Monetary Policy and the Mortgage Market*

Itamar Drechsler Alexi Savov Philipp Schnabl
Dominik Supera

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Abstract

Mortgage markets are central to monetary policy transmission. We show that this is because monetary policy impacts the supply of mortgage credit by the two largest mortgage holders: banks and the Federal Reserve. The Fed's supply of mortgage credit consists of buying or selling mortgage-backed securities (MBS) under its quantitative easing and tightening (QE and QT) programs. Banks' supply of mortgage credit is driven by the deposits channel of monetary policy. Under the deposits channel, when the Fed lowers rates, banks receive large inflows of deposits. They invest these deposits in long-term fixed-rate assets, in particular MBS, to match the interest-rate sensitivity of their income and expenses. The deposits channel reverses when the Fed raises rates: deposits flow out and banks sell MBS. Through the combined effect of QE/QT and the deposits channel, monetary policy drives mortgage rates, mortgage originations, and residential investment. We show that QE/QT and the deposits channel played a large role in the expansion and contraction of mortgage credit during the 2020–24 monetary policy cycle. Our results imply that monetary policy will continue to operate through these channels in future cycles.

*Drechsler: University of Pennsylvania and NBER, idrechsl@wharton.upenn.edu. Savov and Schnabl: New York University and NBER, asavov@stern.nyu.edu and schnabl@stern.nyu.edu. Supera: Columbia University, ds3791@columbia.edu. We thank Annette Vissing-Jorgensen for comments and Gede Viranandafor excellent research assistance. Preliminary, comments welcome.

1 Introduction

The last four years saw massive changes in monetary policy. The Federal Reserve cut interest rates sharply at the onset of Covid-19 to address the economic effects of the pandemic. The Fed also implemented an aggressive program of quantitative easing (QE), purchasing large amounts of Treasury bonds and mortgage-backed securities (MBS). As the economy recovered, inflationary pressures emerged, and the stance of monetary policy shifted. The Fed raised rates rapidly, from 0% to over 5% in the course of a year and a half. The Fed also undertook a program of quantitative tightening (QT), aimed at reducing its Treasury and MBS holdings.

There has been wide discussion of the economic effects of these monetary policy actions. It remains an open question to what extent the loosening and tightening of monetary policy affected household consumption, the labor market, and corporate investment. One area for which there is agreement, is that monetary policy had a large impact on the housing sector through its effect on mortgage markets. Mortgage rates fell rapidly during the loosening phase of the cycle. Mortgage originations boomed, house prices rose, and residential investment surged. All of these trends reversed during the tightening phase. This experience shows that mortgage markets are central to the transmission of monetary policy. How does this transmission work, and why is it so central?

We show that monetary policy had a powerful impact on mortgage markets by shifting the supply of mortgage credit of the two largest mortgage holders, banks and the Fed. Banks and the Fed bought enormous quantities of mortgages during 2020–21, causing mortgage rates to decline drastically. The decline was so large that the spread between mortgage rates and Treasury yields, the mortgage spread, fell to a historic low. When monetary policy reversed course, banks and the Fed cut back their mortgage holdings, causing mortgage rates to rise and the mortgage spread to widen. Monetary policy thus had an outsized impact on mortgage rates, leading them to move more than one-for-one with Treasury yields. This explains why mortgage markets were so central to monetary policy transmission.

How does monetary policy shift the supply of mortgage credit by banks and the Fed? For the Fed it does so directly: MBS purchases under QE are exactly a shift in the Fed's mortgage credit supply. Because the Fed's MBS purchases are large, this shift has a significant impact on the MBS market, which is the largest source of mortgage financing. By expanding mortgage credit, the Fed seeks to lower borrowing costs for homeowners and spur economic activity.

For banks, monetary policy affects mortgage credit supply through the deposits channel of monetary policy (Drechsler et al., 2017). In the deposits channel, banks have market power in deposit markets, which allows them to keep deposit rates low when the Fed raises rates, i.e. deposit rates have a "low beta". Holding deposits thus becomes more expensive when rates rise, which leads some depositors to withdraw their deposits from banks and invest in other assets. When the Fed lowers rates, the reverse happens and banks receive deposit inflows.

Deposit flows drive banks' supply of mortgage credit because banks invest low-beta deposits in long-term fixed-rate assets such as MBS (Drechsler et al., 2021; Supera, 2021). A low beta means that banks' interest expense on deposits is insensitive to the Fed funds rate, similar to long-term debt. Investing in long-term fixed-rate assets generates interest income that is also insensitive to the Fed funds rate. By matching the interest sensitivity of their interest income and expenses, banks hedge their cash flows to fluctuations in interest rates. This is why banks invest low-beta deposits in assets like MBS. Thus, monetary policy drives banks' supply of mortgage credit by causing inflows and outflows of deposits via the deposits channel.

The impact of this channel is large because banks are the largest provider of mortgage credit in the economy. Banks both hold mortgages that they themselves originate (portfolio loans) and invest heavily in securitized mortgages (MBS). As of 2024q1, banks own $6.3 trillion of residential mortgage debt, roughly half of the entire market (their share of MBS is close to a third). As a result, when banks change their mortgage holdings, the effect on the total supply of mortgage credit is large.

The second largest investor in mortgages is the Federal Reserve due to QE. At the peak of its MBS holdings in 2021, the Fed held $2.7 trillion of MBS, which is about a quarter of all MBS and a fifth of all mortgages. Together, banks and the Fed hold more than half the MBS market and close to three quarters of the total mortgage market.

The equilibrium impact of Fed and bank MBS purchases depends on the response of other MBS investors. These investors are mainly asset managers such as mutual funds, pension funds, and private wealth managers. In contrast to banks and the Fed whose purchases are driven by monetary policy, asset managers respond to changes in MBS prices. When banks and the Fed purchased MBS during 2020–21, driving MBS prices up, asset managers became net sellers. Conversely, when banks and the Fed cut their holdings during 2022–23, driving MBS prices down, they bought. For this to occur, the equilibrium price of mortgage credit had to change. This explains why mortgage spreads fell during 2020–21 and then rose during 2022–23.

These changes in the cost of mortgage credit led to large quantity responses from mortgage borrowers. The fall in mortgage spreads in 2020–21 contributed to a massive $8-

trillion mortgage origination boom.[1] Many of these were refinance originations, which allow households to lower their mortgage payments and increase their spending on goods and services. Other originations were for purchasing new homes, some of which were newly constructed, leading to an increase in residential investment. The rise in originations led to a large increase in MBS issuance even after netting out prepayments. The rise in mortgage spreads in 2022–23 had the opposite effect: mortgage originations, MBS issuance, and residential investment fell. These dynamics explain why mortgage markets were important for monetary policy transmission.

The impact of monetary policy on mortgage credit supply is not confined to the recent cycle. While this impact was especially large during this time due to the combination of QE and conventional monetary policy, we document that monetary policy has always had a large effect on banks' mortgage holdings and the mortgage spread through the deposits channel. Specifically, we find a tight relationship between deposit, banks' MBS holdings, and mortgage spreads over the past four decades. We therefore expect that the deposits channel, in addition to any future rounds of QE, will continue to play a large role in monetary policy transmission.

The first part of the paper presents aggregate evidence of the impact of monetary policy on the supply of mortgage credit. To isolate the disproportionate impact of monetary policy on mortgage costs, we focus on the mortgage spread. We find that the mortgage spread declined by about 100 bps during the easing phase of 2020–21 and then rose by over 100 bps during the tightening phase of 2022–23. The same pattern holds for the option-adjusted spread (OAS), which removes the estimated value of the prepayment option and other components such as mortgage fees. This confirms that monetary policy impacted mortgage rates over and above Treasury yields.

Turning to quantities, total mortgage originations grew from $2.3 trillion in 2019 to $4.7 trillion in 2021 and then fell to $1.3 trillion in 2023. The negative relationship between the price of mortgage credit (the mortgage spread) and the quantity (originations) indicates that there was a net shift in mortgage credit supply. Other factors, such as increased demand for housing due to work-from-home, represent shifts in demand that would lead mortgage spreads and originations to move in the same direction.

To explain the shift in mortgage credit supply, we analyze the mortgage holdings of banks and the Fed. We show that the changes in their holdings were very large: during 2020–2022q1, the Fed increased its MBS holdings from $1.4 trillion to $2.7 trillion. At the

[1] Other factors behind the origination boom were the decline in long-term rates and increased demand for housing due to work-from-home. We provide an estimation to isolate the impact of MBS purchases on mortgage originations and find they played a large role.

same time, banks increased their MBS holdings from $2.2 trillion to $3.1 trillion, a 41% increase.[2] This increase closely tracks the growth of their deposits, which was 45%. Combined, banks and the Fed thus purchased over $2.2 trillion of MBS, representing almost a quarter of MBS outstanding. Other MBS investors (asset managers) were net sellers during this period, reducing their MBS holdings by about $1.5 trillion. The equilibrium result of this reallocation was the large reduction in the mortgage spread.

The subsequent increase in mortgage spreads during 2022–23 also closely aligns with changes in the MBS holdings of banks and the Fed. From the end of 2021, when the mortgage spread began to rise, to the end of 2023, when it was near its peak, banks decreased their MBS holdings by $0.5 trillion. Over the same period, the Fed reduced its MBS holdings by $0.3 trillion under QT. Asset managers again took the other side and bought MBS. Since the mortgage spread had risen, they did so at a low price.[3]

The second part of the paper provides a simple framework to interpret our findings and quantify the impact of monetary policy on the supply of mortgage credit. Our framework features two price-insensitive agents: banks and the Fed, and a price-sensitive asset manager. Together, these three agents supply credit to mortgage borrowers by purchasing MBS. When banks and the Fed buy MBS, they drive down the mortgage spread. As mortgage costs decline, borrowers take out more mortgage debt.

The equilibrium impact of Fed and bank MBS purchases depends on two key parameters. The first is the price elasticity of asset managers. Identifying this parameter is challenging because prices are an equilibrium quantity that depends on unobserved demand and supply shocks. We address this challenge by instrumenting for changes in the mortgage spread using Fed MBS purchases. The identifying assumption is that the Fed is guided by broad economic conditions (e.g., the output and inflation gap) and not unobserved changes in asset managers' demand for MBS. To avoid confounding factors during Covid-19, we estimate the relationship up to 2019.

We find that Fed MBS purchases have a large negative impact on mortgage spreads. A 10 percentage point increase in Fed holdings as a share of total MBS leads to a 40-bps decline in the mortgage spread. Consistent with our identification assumption, the result

[2]We measure deposits as checking and savings accounts net of reserves. We exclude reserves to avoid double-counting QE. When the Fed buys a security from an investor, it issues reserves, which banks must hold. Banks then credit the deposit account of the investor, which increases deposits by an equal amount.

[3]We provide causal evidence of the impact of banks on MBS pricing using an event study around the collapse of Silicon Valley Bank in March 2023. This collapse triggered concerns about large deposit outflows at regional banks. Investors also became concerned that banks' deposit betas would rise. Under the view that banks invest low-beta deposits in MBS, this shock represents a downward shift in banks' willingness to hold MBS. Consistent with this prediction, we find that MBS prices fell and MBS spreads rose relative to Treasury benchmarks immediately following SVB's collapse. This shows that banks are important for MBS pricing, and hence the supply of mortgage credit via the MBS market.

is not sensitive to controlling for economic conditions. As a more stringent test, we control for the expected amount of Fed MBS purchases using survey data from primary dealers. To the extent primary dealers factor the Fed's objectives into their forecasts, this helps to control for potential unobserved factors.

Our instrumented regression shows that asset managers are price-sensitive. When the mortgage spread widens by 100 bps, they shrink their holdings by as much as 20% of total MBS. The estimated sensitivity is significantly larger than if we use an OLS regression. This is expected given the downward bias in OLS due to unobserved demand shocks. This confirms the need for an instrument.

We find that banks behave very differently from asset managers. Their purchases do not respond significantly to changes in mortgage spreads. Instead, banks' MBS holdings are explained well by deposit growth. Banks are thus price-insensitive, similar to the Fed. It is therefore the combined MBS purchases of banks and the Fed that drive outcomes in the MBS market.

The second key parameter is the elasticity of mortgage borrowers with respect to the cost of mortgage borrowing. We estimate it in two ways, using OLS and by backing it out from the instrumental variables estimation based on the relationships implied by our model. We find that changes in mortgage rates have a large impact on mortgage originations, both gross (including refinancings) and net. When mortgage rates drop by 100 bps, gross originations rise by 10.8% while net originations rise by 4.3%.

We use these estimates to quantify the impact of monetary policy on mortgage markets during the recent cycle. Our counterfactual analysis isolates the impact of monetary policy from other factors such as increased demand for housing due to work-from-home. We find that banks and the Fed were each responsible for about a 40-bps reduction in the mortgage spread during 2020–21. Our estimates imply that this led a cumulative increase in net MBS issuance of about $1 trillion. Of this, banks were responsible for about half. The impact on gross mortgage originations is even larger, almost $3 trillion, again roughly balanced between banks and the Fed.

The remainder of the paper is organized as follows: Section 2 reviews the literature, Section 3 presents the aggregate evidence, Section 4 provides the framework, Section 5 summarizes data sources used in the estimation, Section 6 shows the estimation results, Section 7 runs the counterfactual analysis, and Section 8 concludes.

2 Related Literature

Our work connects to the literature on the impact of quantitative easing (QE) on asset prices and the real economy. This literature emphasizes two main transmission channels: the portfolio rebalancing channel (Bernanke, 2010) and the signaling channel (Woodford, 2012; Bauer and Rudebusch, 2014). The portfolio rebalancing channel is predicated on the idea that different assets are imperfect substitutes, possibly due to investors' "preferred habitats" (Vayanos and Vila, 2009) resulting from specialized expertise, liquidity needs, or regulatory constraints (Gertler and Karadi, 2011). When the central bank purchases assets, investors rebalance into similar assets, thereby raising their prices and reducing their risk premia. The signaling channel posits that QE communicates information about the future path of short-term interest rates, possibly signaling a commitment to keep rates lower in the future. The portfolio rebalancing channel primarily works through risk premia, while the signaling channel works through the expected path of the short-term rate (Bernanke, 2020).

A more skeptical strand of the literature argues that QE has little effect since it simply exchanges one form of government debt (e.g., Treasury bonds or agency MBS) with another (bank reserves). Along these lines, Curdia and Woodford (2011) and Woodford (2012) argue that QE is generally ineffective, except for targeted purchases when financial markets are disrupted. A common thread across both views is that QE only affects financial markets and the real economy if asset markets are segmented.

A large empirical literature examines the effects of QE on Treasury yields, MBS yields, and other asset prices, mostly relying on high-frequency event studies. Most studies find that QE affects asset prices, but estimates vary in terms of magnitude and the precise channel. Some studies find support for a signaling channel (Krishnamurthy and Vissing-Jorgensen, 2011; Bauer and Rudebusch, 2014; Bhattarai et al., 2015), while others favor portfolio rebalancing (Gagnon et al., 2011; Joyce et al., 2011; Swanson, 2011; D'Amico et al., 2012; Carpenter et al., 2015; Neely, 2015). In their Jackson Hole paper, Krishnamurthy and Vissing-Jorgensen (2013) find evidence for a relatively narrow portfolio rebalancing channel. Borio and Zabai (2018) provide an overview of the empirical literature on QE. A challenge in interpreting the event study evidence is the small number of QE announcements and the difficulty of controlling for investors' expectations about QE on the eve of these announcements (Greenlaw et al., 2018; D'Amico and Seida, 2024). Different from the rest of this literature, Selgrad (2023) uses portfolio holdings data to test the portfolio rebalancing channel directly and finds support for its existence.

A smaller literature studies quantitative tightening (QT). Lopez-Salido and Vissing-

Jorgensen (2023) study the impact of QT on the Fed's ability to control short-term interest rates. Ludvigson (2022), Smith and Valcarcel (2023), and Du et al. (2024) run event studies of QT similar to the QE literature. Du et al. (2024) find smaller announcement effects for QT than QE, consistent with a possible asymmetry in the impact of QE and QT. However, they caution this could be due to differences in the market environment or investor expectations.

Our paper also connects to the literature on monetary policy transmission through bank lending. Traditional theories of the bank lending channel operate through changes in bank reserves (Bernanke, 1983; Bernanke and Blinder, 1988; Kashyap and Stein, 1994). The reserves mechanism ceased to operate due to changes in banking structure, calling into question the idea of a sizable bank lending channel (Romer and Romer, 1990; Bernanke and Gertler, 1995; Woodford, 2010). The deposits channel of monetary policy (Drechsler et al., 2017) provides an alternative mechanism for how monetary policy affects bank lending based on deposit market power. Deposit market power allows banks to keep deposit rates low when the Fed raises rates. This leads some depositors to withdraw their deposit, which induces a contraction in bank lending. The deposits channel provides a new foundation for the large empirical literature on the bank lending channel (Bernanke and Blinder, 1992; Kashyap et al., 1993; Kashyap and Stein, 2000; Xiao, 2020; Wang et al., 2022; Drechsler et al., 2022). Drechsler et al. (2021) show that deposit market power also explains why banks hold long-term fixed rate assets such as MBS: deposit market power makes deposit rates interest-insensitive (i.e., "low beta"), making them resemble long-term liabilities. Banks hedge these liabilities with long-term assets. Thus, due to the deposits channel, monetary policy has a large impact on bank deposits, and by extension on banks' mortgage holdings.

Many papers examine the impact of monetary policy and QE on mortgages, refinancing, and housing markets. Fuster and Willen (2011) measure the effect of QE on the mortgage origination market, while Di Maggio et al. (2020) study the impact of QE on mortgage refinancing. This work generally finds that mortgage refinancing increases consumer spending (Bhutta and Keys, 2016; Di Maggio et al., 2017; Agarwal et al., 2018; Abel and Fuster, 2021; Beraja et al., 2019). The literature also finds that the effects of monetary policy through the refinancing channel are state-dependent (Berger et al., 2021; Eichenbaum et al., 2022). Amromin et al. (2020) survey the mortgage refinancing literature. Fuster et al. (2021) study originator markups during the Covid-19 crisis. DeFusco and Paciorek (2017) uses micro data to estimate the elasticity of mortgage demand to mortgage interest rates. Drechsler et al. (2022) analyze the impact of monetary policy on mortgage financing before the 2008 financial crisis.

A strand of the literature looks at the impact of QE on bank lending. Acharya and Rajan (2022) argue that QE leads to an increase of uninsured deposits, creating fragility. Chakraborty et al. (2020) and Rodnyansky and Darmouni (2017) find that banks that sell MBS to the Fed increase their own mortgage lending. Diamond et al. (2024) argue that the additional reserves created by QE crowd out bank lending.

Our quantitative analysis builds on the work of Koijen and Yogo (2019) who show how to construct demand systems for studying the impact of asset purchases on asset prices. Koijen et al. (2017) and Koijen et al. (2021) apply a version of this methodology to asset purchases by the European Central Bank. They find sizable effects of purchases on asset prices, similar to our quantitative results.

3 The Transmission of Monetary Policy to Mortgage Credit

3.1 The fall and rise in the cost of mortgage credit

The U.S. mortgage market experienced large changes since the onset of COVID-19. Figure 1 shows the average interest rate for the most common mortgage product, the 30-year fixed-rate conforming mortgage, from January 2019 to June 2024. Before COVID-19, the mortgage rate hovered at around 4%. It dropped to 3% at the start of the pandemic in March 2020. The rate hit a historic low of 2.8% in December 2020 and remained around 3% until late 2021. Starting in late 2021, the mortgage rate rose sharply as the Federal Reserve increased interest rates to combat inflation. By March 2023, the rate had surged to close to 7% and has stayed at around 7% or higher since, reaching a peak of 7.8% in October 2023.

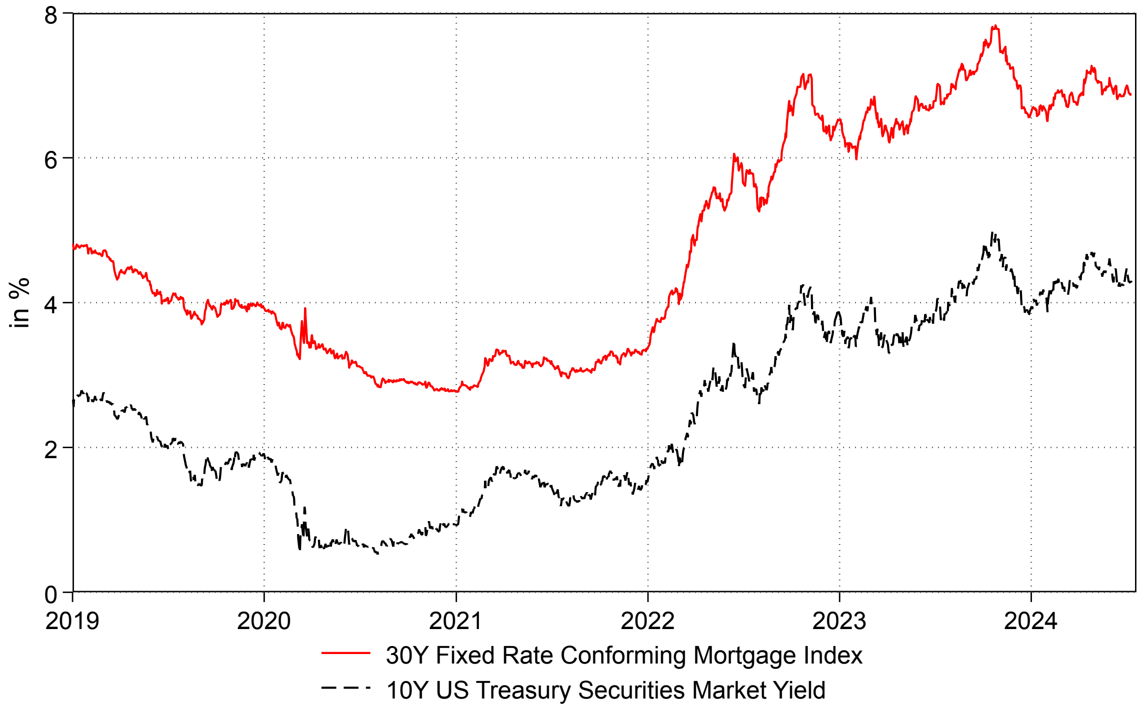
Figure 1 also shows the 10-year Treasury yield, a common benchmark for the 30-year fixed rate mortgage because the two have similar duration. The 10-year Treasury yield fell from around 2% before COVID-19 to less than 1% after the onset of COVID-19. It remained at around 0.5–1.5% until late 2021. From late 2021 to early 2023, the 10-year yield increased from 1.5% to around 3.5–4.5%. This increase is attributable to a shift in the stance of monetary policy, reflected in changes in the expected path of short-term rates and in the term premium.[4]

Figure 2 plots the mortgage spread, measured as the difference between the 30 year-fixed rate conforming mortgage rate and the 10-year Treasury yield (i.e, the difference

[4] There is no evidence that an increase in long-term inflation expectations contributed to the rise in the yield, as inflation expectations (measured using the yields of inflation-protected Treasury bonds) remained around 2%.

Figure 1: **Mortgage and US Treasury Rates**

This figure plots the mortgage rate and US Treasury rate from 1 Jan 2019 to 5 Jul 2024. The mortgage rate is the 30-year fixed rate conforming mortgage index from FRED. The US Treasury rate is the market yield on US Treasury securities at 10-year constant maturity, also from FRED.



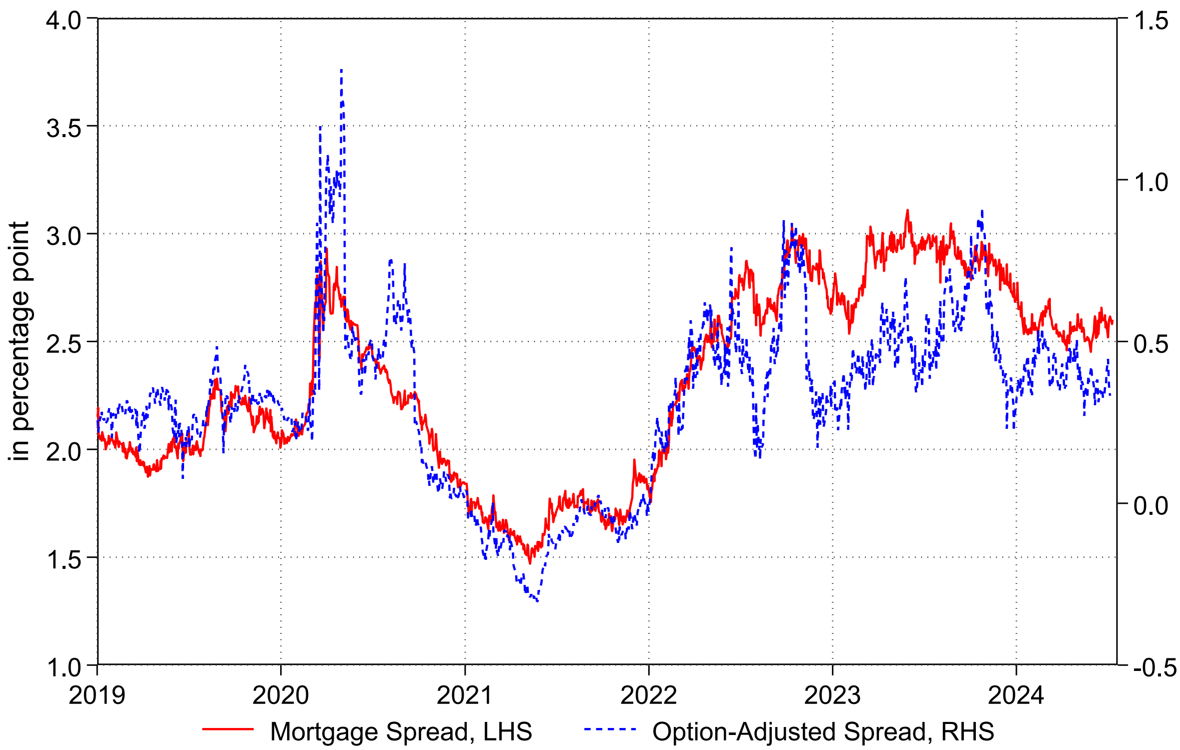
between the two lines in Figure 1). The mortgage spread represents the yield premium that mortgage borrowers pay in excess of long-term Treasury rates. As shown in the figure, the mortgage spread fell and rose in line with overall interest rates. This means that mortgage rates moved more than one-for-one with other long-term rates.

