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The Macroeconomic Effects of Government Asset Purchases: Evidence from Postwar US Housing Credit

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Abstract

We document the portfolio activity of federal housing agencies and provide evidence on its impact on mortgage markets and the economy. Through a narrative analysis, we identify historical policy changes leading to expansions or contractions in agency mortgage holdings. Based on those regulatory events that we classify as unrelated to short-run cyclical or credit market shocks, we find that an increase in mortgage purchases by the agencies boosts mortgage lending, in particular refinancing, and lowers mortgage rates. Agency purchases influence prices in other asset markets, stimulate residential investment and expand homeownership. Using information in GSE stock prices to construct an alternative instrument for agency purchasing activity yields very similar results as our benchmark narrative identification approach.

***Keywords**:* Credit Policy, Monetary Policy, Mortgage Credit, Residential Investment, Government-Sponsored Entreprises.

Jel codes: E44, E52, N22, R38, G28

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1 Introduction

The residential mortgage market in the United States is one of the largest capital markets in the world and by far the dominant source of credit for American households. The mortgage market finances housing, which is a key component of both household wealth and aggregate spending, see e.g. Leamer (2007). Many accounts of the causes and propagating factors of the 2007/08 financial crisis assign an important role to a boom and bust in the availability of mortgage credit.[1] The US mortgage market is also subject to heavy government involvement through various federal agencies, including the housing government-sponsored enterprises (GSEs). In the decades preceding the 2007/08 crisis, the various agencies collectively accumulated a large share of the total outstanding US mortgage debt on their balance sheets. In this paper, we investigate whether agency portfolio purchases of mortgage assets influence the availability and cost of housing credit, and whether there are spillovers to other debt markets and economic activity more broadly.

While the history of agency activity offers a rich source of variation to study the effects of government asset purchases, it also presents a number of challenges. The largest agencies, Fannie Mae and Freddie Mac, have been privately owned for much of their existence and therefore carry responsibilities to stock owners as well as to their public missions of providing "stability" and "ongoing assistance" in mortgage markets. Both profit and public objectives cause these agencies to systematically and rapidly respond to market conditions, such that changes in their mortgage purchasing activity reflect changes in housing credit demand and many other influences. Some of the correlation between agency balance sheets on the one hand and credit growth or mortgage rates on the other is therefore likely to reflect reverse causality.

We propose two different strategies to isolate changes in agency purchasing activity free of confounding influences. Our first and principal strategy is to focus on historical credit policy interventions affecting agency mortgage holdings, in the spirit of the approaches in Romer and Romer (1989, 2010) and Ramey (2011) to studying monetary and fiscal policy. Based on a narrative analysis of the regulatory history of the housing agencies, we identify and quantify significant policy events affecting agency purchases. These include adjustments to capital requirements, portfolio caps, or statutory borrowing authority, direct appropriations and

[1] See e.g. Mian and Sufi (2009), Justiniano, Primiceri, and Tambalotti (2014), or Di Maggio and Kermani (2016).

capital injections by the Treasury, or changes to the pool of mortgages eligible for agency purchase, such as changes in conforming loan limits or authorizations to enter new mortgage market segments.

Credit policy changes are often reactions to cyclical conditions in mortgage and housing markets, the recent crisis being a prime example. However, many interventions are motivated by other longer run objectives such as increasing homeownership. Based on an extensive analysis of historical sources, we classify each significant credit policy change as motivated by either cyclical considerations or by other non-cyclical objectives.[2] This results in an indicator summarizing the non-cyclically motivated policy events, which we use as an instrumental variable in regressions of a variety of outcome variables on measures of agency purchasing activity. Similar to the approach in Ramey and Zubairy (2016) to estimating government spending multipliers, we estimate the cumulative effects of an increase in agency purchases on mortgage credit and originations, as well as impulse responses to news shocks about future agency purchasing activity.

Our second and complementary identification approach is based on instrumenting measures of agency purchasing activity with orthogonalized innovations in Fannie and Freddie excess stock returns. This alternative strategy is analogous to Fisher and Peters (2010), who use excess return innovations in major US defense stocks as a measure of news shocks to military spending. Passmore (2005) estimates that the advantages granted by federal housing credit policy account for much of the market value and portfolio size of Fannie and Freddie. We show that news about policy interventions affecting GSE balance sheets is reflected in their stock market valuation. Positioned last in a causal ordering behind credit aggregates, interest rates, and other macro variables, we find that residual variation in Fannie and Freddie excess stock returns predicts agency mortgage purchases. This motivates us to use this residual variation as an alternative instrumental variable to estimate the response of credit aggregates to shocks to agency mortgage purchases.

It is not clear ex ante that government purchases of mortgage assets have meaningful effects on the cost and availability of housing credit. If financial market frictions are relatively unimportant, an increase in agency purchases may have little impact on the volume of mortgage credit, and simply lead to crowding out

[2]The full narrative analysis is in a companion background paper, Fieldhouse and Mertens (2017), available at `http://www.nber.org/papers/w23165`.

of private holdings. If such frictions are instead pervasive, mortgage market policies may on the other hand be very important for the provision of credit to residential borrowers. Based on our methodology, we find that agency purchases indeed lead to statistically significant expansions in mortgage credit. Our estimates indicate that each additional dollar in agency mortgage purchases leads to a 3 to 4 dollar cumulative increase in mortgage originations over the course of three to four years, and a net expansion in the stock of mortgage debt of around one dollar. The rise in originations is largely driven by an increase in refinancing activity, but is also followed by a greater volume of originations financing home purchases. The expansionary effects on housing credit are accompanied by temporary reductions in mortgage interest rates, which fall by 10 to 15 basis points for more than a year following an increase in agency purchases of one percent of trend originations.

