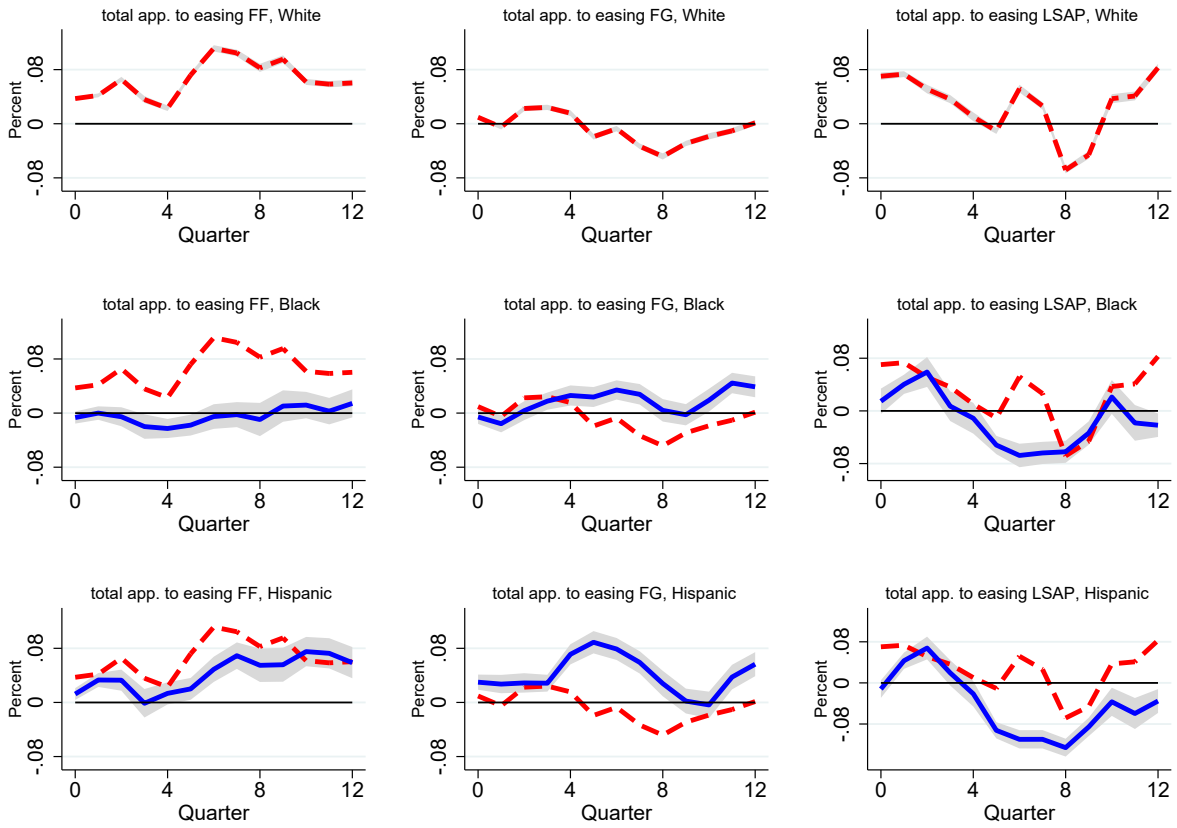
B Additional results for mortgage applications and originations

Figure 6 provides the estimated responses of the growth of total mortgage applications to one-standard-deviation expansionary monetary policy. For a 100% white county, shown in the top panel, after a one-standard-deviation of FF easing, the total application in mortgage increases by 0.04%. The response to FG shock is small, but the initial response to a drop in LSAP shock is almost 0.08%. The middle panel of Figure 6 shows the responses for a 100% black county. The responses to FF and FG shocks are almost 0, and the responses to LSAP shock is slightly smaller than that of a white county. The lower panel of Figure 6 shows the responses for a 100% hispanic county. The responses to FF and LSAP are slightly smaller than a white county, while the responses to FG shocks are around 0.04% in the first year.