The mortgage spread was around 2.1% before COVID-19. It briefly spiked to around 2.9% at the start of the pandemic. This spike reflected uncertainty about COVID-19's impact on the mortgage market and an increase in the markup charged by mortgage originators due to the difficulty of processing large refinancing volumes during the first months of COVID-19. After this initial spike, the spread decreased to less than 1.5% by early May 2021. The spread remained constant for several months and then began to increase as monetary policy turned to a tightening stance in late 2021. For most of 2023, the mortgage spread was around 2.9%, slightly declining thereafter.

For comparison, the figure also plots the OAS ("option-adjusted") spread, which removes the estimated value of the prepayment option and the primary-secondary spread. The prepayment option is the cost of providing mortgage borrowers with the option to

Figure 2: **Mortgage and Option-Adjusted Spreads**

This figure plots the relationship between the mortgage spread and the option-adjusted spread (OAS) from 1 Jan 2019 to 5 Jul 2024. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year US Treasury yield, both from FRED. The OAS is the FNCL TBA Current Coupon BAM OAS I25 Discounting series from Bloomberg, which uses Treasury discounting to adjust Bloomberg's 30-year FNCL Par Coupon index.



refinance. The primary-secondary spread is the difference between the rate mortgage borrowers pay and the rate MBS investors receive. It covers mortgage fees and the originator's markup. The OAS spread follows a similar pattern as the mortgage spread. The increase in 2022 is somewhat smaller primarily due to the rise in the value of the prepayment option. The OAS spread declined to less than -0.4% in June 2021 and increased to around 0.4–0.9% during 2023. As shown in the figure, there is a high correlation between the mortgage spread and the OAS mortgage spread.[5]

In sum, the mortgage spread isolates changes in the cost of mortgage credit over and above changes in the general level of interest rates. The fact that it co-moves with the level of interest rates indicates that monetary policy has a disproportionate impact on the cost of mortgage credit. Understanding this disproportionate impact can explain why the

[5] Krishnamurthy and Vissing-Jorgensen (2013) also find that QE shrinks OAS. Interestingly, they find that the production-coupon OAS turns slightly negative, as we do in Figure 2.

mortgage market plays such a central role in the transmission of monetary policy.

Moving forward, we focus on the mortgage spread as our preferred measure of the excess cost of mortgage credit.

3.2 The rise and fall in mortgage originations and MBS issuance

The previous section showed that the cost of mortgage credit fell in 2020/21 and rose once the Federal Reserve started raising interest rates in 2022. This change in price could be due to a change in either the demand for, or supply of, mortgage credit. To determine which one, we can look at mortgage quantities. If mortgage costs and quantities move in opposite directions, this implies a net shift in the supply curve of mortgage credit. Conversely, if they move in the same direction, it suggests a net shift in the demand curve for mortgage borrowing.

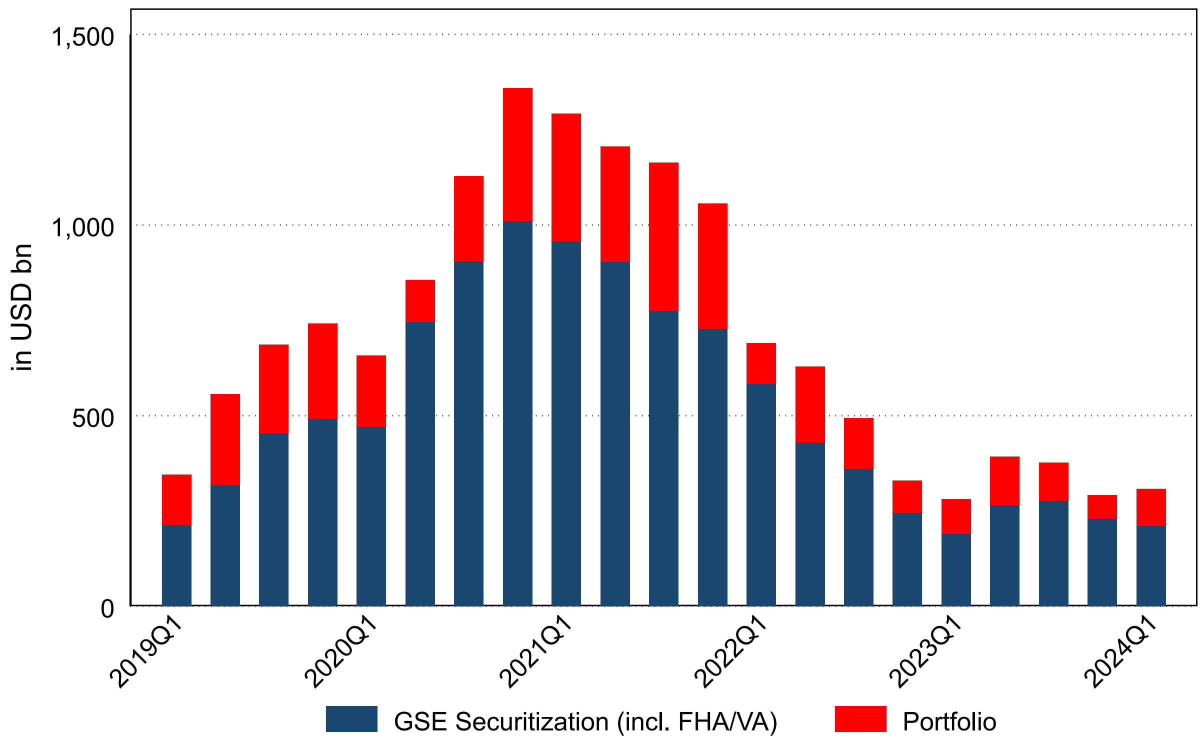
Figure 3 plots total quarterly mortgage originations from January 2019 to March 2024. Quarterly originations averaged around $600 billion from January 2019 to March 2020. About two-thirds of these originations were securitized by the GSEs, i.e., they were sold to the GSEs to be insured against default and packaged into MBS, while the remaining one-third were portfolio loans held on bank balance sheets. From March 2020 to December 2021, average quarterly mortgage originations nearly doubled to $1,050 billion, peaking at around $1,360 billion in the last quarter of 2020. Total new mortgage originations during these seven quarters exceeded $8 trillion. For comparison, total residential mortgages stood at $11 trillion in March 2020, showing there was significant turnover relative to the stock of all mortgages. Total mortgage originations declined significantly after 2021. Average quarterly originations from the first quarter of 2022 to the first quarter of 2024 were about $420 billion, reaching a low of $281 billion in the first quarter of 2023.

A large share of new mortgage originations is refinancing originations. In a refinancing, a homeowner extinguishes an existing mortgage with a new one at a lower rate. Some homeowners also choose to increase their mortgage balances in what is known as a "cash-out refinancing." Refinancing relaxes homeowners' budget and liquidity constraints, allowing them to increase spending on other goods and services. A large literature finds that this has a large impact on aggregate consumption (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023).

Mortgage originations increase the total amount of outstanding mortgages but less than one-for one. Cash-out refinancings increase outstanding mortgages by the change in the mortgage balance. All refinancings extend mortgage duration and hence increase the amount of interest rate risk that mortgage lenders must bear. Purchase loans for existing

Figure 3: **Primary Mortgage Originations**

This figure plots quarterly first lien primary mortgage originations from 2019Q1 to 2024Q1. Mortgage originations are broken down into whether they are portfolio loans or securitized by the government sponsored enterprises (GSE; i.e. Fannie Mae, Freddie Mac, and Ginnie Mae) or the Federal Housing Administration and the US Department of Veteran Affairs (FHA/VA). The figure excludes the small amount of originations that goes into private label securitization. The data source is Urban Institute.



homes increase outstanding mortgages by the difference in size between the mortgage of the buyer and that of the seller (if the seller has a mortgage). Finally, purchase loans for newly constructed homes increase total mortgages one-for-one. These also have a direct effect on economic activity via residential fixed investment.

We can see directly how much gross originations translated into changes in the total amount of outstanding mortgages by looking at net mortgage originations. We do so in the context of the MBS market. Figure 4 plots the quarterly gross and net issuance of agency MBS from the first quarter of 2019 to the first quarter of 2024. Agency MBS includes all securitized residential mortgages guaranteed by U.S. government agencies (Fannie Mae, Freddie Mac, and Ginnie Mae). Annualized gross and net issuances were around $1,600 billion and $300 billion, respectively, from January 2019 to March 2020. These figures increased to around $3,500 billion and $830 billion, respectively, from the second quarter of 2020 to the fourth quarter of 2021. However, from the end of 2021 MBS issuance declined rapidly. From the first quarter of 2022 to the first quarter of 2024, annualized gross and net MBS issuance averaged just $1,300 billion and $350 billion, respectively.

Figure 4: **Agency MBS Issuance, Gross and Net**

This figure plots annualized quarterly gross and net MBS issuance by Fannie Mae, Freddie Mac, and Ginnie Mae from 2019Q1 to 2024Q1. The data source is the Ginnie Mae Global Markets Analysis Report.

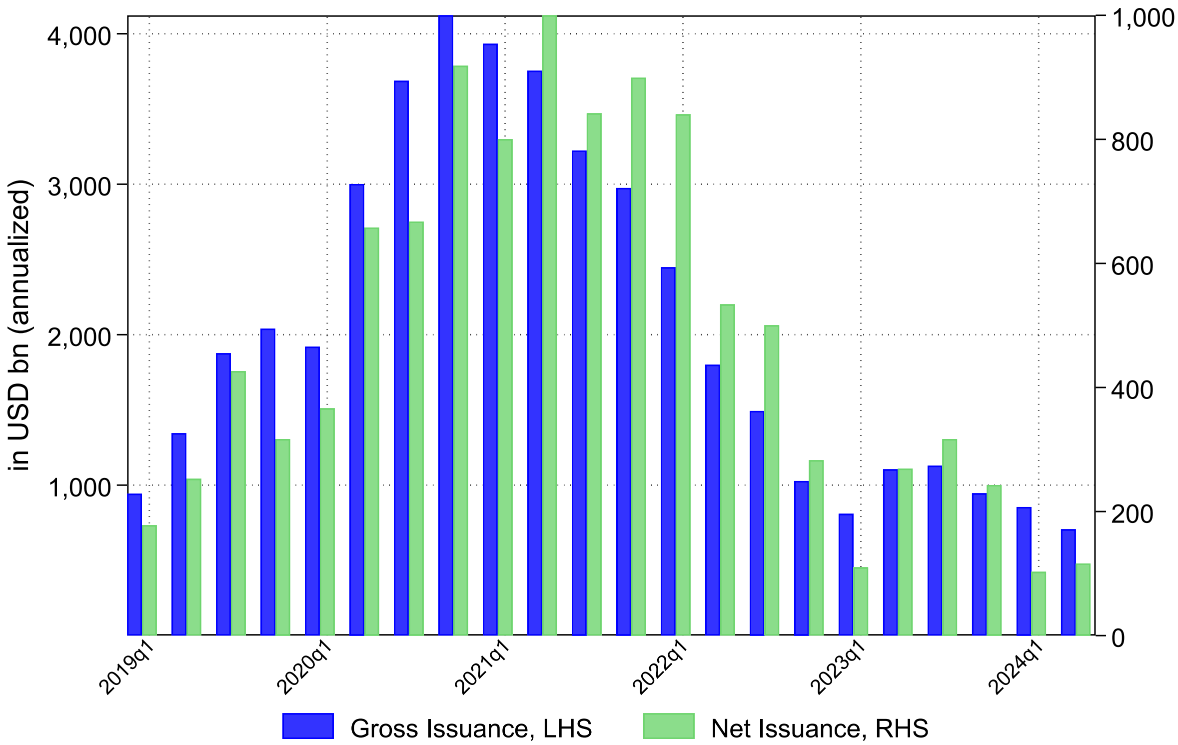
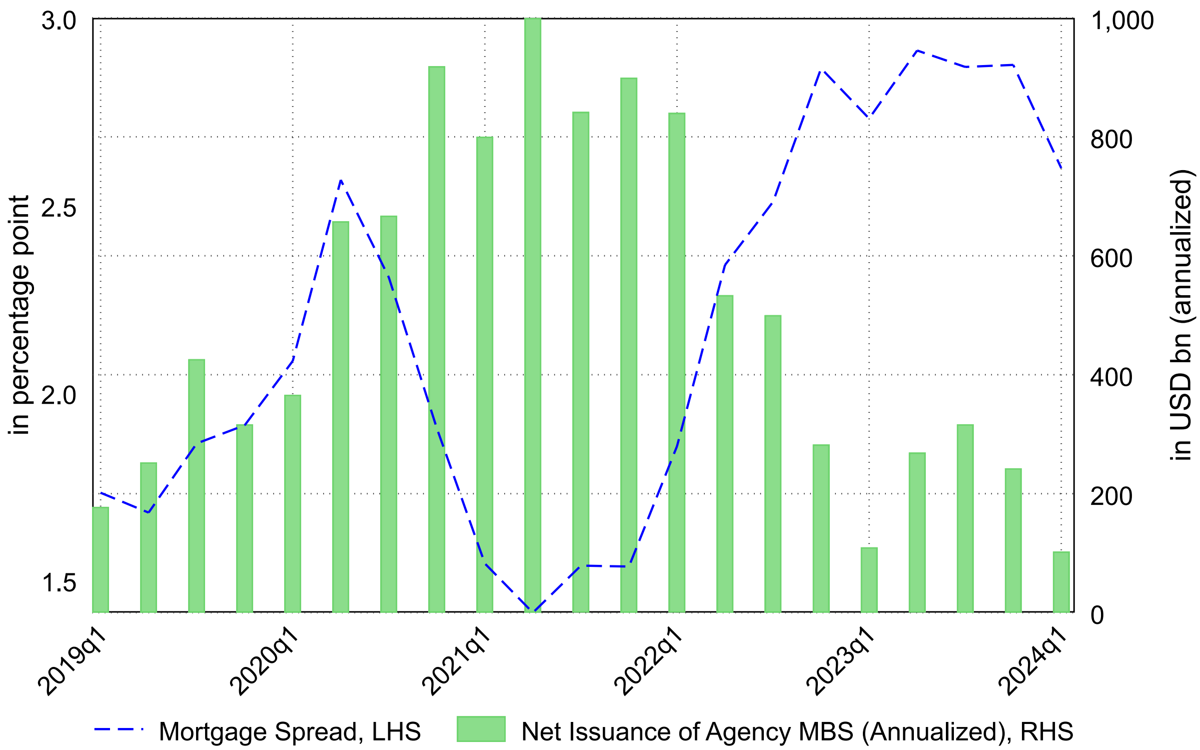


Figure 5 puts together evidence on the quantity of mortgage credit (MBS net issuance) and the price of mortgage credit (the mortgage spread). The figure shows that the mortgage spread contracted from the second quarter of 2020 through the fourth quarter of 2021, coinciding with a boom in MBS issuances and mortgage originations. Once the mortgage spread increased after 2021, total MBS issuance and origination sharply declined. This evidence shows that there was a positive net supply shift in mortgage credit in 2020/21, when the price of mortgages decreased and the quantity of mortgage credit increased. The reverse occurred in 2022/23, when the price of mortgages increased and the quantity of mortgage credit decreased.

Figure 5: **Agency MBS Net Issuance and MBS Spread**

This figure plots the relationship between the mortgage spread and net agency MBS issuance (i.e. by Fannie Mae, Freddie Mac, and Ginnie Mae) from 2019Q1 to 2024Q1. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year US Treasury yield, both from FRED. The values are quarterly average of the daily spread. Net agency MBS issuance is annualized and sourced from the Ginnie Mae Global Markets Analysis Report.



3.3 What Caused the Shift in the Supply of Mortgage Credit?

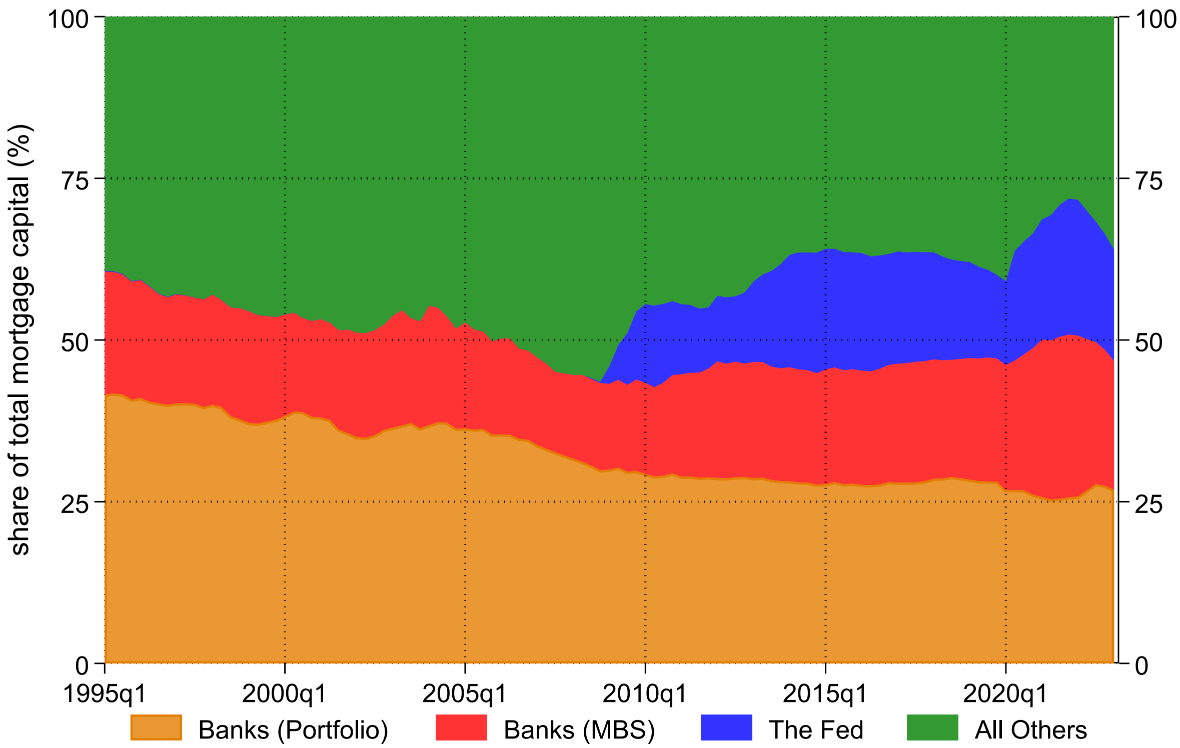
3.3.1 The main providers of mortgage credit

Figure 6 plots the share of mortgages owned by by the three main groups of mortgage investors over the period from 1995 to 2023: (i) the banking sector, (ii) the Federal Reserve, and (iii) other MBS investors. We compute the share based on the ultimate investors in the mortgage, i.e., the investor holding the mortgage on balance sheet, or if the mortgage is securitized, the investor holding the MBS. We refer to securitized mortgages as MBS and non-securitized mortgages as portfolio loans. Total mortgages are the sum of MBS and portfolio loans.

The figure shows that banks have consistently financed around 50% of total mortgages over the past three decades. Their share has been remarkably stable, even though this period witnessed major developments in mortgage markets, including the 2008 financial crisis, the growth of non-bank mortgage originators, and the emergence of FinTech lenders.

Figure 6: **Mortgage Financing by Entity**

This figure plots the share of mortgage financing by banks (divided into portfolio and MBS), the Fed, and all other MBS investors from 1995Q1 to 2023Q1. These shares are calculated by first obtaining residential mortgage and MBS holding by the different entities (i.e. banks, Fed, rest of the world, household, REITs, mutual funds, money market funds, pension funds, life insurance, non-bank ABS issuers), all from the Z.1 release or the flow of funds data in FRED, then dividing each by their sum. For banks, we add up primary mortgages or mortgage-backed securities holdings of US-chartered depository institutions and credit unions. The data are in market values.



This result may be surprising since there is a common misconception that banks no longer play a major role in financing mortgages due to the rise of securitization. While securitization has grown, and non-bank mortgage originators (e.g., Quicken Loans/Rocket Mortgage) issue an increasingly large share of securitized mortgages, these non-bank originators do not provide the ultimate financing for these loans. Instead, they almost immediately sell them to the Government-Sponsored Enterprises (GSEs), Fannie Mae and Freddie Mac, who then securitize them into MBS which they sell to investors. The cost of credit for these securitized mortgages is determined by the investors who are the final buyers of the MBS, not by the mortgage originators.

Banks are the largest investors in MBS, holding about 30% of all MBS, in addition to their holdings of portfolio loans. This means that banks play a major role even when focusing solely on MBS. Together with their holdings of portfolio mortgage loans, they are by far the largest provider of mortgage credit to the economy.

The main change in mortgage credit provision over the last 30 years has been the increasing role of the Federal Reserve in the MBS market. The Fed started buying MBS in 2008 as part of its effort to stabilize the economy and support the housing market in the aftermath of the 2008 financial crisis. Since then, the Fed has owned between 10% and 25% of the MBS market. The Fed's increased footprint has reduced the share of other investors in the mortgage market, including pension funds, mutual funds, insurance companies, and foreign investors, but not banks. These investors owned around 50% of mortgages from 1995 to 2007, but their share has since declined to 35–40%. The share of banks, meanwhile, has remained stable.

Therefore, while specialized non-bank originators have become prominent in the origination of mortgages, banks have remained at the center of mortgage credit provision through their investments in MBS and portfolio loans. Together with the Federal Reserve, they play a dominant role in the mortgage market.

3.3.2 The Federal Reserve's MBS Purchases

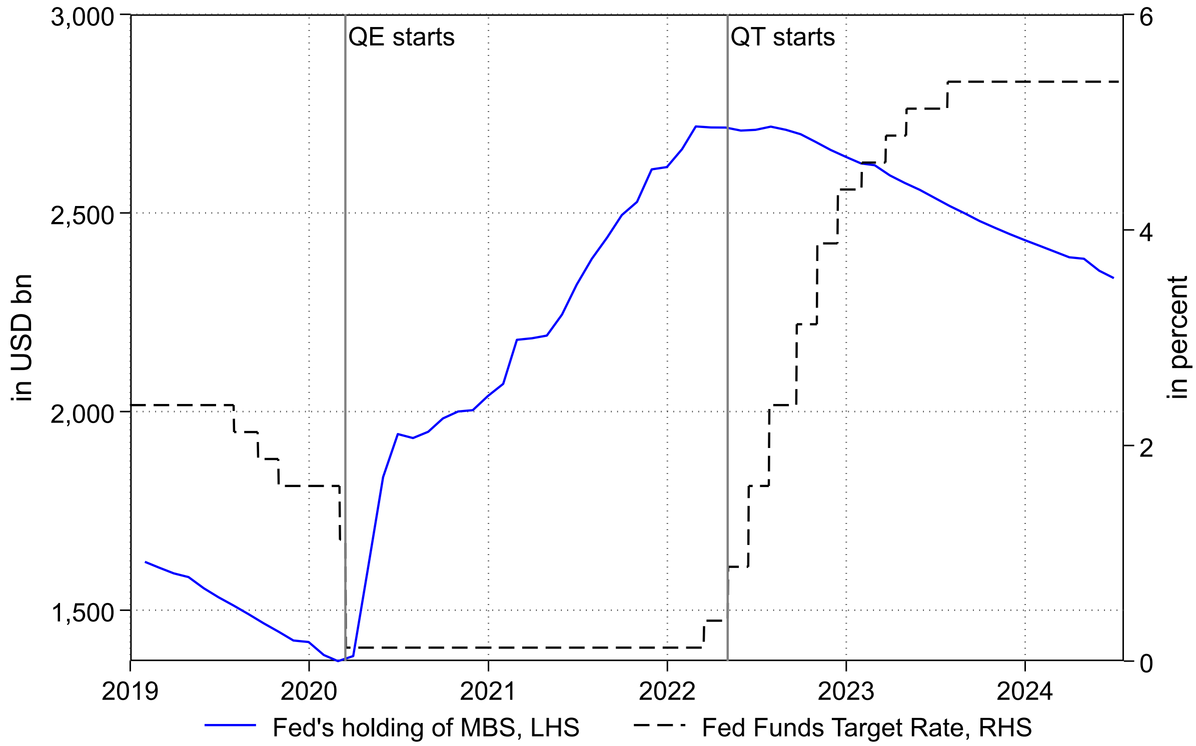
Over the past four years, the Federal Reserve bought and sold large amounts of MBS as part of its quantitative easing (QE) and tightening (QT) programs. At the end of 2019, the Fed held around $1.4 trillion in MBS, which it had purchased during previous rounds of QE (the Fed was engaged in QT at the onset of Covid-19). When the Covid-19 pandemic began in March 2020, the Federal Reserve announced a new round of QE in order to support the economy.

Figure 7 plots the Federal Reserve's MBS holdings. The Fed purchased around $550 billion in the second quarter of 2020 and gradually increased its holdings in the following quarters with further purchases. By the first quarter of 2022, the Federal Reserve had increased its holdings by another $750 billion, leading to total purchases of $1.3 trillion since the onset of COVID-19 and total holdings of $2.7 trillion.