Agency purchases also affect prices in other asset markets. We estimate that the 10-year Treasury rate and the 3-month T-bill rate both decline when the agencies increase their purchases of mortgages. A key policy objective behind President Hoover's introduction of housing credit policies in the 1930s was to stimulate the construction sector, while another recurrent motivation has been to promote homeownership. We find evidence that supports these roles of the agencies in that new housing starts and homeownership rates rise following an increase in agency mortgage purchases. We also find some evidence that agency mortgage purchases increase house prices and stimulate private sector consumption. There is no clear evidence of any significant impact on the unemployment rate or personal income.

Perhaps our most surprising finding concerns the relationship between housing credit and monetary policies. We show that the narratively identified housing credit policy shocks have forecasting power for the residual shock component of the Romer and Romer (2004) decomposition of funds rate target changes, while the reverse is not true. Instead, we find that cyclically motivated housing credit policy changes lean against the wind of contractionary monetary disturbances. Housing credit policy shocks have larger effects on refinancing originations than interest rate shocks, and influence homeownership independent of short-term interest rates. The quantitative effects of housing credit policy and conventional monetary shocks are very similar along many other dimensions. These findings suggest that both may share similar transmission channels, and that the interplay between monetary and credit policy deserves more attention.

2 Mortgage Purchases as Credit Policy in the United States

The US government intervenes in the mortgage market in many ways. We focus attention on the federal involvement in purchasing residential mortgages. The first significant use of this type of policy dates back to the Great Depression. The sharp and sustained downturn in credit markets motivated Congress to create the Home Owners' Loan Corporation in 1933. Financed by bonds, the Corporation purchased delinquent mortgages from lenders and refinanced these mortgages into fully amortizing fixed-rate loans with long maturities to lower monthly payments for distressed mortgagors. In 1938, Congress created Fannie Mae to support a secondary market for government-guaranteed mortgages. Fannie's authority to acquire mortgage debt was increased greatly after WWII to support the construction sector and promote homeownership among veterans. The late 1960s saw the creation of Ginnie Mae to provide continued support the market for government-guaranteed mortgages. In 1970, Fannie Mae obtained permission to enter the conventional market, i.e. the market for loans not directly guaranteed or insured by the government, and the newly created Freddie Mac joined Fannie Mae in developing a nationwide secondary market for conventional mortgages.

Over time, the agencies have played an increasingly active role. The two largest GSEs, Fannie and Freddie, acquire mortgages through advance commitments to buy loans from mortgage lenders, which are delivered once the loans are originated in the primary market.[3] Until the late 1960s, the purchases by Fannie were financed predominantly by borrowing from the Treasury. Afterwards, as quasi-private entities, Fannie and Freddie have financed these purchases with a mix of private capital and debt issued in capital markets. A third financing option is the issuance of mortgage pools, i.e. mortgage-backed securities (MBS). Securitization was brought to the conventional market by Freddie Mac in the early 1970s, and took off in the 1980s when it was also adopted by Fannie Mae. Mortgage securitization has consistently been GSE-dominated, perhaps with the brief exception of the 2004-2006 private-label securitization boom. In the process of packaging whole mortgages into securities, the agencies also assume the credit risk in return for guarantee fees. From the early 1990s onwards, the agencies increasingly retained their own and acquired each other's MBS, as opposed to selling them to private investors.

[3] Another major housing GSE is the Federal Home Loan Bank System, chartered during the Depression to provide wholesale liquidity to member mortgage lending institutions. We use the term 'GSE' to refer to Fannie and Freddie.

Figure 1 illustrates the evolution of agency involvement in the residential mortgage market over time. The upper left panel shows the stock of total residential mortgage debt both as a ratio of GDP and as ratio of total residential wealth. The upper right panel shows the total annualized volume of residential mortgage originations as a ratio of GDP and as a fraction of outstanding mortgage debt. The lower panels of Figure 1 provide measures of agency market shares, constructed by consolidating data on holdings and net purchases of whole loans and MBS as reported on the agencies' balance sheet and activity statements. The left panel shows the fraction of mortgage debt owned by Fannie, Freddie, and Ginnie as well as all other federal agencies with mortgage holdings, such as the Federal Home Loan Banks and the Federal Reserve.[4] The lower right panel show the flows of net mortgage purchases by the agencies as a percentage of total originations. The blue line shows the net portfolio purchases. To distinguish these portfolio purchases clearly from those for securitization, the figure also shows in red the combined issuance of MBS by the agencies.[5]