The cumulative growth for home purchase mortgage application is shown in Figure 7. In most case, no matter which race and ethnicity groups we are looking at, there's not too much reaction in home purchase mortgage origination.

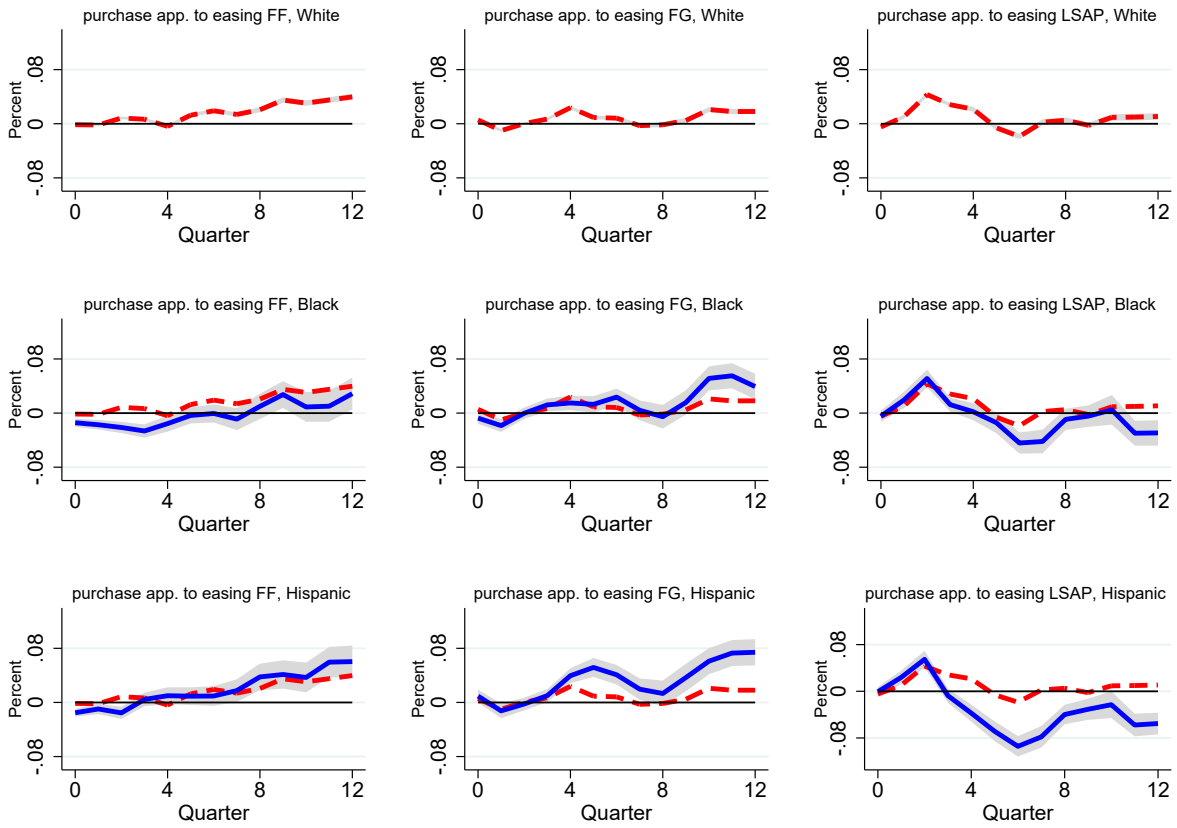
Figure 8 is the responses of cumulative growth of total mortgage originations. The cumulative growth for home purchase mortgage origination is shown in Figure 9. Again, In most case, there's not too much reaction in home purchase mortgage origination.