In early April 2022, the Fed announced that it would start QT. The Fed initially decreased its holdings by a predetermined amount per month, eventually settling on a decrease of $35 billion per month. The expectation was that the Federal Reserve would not need to actively sell MBS but simply let its holdings run off without reinvesting the proceeds. Since 2022Q2, the Fed has reduced its total holdings by around $300 billion, with

Figure 7: **The Fed's Holding of MBS and the Federal Funds Rate**

This figure plots the Fed's monthly holding of MBS against the Federal Funds Target Rate from Jan 2019 to Jul 2024. The Fed's MBS holding is in face value, sourced from the H.4.1 release table in FRED.



total holdings declining from $2.7 trillion to $2.4 trillion by the first quarter of 2024.

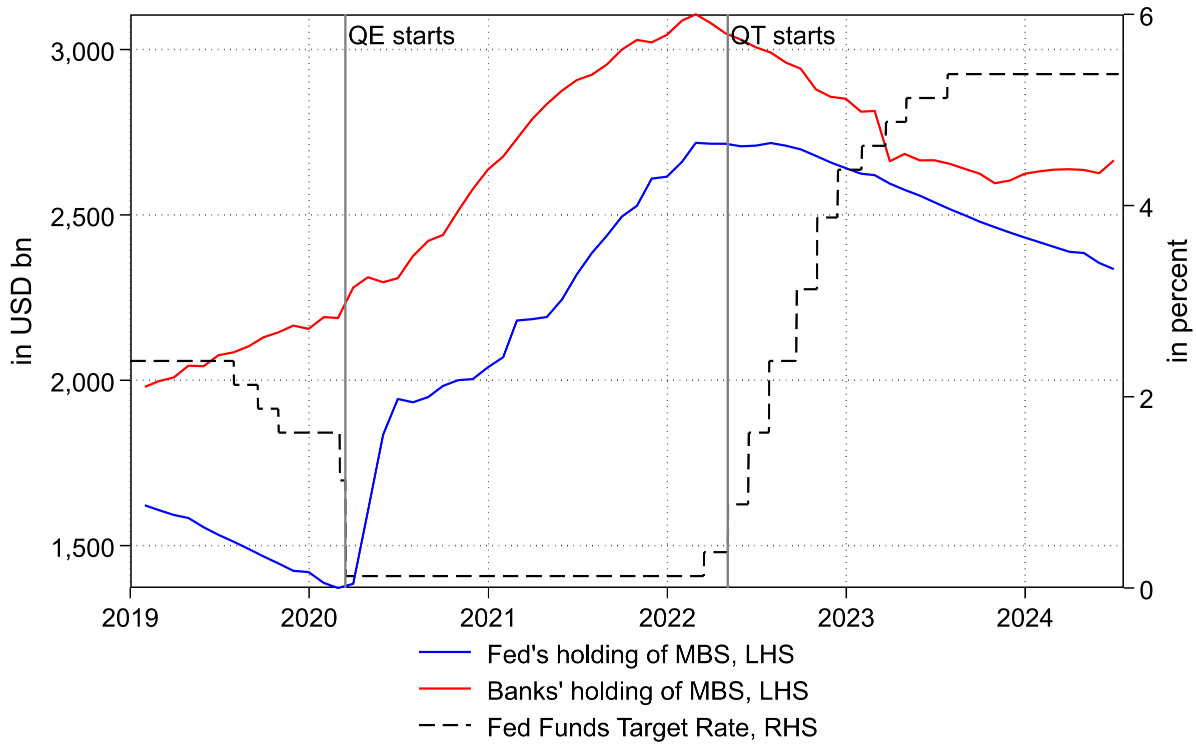
This strategy of predetermined purchases and reductions in MBS is a central element of the Federal Reserve's quantitative easing and tightening policies. It is viewed as maximizing the impact of quantitative easing by providing forward-looking investors with certainty, thereby reducing market volatility. Importantly, this strategy means the Fed is effectively price-inelastic when implementing QE/QT, i.e., it purchases and sells MBS regardless of the mortgage spread. We therefore consider the Fed to be a price-insensitive buyer and seller of MBS.

3.3.3 Banks' MBS Purchases

Figure 8 plots the total MBS holdings of the US banking sector together with the Fed's holdings. As mentioned in the previous section, banks are the single largest holders of MBS. At the start of 2020, they held about $2.2 trillion in MBS, or 57% more than the Federal Reserve. Including portfolio loans that are originated and held on balance sheets,

Figure 8: **The Fed's and Banks' Holding of MBS and the Federal Funds Rate**

This figure plots the Fed's holding of MBS and banks' holding of MBS against the Federal Funds Target Rate monthly from Jan 2019 to Jul 2024. The Fed's MBS holding is sourced from the H.4.1 release table in FRED. The banks' MBS holding is sourced from the H.8 release table in FRED.



banks owned close to half of all U.S. mortgages.

Like the Federal Reserve, the U.S. banking sector significantly increased its MBS holdings after the onset of Covid-19. Banks purchased about $1 trillion in MBS from the first quarter of 2020 until the first quarter of 2022. Banks began reducing their holdings earlier than the Fed, during the first quarter of 2022. From the second quarter of 2022 to the first quarter of 2024, banks reduced their holdings by around $0.4 trillion, 35% more than the Fed's reduction under QT.

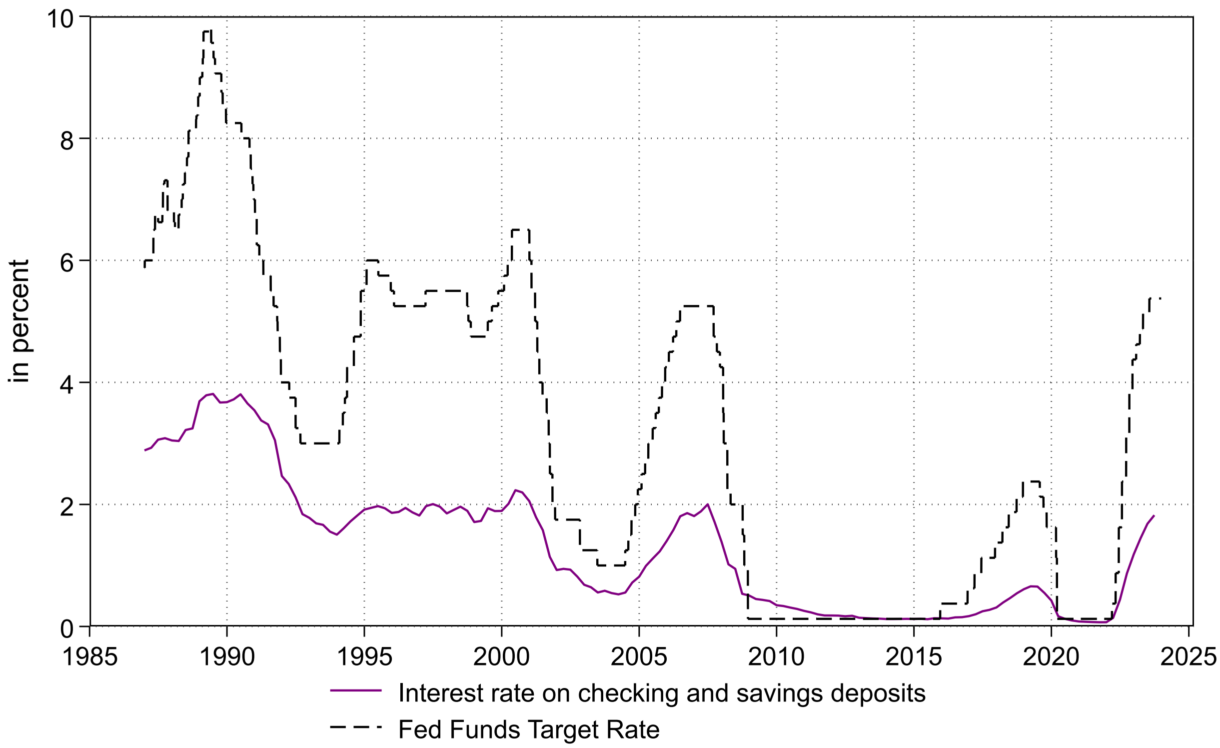
Like the Federal Reserve, banks purchased MBS when the mortgage spread was low (i.e., the price of MBS was high) and sold MBS when the spread was high (i.e., the price was low). Since a price-sensitive behavior would behave in the opposite fashion, this suggests that, similar to the Fed, banks buying and selling was price insensitive, and hence driven by a factor other than the mortgage price.[6] As the figure shows, the MBS

[6]We formally estimate the price-sensitivity of banks in Section 6.2. Our results confirm that banks are price-insensitive MBS investors.

purchases of banks and the Fed tracked each other over time and hence their combined impact drove the changes in the supply of mortgage credit.

Figure 9: **The Federal Funds Rate and Deposit Rate**

This figure plots the relationship between the Federal Funds Target Rate and interest rate on transaction and savings deposits quarterly from 1987Q1 to 2023Q4. Interest rate on transaction and savings deposits are calculated by adding interest expense on transaction deposits and interest expense on savings deposits then dividing it by the sum of transaction and savings deposits, all from the call reports. The sample includes all commercial banks.



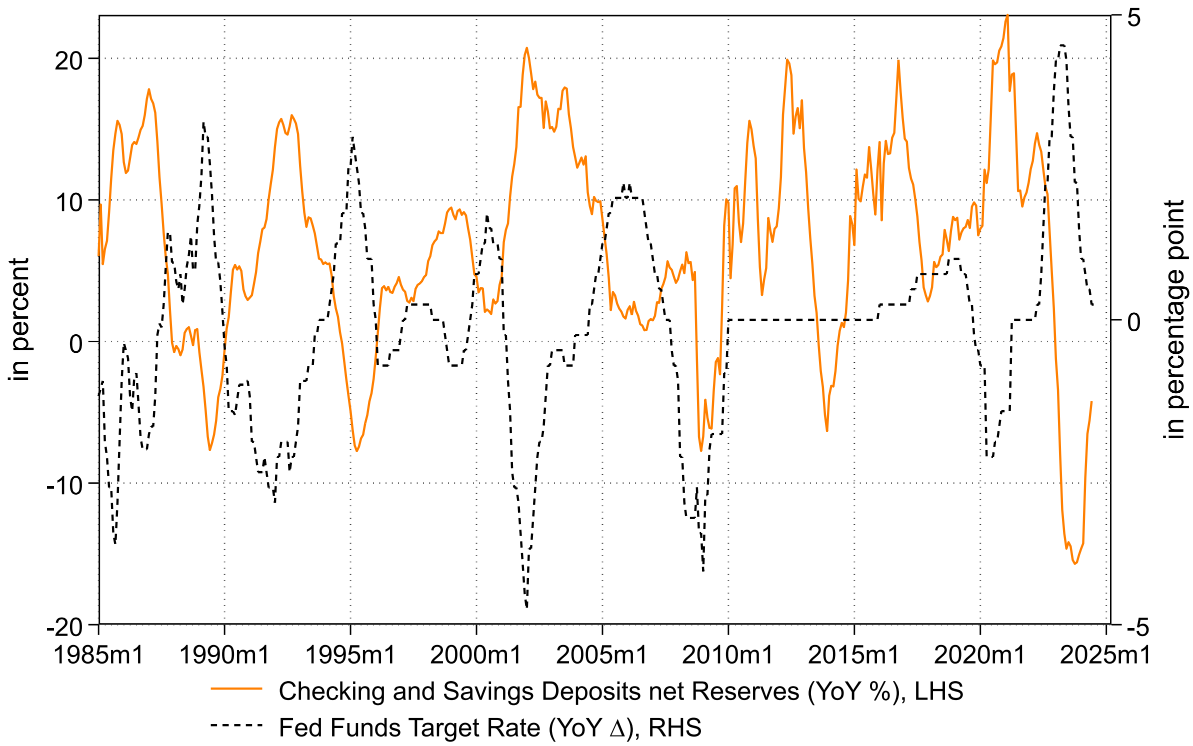
3.4 Why Do Banks Invest in MBS?

3.4.1 The deposits channel of monetary policy

Prior research shows that banks' purchases of MBS are driven by inflows and outflows of deposits, such as checking and savings account, whose deposit rates have a low "interest-rate beta," meaning they increase much less than one-for-one with market rates (Drechsler et al., 2021; Supera, 2021). Banks have market power in deposit markets, which they exercise by paying deposit rates that are low and insensitive to market rates. This low beta allows banks to invest in assets whose cash flows are also insensitive to interest rates,

Figure 10: **The Federal Funds Rate and Deposits Change**

This figure plots the relationship between the change in the Federal Funds Target Rate and the growth of deposits from Jan 1985 to Jun 2024. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release.



namely long-term fixed-rate assets, such as MBS, without risking insolvency if interest rates change. Banks also incur substantial operating costs to maintain their deposit market power (for branches, marketing, salaries). These costs are also interest-insensitive. To make sure they have sufficient income to pay them, banks must in fact hold a certain amount of long-term fixed-rate assets like MBS. As a result, when low-beta deposits flow in, banks purchase MBS, and when low-beta deposits flow out, banks sell MBS.

What makes deposits flow in and out? The main driver of deposit flows is the Fed Funds rate, the standard measure of conventional monetary policy. When the Federal Reserve increases the Fed funds rate, banks exercise their market power by keeping deposit rates low. This increases the opportunity cost of holding deposits, the spread between the Fed funds rate (the market rate) and the deposit rate, leading some depositors to reduce their deposit holdings and invest in other, higher-yielding assets. Conversely, when the Fed lowers the Fed funds rate, the deposit spread shrinks, and deposits flow into the banking system. This mechanism is known as the deposits channel of monetary policy (Drechsler et al., 2017).

Figures 9 and 10 show the deposits channel at work over the past four decades. Figure 9 plots the Fed funds rate and the average deposit rate from January 1987 to December 2023. The average deposit rate is below the Fed funds rate and rises less than one-for-one with it. When the Fed funds rate is low, deposit rates are also low and the opportunity cost of holding deposits (the deposit spread) is small. But when the Fed funds rate is high, deposit rates are far below it, and deposits become much more costly to hold. This dynamic also took place during the recent cycle. When the Fed cut rates at the onset of Covid-19, the deposit spread narrowed to zero. When the Fed raised rates in 2022–23, a wide deposit spread opened up. The behavior of deposit rates during the recent cycle is thus fully in line with past cycles.

Figure 10 shows the impact of the deposits channel on deposit growth. It plots year-over-year growth in checking and savings deposits (net of reserves) and year-over-year changes in the Fed funds rate from January 1985 to March 2024. The figure shows that deposits flow in when the Fed funds rate falls and the deposit spread shrinks, and deposits flow out when the Fed funds rate rises and the deposit spread expands. As with rates, this pattern takes place during all monetary policy cycles, including the recent one. As the Fed funds rate and deposit spread fell at the start of Covid-19, deposit growth shot up, and as the Fed funds rate and deposit spread rose in 2022–23, deposit growth plummeted.[7]

These patterns show that the deposits channel is a robust mechanism that has played out in past cycles as well as the recent one. It is therefore likely to play a similar role in the future.

3.4.2 Deposit inflows and outflows during the recent cycle

Figure 11 zooms in on the deposits channel during the recent cycle. It plots total savings and checking deposits net of reserves issued by the U.S. banking sector from January 2019 to March 2024.[8] Savings and checking deposits are generally referred to as zero-maturity

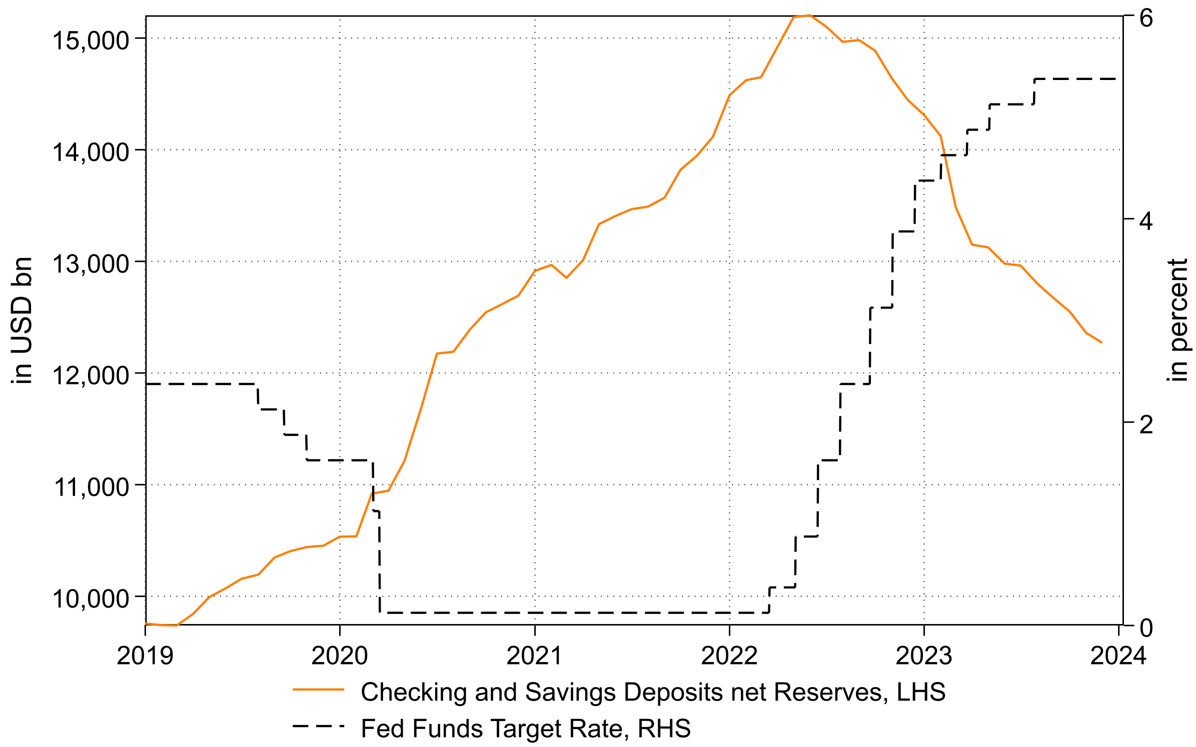
[7] Additional factors likely amplified deposit growth during the recent cycle. The government's large stimulus program provided economic support to households and businesses, increasing deposit inflows during the early part of the pandemic. A flight-to-safety may have further increased deposits.

[8] We net out reserves to avoid double-counting QE. When the Federal Reserve purchases MBS from an investor, it creates reserves which it transfers to the investor's bank. The bank then credits the investor's deposit account and this is how the investor gets paid. QE thus creates deposits in an amount equal to the increase in reserves. Netting them out removes this impact and ensures we are measuring non-QE deposit flows. See Acharya and Rajan (2022) for further discussion of QE-driven deposit growth.

deposits because they can be withdrawn at will. These deposits are the main sources of funding for U.S. banks, representing 84% of total bank deposits.[9]

Figure 11: **Deposits and the Federal Funds Rate**

This figure plots the relationship between the Federal Funds Target Rate and bank deposits monthly from Jan 2019 to Dec 2023. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release.



The figure shows that zero-maturity deposits (net of reserves) grew by an astounding $4.7 trillion or 45%, from around $10.5 trillion in February 2020 to $15.2 trillion in May 2022. This substantial increase in the size of the U.S. banking sector occurred over a period of less than two years and, since we net out banks' reserve holdings, was over and above any increase due to the expansion of the Federal Reserve's balance sheet.

The growth in zero-maturity deposits reversed in the beginning of 2022. From the first quarter of 2022 to the fourth quarter of 2023, deposits declined by $2.9 trillion, from $15.2 trillion to $12.3 trillion. These outflows undid almost 40% of the earlier inflows. Given

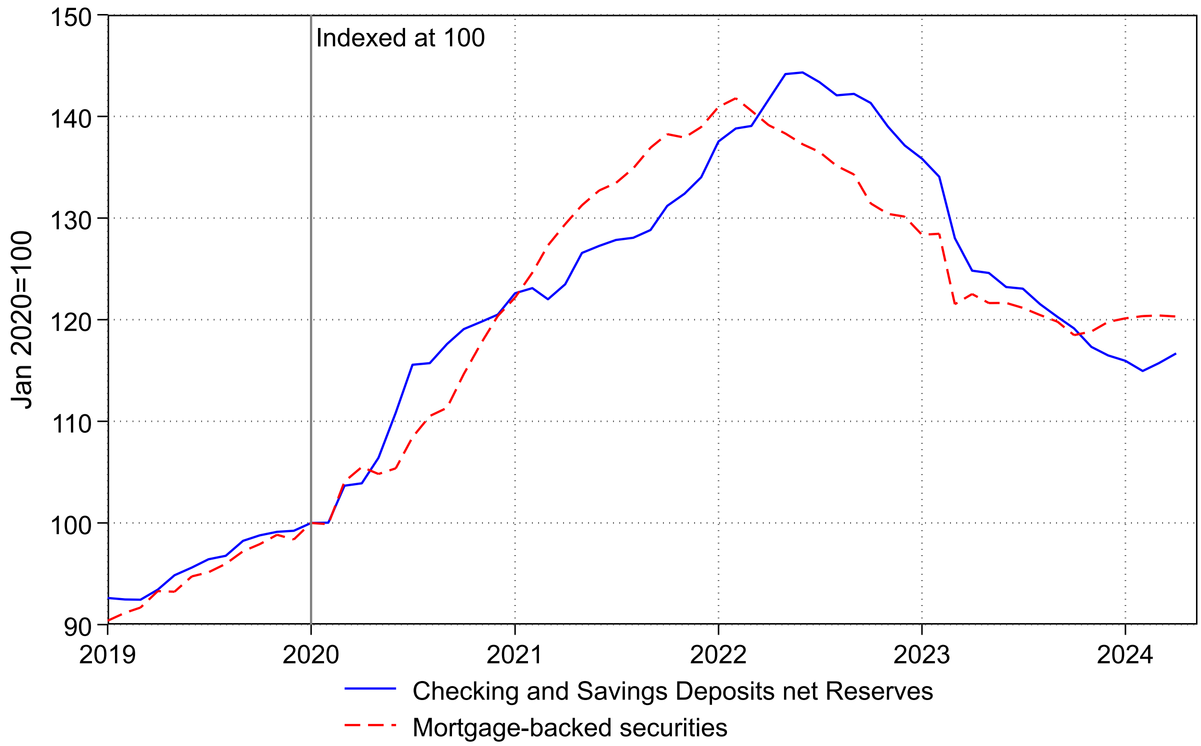
[9]The remaining category, time deposits (i.e., CDs), have deposit betas close to one. Supera (2021) shows that because of this, banks tend to invest time deposits in floating-rate assets, such as commercial and industrial (C&I) loans, rather than MBS.

the importance of deposits for bank funding, the magnitude of this reduction required a large contraction of bank balance sheets.

3.4.3 Banks invest deposits in MBS

Figure 12: **Bank Deposits and MBS Holding**

This figure plots the relationship between the growth in bank deposits and the growth in banks' MBS holdings monthly from Jan 2019 to Apr 2024. Bank deposits and banks' MBS holdings are both normalized to 100 as of January 2020. Deposits are computed as transaction plus savings deposits minus reserves. Transaction deposits are demand deposits while savings deposits are other liquid deposits, which are the sum of savings deposits and other checkable deposits, both from the H.6 release in FRED. Reserves are reserve balances also from the H.6 release. MBS holdings are obtained from the H.8 release in FRED.



Consistent with the prior literature, the large inflows and outflows of low-beta deposits since 2020 can account for the large increase and decrease of banks' MBS holdings.

Figure 12 plots the growth in checking and savings deposits (net of reserves) against the growth of banks' MBS holdings from January 2019 to April 2024, both indexed to 100 in the first quarter of 2020. The increase in MBS holdings closely tracks the growth in zero-maturity deposits, with both increasing by about 45% from the first quarter of

2020 to the first quarter of 2022. Both then decline in tandem by around 25% from the first quarter of 2022 to the first quarter of 2024, demonstrating how deposit inflows and outflows lead banks to change their MBS holdings.

3.4.4 Cross-sectional evidence

Figure 13 examines the relationship between deposit growth and MBS purchases at a disaggregated level by comparing them across individual banks over the same time period. The figure includes all commerical and is a binscatter plot showing the relationship between the change in deposits and the change in MBS holdings during both the QE period (blue dots) and QT period (red dots). The figure plots zero-maturity deposit growth (net of reserves) on the x-axis and MBS purchases on the y-axis. The QE period is defined as the first quarter of 2020 until the first quarter of 2022, and the QT period is defined as the second quarter of 2022 until the first quarter of 2024. The deposit and MBS changes are measured relative to the bank's assets at the start of the period.

There is significant variation in deposit growth across banks during the QE period, with growth ranging from 0% to as high as 60%. There is a tight and linear relationship between a bank's deposit growth and the growth of its MBS holdings. A 10-percentage point increase in deposits relative to assets is associated with a 1.7 percentage point increase in MBS holdings relative to total assets. Similarly, there is also significant variation in deposit growth during the QT period, ranging from −15% to 20%, with a clear linear relationship between more negative deposit growth and greater reductions in MBS holdings. A 10 percentage point reduction in deposit growth is associated with a 1.2 percentage point reduction in MBS holdings relative to assets.[10] Thus, there is a tight connection at the individual bank level between deposit growth and MBS purchases during both the QE and QT periods.