The post-WWII period witnessed a marked expansion in mortgage debt, rising from around 10 percent of GDP at the end of WWII to more than 80 percent by 2008, before steadily declining in the wake of the 2007/08 financial crisis. Originations of new mortgages are volatile, procyclical, and average around 20 percent of outstanding debt at an annualized rate.[6] By any measure, the government agencies have over time become large players in the mortgage market. Between 1980 and 2006, total purchases in the secondary market by Fannie and Freddie alone average around 40 to 50 percent of originations. The majority of these acquisitions were packaged in MBS and sold off to private investors. The portfolio purchases, comprising whole loans retained for the portfolio as well as net acquisitions of MBS, have averaged 7 percent of originations between 1967 and 1990, and about 15 percent between 1990 and 2006. At the peak in 2004, almost a quarter of all residential mortgage debt resided on the balance sheet of a federal agency, with roughly 20 percent owned by Fannie and Freddie alone. In early September 2008, Fannie and Freddie were taken into conservatorship and were required to gradually wind-down their balance sheets by two-thirds. The Federal

[4] Other agencies include the Home Owners' Loan Corporation, Treasury, Veterans Administration, Federal Housing Administration, Federal Farmers Home Administration, Resolution Trust Corporation, Federal Deposit Insurance Corporation, and Public Housing Administration. We do not include mortgages in government pension funds. See the data appendix for sources.

[5] Because purchases may include loans originated in prior periods, the market shares may occasionally exceed 100 percent.

[6] Net additions to the stock of mortgage debt are considerably smaller than originations since both existing home sales as well as refinancing transactions typically lead to minor net changes in mortgage debt.

Reserve subsequently pursued several rounds of large-scale purchases of agency MBS under its quantitative easing (QE) programs, and its current holdings amount to roughly 15 percent of total mortgage debt outstanding. For readers wishing more information about the institutional history of the housing agencies, the appendix provides more background.

The focus of this paper is on the portfolio purchases of the housing agencies, shown in blue in the lower right panel in Figure 1. Prior to the Fed's QE programs, Fannie and Freddie accounted for the bulk of agency mortgage acquisitions. Even as privately owned corporations, Fannie and Freddie have been key agents of federal housing policy and differ from traditional financial intermediaries in a number of important ways. First, they have always maintained authorization to borrow from the Treasury. While this authorization was limited and never formally exercised, it sufficed to create the widely held belief that the US government would never allow a GSE to default. This perception, eventually justified by the government takeover of Fannie and Freddie in 2008, meant that interest rates on agency bonds have typically been close to Treasury rates. Second, agency debt is eligible for open market operations by the Fed. In the 1960s and 1970s the Fed made significant purchases of agency debt, see Haltum and Sharp (2014), and again so under the QE programs. Third, the prudential supervision of the GSEs is separate from private banks and, prior to 2008, resided within the Department of Housing and Urban Development (HUD).[7] Regulatory oversight of the GSEs was traditionally light compared to that of private banks, and the GSEs generally enjoyed much less stringent capital and reporting requirements. For instance, despite being publicly listed companies, Fannie and Freddie were exempt from filing with the Security and Exchange Commission until the early 2000s. Finally, for much of their existence, the GSEs have also benefitted from various preferential tax treatments.

In exchange for the privileges granted by federal law, the GSEs face a number of restrictions and obligations. Fannie and Freddie cannot originate loans in the primary market and are not allowed to diversify portfolio holdings much beyond mortgage assets. Their purchases are limited to conforming mortgages that must meet certain underwriting standards, and the principal on the loans cannot exceed a maximum amount, known as the conforming loan limit. The authority for adjusting the limit and other loan characteristics that

[7] Since 2008, the regulatory authority lies with the Federal Housing Finance Agency, an independent federal agency.

determine what mortgages are conforming has generally lied with Congress and the HUD Secretary. In 1980 the conforming loan limit became indexed to a house price index maintained by Freddie Mac. Since then typically around 80 percent of mortgages have been conforming.[8] Finally, the GSEs are expected to balance stock owner interests with certain public policy objectives, including the stabilization and enhancement of mortgage markets, as well as assistance with the provision of credit to lower-income households.

3 Related Literature

There are relatively few attempts at identifying the dynamic effects of agency purchases on mortgage credit, residential investment or homeownership. An early literature estimates reduced form models of credit and housing markets to assess the impact of GSE activity in the 1970s, e.g. Arcelus and Meltzer (1973), Meltzer (1974), Hendershott and Villani (1977, 1980), Jaffee and Rosen (1978), and Kaufman (1985). Although no clear consensus emerges from this early work, Smith, Rosen, and Fallis (1988) conclude that an additional dollar in government lending increases mortgage debt by 25 to 35 cents after three to four quarters. Arcelus and Meltzer (1973) and Meltzer (1974), however, argue there is no effect on residential investment or home purchases, while Jaffee and Rosen (1978) and Hendershott and Villani (1977, 1980) find a positive impact of agency activity on home construction.

Starting with Hendershott and Shilling (1989), a number of studies document significant interest rate spreads between conforming and jumbo loans, which suggests that the GSEs affect the cost of mortgage credit. Hendershott and Shilling (1989) attribute this result to a credit supply channel operating through agency securitization. A number of studies investigate the time series relationship between GSE activity and credit costs. Naranjo and Toevs (2002), for instance, find a negative long-run relationship between GSE purchases and mortgage rates, while González-Rivera (2001) finds only a negative short-run relationship.[9] Lehnert,

[8] In response to the financial crisis, the limit was increased substantially for the financing of homes in urban areas, which further expanded the pool of mortgage debt eligible for GSE purchase.