Appendix Figure 6: Total mortgage application responses to a one-standard-deviation easing MP shock



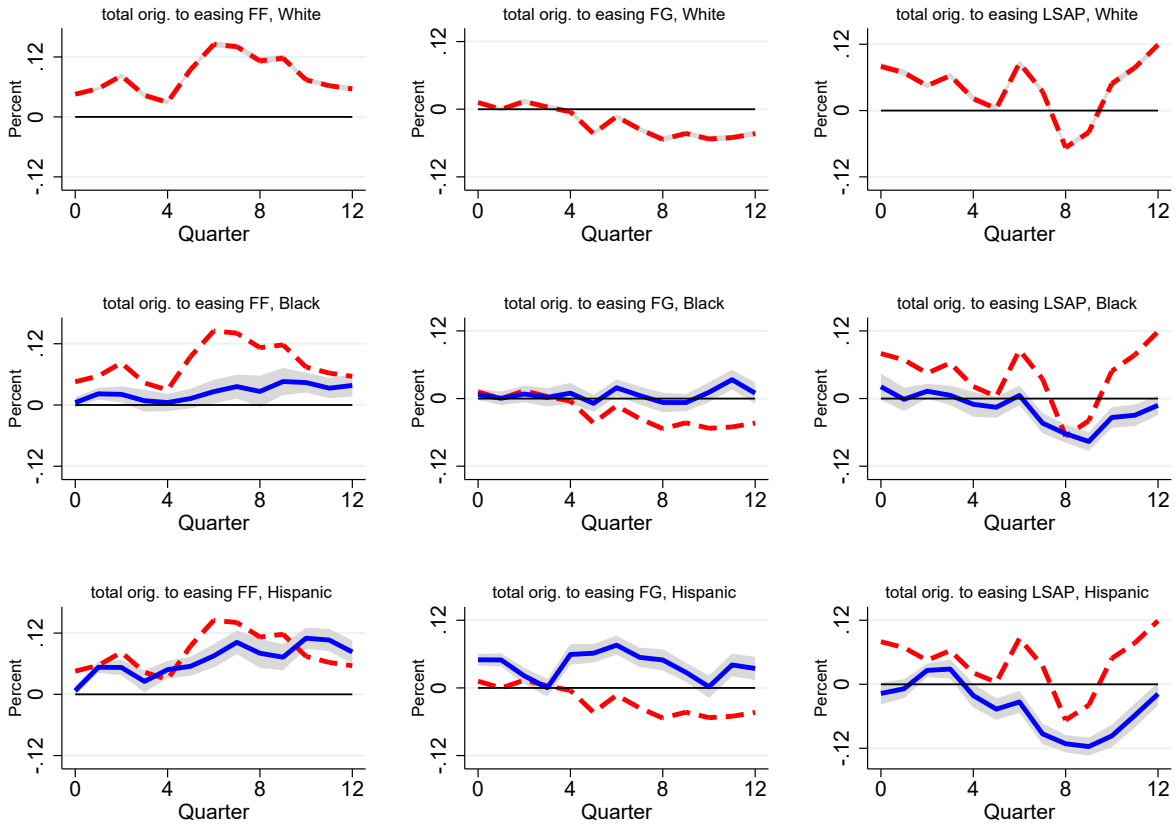
Notes: The figure provides the cumulative growth in total mortgage applications in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 7: Total purchase application responses to a one-standard-deviation easing MP shock