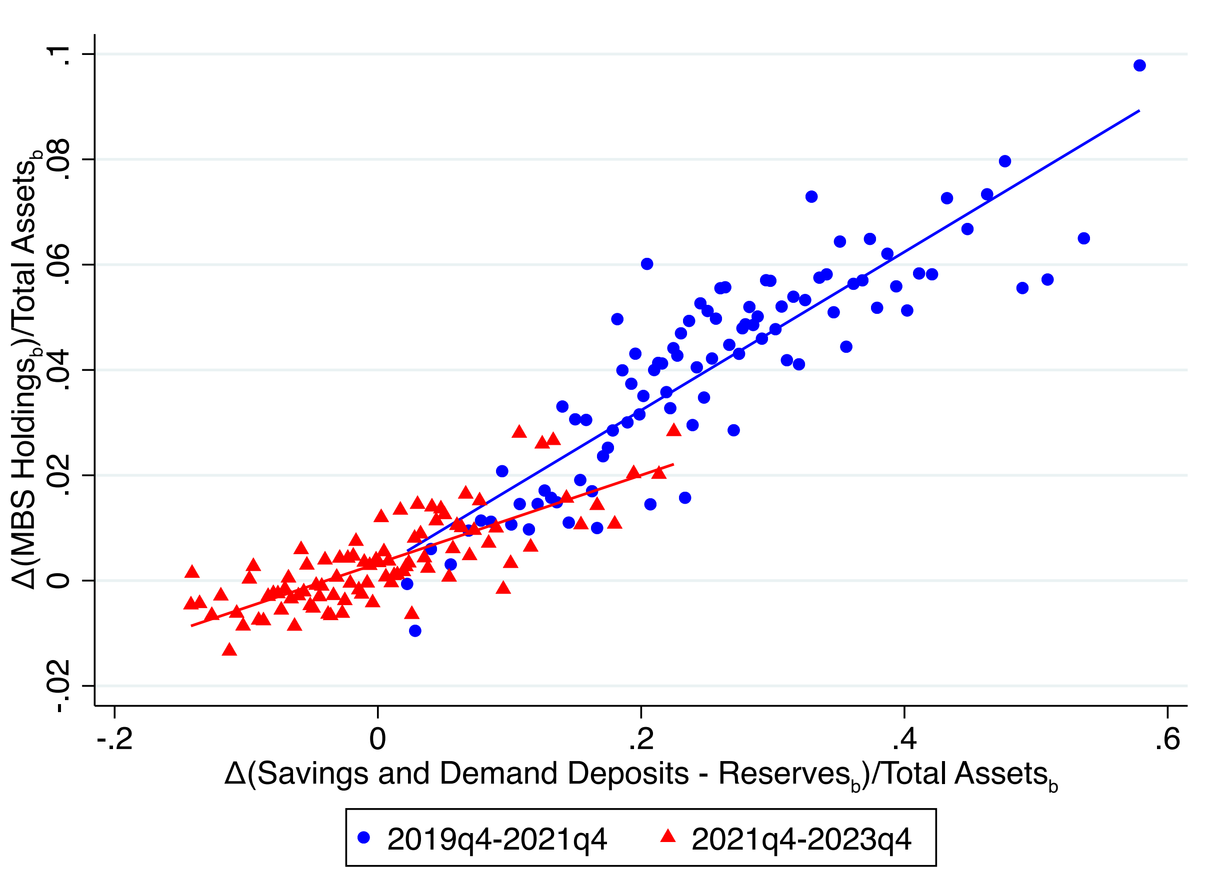
3.5 Equilibrium in the MBS Market

How do the Federal Reserve's and banks' MBS purchases and sales affect the mortgage market? As discussed above, when monetary policy induces the Fed or banks to change their holdings of MBS, they tend to be price-insensitive buyers and sellers. The Federal Reserver purchases and sells MBS based on the broad economic objectives of its QE/QT policy. Banks purchase and sell MBS based on their deposit inflows and outflows. Who

[10]The relationship appears slightly flatter during the QT period than the QE period, hence there may be some asymmetry between the effects of loosening and tightening. We caution, however, that the apparent asymmetry is small and the tightening cycle is still ongoing.

Figure 13: **Deposit Flows and MBS Investment Across Banks**

This figure provides binscatter plots of the relationship between the change in bank deposits and the change in banks' MBS holdings across banks, both as share of total assets, quarterly for 2019Q4-2021Q4 (blue dots) and 2021Q4-2023Q4 (red triangles). Deposits are computed as transaction plus savings deposits minus reserves, all from the call reports. MBS holdings by banks are also from bank call reports. The sample includes 4,667 banks for the 2019Q4-2021Q4 period and 4,457 banks for the 2021Q4-2023Q4 period.



takes the other side?

There are two groups: price-sensitive MBS investors who absorb Fed and bank purchases by reducing their own holdings, and mortgage borrowers who do so by taking out additional mortgage debt. We consider them in turn.

3.5.1 The role of price-sensitive MBS investors

The main groups of MBS investors besides banks and the Fed are pension funds, insurance companies, hedge funds, private wealth (households), and foreign investors. We refer to them collectively as other MBS investors. These investors tend to be price-sensitive, meaning their demand is more elastic with respect to price than that of banks and the Fed. In equilibrium, the price sensitivity of other MBS investors determines the impact of changes in Fed and bank MBS holdings on the price of mortgage credit.

Figure 14: **Cumulative Net Purchase of MBS, by Entity**

This figure plots the cumulative net purchase of MBS since 2020Q1 for the Fed, banks, and all others, quarterly from 2020Q1 to 2024Q1. Net purchase of MBS is calculated by taking the quarterly change in the outstanding agency and GSE-backed securities held by each entity from the Z.1 release in FRED. Banks comprise of US-chartered depository institutions, banks in US-affiliated areas, and credit unions. We normalize the net purchase of MBS to zero in 2020Q1 to get cumulative net purchase. The data are in market values.

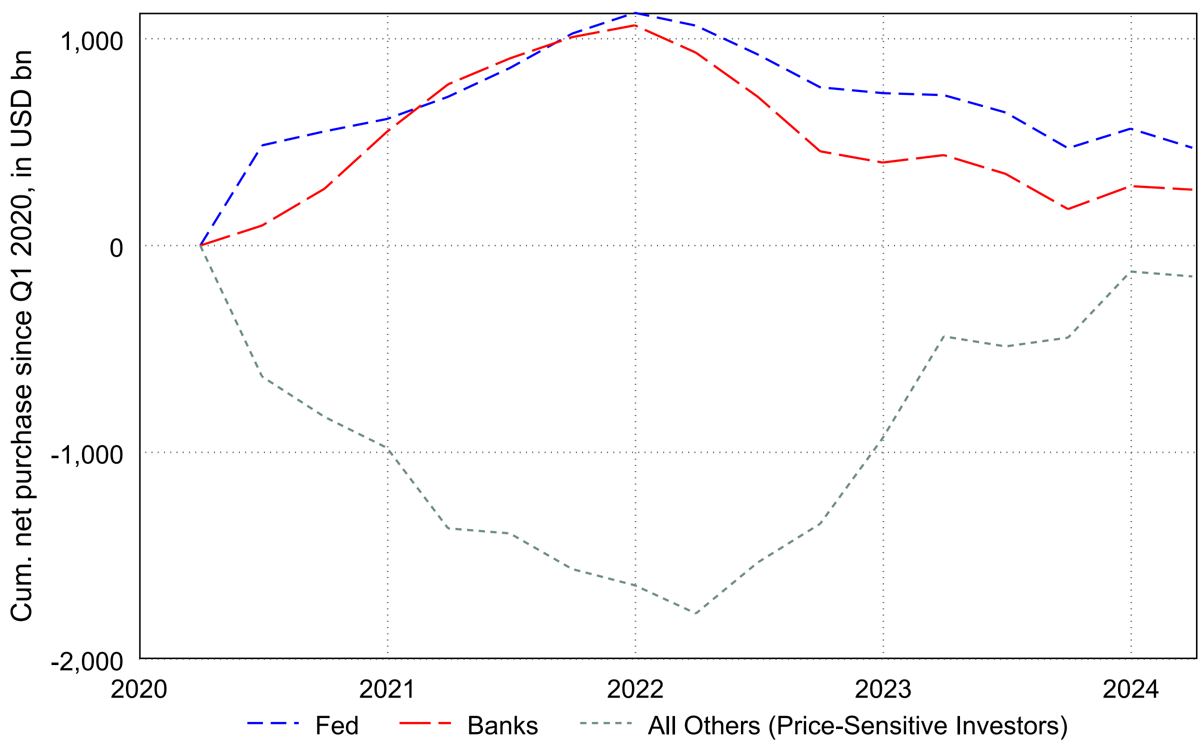


Figure 14 looks at the MBS purchases and sales of the Fed, banks, and other MBS investors. The figures plots the cumulative purchases for each investor group from January 2020 to March 2024. The Fed and the banking sector purchased $2.2 trillion from the first quarter of 2020 until the first quarter of 2021. At the same time, other MBS investors sold $1.4 trillion of MBS. Recall from Figure 2 that the mortgage spread was historically low during this period. Thus, other MBS investors sold when the price of MBS was high, consistent with a high degree of price sensitivity.

The figure shows the same dynamic in reverse during the QT period. Banks and the Fed reduced their MBS holdings by around $1.2 trillion while other MBS investors increased theirs by $1.4 trillion. The mortgage spread was high during this period, hence other MBS investors again acted in a price-sensitive manner.

Note, however, that if other MBS investors were perfectly price-sensitive, mortgage spreads would neither have fallen during the QE period nor risen during the QT period. The fact that they did, and did so substantially, implies that other MBS investors have considerations other than price, such as the increased risk that larger holdings pose to their portfolios. It also implies that bank and Fed MBS purchases have a significant impact on the price of mortgage credit.

3.5.2 The quantity response of mortgage borrowers

As we saw in Figure 14, when the Fed and banks purchased $2.2 trillion of MBS during 2020–22, other MBS investors sold $1.4 trillion. This implies that the overall size of the MBS market increased by $800 billion. Thus, the reduction in mortgage spreads induced by Fed and bank MBS purchases translated into a large, positive aggregate quantity response. Similarly, the subsequent widening of mortgage spreads induced by Fed and bank MBS sales during 2022–23 induced a large negative quantity response. We saw these quantity responses in Figures 3 and 4. They imply significant economic effects on consumer spending and residential investment.[11]

3.5.3 Putting it all together

We argue that monetary policy, acting both directly through the Fed and indirectly through the banking sector, played a large role in first expanding and then contracting the supply of mortgage credit since 2020. It did so through two mechanisms: the Fed's QE/QT programs and banks' buying and selling of mortgages driven by the deposits channel of monetary policy. The combination of these two mechanisms explains why mortgage markets played such a central role in monetary policy transmission during the recent cycle.

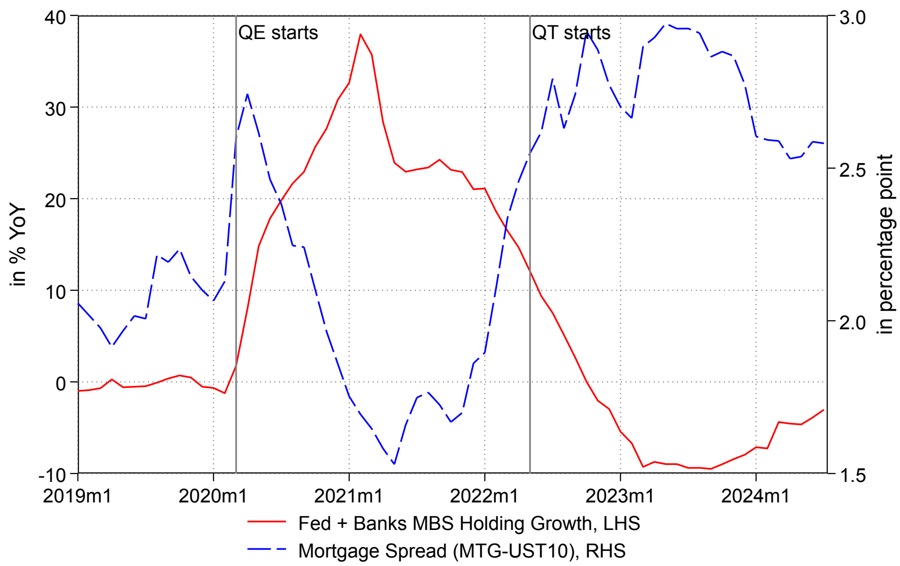
Figure 15 illustrates the key dynamics of this transmission. Panel A plots the year-on-year growth in the combined MBS holdings of the Fed and banks against the mortgage spread from January 2020 to March 2024. The figure shows that when the Fed and banks grew their MBS holdings, the cost of mortgage credit fell and when the Fed and the banks shrank their MBS holdings, the cost of mortgage credit rose.

Panel B plots the same year-on-year growth in the combined Fed and bank MBS holdings against net MBS issuances over the same time period. It shows that when the Fed

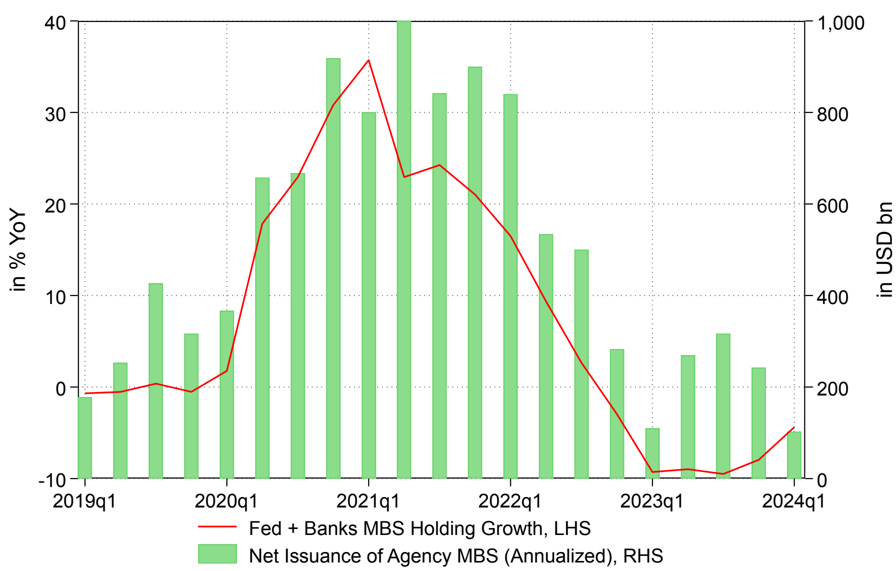
[11] These quantity responses were also likely influenced by other factors such as demand for housing due to the rise of work-from-home. We provide a quantitative estimation of the impact of Fed and bank MBS purchases on gross and net mortgage originations in Section 6 below.

Figure 15: **The Fed and Banks' MBS Holding, Mortgage Spread and MBS Net Issuance**

Panel A plots the relationship between the growth in the Fed and banks' MBS holding and the mortgage spread, monthly from Jan 2019 to May 2024. The Fed's MBS holding is sourced from the H.4.1 release table in FRED. The banks' MBS holding is sourced from the H.8 release table in FRED. We sum them then take the year-over-year percentage growth. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage index and the 10-year US Treasury yield, both from FRED. The values are quarterly average of the daily spread. Panel B plots the relationship between the growth in the Fed and banks' MBS holding and net issuance of agency MBS, quarterly from 2019Q1 to 2024Q1. Net agency MBS issuance is annualized and sourced from the Ginnie Mae Global Markets Analysis Report.



(a) MBS Holding and Mortgage Spread



(b) MBS Holding and Net Issuance

and banks bought MBS, making mortgage credit cheaper, the net issuance of new MBS rose. Conversely, when the Fed and banks sold off their MBS and the cost of mortgage credit rose, there was a significant reduction in new MBS issuance. This supports the view that banks and the Fed induced large shifts in the supply curve of mortgage credit.

This shift in the supply of mortgage credit contributed to significant fluctuations in the housing market. Moreover, it helps to explain the disproportionate impact that monetary policy had on housing during the recent cycle. Through this impact, monetary policy directly influences the accessibility and affordability of housing and the construction of new housing units.

3.5.4 Beyond the recent cycle

While the Federal Reserve's involvement in mortgage markets is a relatively recent development, monetary policy has always influenced banks' willingness to supply mortgage credit. Figure 16 shows the relationship between banks' MBS purchases and mortgage spreads over the past three and a half decades. Panel A plots year-on-year deposit growth against year-on-year growth in banks' MBS holdings. The close relationship observed during the recent cycle is also evident in each previous one. Panel B plots the year-on-year growth in MBS holdings against the year-on-year change in the MBS spread over the same period. Here too, we find that the relationship observed recently mirrors the historical one: the mortgage spread declines when banks expand their MBS holdings and the mortgage spread rises when banks reduce their MBS holdings.

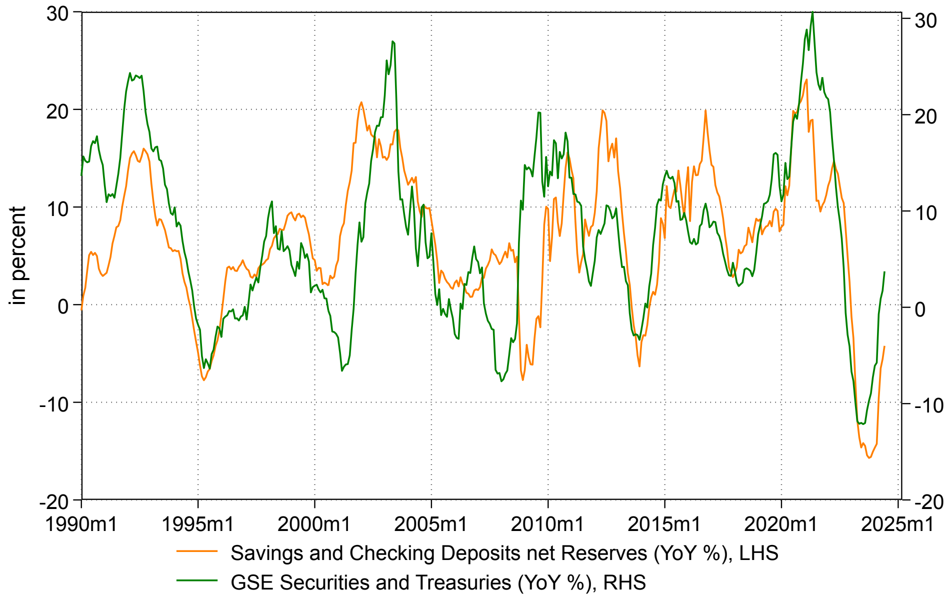
Consequently, the influence of monetary policy on mortgage credit does not require QE. When only conventional monetary policy is in effect (e.g. away from the zero lower bound), it influences mortgage credit through banks and the deposits channel. When the Fed also steps in and conducts its own asset purchases in addition to banks, the two add up and play an outsized role. The robustness of this mechanism over the past decades makes it likely that it will continue to play a central role in the transmission of monetary policy going forward.

3.6 The regional banking crisis of 2023: an event study

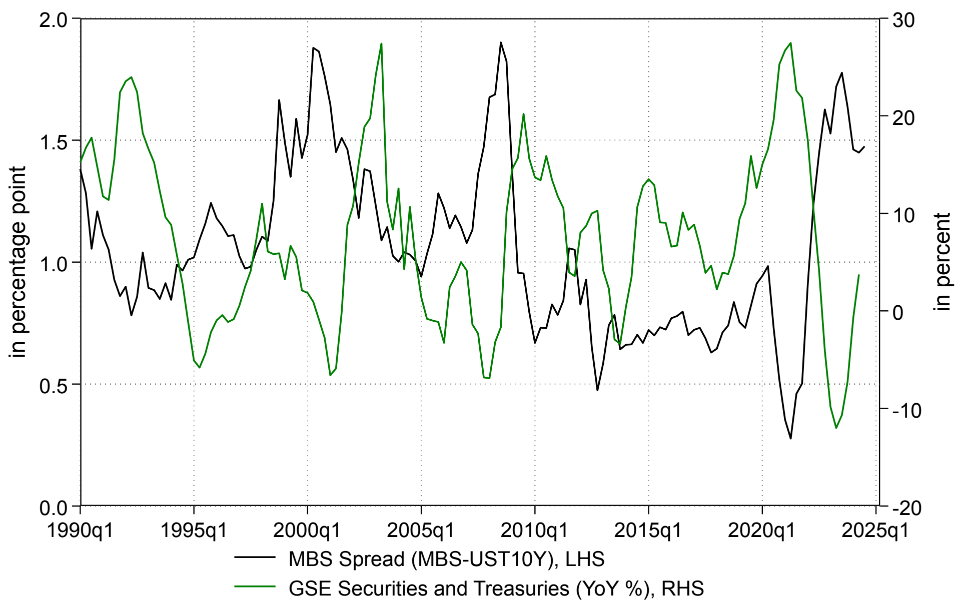
To underscore the importance of banks in the MBS market, we present evidence from an event study examining the regional banking crisis of 2023. We argue that this event serves as a shock to banks' demand for MBS. The crisis raised concerns that banks would face large deposit outflows and an increase in deposit betas. Since banks use low-beta deposits to invest in MBS (Drechsler et al. (2021); Supera (2021); Drechsler et al. (2023)), this

Figure 16: **Banks' Deposits, MBS Holding and MBS Spread**

Panel A plots the relationship between the year-over-year growth rate in bank deposits and banks' holding of MBS and Treasury securities, monthly from Jan 1990 to Jun 2024. Deposits are computed as transaction plus savings deposits minus reserves. MBS and Treasury securities holding by banks is taken from the H.8 release in FRED. Panel B plots the relationship between the MBS spread and the year-over-year growth in banks' holding of MBS and Treasury securities, quarterly from 1990Q1 to 2024Q2. The MBS spread is the spread between the 30-year FNCL Par Coupon index from Bloomberg and the 10-year US Treasury yield from FRED. The values are quarterly average of the daily spread.



(a) Deposits and MBS Holding Growth



(b) MBS Holding Growth and MBS Spread

translates into lower bank demand for MBS. If banks are important for the MBS market, this should lead to a drop in MBS prices and an increase in mortgage spreads.

We test this prediction using an event study methodology. Specifically, we perform a high-frequency analysis of an MBS exchange-traded fund (ETF) that tracks a broad market index of agency MBS. Figure 17 plots the return of this index in excess of the return of a duration-matched Treasury ETF (blue line) around the collapse of Silicon Valley Bank (SVB) on March 10, 2023 (vertical red line), which triggered the regional banking crisis.[12] The two ETFs move closely together in early 2023, which supports using the duration-matched Treasury ETF as a benchmark.

The MBS and Treasury ETFs diverge significantly in March 2023. On the day SVB failed, the MBS ETF lost around 1 percent in value relative to the Treasury ETF.[13] The gap that opened up between the MBS and Treasury ETFs remained for the next few months after the start of the regional banking crisis. The drop value of the MBS ETF aligns closely with an abrupt outflow of deposits from small banks (black dash line), illustrating the concerns raised by the crisis.

This high-frequency evidence demonstrates how deposits impact the mortgage market, with MBS prices immediately reflecting banks' expected demand for these long-term assets.

4 Framework

We now provide a stylized framework for quantifying the impact of banks and the Fed on mortgage spreads and originations during 2020–2023.

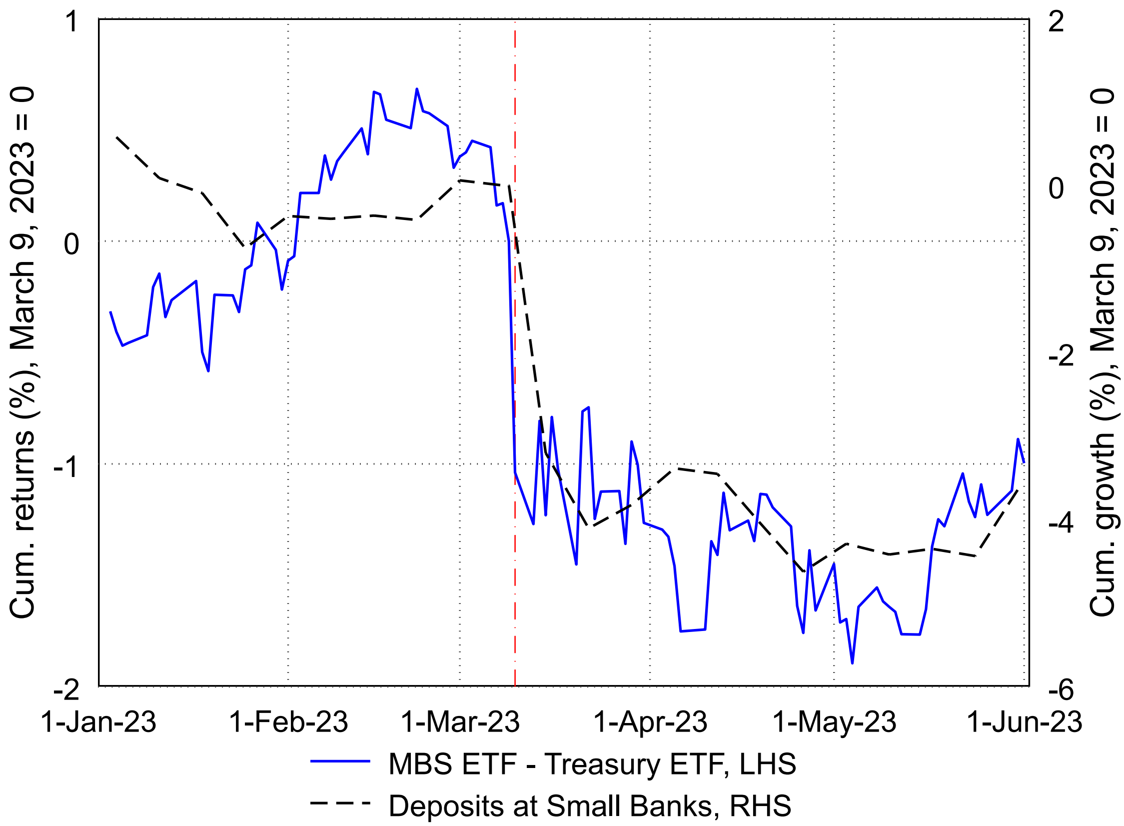
Time is infinite and discrete, $t \geq 0$. There is an asset, MBS, whose expected rate of return is R_t^{MBS}, which is endogenous. There is also a bond whose rate of return is R_t,

[12] We use the iShares MBS ETF (MBB) and the iShares 7-10 Year Treasury Bond ETF (IEF). The duration of MBB and IEF were similar: around 6 and 7 years, respectively. Our results are robust to using a portfolio of IEF and cash that exactly matches the duration of MBB.