[9] Naranjo and Toevs (2002), who use vector error-correction (VEC) and GARCH (generalized autoregressive conditional heteroskedastic) models and monthly time series data from 1986 to 1998, find that both GSE purchases and securitization reduce conforming mortgage spreads and volatility, while documenting some spill over to reductions in non-conforming loans, which they attribute to investor substitution effects. González-Rivera (2001), who uses VEC models and monthly data from 1994 to 1999, finds a negative short-run relationship of GSE purchases responding to widening secondary mortgage market spreads, and some evidence of a pass through from secondary to primary mortgage rates from agency purchases.

Passmore, and Sherlund (2008) study the impact of GSE activities on primary and secondary market mortgage spreads using both generalized impulse response analysis and causal orderings in VAR models. Based on monthly data from 1993 to 2005, these authors find little evidence that higher GSE purchases impact mortgage spreads, which is consistent with the Meltzer view that credit market interventions are neutral. In a May 2005 speech, Federal Reserve Chairman Alan Greenspan conveys a similar view of the role of the GSEs' portfolio activities, stating that "*Fannie's and Freddie's purchases... with their market-subsidized debt do not contribute usefully to mortgage market liquidity, to the enhancement of capital markets in the United States, or to the lowering of mortgage rates for homeowners*" (Greenspan, 2005).

In this paper, we contribute new evidence against the Greenspan-Meltzer view that agency mortgage purchase have little effect on the cost and availability of mortgage credit. Our approach is similar in spirit to Lehnert et al. (2008), but adopts novel and arguably better identification strategies to control for the endogeneity of agency purchases. We also study a much longer time frame than any of the earlier papers, and we estimate the effects on both credit aggregates and mortgage rates. Moreover, our dynamic regressions allow us to study many other variables of interest, including housing starts, home prices, homeownership rates, cyclical indicators, and various other interest rates and credit spreads.

Our paper is related to the many analyses of the large-scale MBS purchases by the Federal Reserve under the QE programs. To isolate the effects of these purchases, the literature typically restricts attention to high frequency financial data, and most studies conclude that the MBS purchases lowered secondary market mortgage yields on impact, see e.g. Gagnon et al. (2011), Krishnamurthy and Vissing-Jørgensen (2011), Patrabansh, Doerner, and Asin (2014), and Hancock and Passmore (2011, 2015).[10] Exploiting cross-sectional variation, a few recent studies also uncover evidence that is suggestive of a positive impact on mortgage lending. Di Maggio, Kermani, and Palmer (2016), for instance, find that, after the first QE intervention, originations of mortgages qualifying for inclusion in securities eligible for purchase by the Fed increased substantially more than those of non-qualifying mortgages. No such differential effects are evident after the second QE intervention, which did not include MBS purchases. Darmouni and Rodnyansky (2016)

[10] Stroebel and Taylor (2012) instead find no effects of the MBS purchases under QE1.

find that banks with larger mortgage positions increased lending relative to banks with smaller positions, and Chakraborty, Goldstein, and MacKinlay (2016) show that banks with MBS exposure increased their mortgage origination share relative to other banks. By studying a longer history of housing credit policy interventions, we are able to circumvent some key limitations of the event studies of the Fed's large-scale MBS purchases. Our approach permits an analysis beyond the very short-run response of financial variables, and unlike the cross-sectional studies, provides direct evidence on aggregate rather than relative effects.

Our study also fits in a broader empirical literature that aims to identify credit supply shocks and estimate their aggregate effects. Peek, Rosengren, and Tootell (2003), for instance, use bank health indicators as proxies for loan supply shocks and find substantial effects on inventory investment and other aggregates. Gilchrist and Zakrajšek (2012) look at innovations in corporate bond spreads after removing cyclical default premia, and demonstrate their strong predictive content for macroeconomic fluctuations. Bassett, Chosak, Driscoll and Zakrajšek (2014) study residual variation in survey measures of bank lending standards and find an impact on economic activity. Mian, Sufi, and Verner (2017) use variation in the timing of bank branching deregulation in the 1980s to construct differential state-level credit supply shocks, and find that these shocks impact household borrowing and employment. Both our narrative policy indicator and the GSE excess return shocks can similarly be viewed as proxies for credit supply shocks in the mortgage market.

Many existing theories of financial frictions can explain the non-neutrality of agency mortgage purchases. Krishnamurthy and Vissing-Jørgensen (2011) and Di Maggio et al. (2016), among others, discuss a variety of potential transmission channels associated with the MBS purchases under the QE programs. Many of these channels have similar implications for mortgage purchases by the GSEs. Through the portfolio rebalancing channel, for instance, private investors bid up the price of mortgages when rebalancing assets towards some desired composition of mortgages and agency liabilities. For the GSEs, the latter are not reserves, but debt instruments that closely substitute for Treasuries in terms of liquidity and (perceived) safety.[11] Depending on the level of segmentation in financial markets, rebalancing effects may spill over to other asset markets, in which case yields on mortgage substitutes—particularly other types of long-term debt—may fall as well.

[11] This difference may be less important if the Federal Reserve simultaneously acquires agency debt.