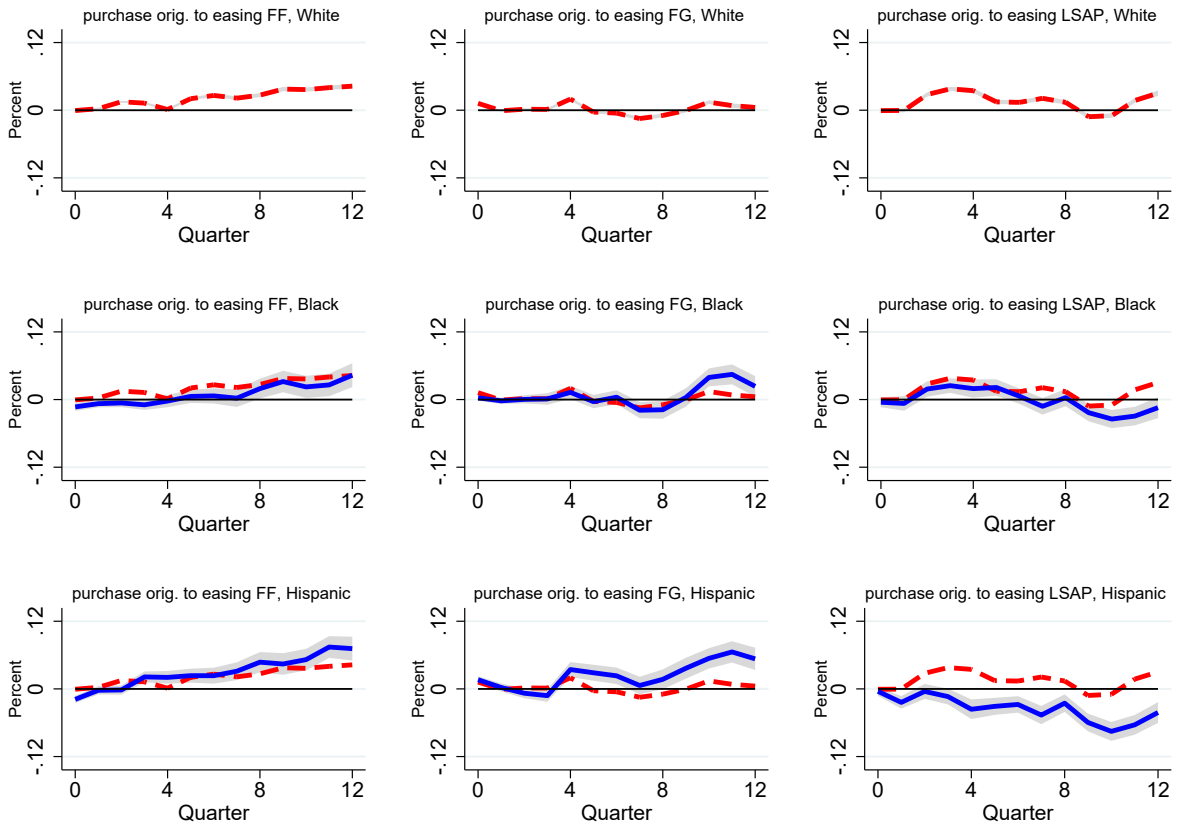
Notes: The figure provides the cumulative growth in home purchase mortgage applications in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 8: Total originations responses to a one-standard-deviation easing MP shock



Notes: The figure provides the cumulative growth in total mortgage originations in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

Appendix Figure 9: Total purchase originations responses to a one-standard-deviation easing MP shock