[13] A potential concern is that the decline in the MBS ETF relative to the Treasury ETF could be driven by an increase in mortgage prepayment risk rather than banks' demand for MBS. In particular, the expected volatility of long-term rates, as measured by the MOVE index, increased (MOVE is similar to VIX but for Treasury bonds). Higher rate volatility raises the value of the prepayment option and this could be why the MBS ETF declined. To alleviate this concern, we perform a robustness analysis, where we account for the changes in prepayment risk by controlling for changes in the MOVE index in our event study. We obtain a residual from a regression of the MBS ETF excess returns on changes in the MOVE index changes prior to the regional bank crisis. The resulting adjusted (hedged) MBS ETF excess return exhibits a similar pattern to the raw one and also falls sharply after SVB's collapse. We also look at the option-adjusted spread (OAS), which removes the estimated value of the prepayment option. We use OAS constructed by Bloomberg for the entire portfolio of outstanding MBS, which matches the holdings of the MBS ETF. OAS increases by about 10 basis points following the collapse of SVB. These robustness results are presented in Appendix B.

Figure 17: **MBS excess returns and deposits around the collapse of Silicon Valley Bank**

This figures plot MBS excess returns and deposits at small banks, weekly from 1 Jan 2023 to 1 Jun 2023. Excess returns is measured by the difference in cumulative returns between iShares MBS ETF (MBB) and iShares 7-10 Year Treasury Bond ETF (IEF). Deposits at small banks is the cumulative growth in total deposits at small domestically chartered commercial banks from the Federal Reserve's weekly H. 8 report on assets and liabilities of commercial banks in the US. Both series are normalized to be 0 on March 9, 2023. Vertical red line denotes March 10, 2023, when SVB collapsed.



which is exogenous. There are three types of agents who hold MBS: the Fed (F), banks (B), and investors (I). There are also mortgage borrowers who supply MBS.

The Fed: The Fed holds MBS in the amount F_t each period, according to its QE program. We take the process F_t as exogenous, but in principle it could be driven by economic conditions such as whether the policy rate is at the zero lower bound, whether the output gap is high or low, and whether inflation is running above or below target. We can control for these factors empirically.

Banks: Banks are risk averse agents with background risk in the form of a deposit franchise. As in Drechsler et al. (2021), the deposit franchise has negative duration, creating a hedging demand for MBS. Consistent with this theory, there is a strong empirical relationship between deposit growth and bank MBS purchases. We therefore directly assume that banks' demand for MBS depends on deposits D_t:

$$B_t = \alpha^B D_t, \quad (1)$$

where α^B is banks' portfolio share of MBS. By omitting the rate of return on MBS, we are implicitly assuming that banks are price-insensitive, i.e. they care only about hedging. We can test this assumption in the data.

What drives deposits? Following the deposits channel of monetary policy (Drechsler et al., 2017), we assume deposits are a decreasing function of the interest rate: $D_t = D(R_t)$ with $D' < 0$.[14] This means that when interest rates fall banks purchase MBS, and when interest rates rise they sell MBS.

Investors: Investors have mean-variance preferences. They hold a portfolio of MBS and bonds. Their demand for MBS therefore depends on the spread between MBS and bonds:

$$I_t = \alpha^I \left(R_t^{MBS} - R_t \right) + \epsilon_t^I, \quad (2)$$

where α^I is the elasticity of investors' demand for MBS with respect to the MBS spread. This elasticity is given by $\alpha^I = 1/\left(\gamma^I \sigma^2\right)$, where γ^I is investors' risk aversion and σ_t^2 is the variance of MBS returns.

Investors' demand for MBS includes a demand shock ϵ_t^I. This could be due to flight to quality effects from other (risky) assets or a general increase in assets under management. The demand shock is generally unobserved, hence it presents an identification challenge when estimating investors' demand elasticity α^I.

Supply: The supply of MBS is decreasing in the MBS rate, capturing mortgage borrowers' demand for mortgages:

$$S_t = -\alpha^S R_t^{MBS} + \epsilon_t^S, \quad (3)$$

[14] In the deposits channel, deposits depend on the short-term interest rate but since our framework is static there is no distinction between short- and long-term rates.

where α^S is the elasticity of MBS supply with respect to the mortgage rate and ϵ_t^S is an MBS supply shock. In practice, the outstanding supply of MBS depends partly on the history of past mortgage rates. However, the net supply of new mortgages each period primarily depends on the most recent mortgage rates. This suggests that we should estimate the model in changes.

The MBS supply shock ϵ_t^S plays a similar role as the investor demand shock ϵ_t^I. An important example of an MBS supply shock is the rise in demand for housing during Covid due to widespread work-from-home, which contributed to a surge in mortgage originations. This is among the reasons we estimate the model pre-Covid and use the results to construct counterfactuals during the Covid period.

Market clearing: Total demand for MBS must equal supply:

$$F_t + B_t + I_t \quad = \quad S_t. \tag{4}$$

Notice that the market clearing condition also holds in changes. We can further scale by lagged supply to obtain stationarity for our empirical specifications:

$$\frac{\Delta F_t}{S_{t-1}} + \frac{\Delta B_t}{S_{t-1}} + \frac{\Delta I_t}{S_{t-1}} \quad = \quad \frac{\Delta S_t}{S_{t-1}}. \tag{5}$$

We refer to these as scaled dollar changes in MBS holdings and supply.

The MBS spread: The market clearing condition pins down the mortgage spread. Substituting for the demand of each type of investor and total supply, the MBS spread is given by

$$R_t^{MBS} - R_t \quad = \quad -\frac{1}{\alpha^I + \alpha^S}\left(F_t + \alpha^B D_t\right) - \frac{\alpha^S}{\alpha^I + \alpha^S} R_t - \frac{1}{\alpha^I + \alpha^S}\left(\epsilon^I - \epsilon^S\right). \tag{6}$$

The MBS spread shrinks when the Fed or banks increase their MBS holdings, in the case of banks because they have more deposits. The spread depends on the combined holdings of the Fed and banks, i.e. a dollar purchased by the Fed has the same impact on the cost of mortgage credit as a dollar purchased by banks.

The MBS spread also shrinks when interest rates rise because demand for mortgages falls. From this perspective, the recent widening of MBS spreads during a period of high interest rates is puzzling without accounting for the behavior of the Fed and banks.

Finally, the MBS spread depends on the net demand shock for MBS, $\epsilon^I - \epsilon^S$.

Identification: We are interested in estimating the impact of Fed and bank MBS purchases on mortgage spreads and mortgage originations. This requires identifying the elasticity parameters α^I and α^S. We cannot estimate α^I directly by regressing investor holdings I_t on the spread $R_t^{MBS} - R_t$ because the spread depends partly on the demand shock ϵ^I, which enters I_t as an omitted variable. In words, if investors demand more MBS, then their holdings will rise while the MBS spread falls. This will make them look inelastic even if they are not. Formally, running this regression would lead to a biased estimate of α^I toward zero:

$$\widehat{\alpha}^I_{OLS} = \frac{Cov\left(I_t, R_t^{MBS} - R_t\right)}{Var\left(R_t^{MBS} - R_t\right)} = \alpha^I - \frac{1}{\alpha^I + \alpha^S} \frac{Var\left(\epsilon^I\right)}{Var\left(R_t^{MBS} - R_t\right)} < \alpha^I. \tag{7}$$

The same argument holds for regressing the supply of MBS, S_t, directly on the MBS rate R_t^{MBS}. If the MBS rate rises because homebuyers demand more mortgages, then the supply of MBS will not fall, making homebuyers appear inelastic even if they are not. In this case the supply shock ϵ^S would act as an omitted variable, also biasing α^S toward zero.

We therefore need an instrument for the MBS spread that is plausibly uncorrelated with ϵ^I and ϵ^S. A valid instrument within the model are Fed purchases F_t. Using Fed purchases as an instrument recovers an unbiased estimate of α^I:

$$\widehat{\alpha}^I_{IV} = \frac{Cov\left(I_t, F_t\right)}{Cov\left(R_t^{MBS} - R_t, F_t\right)} = \frac{-\frac{\alpha^I}{\alpha^I + \alpha^S}}{-\frac{1}{\alpha^I + \alpha^S}} = \alpha^I. \tag{8}$$

In practice, the Fed is a price-insensitive buyer driven by macroeconomic conditions. Fed purchases are a valid instrument under the assumption that the macroeconomic conditions the Fed cares about, such as the output gap and inflation, are uncorrelated with the demand and supply shocks for MBS. To the extent they are correlated, we can control for them directly and see if our results change.

A deeper concern would be if the Fed cares about the mortgage market over and above the broad state of the economy. For instance, it could be that the Fed specifically targets mortgage spreads in order to stimulate housing. Notice that in that case we would observe a positive correlation between Fed purchases and mortgage spreads, i.e. our results would "go the other way."

Lastly, we can use survey data on expected Fed purchases from the Survey of Primary Dealers. This is helpful to the extent private forecasters have a better sense of the endogenous—and hence predictable—component of Fed purchases than we do as econometricians. As with the other controls, we can gauge the plausibility of our identification assumption by checking whether the results are sensitive to controlling for expected Fed purchases.

Identifying α^S: There is an additional challenge in identifying the supply elasticity α^S. Notice that MBS supply (3) depends on the level of mortgage rates, R_t^{MBS}, not the spread. This makes sense because mortgage borrowers pay the full mortgage rate, not just the spread. Yet instrumenting for the level of interest rates is much more challenging than a spread because the level of interest rates equilibrates saving and investment for the whole economy, not just the MBS market. Moreover, the Fed engages in QE precisely when it wishes to reduce the equilibrium level of interest rates and is unable to do so through conventional policy due to a binding zero lower bound.

We address this challenge as follows. First, we run the (potentially biased) OLS regression of mortgage originations on the mortgage rate pre-Covid. This removes the large mortgage demand shock associated with the rise of work-from-home. We also extend the sample back to 1990 to see if the elasticity estimates are stable. This is helpful if other mortgage demand shocks are clustered during specific periods, e.g. the early 2000s housing boom.[15]

We also use our framework to go a step further. Under the assumption that Fed MBS purchases are a valid instrument for the MBS spread, the first-stage coefficient recovers a combination of α^I and α^S:

$$\widehat{\beta}^{First\,Stage} = \frac{Cov\left(R_t^{MBS} - R_t, F_t\right)}{Var\left(F_t\right)} = -\frac{1}{\alpha^I + \alpha^S}. \tag{9}$$

Given our IV estimate of α^I, $\widehat{\alpha}_{IV}^I$, we can use this relationship to back out an implied IV estimate of α^S:

$$\widehat{\alpha}_{IV,Implied}^S = -\frac{1}{\widehat{\beta}^{First\,Stage}} - \widehat{\alpha}_{IV}^I. \tag{10}$$

The implied IV estimate identifies α^S under the additional assumption that the model is well-specified. For instance, a key model assumption is that banks are rate-insensitive. If they are not, then the first-stage coefficient would pick that up. Thus, while $\widehat{\alpha}_{IV,Implied}^S$ has the advantage of correcting for OLS bias, it is potentially sensitive to model misspeci-

[15] As one more check, we also compare our estimates to micro elasticities identified in the literature.

fication. For this reason, we rely on both our OLS (biased but model-free) and implied IV (unbiased but model-specific) estimates of α^S.

5 Data sources

We use a variety of price and quantity data to estimate our framework. Unless otherwise noted, all data was downloaded from the Federal Reserve Bank of St. Louis' FRED database, starting in 1990.

MBS holdings: Our main data source is the Financial Account of the U.S., also known as the "flow of funds" or the Z.1 release. We use Table L.211, "Agency- and GSE-Backed Securities" at the quarterly frequency to measure the holdings of Agency MBS of different types of investors. Total MBS holdings are line 5, "Total Assets". Fed holdings (F_t) are line 10, "Monetary Authority". For banks (B_t), we take the sum of lines 11 ("U.S.-chartered depository institutions"), 13 ("Banks in U.S.-affiliated areas"), and 14 ("Credit unions"). We define investor holdings (I_t) as total holdings minus Fed holdings and bank holdings. In some tests we split investors into households ("Household sector," line 6), asset managers (the sum of "Property-Casualty Insurance Companies," "Life Insurance Companies," "Private Pension Funds," "Federal Government Retirement Funds," "State and Local Government Employee Defined Benefit Retirement Funds," "Money Market Funds," and "Mutual Funds;" lines 16–21), rest of the world (the sum of "Rest of the World," line 27, and "Foreign banking offices in U.S.," line 12), and others (all remaining categories). We use Table L.210, "Treasury Securities," to obtain the Fed's Treasury holdings from line 21, "Monetary Authority".

Deposits: For bank deposits (D_t), we use the Fed's H.6 release, "Money Stock Measures". We focus on checking and savings deposits because they are the low-beta deposits banks invest in MBS. For checking deposits, we use "Demand Deposits [DEMDEPSL]" (FRED code in brackets). For savings deposits, there is a discontinuity in the reporting in May 2020. Prior to this date, we use "Savings Deposits: Total [SAVINGSL]" plus "Other Checkable Deposits: Total [OCDSL]" (also known as transaction savings deposits). After May 2020, we use "Other Liquid Deposits [MDLM]". We subtract reserves from deposits to avoid double-counting QE (see Acharya and Rajan, 2022). We measure reserves using table L.109, "Monetary Authority" of the flow of funds, specifically line 24, "Depository Institution Reserves [MADIRL]". We then subtract the reserves of foreign banks, which we obtain from Table L.112 "Foreign Banking Offices in U.S.," line 3, "Reserves at Federal

Reserve [FBOUSDIRA].” This ensures consistency across our asset holdings and deposits series.

Rates: For the mortgage rate, we use the “30-Year Fixed Rate Mortgage Average in the United States [MORTGAGE30US]” from Freddie Mac’s Primary Mortgage Market Survey, which is reported weekly. For the mortgage spread, we subtract the weekly yield on the 10-year Treasury note, “Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, Quoted on an Investment Basis [WGS10YR].” We also download the (monthly) Fed funds rate, “Federal Funds Effective Rate [FEDFUNDS],” and the (daily) lower limit of the Fed’s target range for the Fed funds rate, “Federal Funds Target Range - Lower Limit [DFEDTARL]”. We aggregate all of these rates up to the quarterly frequency by taking their end-of-quarter values.

Macro variables: We construct a zero-lower bound (ZLB) indicator variable equal to one when the lower limit of the Fed’s target range for the Fed funds rate is zero, and zero otherwise. We construct the output gap as “Real Gross Domestic Product [GDPC1]” minus “Real Potential Gross Domestic Product [GDPPOT]” divided by “Real Potential Gross Domestic Product [GDPPOT]” and multiplied by one hundred (the underlying source are the National Income and Product Accounts of the U.S.). We construct the inflation gap as the year-over-year percentage change in “Personal Consumption Expenditures: Chain-type Price Index Less Food and Energy (JCXFE),” less 2%.

Mortgage originations: We obtain mortgage originations from the Mortgage Bankers Association. We use “Mortgage Originations: 1-4 Family: Total (Bil.$)” at a quarterly frequency. We multiply originations by 4 to convert to annual rates. This data includes all mortgages, not just MBS. The implicit assumption is that mortgage borrowers have the same interest rate sensitivity whether their mortgage gets securitized or not. The data also includes refinance originations, which tend to be more interest rate-sensitive than purchase loans.[16]

We scale mortgage originations by total mortgages, which we obtain from the flow of funds, Table L.218 “Home Mortgages,” line 5, “One-to-Four-Family Residential Mortgages; Asset, Level [ASHMA].” Using this series ensures consistency with the originations data.

[16] A large literature (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023) finds that mortgage refinancing has a big impact on household consumption.

Expected Fed purchases: We construct series for the expected Fed MBS and Treasury purchases one quarter ahead using data from the Survey of Primary Dealers (SPD) conducted by the Federal Reserve Bank of New York (NY Fed). The data is available for the period 2011–2018. The surveys are filled out by primary dealer firms about a week before each Federal Open Market Committee (FOMC) meeting. Results from the survey for January 2011 and onward are provided on the NY Fed's website. The questionnaires from January 2011 until January 2015 and from March 2020 onward contain questions about the expected future size of either the Fed's balance sheet or its asset purchases. We use expected changes in the size of the balance sheet to measure purchases when not directly available. Starting in August 2011, the SPD provides a breakdown between MBS and Treasury securities. For periods prior, we apply the breakdown from the Fed's actual purchases in the last period before the current one. We obtain actual purchases from the NY Fed's SOMA holdings dataset. Additional details on the construction of our expected Fed purchases measure are provided in Appendix A. Our approach is similar to Kim et al. (2020), except we focus on MBS purchases (versus total) at the quarterly frequency (versus annual).

Summary statistics: Table 1 presents summary statistics for all variables used in the analysis. We report means and standard deviations separately for the longer sample, 1990–2019, and the shorter recent sample, 2010–2019.

6 Estimation and results

We estimate our model pre-Covid and use the results to conduct counterfactuals during the Covid period. We use two main estimation samples, 1990–2019, and 2010–2019. The longer sample gives greater statistical power, while the shorter one is more current and allows us to use Fed MBS purchases as an instrument. The extent to which the two samples yield similar results establishes robustness of our estimates.

We estimate the model in scaled dollar changes, as shown in (5). We take these changes over four quarters to remove seasonality and allow for gradual adjustment of portfolios. For instance, for Fed MBS purchases, we calculate

$$\Delta \text{Fed MBS}_t = \frac{\text{Fed MBS}_t - \text{Fed MBS}_{t-1}}{\text{Total MBS}_{t-1}}, \quad (11)$$

where $t-1$ is one year (four quarters) prior to t. We do the same for banks and investors.

Table 1: **Summary statistics**

This table presents summary statistics at the quarterly level. Deposits are the sum of checking and savings deposits minus reserves. Holdings of MBS are holdings of agency and GSE-backed securities by different investor categories, where Others are all remaining after the first four categories and Investors are all aside from Banks and the Fed. Fed Treasury is the Fed's holding of Treasury securities. Expected Fed Net MBS is the expected Fed purchase of MBS minus the expected purchase of Treasury securities. GDP gap is real GDP minus real potential GDP divided by real potential GDP, multiplied by one hundred. Inflation gap is the year-over-year percentage change in the PCE price index, excluding food and energy, minus 2%. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. All variables aside from ZLB are in changes. For mortgage originations, we take the year-over-year change divided by total mortgages. For rates or spreads, as well as GDP gap and inflation gap, we take the simple difference from one year prior. For deposits, holdings of MBS, and Fed Treasury, we take the change from one year prior then divide by total MBS from one year prior. For expected Fed Net MBS, we take the four quarters trailing sum then divide by total MBS from one year prior.

	2010-2019		1990-2019	
	Mean	St. Dev.	Mean	St. Dev.
Holding of MBS				
Δ Banks MBS	0.013	0.009	0.014	0.012
Δ Fed MBS	0.011	0.033	0.006	0.025
Δ Asset managers MBS	0.001	0.016	0.020	0.026
Δ Rest of world MBS	−0.001	0.010	0.010	0.018
Δ Others MBS	−0.011	0.025	0.015	0.035
Δ Investors MBS	−0.008	0.056	0.053	0.073
Bank's balance sheet				
Δ Deposits	0.072	0.025	0.055	0.042
The Fed's balance sheet				
Δ Fed Treasury	0.022	0.035	0.013	0.024
Expected Δ Fed Net MBS	0.002	0.010		
Mortgage originations				
Δ Mortgage originations	0.002	0.051	0.018	0.112
Rates or spreads ($\times$100)				
Δ Mortgage rate	−0.132	0.597	−0.217	0.758
Δ Mortgage spread	0.001	0.252	−0.005	0.316
Δ Fed funds rate	0.193	0.358	−0.237	1.386
Other variables				
Δ GDP gap	0.544	0.633	−0.000	1.427
Δ Inflation gap	0.072	0.405	−0.084	0.441
ZLB	0.575	0.501	0.225	0.419
Observations	40		120	

We similarly take price and macro variables in changes over four quarters. For example, for the change in the mortgage spread we take

$$\Delta\text{Mortgage spread}_t \quad = \quad \left(R_t^{MTG} - R_t^{10Y}\right) - \left(R_{t-1}^{MTG} - R_{t-1}^{10Y}\right), \tag{12}$$

where R^{MTG} is the mortgage rate, R^{10Y} is the ten-year Treasury rate, and $t-1$ is again one year (four quarters) prior to t.

6.1 Fed MBS purchases and the mortgage spread

We begin by testing whether Fed MBS purchases are associated with a decline in the mortgage spread as predicted by Equation (6) in our framework. This test also serves as the first stage for our instrumental variables regressions. We run

$$\Delta\text{Mortgage spread}_t \quad = \quad \gamma + \beta^{First\ Stage} \times \Delta\text{Fed MBS}_t + X_t + \varepsilon_t^{First\ Stage}, \tag{13}$$

where Fed MBS are Fed MBS purchases and X_t are the following control variables: Fed Treasury purchases (Δ Fed Treasury), a zero-lower bound indicator variable (ZLB), and the changes in the Fed funds rate (Δ Fed funds), output gap (Δ GDP gap), and inflation gap (Δ Inflation gap). As a final control, we use the expected Fed purchases of MBS relative to Treasuries (Δ Expected Fed Net MBS). The sample is from 2010 to 2019 (there are no Fed purchases prior to 2008 hence we cannot use the longer sample for this test). Throughout the paper, we use Newey-West standard errors with three lags to account for the overlap in the data induced by taking year-over-year first differences.

The identifying assumption in (13) is that Fed MBS purchases are uncorrelated with unobserved shocks to the mortgage spread contained in $\varepsilon_t^{First\ Stage}$. A plausible counterexample would be if the Fed steps in to shrink spreads when they widen during a crisis. We exclude crises (both 2008–2009 and Covid) from our sample, but also note that this type of endogeneity would produce the opposite sign from our theory ($\beta^{First\ Stage} > 0$ instead of $\beta^{First\ Stage} < 0$), hence we can test for it.

The results of regression (13) are reported in Table 2. Column (1) runs a univariate specification with no controls. The coefficient on Fed MBS purchases, -4.233, is negative and strongly significant. Figure 18 shows a scatter plot of the relationship. There is a clear negative pattern. There is a potential outlier in 2010q1, but removing it has only a modest impact on the coefficient.

The economic magnitude of the coefficient is substantial: if the Fed purchases 10% of the MBS market, the mortgage spread is predicted to decline by 42 bps. The MBS market

Table 2: **Fed MBS purchases and the mortgage spread**

This table presents results from first stage regressions of mortgage spread on the Fed's MBS holding:

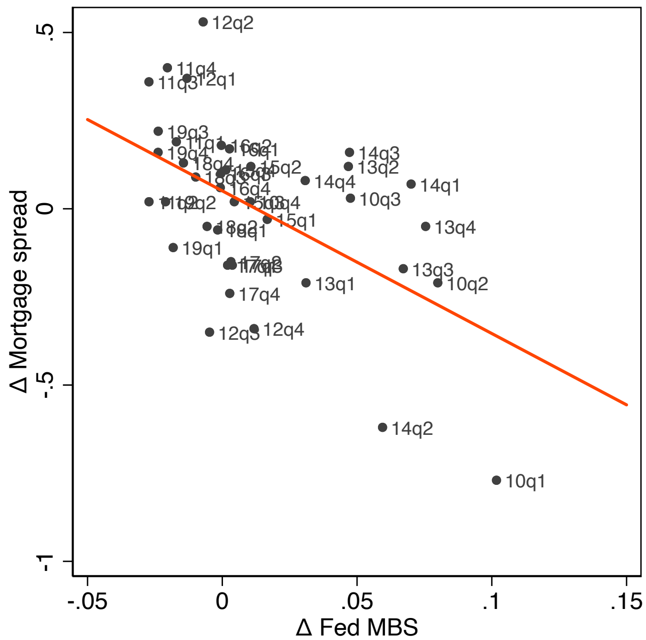
$$\Delta\text{Mortgage spread}_t \quad = \quad \gamma + \beta^{First\ Stage} \times \Delta\text{Fed MBS}_t + X_t + \varepsilon_t^{First\ Stage}.$$

Δ Fed MBS and Δ Fed Treasury are the year-over-year changes in the Fed's MBS and Treasury holding, respectively, scaled by total MBS. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. For expected Δ Fed Net MBS, we take the four quarters trailing sum of expected Fed purchase of MBS net of expected Fed purchase of Treasury securities, then divide by total MBS from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data from 2010 to 2019.