Agency mortgage purchases also matter when private mortgage lenders face capital constraints because of regulations or binding incentive constraints, for instance as in the theoretical models of Gertler and Kiyotaki (2010) or Cúrdia and Woodford (2011). Because the GSEs are more highly leveraged than private lenders, aggregate lending capacity increases with agency market share. Agency purchases that drive up the price of mortgages may additionally improve the net worth position of private mortgage lenders, while the exchange of mortgages for agency debt lowers their risk-weighted leverage ratios. Increased agency activity in the secondary mortgage market may also reduce liquidity premia. Our findings support a role for credit supply channels in determining household debt, homeownership, and residential investment, but it is beyond the scope of this paper to isolate precisely which of these channels may be more important.

4 Identifying Causal Effects of Agency Mortgage Purchases

4.1 Endogeneity Problems

To assess the impact of agency portfolio purchases, one might be tempted to simply correlate measures of agency activity, such as those in Figure 1, with credit and other macroeconomic aggregates. This would, however, ignore various endogeneity problems. For one, the agencies respond to changes in market conditions. To maintain market share, for instance, the GSEs vary purchases with the supply of mortgages into the secondary market, which in turn depends on fluctuations in the housing market and the economy. A different endogeneity concern is that agency purchases typically expand relative to the mortgage market when credit is tight and/or conditions in the housing market are deteriorating. This was evidently the case during the latest financial crisis through the actions of the Fed and Treasury, but is also true of earlier episodes.

Figure 2 shows the average real levels of agency and private holdings of mortgage debt over the course of business and credit cycles since the mid-1950s. The left panel of Figure 2 shows the average real levels of agency and privately held mortgage debt centered around NBER business cycle peaks. On average, growth in agency holdings is high relative to growth in private holdings prior to a business cycle peak. The growth in private mortgage holdings slows down just prior to the peak and remains low for a prolonged period after the start of a recession. The pace of growth of agency holdings, in contrast, remains roughly unchanged for

at least two years after the beginning of an economic downturn.

The right panel of Figure 2 shows the average real levels of mortgage holdings centered around the peak of credit cycles, defined as the quarter preceding the start of credit crisis episodes based on the datings in Eckstein and Sinai (1986) and subsequent updates.[12] Agency and private holdings grow at roughly similar rates prior to a credit crunch. Growth in private holdings of mortgage debt slows markedly following the start of a credit crisis. In contrast, growth in agency holdings accelerates at the onset of a credit crunch and remains elevated for about ten quarters, before flattening toward the pre-crunch trend.

The evidence thus indicates that agencies tend to increase their share of the market in cyclical downturns and credit crunches. These countercyclical purchase dynamics are robust to omitting the 2007/08 crisis and the Federal Reserve's interventions. There are a number of reasons why the agencies jointly maintain or expand purchases during cyclical downturns. A public mission to provide stability to mortgage markets is mandated in the GSEs' statutory charters. Credit crises also offer particularly profitable opportunities for the GSEs because their lending spreads widen relative to private intermediaries, due to countercyclical mortgage spreads and the implicit guarantee provided by the US government. Finally, the federal government often undertakes deliberate regulatory or legislative actions to further enable agency expansions during downturns. The fact that agency purchases tend to accelerate when mortgage spreads are elevated and/or credit is tight induces a negative relationship with mortgage credit aggregates. This negative association needs to be accounted for in order to determine the causal effects of agency mortgage purchases.

4.2 Narrative Analysis of Policy Changes Affecting Agency Mortgage Holdings

Our principal strategy to control for reverse causality in the relationship between agency mortgage purchases and credit conditions is to use a narrative identification approach involving major regulatory events impacting agency mortgage holdings. By focusing on policy interventions by the federal government, we exclude variation in purchase activity resulting from the agencies' regular response to market developments. Be-

[12]The dating of pre-1986 credit crunches is from Eckstein and Sinai (1986). The dating of post-1986 crunches is based on Owens and Schreft (1993) for the 1990 commercial real estate crunch, Lehnert, Passmore, and Sherlund (2008) for the 1998 Russian default/LTCM crisis, and Bordo and Haubrich (2010) for the 2007/08 financial crisis.

cause policymakers themselves often respond to conditions in mortgage and housing markets, we exclude interventions with short-run stabilization motives as the primary objective. The end result of our narrative analysis is a record of housing credit policy events that we use as an instrumental variable for agency purchase activity. Here, we summarize the methodology of the narrative analysis, and describe the resulting policy indicators. A companion background paper, Fieldhouse and Mertens (2017), provides the full narrative analysis of credit policy events, including explanations of relevant findings for each policy event and extensive documentation that allows verification of our analysis.

4.2.1 Overview of Methodology

The development of the narrative instrumental variable follows five steps: Identifying significant policy changes affecting agency portfolios; quantifying their ex ante projected impact on agency holdings; pinpointing the timing of when the policies became publicly known; classifying each policy change as either cyclically or non-cyclically motivated; and restricting the sample for consistent use as an instrument for agency purchasing activity. Next, we describe the procedures used in each of these steps. Table 1 provides an overview of the historical primary sources used in the narrative analysis.

I. Identifying Significant Policy Changes Policy changes affecting agency purchases and mortgages holdings have historically been directed by a range of policymakers, notably Congress, the President and the Cabinet, particularly the Secretaries of the Treasury and HUD, various regulatory agencies in the executive branch, and the Federal Reserve. The relevant regulatory institutions were disbanded and reinvented several times over the decades, and as a result there is no single consistent source tracking the history of housing credit policy. Instead, a wide range of sources is required for identifying and analyzing policy changes.