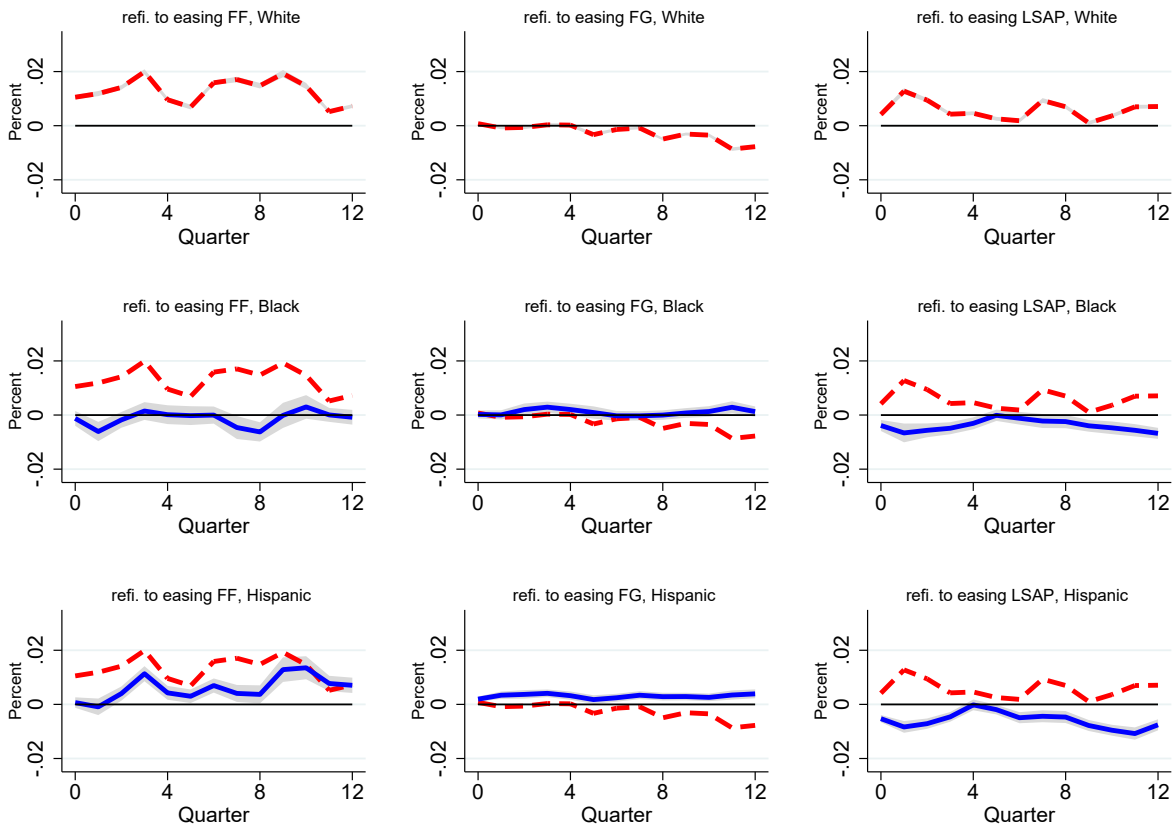
Notes: The figure provides the cumulative growth in home purchase mortgage originations in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

C Refinance fraction

We follow Eichenbaum et al. (2022) and construct the quarterly MSA level refinance fraction using the Freddie Mac data on single-family loans. The data is available from 1999 to 2020.

The cumulative refinance ratio responses to monetary policy shocks are shown in Figure 10. We reconfirmed the results in Section 3 that after a one-standard-deviation easing monetary policy shock, especially FF shock and LSAP shock, counties with 100% white residents refinance very quickly and the magnitude is significantly higher than Black and Hispanic counties at almost all horizons.

Appendix Figure 10: Refinance fraction responses to a one-standard-deviation easing MP shock