	Δ Mortgage spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Fed MBS	−4.233***	−4.430***	−5.294***	−4.385***	−5.632***	−4.519**
	(0.985)	(0.899)	(1.039)	(1.317)	(1.287)	(2.125)
Δ Fed Treasury		1.635*				1.319
		(0.864)				(2.457)
ZLB			0.041		0.039	
			(0.085)		(0.076)	
Δ Fed funds rate			−0.218**		−0.246***	
			(0.087)		(0.080)	
Δ GDP gap				0.008	0.015	
				(0.054)	(0.041)	
Δ Inflation gap				0.072	0.115	
				(0.104)	(0.075)	
Expected Δ Fed Net MBS						−7.170
						(4.443)
Constant	0.047	0.014	0.077	0.040	0.071	0.043
	(0.041)	(0.037)	(0.059)	(0.045)	(0.062)	(0.059)
Obs.	40	40	40	40	40	28
R^2	0.310	0.362	0.426	0.324	0.459	0.218

Figure 18: **Fed MBS purchases and mortgage spreads**

This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in mortgage spread (Δ Mortgage spread). The red line represents a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.



stood at $10 trillion at the start of Covid, hence this would be a $1 trillion purchase, similar to the Fed's actual purchases during 2020–2021.

Column (2) controls for the Fed's Treasury purchases. The reason for this control is that if the Fed purchased equal amounts of MBS and Treasuries, we would not necessarily expect the mortgage spread to shrink. Controlling for the Fed's Treasury purchases ensures this is not the case. Interestingly, the coefficient on Treasury purchases is positive and marginally significant. This is consistent with partial segmentation between Treasury and MBS markets. For our purposes, the important finding is that the coefficient on MBS purchases does not change and in fact slightly increases.

Column (3) controls for whether the zero-lower bound (ZLB) binds. The Fed undertook QE at least in part to overcome the ZLB constraint on conventional monetary policy. It is plausible that mortgage spreads tend to be low when rates are at the ZLB, for instance due to lower prepayment risk. In this case we would observe a spurious negative relationship between Fed MBS purchases and mortgage spreads, at least in levels (though not necessarily in changes). Contrary to this interpretation, we find that the coefficient on

Fed MBS purchases gets even larger when we control for the ZLB.

Column (3) also controls for changes in the Fed funds rate. If the Fed follows a Taylor rule (away from the ZLB), then changes in the Fed funds rate provide a a sufficient statistic for changes in the macroeconomic conditions that the Fed cares about. Controlling for changes in the Fed funds rate therefore controls for these macroeconomic conditions, ensuring that they are not driving the result. The fact that the coefficient is unaffected supports this prediction.

Columns (4) controls for macroeconomic conditions explicitly with the output gap and inflation gap. These have no explanatory power for mortgage spreads and do not significantly affect the coefficient on Fed MBS purchases. Column (5) includes all of the controls so far. The coefficient rises to -6.304, i.e. controlling for economic conditions actually strengthens the impact of Fed purchases on the mortgage spread. This makes sense under the view that the Fed undertakes QE when economic conditions weaken and the mortgage spread widens. This type of endogeneity biases us toward a finding positive coefficient. Controlling for economic conditions has the effect of reducing this bias, recovering an even more negative coefficient. In terms of magnitude, we find that a \$1 trillion Fed MBS purchase reduces mortgage spreads by 63 bps.

The final Column (6) controls for the Fed's expected net MBS purchases (MBS purchases minus Treasury purchases). These are available only over 2011–2018, which shrinks the sample. We use net as opposed to gross expected MBS purchases because net purchases turn out to be a stronger predictor of the mortgage spread: they have the correct sign and higher R^2 (22% versus 9%). Given this specification, we also control for the Fed's actual Treasury purchases as in Column (2). Controlling for expected purchases is yet another way of accounting for the potential impact of economic conditions on the Fed's MBS purchases. Economic conditions are largely publicly observed and hence accounted for in primary dealers' forecasts. Since we use expected purchases one quarter ahead, the only economic shocks we could be missing must occur within the quarter, i.e. QE would need to react to them contemporaneously.

Column (6) shows that Fed MBS purchases remain a robust predictor of mortgage spreads after controlling for expected Fed purchases. This supports the empirical strategy of using Fed MBS purchases as an instrument to identify the rate sensitivities of other investors.

6.2 Bank MBS holdings and deposits

In our framework (see Eq. (6)), $\widehat{\beta}^{First\ Stage}$ identifies the inverse of the combined elasticities of investors and mortgage borrowers, $1/\left(\alpha^I + \alpha^S\right)$. However, this only holds given our assumption that bank purchases $B_t = \alpha D_t$ are rate-insensitive (they depend on deposits). If banks respond to Fed purchases by selling, then $\widehat{\beta}^{First\ Stage}$ would give a downward-biased estimate of $1/\left(\alpha^I + \alpha^S\right)$ and hence an upward-biased estimate of $\alpha^I + \alpha^S$. Intuitively, if banks absorb the Fed's buying, then mortgage spreads would not rise much, and this would make investors and mortgage borrowers appear more elastic than they really are (since they are the only rate-sensitive agents in the model). It is therefore important to test if banks are indeed rate-insensitive as our framework assumes.

We do so by running a regression of changes in bank MBS holdings on mortgage spreads with and without controlling for deposits. We run OLS regressions over our longer sample from 1990–2019 and IV regressions using Fed purchases as an instrument over 2010–2019. The IV regression has the form:

$$\Delta \text{Banks MBS}_t = \gamma + \beta_B^{IV} \times \Delta \widehat{\text{Mortgage spread}}_t + \delta \times \Delta \text{Deposits}_t + X_t + \varepsilon_t^B, \quad (14)$$

where ΔBanks MBS is the year-over-year change in bank MBS holdings scaled by total MBS, $\Delta\widehat{\text{Mortgage spread}}$ is the change in the mortgage spread instrumented with Fed MBS purchases as in Table 2, X are controls that include the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap, and ΔDeposits is the year-over-year change in checking and savings deposits net of reserves, also scaled by total MBS.[17] The common scaling on the left and right side of the regression allows us to interpret the coefficients as dollar amounts.

Table 3 presents the results. Column (1) runs a univariate OLS regression of bank MBS holdings on mortgage spreads over 1990–2019. The coefficient on the mortgage spread is -0.004 and less than a standard error from zero. This supports the view that banks do not respond to changes in mortgage spreads, i.e., they are rate-insensitive.

It is plausible that the OLS coefficient in Column (1) is downward biased. If banks experience an unobserved positive demand shock for MBS, then they will increase their MBS holdings while mortgage spreads shrink. This will push down the OLS coefficient even if banks are rate-sensitive. The solution is to use an instrument. Section 6.1 showed

[17] We net out reserves from deposits to avoid double-counting QE. Acharya and Rajan (2022) argue that QE led to a large expansion of deposits. The reason is that when the Fed buys MBS, it issues reserves that banks must hold. Banks then issue a deposit to whoever sold the MBS to the Fed. We can therefore net out the impact of QE on deposits by subtracting reserves.

Table 3: **Bank MBS demand**

This table presents results from regressions of banks' MBS holding on the mortgage spread, including the instrumental variable regression:

$$\Delta\text{Banks MBS}_t \quad = \quad \gamma + \beta_B^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + \delta \times \Delta\text{Deposits}_t + X_t + \varepsilon_t^B.$$

Δ Banks MBS is the year-over-year change in banks' MBS holding scaled by total MBS. Δ Mortgage spread is the actual change in mortgage spread from a year ago, while Δ $\widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. Δ Deposits is the change in the sum of checking and savings deposits net of reserves, also scaled by total MBS. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

	Δ Bank MBS / Total							
	(1) 1990–19	(2) 2010–19	(3) 1990–19	(4) 2010–19	(5) 1990–19	(6) 2010–19	(7) 1990–19	(8) 2010–19
Δ Mortgage spread	−0.004 (0.006)				−0.004 (0.005)		−0.004 (0.005)	
Δ $\widehat{\text{Mortgage}}$ spread		0.021 (0.022)				0.009 (0.020)		0.009 (0.015)
Δ Deposits			0.123*** (0.037)	0.211*** (0.046)	0.124*** (0.037)	0.175** (0.081)	0.141*** (0.047)	0.185*** (0.066)
ZLB							−0.003 (0.003)	−0.003 (0.004)
Δ Fed funds rate							0.001 (0.001)	−0.002 (0.005)
Δ GDP gap							−0.001 (0.001)	0.003 (0.002)
Δ Inflation gap							−0.003 (0.003)	0.002 (0.005)
Constant	0.014*** (0.002)	0.013*** (0.002)	0.007** (0.003)	−0.002 (0.004)	0.007*** (0.003)	0.000 (0.006)	0.007** (0.003)	−0.000 (0.006)
Obs.	120	40	120	40	120	40	120	40
R^2	0.010	0.124	0.187	0.389	0.198	0.404	0.231	0.474

that Fed MBS purchases have a robust negative impact on mortgage spreads, one that holds conditional on economic conditions and dealer expectations. This provides support for the exclusion restriction needed to make it a valid instrument: that Fed MBS purchases are unrelated to unobserved shocks to MBS demand and supply. We therefore use Fed MBS purchases as an instrument for the mortgage spread.

Column (2) replaces the mortgage spread with the instrumented mortgage spread. The coefficient rises slightly to 0.021 but remains less than a standard error from zero. The slight increase, though not significant, is consistent with the hypothesis that the OLS estimate is downward biased. However, even after correcting for this bias we find no evidence that banks' demand for MBS responds to mortgage spreads, i.e. that banks are rate-sensitive.

If not mortgage spreads, what do banks respond to? Column (3) replaces the mortgage spread with deposit growth. Here we see a large positive and significant coefficient of 0.123. This means that since 1990 banks invested $12.3 dollars per $100 of deposits in MBS. This is close to banks' average MBS portfolio share over this period. The R^2 from the regression is 18.7%, suggesting that deposits have significant explanatory power.

Figure 19, Panel A, provides a scatter plot of the relationship between bank deposits and MBS holdings for 1990–2019. There is a clear positive slope. The only potential outliers are during the financial crisis in 2007–2008 but removing them actually improves the fit. Panel B shows the same relationship for 2010–2019. The slope is again strongly positive. The coefficient estimate is shown in Column (4) of Table 3: 0.211, higher than the one for 1990–2019. This makes sense because the average share of MBS on bank balance sheets has steadily increased. The fit also increases significantly as the R^2 doubles to 38.9%. Thus, bank deposits and MBS holdings have become even more tightly linked.

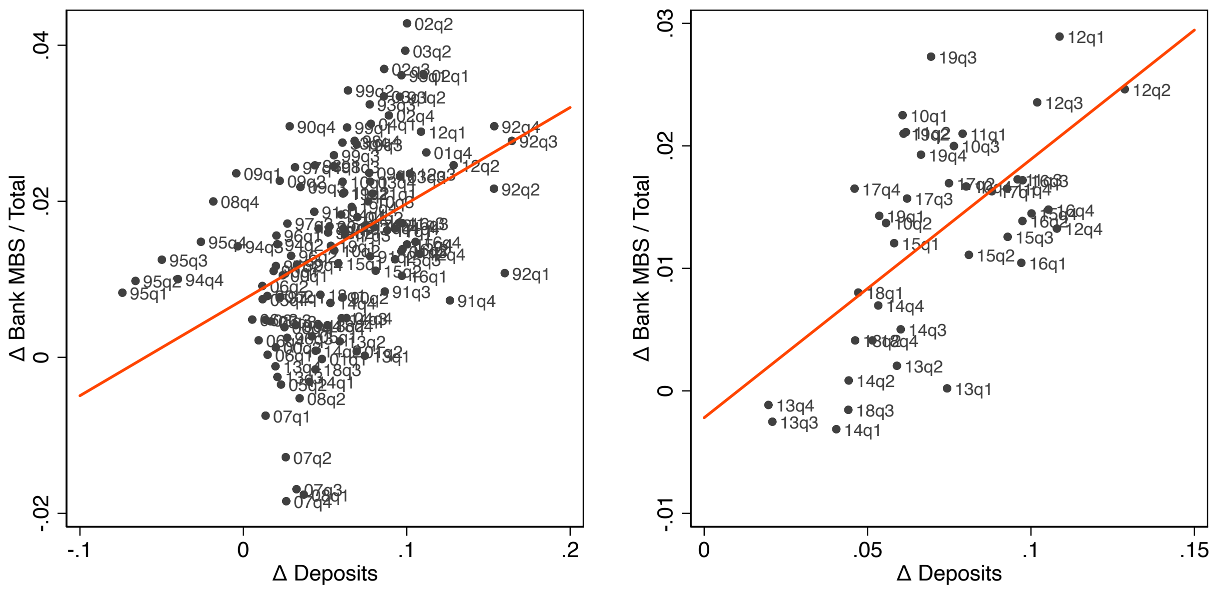
Column (5) of Table 3 runs a horse race between mortgage spreads and deposit growth in the 1990–2019 sample using OLS. Both variables retain their coefficients: mortgage spreads continue to have no explanatory power while deposit growth has high explanatory power. Column (6) shows the IV version of the same regression during 2010–2019. The result is the same: bank MBS holdings are insensitive to mortgage spreads but highly sensitive to deposits.

Column (7) runs the OLS regression from Column (5) with additional controls for economic conditions (the ZLB, Fed funds rate, output and inflation gap). There is no change in the coefficients. Finally, Column (8) adds the same controls to the IV regression in Column (6). There is again no noticeable change.

These results support the assumption of our model that banks are rate-insensitive investors. Their MBS holdings are instead driven by deposit growth. This implies that the

Figure 19: **Bank MBS purchases and deposits**

This figure plots the relationship between the year-over-year change in the sum of checking and savings deposits net of reserves, scaled by total MBS (Δ Deposits), and the year-over-year change in banks' MBS holding scaled by total MBS (Δ Banks MBS / Total). The red lines represent a simple linear fit of the data points. The data points are quarterly from 1990 to 2019 (Panel A) and from 2010 to 2019 (Panel B).



(a) 1990–2019

(b) 2010–2019

first-stage coefficient, $\widehat{\beta}^{First\ Stage}$, gives an unbiased estimate of $\alpha^I + \alpha^S$, which we can use to validate our direct estimation of these quantities.

It also implies that the large inflows of deposits during 2020–2021 can account for banks' expanded MBS holdings. Deposits (net of reserves) increased from \$9,846 billion in 2019q4 to \$14,557 billion in 2022q2, an increase of \$4,711 billion. Based on the coefficient for the recent sample in Column (4), the predicted increase in MBS holdings is $0.211 \times 4711 =$ \$994 billion. This is extremely close to the actual purchases of \$1 trillion documented in Section 3.3.3

6.3 Investor MBS holdings

Our framework shows that the impact of Fed and bank MBS purchases on mortgage spreads and mortgage originations depends on the rate-sensitivity (demand elasticity) of all other MBS investors, α^I. We estimate is with the same approach we used for banks.

We run OLS and IV regressions of investor MBS holdings on the mortgage spread, e.g.

$$\Delta\text{Investor MBS}_t \quad = \quad \gamma + \beta_I^{IV} \times \Delta\widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I, \tag{15}$$

where ΔInvestor MBS is the year-over-year change in investor MBS holdings scaled by total MBS, $\Delta\widehat{\text{Mortgage spread}}$ is the change in the mortgage spread instrumented with Fed MBS purchases as in Table 2, and X are controls (the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap). Investor holdings are those of all other categories besides banks and the Fed. Later we provide a breakdown by investor type (household sector, asset managers, rest of the world, and others).

The results of these regressions are presented in Table 4. Column 1 runs an OLS regression over the full sample, 1990–2019. In contrast to banks, investors appear strongly rate-sensitive. The coefficient on the mortgage spread is 0.092 and highly significant. Thus, a 100-bps widening of mortgage spreads leads investors to increase their MBS holdings by 9.2% of the total MBS market. This is despite the potential downward bias in the OLS estimate. Column 2 adds in economic controls. These have some impact: the coefficient on the mortgage spread drops to 0.065 but remains significant. Among the controls, the ZLB has the largest effect, perhaps because it picks up the aftermath of the 2008 financial crisis when investor demand for MBS fell.

Columns (3) and (4) repeat the first two for the shorter, 2010–2019 sample. These more recent estimates, which exclude the 2008 financial crisis, are similar to the earlier ones. The coefficient in Column (4), which includes economic controls, is 0.099, i.e. investors buy about 10% more of the MBS market when the mortgage spread widens by 100 bps. Overall, the OLS results appear robust.

Columns (5) and (6) run IV regressions to remove the potential bias in the OLS results. In Column (5), the instrumented coefficient is 0.388 and highly significant. This is triple the OLS coefficient, suggesting significant bias. Column (6) adds in the economic controls. These reduce the coefficient to 0.210, i.e. investors buy 21% of MBS outstanding per 100 bps increase in the mortgage spread.

Figure 20 shows a scatter plot of investor MBS holdings changes against Fed purchases. This relationship is the reduced-form specification corresponding to the IV regression in Column (5) of Table 4. There is a strong downward pattern. The R^2 is very high, 72.8%. There are potential outliers around 2010 but the relationship is not affected by their removal. The figure thus shows clearly that unlike banks, when the Fed buys investors sell.

Table 4: **Investor MBS demand**

This table presents results from regressions of investor's MBS holding on the mortgage spread, including the instrumental variable regression:

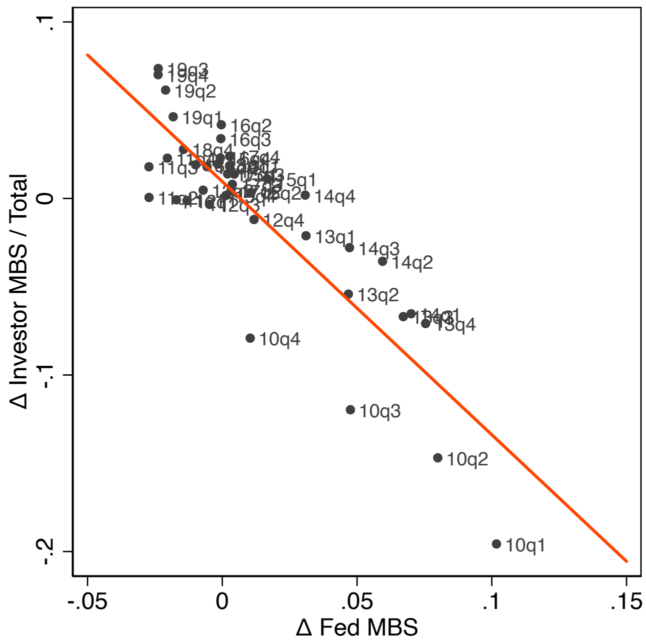
$$\Delta \text{Investor MBS}_t = \gamma + \beta_I^{IV} \times \Delta \widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I.$$

Δ Investor MBS is the year-over-year change in investors' MBS holding scaled by total MBS, with investors defined as all investor categories other than the Fed and banks. Δ Mortgage spread is the actual change in mortgage spread from a year ago, while Δ $\widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

	Δ Investor MBS / Total						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1990–19	1990–19	2010–19	2010–19	2010–19	2010–19	2010–19
Δ Mortgage spread	0.092***	0.065***	0.104**	0.099***			
	(0.035)	(0.019)	(0.051)	(0.035)			
Δ $\widehat{\text{Mortgage spread}}$					0.338***	0.210***	
					(0.084)	(0.033)	
Δ $\widehat{\text{Mortgage spread}}$, lag							0.193***
							(0.034)
ZLB		−0.113***		−0.057***		−0.043**	−0.059***
		(0.016)		(0.017)		(0.019)	(0.020)
Δ Fed funds rate		−0.012*		0.011		0.035*	0.025
		(0.006)		(0.017)		(0.021)	(0.023)
Δ GDP gap		−0.003		−0.009		−0.005	−0.001
		(0.005)		(0.011)		(0.012)	(0.017)
Δ Inflation gap		−0.016		−0.043*		−0.048***	−0.030**
		(0.016)		(0.022)		(0.013)	(0.013)
Constant	0.054***	0.075***	−0.008	0.031**	−0.008	0.016	0.023
	(0.011)	(0.008)	(0.013)	(0.013)	(0.015)	(0.017)	(0.019)
Obs.	120	120	40	40	40	40	40
R^2	0.161	0.667	0.222	0.644	0.728	0.805	0.805

Figure 20: **QE and Investor MBS purchases**

This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in the MBS holding of investors scaled by total MBS (Δ Investor MBS / Total). Investors are all investors aside from the Fed and banks. The red line represents a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.



6.3.1 Delayed effects on investor portfolios

We check for delayed effects of Fed purchases on investor portfolios. It is plausible that the initial adjustment is in part transitory. When the Fed buys MBS, investors might initially sell to the Fed but then buy some of it back as the supply of MBS expands. As we will see in Section 6.4, mortgage originations respond to mortgage rates with a one-quarter lag. Hence, we expect investors' initial portfolio adjustment to revert slightly over that time.

Column (7) of Table 4 tests for this by adding an additional quarter to the change in investor holdings and the mortgage spread while keeping Fed purchases year-over-year. This captures the investors' adjustment over five quarters to Fed purchases over four quarters. The coefficient on the instrumented mortgage spread drops slightly to 0.193 and remains significant. Thus, when the mortgage spread rises by 100 bps, investors increase their MBS holdings by 19.3% of the MBS market over five quarters.

6.3.2 Investor MBS holdings by type

Table 5 provides a breakdown by different types of investors. We group them into households (this includes hedge funds, family offices, and non-profits), asset managers (insurance companies, pension funds, and mutual funds), rest of the world (foreign investors and foreign banks), and other investors (mainly broker-dealers, REITS, and holding companies). We run OLS and IV regressions for the full sample and recent sample, respectively. We include the economic controls as in Columns (2) and (6) of Table 4.

The results show that our findings for all investors are robust to each type of investor. The OLS estimates tend to be small and in one case (asset managers), insignificant, but the IV estimates in all cases are large and significant. Thus, all types of investors are rate-sensitive, especially compared to banks. The most rate-sensitive type are other investors with a coefficient of 0.076, followed by households, 0.057, asset managers, 0.051, and rest of the world, 0.026. Note that adding the four coefficients in Table 5 exactly matches the 0.210 coefficient in Table 4. This is by construction given our dollar scaling.

Figure 21 shows the scatter plots corresponding to the reduced-form IV specification. There is a clear downward pattern for each investor type. We conclude that while there is some heterogeneity, the result from Table 4 that investors are rate-sensitive is robust to looking at different classes of investors.

6.4 Elasticity of mortgage originations

The final parameter of our framework is the elasticity of total mortgages to the mortgage rate. Estimating this elasticity is more challenging because unlike the mortgage spread, the mortgage rate depends on the general level of interest rates. The general level of interest rates equilibriates saving and borrowing across the whole economy, not just in the MBS market. It is therefore much more likely to be endogenous with respect to Fed purchases and other possible instruments.

We deal with this challenge by proceeding along two tracks. The first is to estimate OLS regressions of mortgage originations on mortgage rates. We use different samples and controls to gauge sensitivity to potential omitted variables. The second track is to use our framework to back out the implied elasticity of mortgage originations from our earlier IV estimates. The advantage of this approach is that it uses IV to correct for endogeneity. The disadvantage is that it could be sensitive to model misspecification. In this way, it is complementary to the OLS approach.