Policy actions generally originate from one of three sources: enacted legislative changes, regulatory policy changes published in the Federal Register or as other binding agreements with regulators, and macroeconomic stabilization policies managed by the Federal Reserve or Treasury. We restrict attention to significant policy actions, meaning actions that would either be expected to directly impact agencies' permissible volume of net purchases and retained portfolio holdings, or else considerably expand the pool of eligible mort-

gages an agency was authorized or required to purchase. Interventions determined at the legislative level include adjusting statutory leverage ratios, capital requirements, and conforming loan limits, provision of working capital, mandatory retirements of public stock, and direct appropriations or borrowing authority for purchases, among others. Regulatory policy actions include setting permissible debt-to-capital ratios, imposing capital surcharges in excess of statutory capital requirements, capping portfolio size or growth, setting affordable housing goals, and authorizing entrance to new segments of the mortgage market. Macroeconomic stabilization actions include the Fannie and Freddie conservatorship agreement in September 2008, subsequent amendments to these agreements, and the large-scale MBS purchase programs conducted by the Federal Reserve and Treasury since 2008.

We use the comprehensive Congressional Research Service report "*A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003"* (CRS, 2004) as a starting point for identifying significant policy changes, particularly pertinent public laws. This legislative history is cross-referenced with the *Congressional Quarterly Almanac*'s Housing and Development tracker. We additionally search appendices of the *Budget of the United States Government* for information about policy changes affecting Ginnie Mae during relevant years, cross-referenced with HUD appropriations bills and related reports of the House and Senate Appropriations Committees. After identifying public laws affecting the agencies, we use the ProQuest Congressional Publications Database to collect the legislative text of those enacted laws, related committee reports and Congressional hearing transcripts, and any preceding House and Senate versions of the final bill.[13] We then analyze relevant sections of these primary sources to confirm these laws' material impact on mortgage holdings and better understand the nature of the policy changes.

Legislative actions often set in motion the drafting of new regulatory rules. Identified significant legislative events are the starting point for a directed search of the related regulatory changes in HeinOnline's Federal Register Library. We also obtain information from the GSEs' annual reports about significant regulatory changes, as well as from 10-K filings in more recent years. We additionally used sections of the *Economic*

[13]The ProQuest Congressional Publications Database provides a comprehensive compilation of all public laws, committee reports, and hearings. Public laws and related legislative actions since 1973 are available from Congress.gov, a project of the Library of Congress, along with committee reports since 1995. Most older public laws are available through LegisWorks Statutes at Large Project. Most hearing transcripts are digitally available since 1985 from the US Government Publishing Office.

Report of the President and *Annual Report of the Board of Governors of the Federal Reserve*, as well as the various reports by regulators to collect information about regulatory rulings. We use newspapers, financial newswires, and mortgage industry newsletters to help direct the search for information about the rulings in the Federal Register, particularly the *Wall Street Journal*, *American Banker*, and *National Mortgage News*.[14] Final rules published in the Federal Register almost always include a detailed background and overview of the initial proposed rule, public comments received, and subsequent modifications.

Using these procedures, we are confident that we have identified the overwhelming majority of significant policy events. The main concern is developing a policy indicator that is correlated with underlying regulatory shocks to agency purchasing activity. The larger the number of significant policy events identified, the higher the relevance of the instrument.

II. Quantification To be included, we require that primary sources either explicitly cite projections of the policy change's impact, or contain information that can be used to quantify the impact. We describe here our general approach, and show later that the resulting projections align closely with the ex post estimated balance sheet impact.

For each policy change, we use contemporaneous sources to obtain an ex ante estimate of the projected impact on the agencies' capacity to purchase mortgages, measured in annualized billions of dollars. If a baseline is needed for quantifying a policy change, say for Fannie's regulatory capital when its debt-to-capital ratio is increased, we use the most recent data publicly available prior to the policy change. We use ex ante balance sheet data on regulatory capital, liabilities, and/or assets in conjunction with standing leverage or capitalization requirements to estimate the impact of related changes, such as increases in permissible leverage ratios. Similarly, public capital injections are quantified as a multiple of one more than the prevailing leverage ratio, to capture the potential increase in assets supported by related debt issues plus the working capital itself. Direct appropriations are straightforward to quantify, at most requiring a pro-rata annualization adjustment based on relevant implementation lags. To quantify potential impacts of discretionary

[14]This is done by Factiva and LexisNexis Academic searches of key words related to the regulatory policy change, in search windows around the vicinity of the event. After roughly pinpointing the publication date of a rule, we search the Federal Register for the rule itself, and then work backwards to initial rulings.

conforming loan limit changes, we rely on estimates from Congressional committee reports accompanying legislation. Such reports typically cite the extent to which a large conforming loan limit increase would restore a GSE's real purchase activity. We quantify the impact of such adjustments as the difference between annualized purchase volumes immediately preceding the policy change and the home price index-adjusted purchase volume of the benchmark year being restored. For relatively large, open-ended changes, such as leverage ratio increases, potential effects on mortgage holdings are annualized using a two-year rule, which assumes half of the full potential impact would be realized within the first year of taking effect.