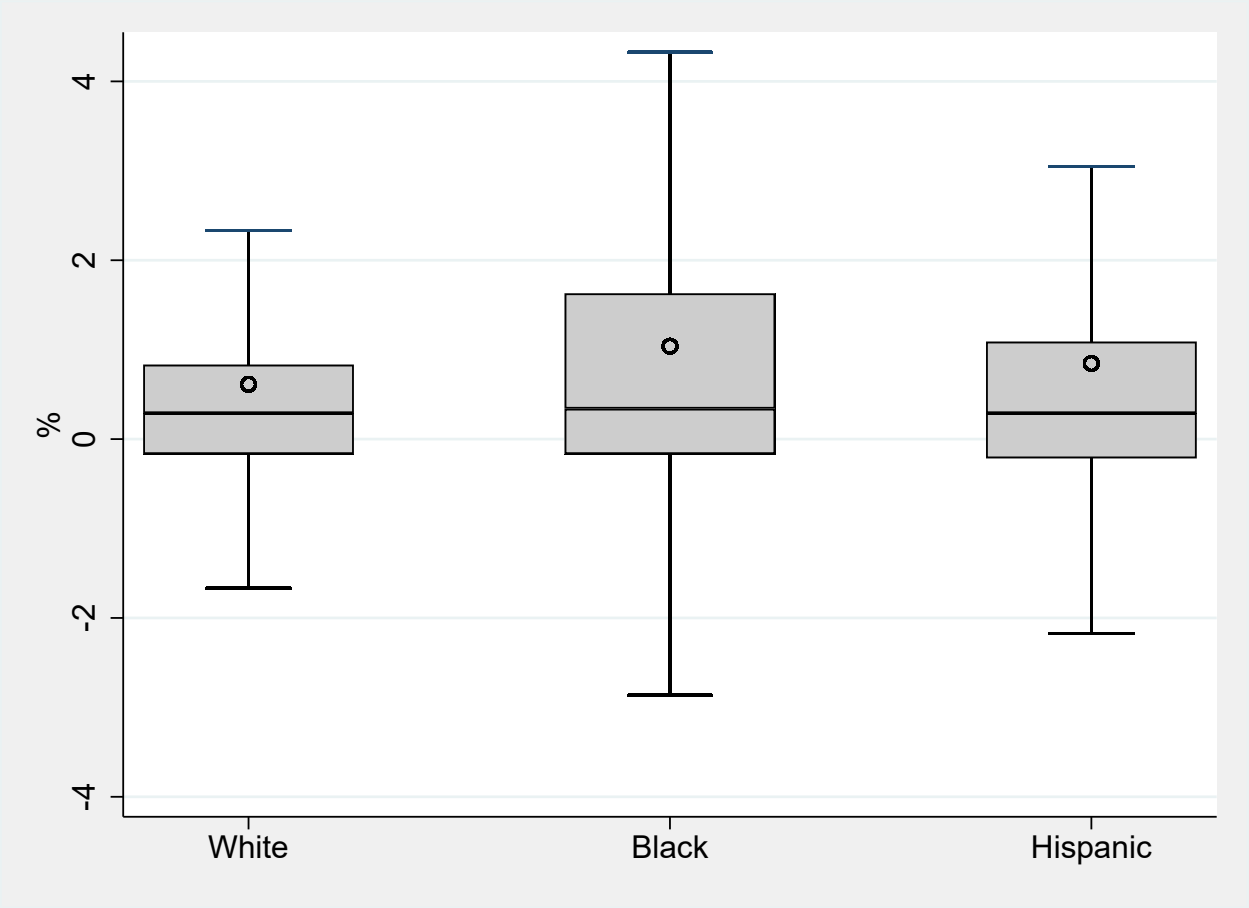


Notes: The figure provides the cumulative growth in refinance fractions in a county with 100% White (top panel) or 100% Black (middle panel) or 100% Hispanic (lower panel) residents when the federal funds target shock (left), forward guidance shock (middle), and LSAP (right) decreases by a one-standard-deviation, separately. Responses are estimated using specification (2). Shaded area represents the 90 percent confidence interval. The standard error is clustered at the county by year level.