Table 5: **Investor MBS demand by type**

This table presents results from regressions of MBS holding by different investor types on the mortgage spread, including the instrumental variable regression:

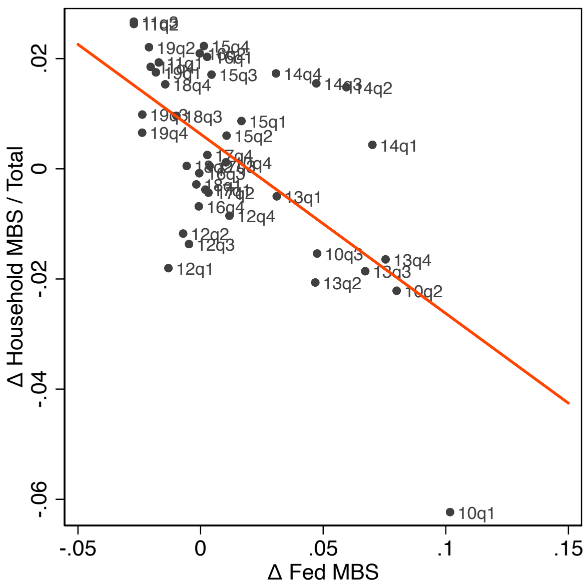
$$\Delta \text{MBS}_t \quad = \quad \gamma + \beta_I^{IV} \times \Delta \widehat{\text{Mortgage spread}}_t + X_t + \varepsilon_t^I.$$

ΔMBS is the year-over-year change in MBS holding by an investor type scaled by total MBS. Households include hedge funds, family offices, and non-profits. Asset managers include insurance companies, pension funds, and mutual funds. Rest of the world include foreign investors and banks. Others is a residual category that includes broker-dealers, REITs, and holding companies. Δ Mortgage spread is the actual change in mortgage spread from a year ago, while Δ $\widehat{\text{Mortgage spread}}$ is the predicted change in mortgage spread from the first-stage regression. ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

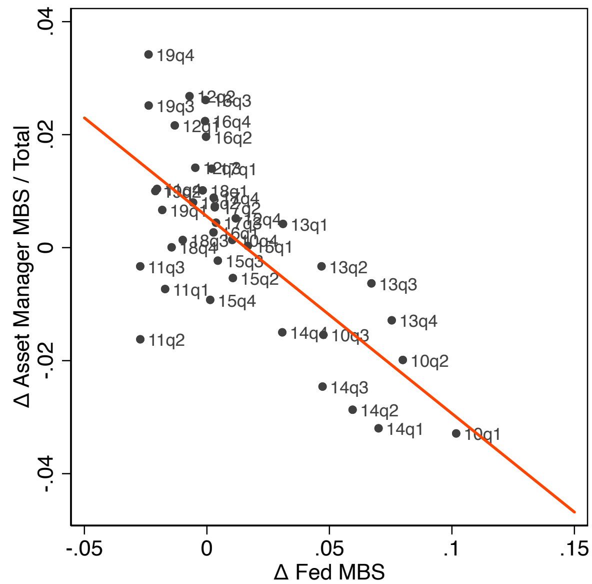
	Households		Asset Managers		Rest of World		Others	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1990–19	2010–19	1990–19	2010–19	1990–19	2010–19	1990–19	2010–19
Δ Mortgage spread	0.031***		−0.001		0.012**		0.023**	
	(0.012)		(0.007)		(0.006)		(0.009)	
Δ $\widehat{\text{Mortgage spread}}$		0.057***		0.051***		0.026***		0.076***
		(0.020)		(0.016)		(0.006)		(0.015)
ZLB	−0.016**	−0.001	−0.031***	−0.018*	−0.027***	−0.014***	−0.039***	−0.010
	(0.006)	(0.005)	(0.006)	(0.009)	(0.003)	(0.003)	(0.009)	(0.011)
Δ Fed funds rate	0.000	0.013**	−0.010***	−0.003	0.000	0.001	−0.002	0.024*
	(0.003)	(0.005)	(0.002)	(0.009)	(0.002)	(0.003)	(0.004)	(0.012)
Δ GDP gap	0.005**	−0.003	−0.003**	0.001	0.002	0.004**	−0.007**	−0.007
	(0.002)	(0.004)	(0.001)	(0.004)	(0.001)	(0.002)	(0.003)	(0.008)
Δ Inflation gap	−0.010	−0.016**	−0.003	−0.002	0.006*	−0.004	−0.009	−0.026***
	(0.007)	(0.006)	(0.005)	(0.004)	(0.003)	(0.003)	(0.009)	(0.006)
Constant	0.011***	0.003	0.025***	0.011*	0.017***	0.005**	0.022***	−0.004
	(0.004)	(0.004)	(0.003)	(0.007)	(0.003)	(0.003)	(0.006)	(0.010)
Obs.	120	40	120	40	120	40	120	40
R^2	0.318	0.458	0.666	0.571	0.548	0.771	0.428	0.630

Figure 21: **QE and Investor MBS purchases by type**

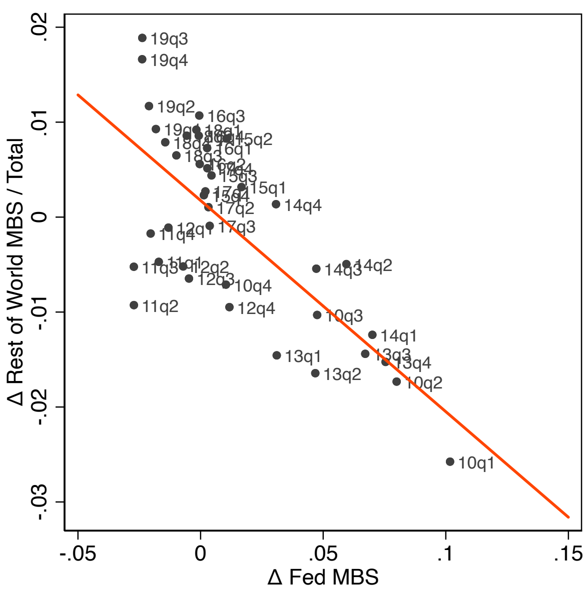
This figure plots the relationship between the year-over-year change in the Fed's MBS holding scaled by total MBS (Δ Fed MBS) and the year-over-year change in the MBS holding of an investor type scaled by total MBS. Households (Panel A) include hedge funds, family offices, and non-profits. Asset managers (Panel B) include insurance companies, pension funds, and mutual funds. Rest of the world (Panel C) includes foreign investors and banks. Others (Panel D) is a residual category that includes broker-dealers, REITs, and holding companies. The red lines represent a simple linear fit of the data points. The data points are quarterly from 2010 to 2019.



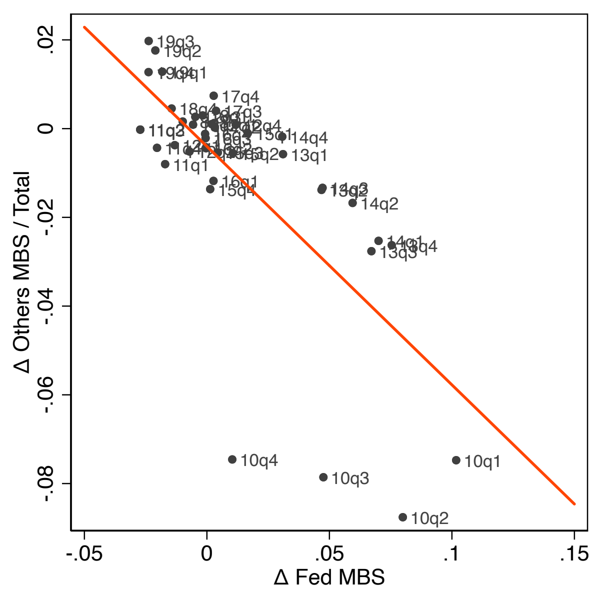
(a) Households



(b) Asset managers



(c) Rest of world



(d) Others

6.4.1 OLS regressions

Another difference between mortgage borrowers and MBS investors is that mortgage borrowers are likely to respond to interest rates with a lag. It takes time to learn about a change in mortgage rates, shop for a house, or refinance a mortgage. We allow for this by lagging the mortgage rate in our OLS regressions:

$$\Delta\text{Mortgage Originations}_t = \gamma + \beta_S^{OLS} \times \Delta\text{Mortgage rate}_{t-1/4} + X_t + \varepsilon_t^S, \qquad (16)$$

where ΔMortgage Originations is the year-over-year change in mortgage originations scaled by total mortgages, ΔMortgage rate is the change in the mortgage rate lagged by one quarter, and X stacks the ZLB indicator and changes in the Fed funds rate, output gap, and inflation gap as controls. We also show results without lagging the mortgage rate for robustness.

Table 6 shows the results. The first three columns are for the recent sample, 2010–2019, and the last three are for the long sample, 1990–2019. Column (1), which does not lag the mortgage rate, shows a significant coefficient of -0.039, hence a 100-bps increase in mortgage rates is contemporaneously associated with a decline in mortgage originations equal to 3.9% of the stock of all mortgages per year. This comes to about $436 billion at the end of 2019.

Column (2) lags the mortgage rate by one quarter. The coefficient nearly doubles to -0.065, supporting the view that originations slightly lag mortgage rates. The magnitude of this estimate is substantial: a 100-bps increase in mortgage rates leads to a decline in mortgage originations equal to 6.5% of all mortgages or $727 billion in 2019.

Panel A of Figure 22 shows a scatter plot of the relationship in Column (2) of Table 6. There is a clear downward pattern. The fit is good as the regression R^2 is 56.6% and there are no obvious outliers. This suggests that mortgage rates are the primary driver of mortgage originations.

Column (3) of Table 6 adds in the economic controls. The coefficient becomes slightly larger, -0.070 ($783 billion in 2019), and the fit improves further to 73.6%. Of the controls, only the ZLB indicator comes in significant, potentially capturing the fact that mortgage demand was low in the aftermath of the 2008 financial crisis.

Column (4) of Table 6 repeats Column (1) for the full sample 1990–2019. The coefficient is slightly larger, -0.075 (versus -0.039) and significant. Lagging the mortgage rate by a quarter (Column (5)) raises it further to -0.104. This relationship is depicted in Panel B of Figure 22. The fit is again very high over this longer sample. The only potential outliers are the housing boom years of the early 2000s. These see a large increase of

Table 6: **Mortgage originations**

This table presents results from regressions of mortgage originations on the mortgage rate:

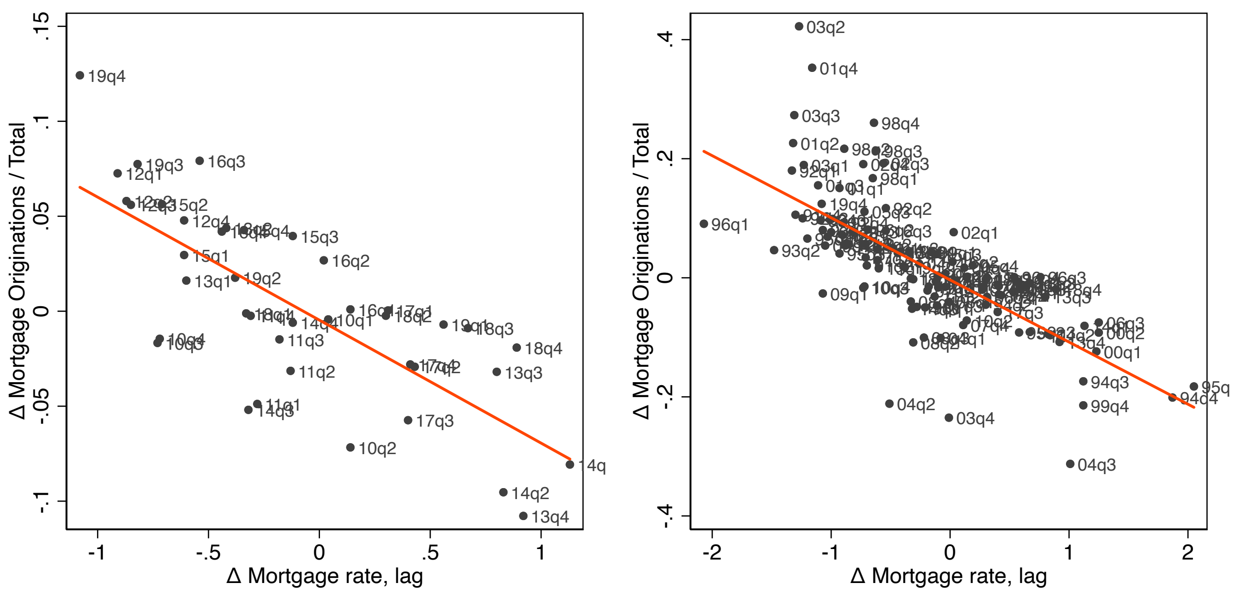
$$\Delta\text{Mortgage Originations}_t \quad = \quad \gamma + \beta_S^{OLS} \times \Delta\text{Mortgage rate}_{t-1/4} + X_t + \varepsilon_t^S.$$

ΔMortgage Originations is the year-over-year change in mortgage originations scaled by total mortgages. Δ Mortgage rate is the year-over-year change in mortgage rate, lagged by one quarter for columns (2)-(3) and (5)-(6). ZLB equals one when the lower limit of the Fed funds target rate is zero, and zero otherwise. Δ Fed funds rate, Δ GDP gap, and Δ inflation gap are all simple differences from one year prior. Standard errors are computed using the Newey-West procedure with adjustment up to 3 lags. The sample is quarterly data either from 1990 to 2019 or from 2010 to 2019.

	Δ Mortgage Originations / Total					
	(1) 2010–19	(2) 2010–19	(3) 2010–19	(4) 1990–19	(5) 1990–19	(6) 1990–19
Δ Mortgage rate	−0.039***			−0.070***		
	(0.012)			(0.012)		
Δ Mortgage rate, lag		−0.065***	−0.070***		−0.104***	−0.108***
		(0.011)	(0.008)		(0.013)	(0.017)
ZLB			−0.042***			−0.040**
			(0.013)			(0.018)
Δ Fed funds rate			−0.015			0.005
			(0.018)			(0.012)
Δ GDP gap			−0.014*			−0.008
			(0.008)			(0.008)
Δ Inflation gap			0.002			0.009
			(0.011)			(0.021)
Constant	−0.003	−0.005	0.029***	0.003	−0.004	0.007
	(0.010)	(0.008)	(0.009)	(0.012)	(0.010)	(0.012)
Obs.	40	40	40	116	116	116
R^2	0.210	0.566	0.736	0.231	0.506	0.535

Figure 22: **Mortgage rates and originations**

This figure plots the relationship between the year-over-year change in the mortgage rate, lagged by one quarter (Δ Mortgage rate, lag), and the year-over-year change in mortgage originations scaled by total mortgage (Δ Mortgage Originations / Total). The red lines represent a simple linear fit of the data points. The data points are quarterly from 2010 to 2019 (Panel A) and from 1990 to 2019 (Panel B).



(a) 2010–2019

(b) 1990–2019

mortgage originations even accounting for the mortgage rate. In the language of our model (Eq. (3)), the housing boom can be interpreted as a positive mortgage demand shock ϵ^S. Nevertheless, the relationship is robust to excluding the housing boom.

Column (6) shows our final specification with a lagged mortgage rate and economic controls over the full sample 1990–2019. The coefficient settles at -0.108 and remains significant. The magnitude implies that a 100-bps increase in mortgage rates leads to a decline in mortgage originations of 10.8% or $1,208 billion in 2019.

6.4.2 Implied IV estimate

Recall from Eq. (10) that we can back out an implied IV estimate of the sensitivity of mortgage originations to mortgage rates from the first-stage coefficient $\widehat{\beta}_{IV}^{First\ Stage}$ and the IV estimate of investors' rate-sensitivity, $\widehat{\alpha}_{IV}^{I}$. Intuitively, the first-stage coefficient identifies the joint elasticity $\alpha^I + \alpha^S$ of investors and mortgage borrowers under the assumption that banks are rate-insensitive (and Fed purchases are a valid instrument). We found support for this assumption in Section (6.2). We therefore now use Eq. (10) to arrive at an implied IV estimate of borrowers' rate sensitivity.

For the first stage coefficient, $\widehat{\beta}^{First\ Stage}$, we use the estimate in Column (1) of Table 2, -4.233.[18] For the rate-sensitivity of investors, $\widehat{\alpha}^{I}_{IV}$, we use the estimate in Column (7) of Table 4, 0.193, because it allows for lagged adjustment of investor portfolios. As we saw in Table 6, mortgage borrowers react to rate changes with a one-quarter lag, hence it important to take this lag into account when estimating their elasticity. This gives us an implied IV estimate of

$$\widehat{\alpha}^{S}_{IV,Implied} = -\frac{1}{\widehat{\beta}^{First\ Stage}} - \widehat{\alpha}^{I}_{IV} = -\frac{1}{-4.233} - 0.193 = 0.043. \quad (17)$$

This number implies that when mortgage rates rise by 100 bps, mortgage borrowers demand 4.3% fewer mortgages as a percentage of total mortgages. Importantly, this elasticity captures the impact of rates on *net* issuance, not gross originations like in Table 2. We expect it to be smaller because net issuance is much smaller than gross originations due to refinancing and the buying and selling of existing homes. From an economic standpoint, both are expected to have an effect.

7 Counterfactual analysis

We now combine our estimates to construct counterfactual scenarios for mortgage spreads, originations, and net issuance. We compare the actual path of these quantities against our estimates if there had been no Fed MBS purchases (no QE) and no Fed or bank MBS purchases. The implicit assumption is that a dollar of bank purchases has the same impact as a dollar of Fed purchases, as implied by our framework. This is a reasonable assumption because banks and the Fed are both inelastic buyers. As a result, buying by one does not lead to selling by the other. The impact of their combined purchases on rates and issuance then depends on the elasticities of other investors and mortgage borrowers.

7.1 Impact on mortgage spreads

Panel A of Figure 23 plots Fed and bank MBS purchases scaled by total MBS at the end of 2019. The series are normalized to zero at the start of 2020. Fed purchases (black line) rise quickly starting in early 2020. They reach 12.2% at the end of 2021 before declining

[18] Our results are similar if we use the coefficient from the most restrictive specification in Column (7), which controls for expected Fed MBS purchases.

to 6.5% at the end of 2023. Bank purchases (blue line) rise a little more slowly but then accelerate, reaching a similar 12.6% at the end of 2021 and falling to 4.7% at the end of 2023. The combined purchases of banks and the Fed (red line) peak at 24.8%, or about a quarter of the total amount of MBS outstanding, then drop to 11.2% at the end of 2023. The scale of the intervention is only visible when banks are included alongside the Fed.

We now look at the estimated impact of these purchases on the mortgage spread. From Eq. (6), this impact depends on the combined elasticity $\alpha^I + \alpha^S$:

$$\Delta \widehat{\text{Spread}} \;=\; -\frac{1}{\widehat{\alpha}^I + \widehat{\alpha}^S} \times (\Delta \text{ Fed MBS} + \Delta \text{ Bank MBS}), \tag{18}$$

where Δ Fed MBS and Δ Bank MBS are the scaled Fed and bank purchases from Panel A. For α^I, we use the IV estimate in Column (6) of Table 4, $\widehat{\alpha}^I_{IV} = 0.210$. For α^S, we use the implied IV estimate for net issuance from Section 6.4.2, $\widehat{\alpha}^S_{IV,Implied} = 0.043$. We use net issuance because the equilibrium spread depends on the amount of mortgages outstanding.

Panel B of Figure 23 plots the actual mortgage spread (blue line) against counterfactual mortgage spreads without Fed purchases (black line) and without Fed and bank purchases (red line). We obtain the counterfactual spreads by adding the estimated impact in Eq. (18) back in to the actual spread.

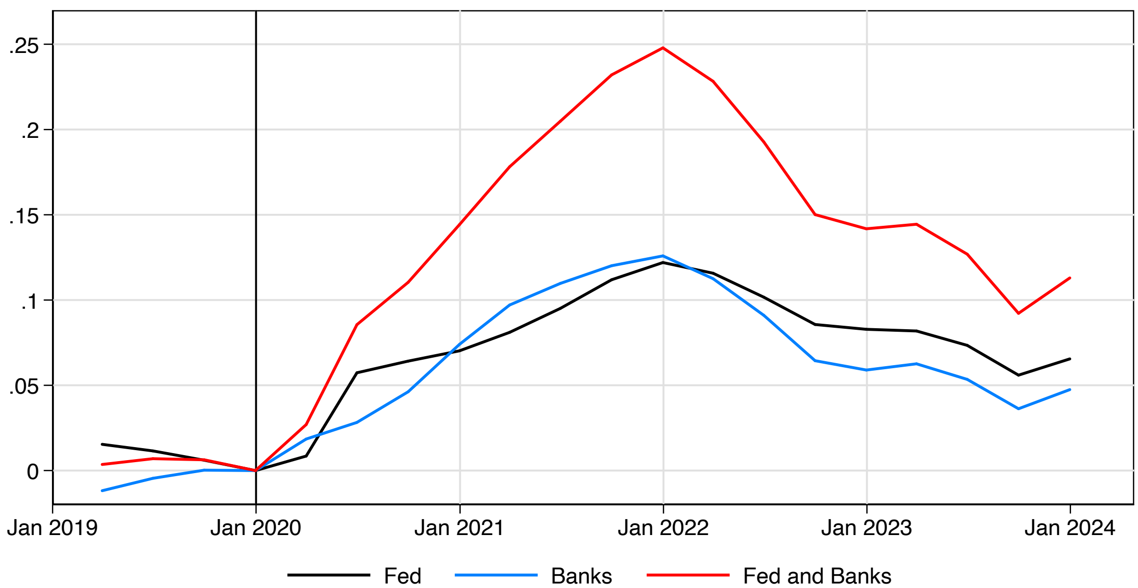
The actual mortgage spread drops sharply by 113 bps from early 2020 to 2021. We estimate that if the Fed had not purchased MBS, the spread would have declined by 75 bps over this period. This implies that Fed purchases contracted the mortgage spread by 38 bps. If we also take away bank MBS purchases, the mortgage spread declines by just 32 bps and remains relatively flat during the period. Thus, the combined purchases of banks and the Fed contracted the mortgage spread by 81 bps. This is a large impact, equal to about half the average mortgage spread over 2010–2019. Of the 81 bps, banks were responsible for 43 bps and the Fed for 38 bps, both substantial amounts.

7.2 Impact on net MBS issuance

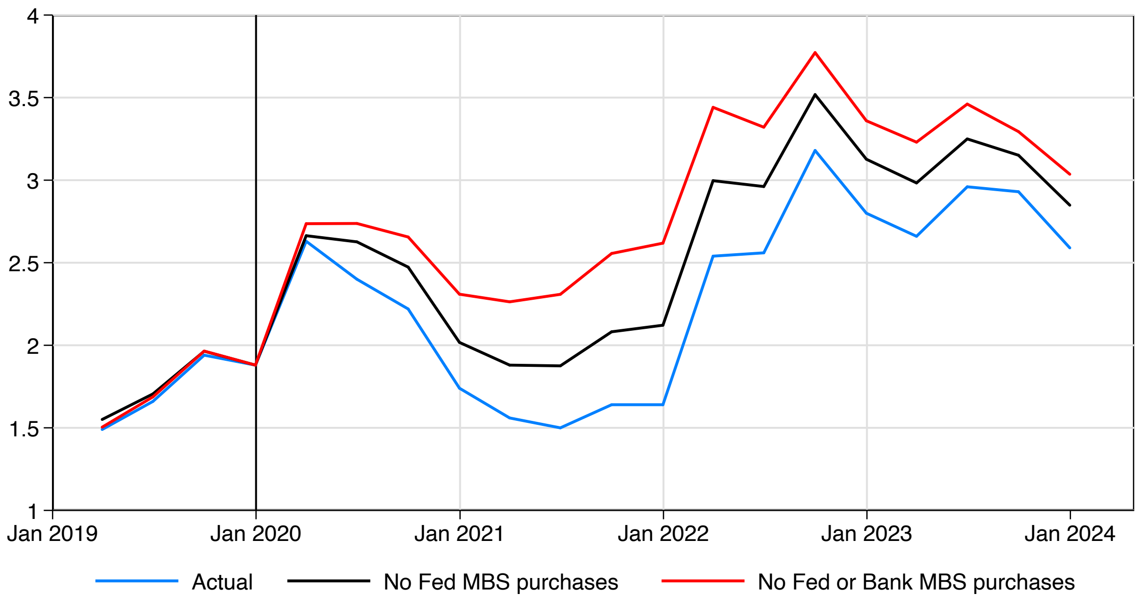
All else equal, shrinking the mortgage spread lowers the mortgage rate paid by borrowers. We therefore expect Fed and bank MBS purchases to lead to increased mortgage borrowing and MBS issuance. We note that it is likely that asset purchases (including the Fed's Treasury purchases) lowered mortgage rates over and above their impact on the mortgage spread, i.e. long-term interest rates declined. However, since such an effect is difficult to identify empirically, we do not factor it into our analysis and focus solely on

Figure 23: **Impact on Mortgage Spreads**

Panel A plots actual purchases of MBS by the Fed, banks, and both in share of total MBS. Values are normalized so that they are zero at the end of 2019. Panel B plots actual mortgage spread along with counterfactual mortgage spreads without Fed purchases and without Fed and bank purchases. We obtain the counterfactual spreads by adding the impact of purchases on spread calculated using estimated elasticities, as shown in Eq. (18), back in to the actual spread. The data points are quarterly from 2019 to 2023.



(a) MBS Purchases / Total



(b) Mortgage Spread

the spread component of the mortgage rate. In this sense, our results are a lower bound on the impact of Fed and bank asset purchases on mortgage activity.

We calculate the impact on MBS issuance as follows. From Eq. (3), the supply of MBS by mortgage borrowers depends on the mortgage rate. The change in MBS supply therefore depends on the change in the mortgage rate. We take that change to be the change in the mortgage spread as calculated in 7.1. We then calculate

$$\Delta \text{ Net } \widehat{\text{MBS Issuance}} = -\widehat{\alpha}^S \times \Delta \widehat{\text{Spread}}. \quad (19)$$

The left-hand side is scaled by total MBS outstanding. We convert it to dollars for interpretability by multiplying by MBS outstanding as of the end of 2019. For the net issuance elasticity $\widehat{\alpha}^S$, we use the implied IV estimate from Section 6.4.2, $\widehat{\alpha}^S = 0.043$.

Panel A of Figure 24 plots the quarterly actual net MBS issuance (blue line), estimated net issuance without Fed MBS purchases (black line), and estimated net issuance without Fed and bank purchases (red line). Actual net issuance triples from $104 billion at the end of 2019 to $318 billion in 2022q2. We estimate that absent Fed MBS purchases, net issuance would have risen to $275 billion in 2022q2. Thus, Fed purchases led to $43 billion in additional quarterly MBS issuance at the peak. If we further remove bank MBS purchase, predicted peak issuance drops to just $236 billion. Thus, banks and the Fed increased peak net MBS issuance by $81 billion per quarter. This is a large amount compared to the $108 billion average issuance in 2019.