For other policies that are inherently harder to quantify, such as authorizations for program expansions into new mortgage market segments, we search for ex ante estimates of projected impacts on purchasing activity from committee reports, market analysts, regulators, or agency executives. We do not include policies that would not have been expected to impose or alleviate binding constraints on agency activity. For instance, when adjustments to leverage ratios or affordable housing goals are viewed as non-binding by most accounts and this appears consistent with the agencies' balance sheet and purchase behavior, we do not consider the policy change significant. We also exclude any laws or regulations that merely extend prior authorizations, and for certain authorizations affecting Ginnie Mae, we use a current policy baseline as opposed to a current law baseline for scoring annual funding changes.

When estimating the quantitative aspects of the policies, we rely on information released by the Congressional Budget Office, Government Accountability Office, Treasury Department, and Congressional Research Service that contain detailed analyses of policy changes, background information, and/or balance sheet data for the agencies in question, see Table 1. We also use information from the annual or periodic reports of the agencies and regulators, particularly regarding balance sheet data, and from appropriations bills and budget appendices for certain policies affecting Ginnie Mae. Committee report language occasionally cites projected effects of a pending policy change, and we also use the financial press and industry newsletters to search for projections of the impact of policies that are difficult to quantify.

III. Timing At the operational level, the agencies sell commitments to purchase conforming mortgages from primary market lenders, which may then be exercised by the mortgagee up to an expiration date. Consequently, actual agency purchases tend to lag behind the issuance of commitments to purchase mortgages from primary market originators. Together with the usual policy implementation lags, the policy events are therefore best thought of as news shocks about agency mortgage purchases. We date each policy intervention to the month in which we estimate that it became publicly anticipated, rather than the month in which it was formally announced or took effect. We show in the next section that this timing approach is roughly consistent with the observed movements in consolidated agency mortgage holdings.

The ProQuest Congressional Publications Database, HeinOnline's Federal Register Library, the *CQ Almanac*, and financial press are the primary sources used for documenting pertinent news surrounding policy changes and the implementation dates. For regulatory changes, we use the month in which proposed rules were first published in the Federal Register or reported in the press. We date legislative changes when the provision including the policy change was agreed upon in the House, Senate, or conference version of a bill, rather than upon subsequent enactment. For Fannie and Freddie, we additionally check the timing by cross-referencing policy announcements with GSE stock price movements and the financial press, as often policy news is priced into GSE shares.

IV. Classification by Motivation The classification of the policy events distinguishes between interventions that are guided by prevailing business cycle and financial conditions, and those that are plausibly free of such contemporaneous influences. Our instrument for agency mortgage purchases only includes the latter to avoid bias due to the systematic relaxation of policies during periods of stress in mortgage or housing markets. The classification is based on identifying the primary motivations underlying each of the policy interventions. To make this classification, we parse historical documents, paying particular attention to the rationales invoked by policymakers and the press, the nature of the legislative vehicles or regulatory processes, the relation to known periods of economic and financial stress, and the time horizon of policy objectives.

The principal data sources for identifying policy motives include Congressional committee reports and hearings, Presidential speeches and signing statements, the *Budget of the US Government*, *Economic Report of the President*, *Federal Reserve Bulletin*, *Annual Report of the Board of Governors of the Federal Reserve*, *CQ Almanac*, and the financial press (see Table 1). For legislated policies, the accompanying reports of the Senate Committee on Banking, Housing and Urban Affairs and the House Financial Services Committee typically detail congressional intent and any pertinent economic context. Major housing policy laws are also usually accompanied by a Presidential signing statement explaining the bill's motivation, context, and intended impact. Budget appendices and/or committee reports accompanying appropriations bills usually explain the impetus for certain policy changes affecting Ginnie Mae. Final rules published in the Federal Register also almost always include a detailed background and history, shedding light on regulators' motives.

Based on these sources, we classify the policy changes as either cyclically motivated or non-cyclically motivated. Interventions classified as cyclically motivated tend to emphasize short-term outcomes, such as boosting housing starts in a recession. Legislative vehicles for such policy actions tend to be quickly drafted and enacted, with a relatively concise legislative history and narrow focus. Policymakers are typically quite explicit about cyclical concerns and objectives, overwhelmingly so when policies are implemented in close proximity to recessions or credit crunches. Language we search for in committee reports and signing statements as strong evidence of cyclical motivations include "*emergency, crisis, recession, credit shortage, credit crunch, housing starts, employment, construction, downturn, depressed, stimulus, boost*", etc. Policies enacted during or near a recession or credit crunch are held to a particularly high bar for being classified as non-cyclical, but are not automatically classified as cyclically motivated.

Interventions motivated by social policy, budgetary, or other more ideological objectives are classified as unrelated to the business or financial cycle, provided the various historical sources do not at the same time indicate significant short-term economic or financial market concerns. Political rather than economic context shapes the development of these interventions, such as an administration's emphasis on expanding affordable homeownership opportunities to lower-income households, concerns regarding the structural budget deficit, or ideological hostility toward the GSEs. It is often hard to establish a single rationale for the non-cyclical ac-

tions, which can be motivated by a mix of objectives. For our purposes, however, a more precise distinction between these objectives is not essential. Language we search for as indicative of non-cyclical motivations include "*long-term, farsighted, comprehensive, low-income, affordable housing, American Dream, home-ownership, budget deficit, reduce borrowing, off-budget, privatize*," etc. Legislative actions classified as non-cyclical emphasize longer-term outcomes, such as increasing homeownership rates. Legislative vehicles for such interventions tend to be slower-moving bills, particularly deliberate overhauls of housing policy with a lengthy legislative history; the National Housing Acts, Housing and Urban Development Acts, and Housing and Community Development Acts of various years tend to meet this description, being slowly crafted and negotiated between the House, Senate, and White House, and focusing on broad, long-term objectives for housing policy, such as urban revitalization or access to affordable housing for various constituencies. New regulatory rules set in motion by such bills also tend to be classified as non-cyclical, such as HUD setting new affordable housing goals for the GSEs. Occasionally, interventions are prompted by specific events that we view as unrelated to the cycle, such as the regulatory actions taken in the aftermath of accounting scandals at Fannie and Freddie in 2003-2004.