D Mortgage perception error by homeownership

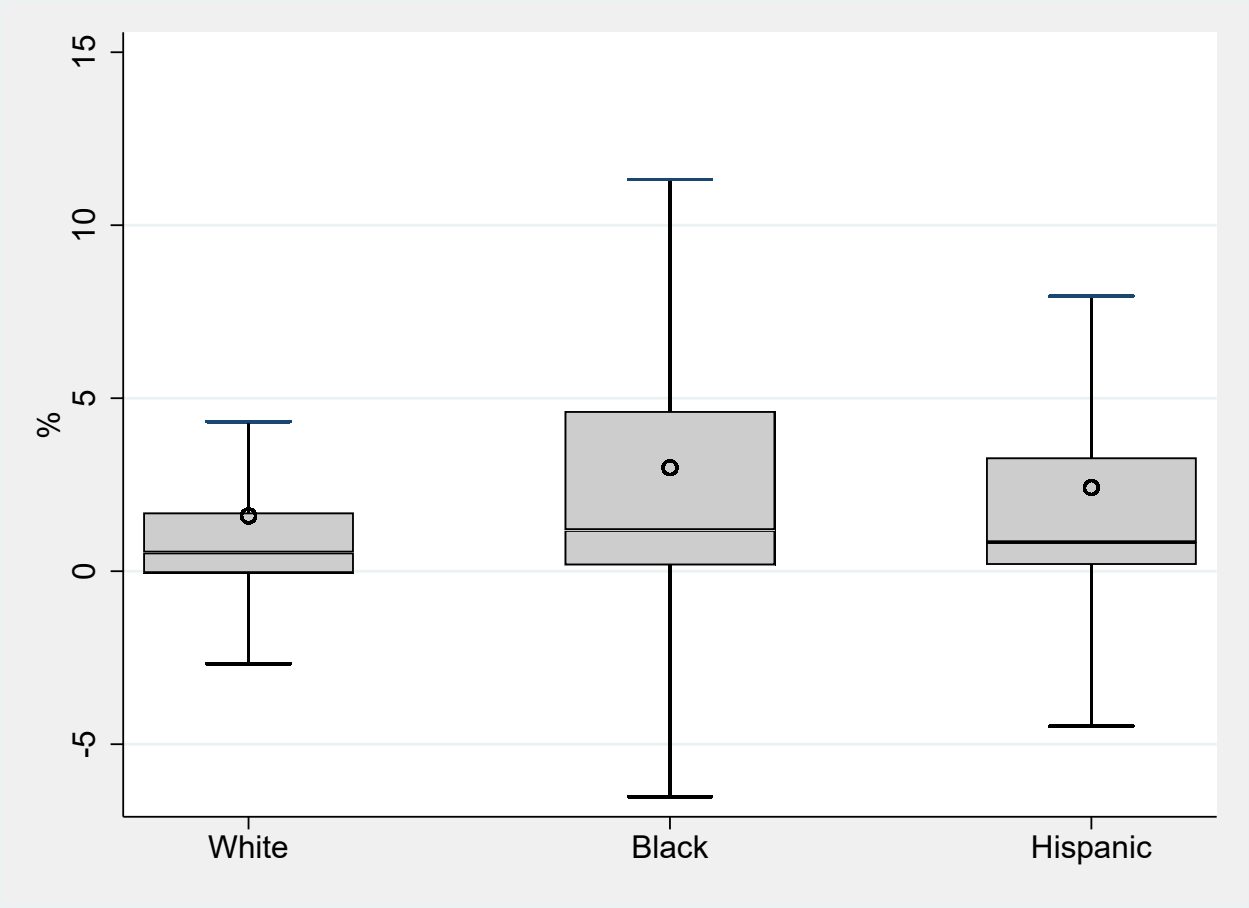
In Section 4, we show that for mortgage rate perception error, the minority households have higher mean, median and wider distribution. In Figures 11, and 12, we show the results are robust if we further split the sample into renter and homeowner.

Appendix Figure 11: Mortgage rate perception error by race and ethnicity groups, homeowner



Notes: The distribution (median, 25th and 75th quartiles, minimum and maximum) of mortgage rate perception error by race and ethnicity group is shown in the boxplot. The shallow dot marker is the sample mean. The unit is percentage. Source: New York Fed's Survey of Consumer Expectations Housing survey.

Appendix Figure 12: Mortgage rate perception error by race and ethnicity groups, renter



Notes: The distribution (median, 25th and 75th quartiles, minimum and maximum) of mortgage rate perception error by race and ethnicity group is shown in the boxplot. The shallow dot marker is the sample mean. The unit is percentage. Source: New York Fed's Survey of Consumer Expectations Housing survey.