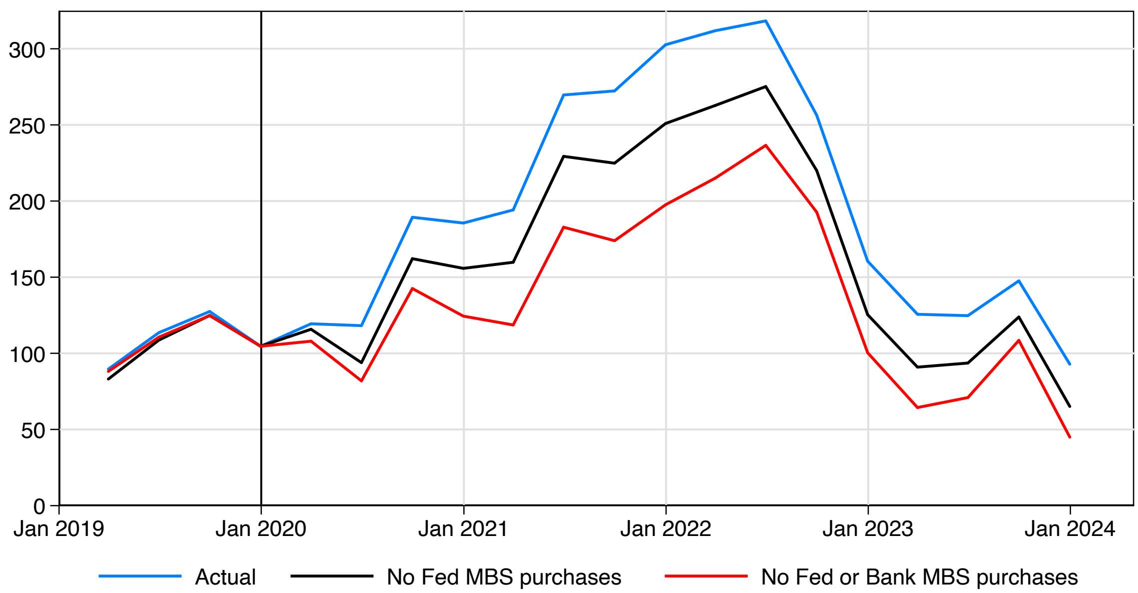
The quarterly impact adds up over time. Panel B of Figure 24 plots the cumulative reduction in net MBS issuance that we estimate would have occurred if the Fed had not purchased MBS (black line) or if the Fed and banks had not purchased MBS (red line). We find that cumulative net MBS issuance would have been $307 billion lower at the end of 2021 and $563 billion lower at the end of 2023 if the Fed had not purchased MBS. If, in addition, banks had not purchased MBS, cumulative net MBS issuance would have been $618 billion lower at the end of 2021 and $1,069 billion lower at the end of 2023. This represents about a third of the actual cumulative net MBS issuance over this period.

7.3 Impact on total mortgage originations

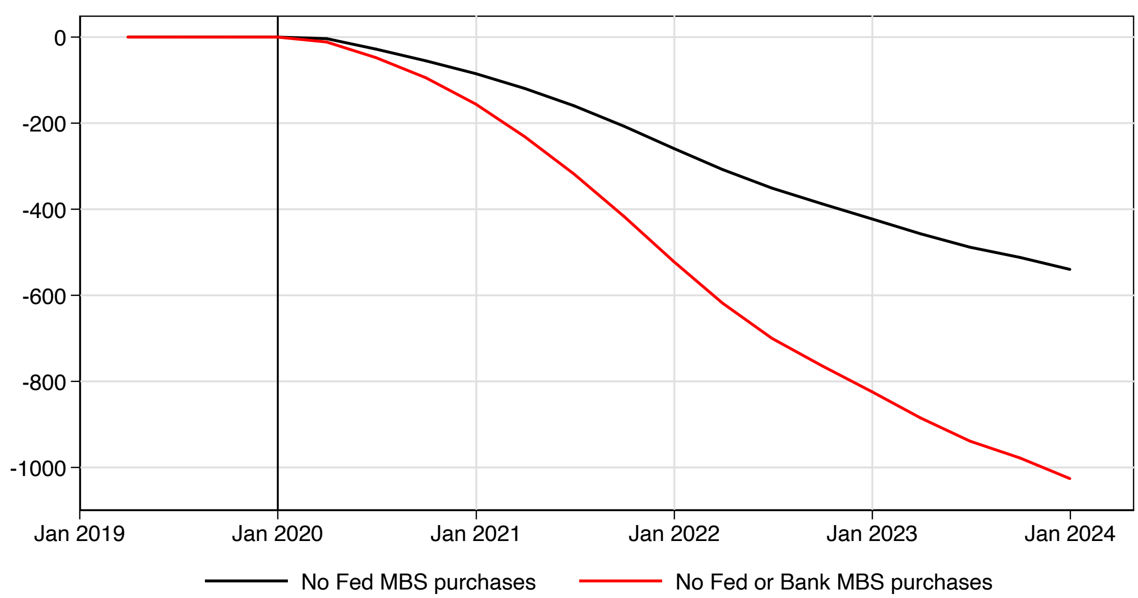
As a final exercise, we look at the impact of Fed and bank MBS purchases on total (gross) mortgage originations. Total originations are of interest beyond net MBS issuance because there is a large literature showing that mortgage refinancing has a substantial impact on household consumption (e.g., Di Maggio et al., 2017; Eichenbaum et al., 2022; Agarwal et al., 2023). As an illustration, Eichenbaum et al. (2022) find that when the average rate on

Figure 24: **Impact on Net MBS Issuance**

Panel A plots actual net MBS issuance along with counterfactual net MBS issuances without Fed MBS purchases and without Fed and bank MBS purchases. We obtain the counterfactual issuances by subtracting from the actual change in net issuance the impact of change in spread on change in issuance calculated using our estimated elasticity as shown in Eq. (17). Panel B plots the cumulative reduction in net MBS issuance that we estimate would have occurred if the Fed had not purchased MBS and if the Fed and banks had not purchased MBS. The data points are quarterly from 2019 to 2023.



(a) Net MBS Issuance, Quarterly



(b) Net MBS Issuance, Cumulative

outstanding mortgages is 50 bps higher than the current mortgage rate, a 25 bps decrease in mortgage rates leads to 0.9% higher consumption. Since, if anything, the mortgage rate gap was higher than 50 bps in 2020, the implied stimulative effect of the 81 bps reduction in mortgage spreads we found in Section 7.1 is at least $0.9 \times 0.81/0.25 = 2.9\%$ of aggregate consumption through greater refinancing alone.

Total mortgage originations also expand the analysis beyond the MBS market to include portfolio loans such as jumbo mortgages. The implicit assumption we are making is that mortgage markets are sufficiently integrated so that rates on portfolio loans move in tandem with rates on securitized mortgages. This is a reasonable assumption given that the interest rate spread between jumbo and conforming mortgages (i.e. those eligible for agency securitization) is quite small. If there is segmentation, then the impact of bank balance sheet growth (due to deposit inflows) on portfolio loan rates is likely to be higher than on MBS because there are no other investors in the portfolio loan market.

We calculate the impact of MBS purchases on total mortgage originations similarly to net issuance (see Eq. 20), except we replace the net supply elasticity with the gross one:

$$\Delta \text{ Total } \widehat{\text{Mortgage}} \text{ Originations} \quad = \quad -\widehat{\alpha}^S_{Gross} \times \Delta \,\widehat{\text{Spread}}. \tag{20}$$

We again convert the left-hand side to dollars by multiplying by total mortgages outstanding as of the end of 2019. For the gross originations elasticity we use the OLS estimate from Column (6) of Table 6, $\widehat{\alpha}^S_{Gross} = 0.108$.

Figure 25 plots the results. Panel A shows actual originations (blue line) and estimated originations without Fed purchases (black line) and without Fed and bank purchases (red line). Quarterly originations rise faster than net issuance, from $738 billion at the end of 2019 to $1,357 at the end of 2020. This surge reflects the refinancing boom of 2020. Originations then decline to $994 billion at the end of 2021.

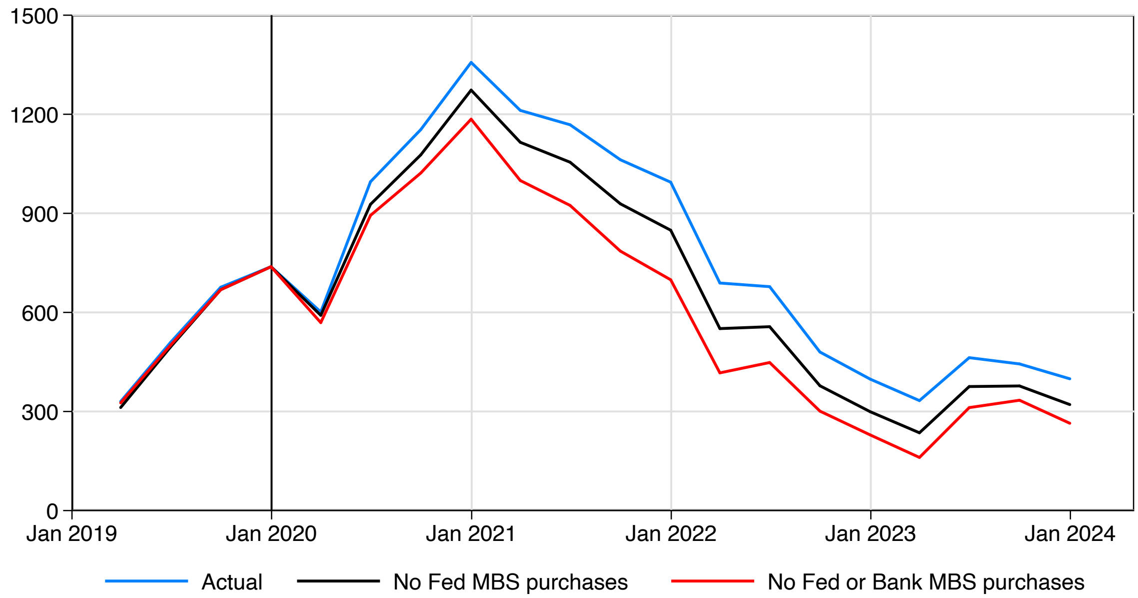
We estimate that without Fed MBS purchases, quarterly mortgage originations would have stood at $1,273 at the end of 2020 and $849 billion at the end of 2021. The impact of Fed purchases on originations was therefore $84 billion and $145 billion per quarter, respectively. This is more than double the impact on net MBS issuance we found in Section 7.2, reflecting the relative quantity of gross versus net issuance.

Without Fed and bank MBS purchases, estimated originations decline to $1,185 billion and $699 billion at the end of 2020 and 2021. Together, the Fed and banks increased mortgage originations by $172 billion and $295 billion on those two dates. Of these, banks were responsible for $88 billion in 2020q4 and $150 billion in 2021q4.

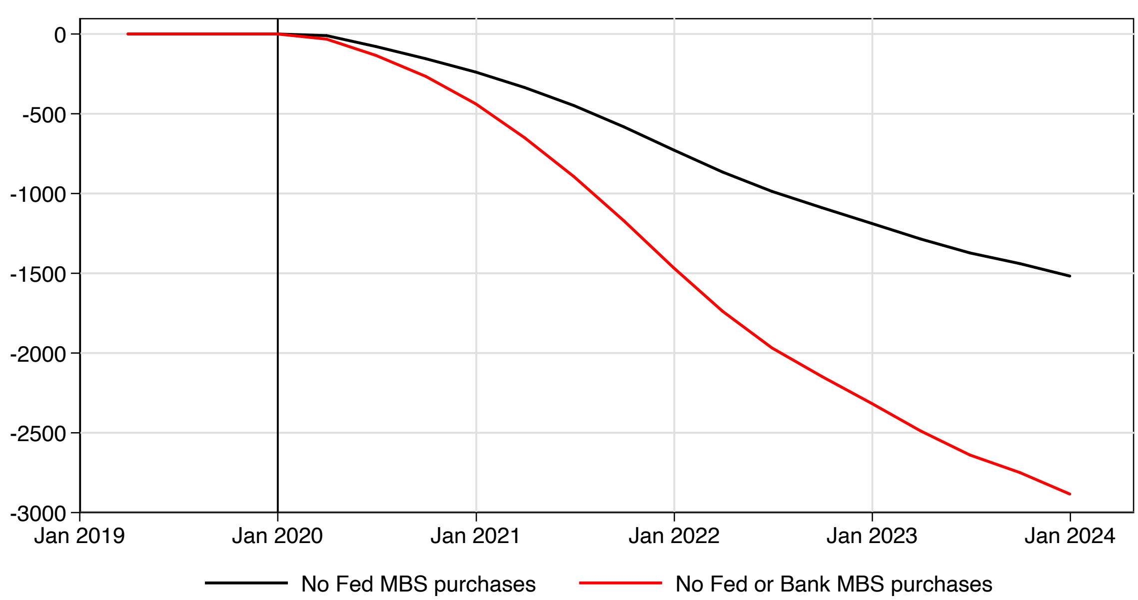
As with net issuance, quarterly total originations add up over time. Panel B of Figure

Figure 25: **Impact on Total Mortgage Originations**

Panel A plots actual total mortgage originations along with counterfactual total mortgage originations without Fed MBS purchases and without Fed and bank MBS purchases. We obtain the counterfactual originations by subtracting from the actual change in originations the impact of change in spread on change in originations calculated using estimated elasticity from column (6) of Table 6. Panel B plots the cumulative reduction in total originations that we estimate would have occurred if the Fed had not purchased MBS and if the Fed and banks had not purchased MBS. The data points are quarterly from 2019 to 2023.



(a) Mortgage Originations, Quarterly



(b) Mortgage Originations, Cumulative

25 shows the cumulative impact of Fed purchases (black line) and Fed and bank purchases (red line). We estimate that at the end of 2020 cumulative total originations would have been $727 billion lower without Fed purchases and $1,466 billion lower without Fed and bank purchases (the cumulative impact of banks is thus $739 billion). By the end of 2021, the cumulative impact of the Fed is $1,187 billion and that of the Fed and banks is $2,316 billion (the impact of banks is $1,129 billion).

Over the full cycle ending in 2023q4, we estimate cumulative total originations would have been $1,517 billion lower without the Fed and $2,884 lower without the Fed and banks. Actual cumulative originations stood at $12,428, so the policy impact is about a quarter of the total. Thus, while much of the refinancing wave would have still occurred in 2020 and 2021 given the drop in rates, Fed and MBS purchases contributed significantly by compressing mortgage spreads.

8 Conclusion

The post-Covid era has seen large fluctuations in monetary policy. Following the onset of Covid-19, the Federal Reserve cut interest rates to zero and implemented an aggressive Quantitative Easing program in which it bought large amounts of Treasury bonds and MBS. After inflationary pressures emerged, the Fed dramatically tightened policy, raising rates by over 5% in a year and a half, and reducing its treasury and MBS holdings under Quantitative Tightening.

Despite these large moves in monetary policy, there is debate about the extant to which policy impacted some of the main economic targets it is believed to influence, including consumption, unemployment, and inflation. In contrast, there is widespread agreement that monetary policy had a clear and powerful impact on the housing sector through the mortgage market. During 2020-21, when monetary policy was loose, mortgage rates and the mortgage spread fell to historic lows, there was a boom in mortgage originations, and residential investment surged. Once the Fed tightened policy, these trends quickly reversed. Mortgage rates and the mortgage spread rose dramatically, and mortgage issuance all but ground to a halt.

In this paper, we show that monetary policy had an outsized impact on the mortgage market because it exerted a powerful influence on the supply of mortgage credit by the two largest holders of mortgages, banks and the Federal Reserve. When monetary policy loose, banks and the Fed accumulated an enormous quantity of MBS, which made mortgage credit historically cheap. Once the Fed started tightening, banks and the Fed reversed course and significantly reduced their MBS holdings, contracting mortgage supply and making mortgage credit expensive.

In the case of the Fed, monetary policy had this impact due to QE and QT, which change the amount of MBS the Fed buys and hence the amount of mortgage credit it supplies. In the case of banks, we show that monetary policy works through the deposits channel. Under this channel, when the Fed lowers rates, banks receive large inflows of low-beta deposits, which they invest in assets with long-term fixed-rate cashflows, particularly mortgages.

Due to the deposits channel, when the Fed lowers rates, banks become aggressive buyers of mortgages. Since banks are the largest investors in mortgages (with a roughly 50% share of all mortgage holdings), and their deposit inflows are very large, banks' mortgage buying causes a significant expansion in mortgage credit supply. The opposite happens when the Fed raises rates: low-beta deposits flow out and banks need to reduce their mortgage holdings, which contracts mortgage credit supply.

Our empirical analysis quantifies the impact of monetary policy on the mortgage market during the 2020–24 monetary policy cycle. We find that banks and the Fed were each responsible for about a 40-bps reduction in the mortgage spread during 2020–21. Our estimates imply that this led to a cumulative increase in mortgage originations of about $3 trillion, and net MBS issuance of about $1 trillion, with banks responsible for roughly half of this increase. Estimates from the macro literature imply that these effects had a large impact on consumer spending and residential investment.

Looking ahead, our findings suggest that the combined effects of QE and the deposits channel on the mortgage market will continue to be important for the transmission of monetary policy.

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Appendix

A Expected Fed purchases

We explain how we construct quarter-ahead expected Fed purchases from the SPD data. Our methodology broadly follows Kim et al. (2020). The main differences are that we focus on MBS and use a quarterly frequency.

For a given period, there are multiple values of expected purchase from different preceding survey months. In principle, we use the expectation value from the closest available survey before the period of interest. For example, the expectation of the Fed's purchase for the second quarter of 2011 is calculated using responses to the March 2011 SPD. This gives us expectations one quarter ahead until after the first quarter of 2015, where the latest survey with our question of interest is from October 2014. Starting from this period, the gap between the period of expected purchase and the time of survey lengthens.

For January 2011 to September 2012, the questionnaires ask respondents their expectations for "the amount of domestic securities held outright in the SOMA portfolio at year end for each of the next five years." Since we are interested in expected purchase, we take this year end value and compare it with the actual outstanding securities holding, taken from NY Fed's SOMA holdings dataset, right before the period of interest to deduce the expected purchase. If the gap between the period of interest and end of year is over a quarter, we take a linear interpolation to get the quarterly value.

For October 2012 to January 2015, the questionnaires inquire expectations for the purchase in two ways. First, they ask expectations for "the most likely change in the amount of domestic securities held in the SOMA portfolio during each of the periods below", where the periods are either half-years or full-years up to three or four years ahead. Second, they ask about the expected "monthly pace of purchases that will be in effect after each of the below FOMC meetings". For each survey month, they ask this for up to nine meetings or about one year ahead. We prioritize using responses from the second question due to its time granularity. Since the dates of reference for this question vary within a month depending on the FOMC schedule, we round them up or down depending on whether it is before or after the 15th. As this question asks for expectations up to one year ahead and the question is no longer asked after January 2015, for expected purchases January 2016 onwards we switch to the first question on expected yearly purchases. Again, we apply linear interpolation to get quarterly amounts.

In all cases, we use the median value of expectations.

Figure A.1 plots the expected Fed MBS and Treasury purchase series against the Fed's actual purchases. The expected and actual series track each other well but not perfectly. As argued by Kim et al. (2020), this suggests that there is a significant unexpected component to Fed purchases.

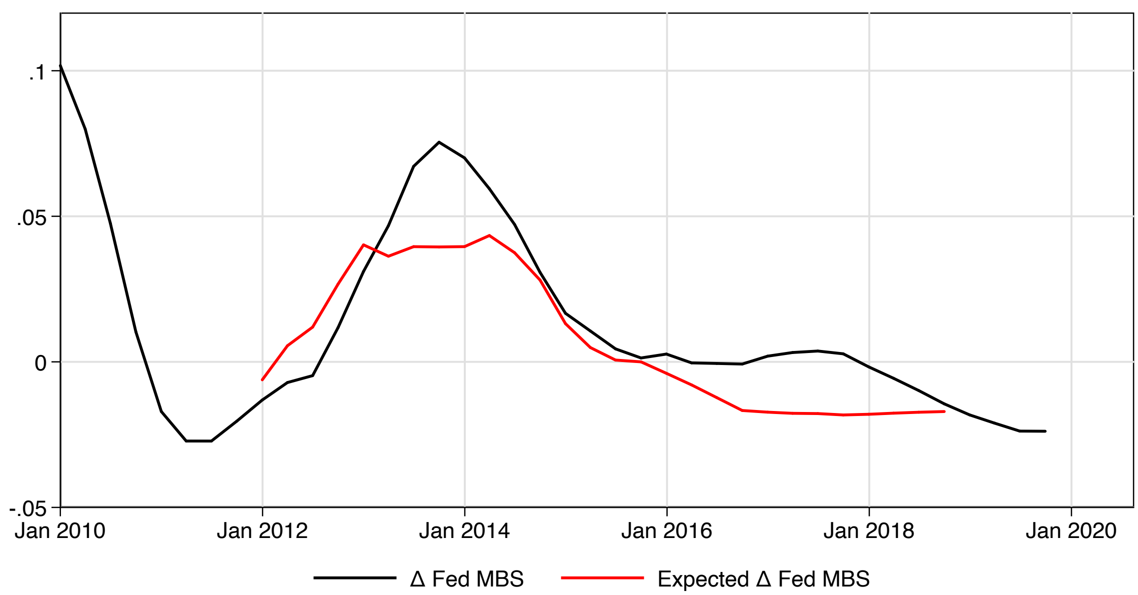
B Regional bank crisis event study: controlling for prepayment risk

Figure A.2 Panel A plots the return of the MBS ETF MSS after adjusting for prepayment risk by controlling for changes in the MOVE index. Panel B plots the option-adjusted spread (OAS) for the existing stock of MBS.

Figure A.1: **Realized and expected Fed purchases**

Panel A plots the expected Fed MBS purchase (Expected Δ Fed MBS) and the actual Fed MBS purchase (Δ Fed MBS). Panel B plots the same series of expected and actual Fed purchases but for Treasury securities. The data points are quarterly, from 2010 to 2019 for actual purchases and from 2012 to 2018 for expected purchases.

Panel A: MBS



Panel B: Treasury

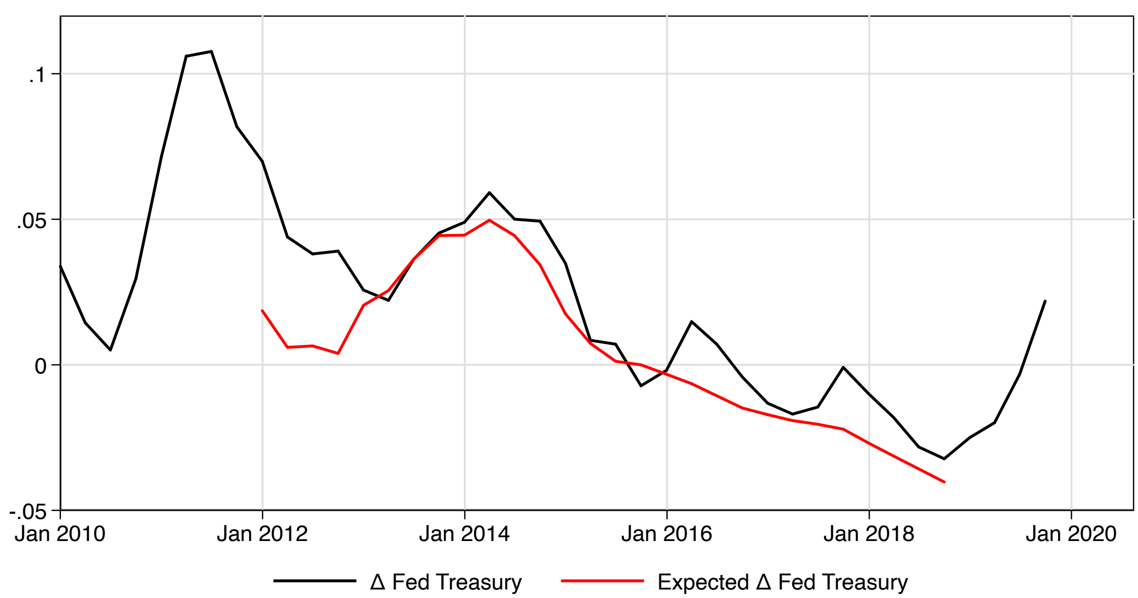
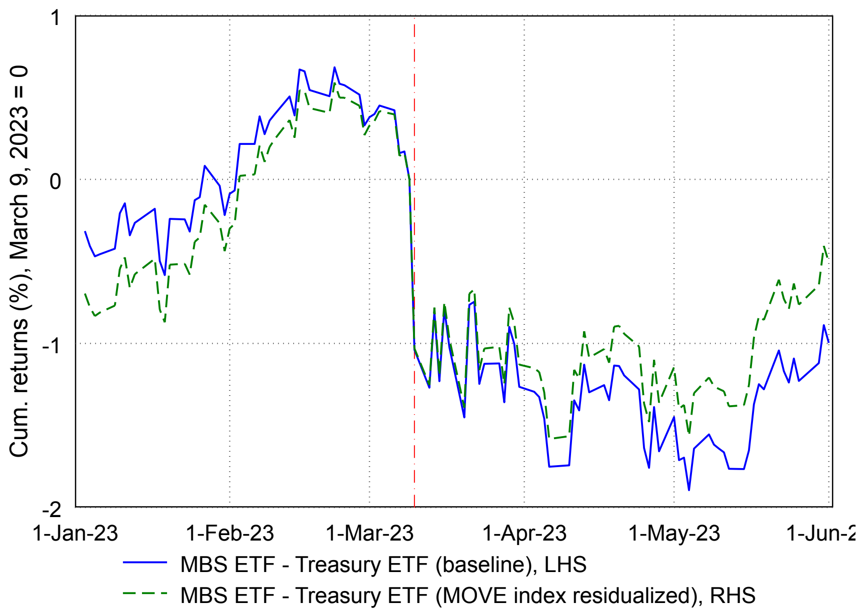


Figure A.2: **Mortgage market around the collapse of Silicon Valley Bank**

Panel A plots the return of the MBS ETF MSS without adjustment and after adjusting for prepayment risk, daily from 1 Jan 2023 to 1 Jun 2023. MBS ETF - Treasury ETF is the difference in cumulative returns between iShares MBS ETF (MBB) and iShares 7-10 Year Treasury Bond ETF (IEF). We adjust MBS ETF - Treasury ETF by the MOVE index by computing a residual from a regression of the MBS ETF excess returns on the MOVE index changes. The mortgage spread is the spread between the 30-year fixed rate conforming mortgage rate and the 10-year US Treasury yield. MBS Index OAS is an option-adjusted spread constructed by Bloomberg for the entire portfolio of outstanding MBSs. Vertical red line denotes March 10, 2023, when SVB collapsed.

Panel A: MBS excess returns: robustness to controlling for the MOVE index



Panel B: Mortgage Spread and MBS Index OAS