V. Sample Restrictions Occasionally a law or public rule sets in place changes in purchase authorizations or balance sheet restrictions to take effect only multiple years after announcement. To obtain a good indicator for news about pending purchase behavior, we exclude changes with very long implementation delays and focus on interventions taking effect within nine months of their news being made public. We also restrict attention to policy events after January 1967. This choice is made to select a period of relative institutional stability, as it roughly coincides with the creation of Ginnie and Freddie, the emergence of a nationwide secondary market for conventional mortgages, and the beginning of the ascendancy of the privatized GSE era. This starting point is also in part determined by the availability of time series used in the empirical analysis. We focus exclusively on the mortgage portfolio activity of Fannie, Freddie, and Ginnie, ignoring less significant government entities for which monthly data is not easily available. We also include purchases by the Federal Reserve and Treasury in the recent financial crisis, but in most of the analysis in Sections 5 and 6 the sample is truncated at December 2006 to deliberately exclude the financial crisis and the Fannie and Freddie conservatorship period. As shown in Figure 1, the three housing agencies that we analyze account

for the large majority of government agency mortgage holdings between 1967 and 2006.

4.2.2 The Narrative Measures of Policy Changes

Table 2 lists the policy events resulting from the narrative analysis. Each intervention is described by the agencies affected, by its annualized projected impact (in billions of US dollars), timing, and motivation. The monthly sample contains 45 months with interventions in the post 1967 sample (there are 52 interventions in total but some occur within the same month). Out of these, 28 are classified as cyclically motivated, leaving 19 distinct non-cyclically motivated policy events. In the sample that excludes interventions after December 2006, there are 15 cyclically and 17 non-cyclically motivated policy events.

Figure 3 depicts the interventions as a percentage of the average annualized level of originations in the preceding 12 months. The left (right) panel shows the non-cyclical (cyclical) policy indicator. For reference, each figure also shows credit crisis episodes in grey. The cyclically motivated interventions almost all occur during credit crunches or recessions, while those not motivated by cyclical concerns appear unrelated to the cycle. The largest interventions are those introduced since the start of the 2007/08 financial crisis, which are mostly classified as cyclical.[15] The only post-2006 events that we consider non-cyclical are the removal of Fannie and Freddie portfolio caps in February 2008, which was contingent on the timely filing of financial reports after the accounting scandals, and a 2012 Treasury decision to accelerate the mandated decline in portfolio caps under the GSE conservatorship agreements. Relative to average originations, the three largest non-cyclical changes are the October 1977 combination of a conforming loan limit increase and the expansion of the Brooke-Cranston Tandem program, an increase in Fannie's debt-to-capital limit in December 1982, and the tightening of Fannie's capital requirements in September 2004 in the wake of the accounting scandals. We refer to Fieldhouse and Mertens (2017) for a detailed discussion of all policy events.

Do the policy changes that we have narratively identified lead to actual changes in agency purchases and retained mortgage portfolios? To investigate this, it is important to take into account the potentially significant delays between the policy events and their impact on the agency portfolios. Recall that agencies

[15] These include the Fed and Treasury MBS programs from late 2008 onwards, but also the loosening of capital requirements and portfolio caps for Fannie and Freddie and the introduction of 'jumbo' conforming loan limits in 2008.

initially make advance commitments to buy loans from mortgage providers and subsequently effectuate these as loans are originated in the primary market. We regress three activity indicators, net mortgage purchase commitments made by the agencies, the actual net purchases of mortgages, and the stock of agency mortgage holdings, on the indicator for non-cyclical policy events m_t:

$$y_t = \alpha + \sum_{j=-l}^{36} \beta_j m_{t-j} + u_t \tag{1}$$

We use monthly observations from January 1967 to December 2014 in log first differences of current dollars. Because monthly commitment and purchase flows are relatively volatile, we run the regressions for a 36 month backward moving average of these two variables. The event indicator m_t is the non-cyclically motivated narrative measure scaled by the average level of agency mortgage holdings over the prior 12 months. All regressions include the current value of m_t as well as three years of lags. For each activity measure, we estimate two versions of (1), one in which we set $l = 0$ and one in which $l = 12$. The second version includes a full year of leads of m_t, which allows us to verify the plausibility of our timing of the interventions. Figure 4 shows the estimated dynamics of the agency activity measures around the policy events, obtained as the sum of the slope coefficients β_j over various horizons, together with 95 percent Newey and West (1987) confidence bands.

The policy change indicator strongly predicts significant changes in agency purchase commitments (left panel) which pick up at date 0 and peak at a 3 to 4 percent higher level roughly two years out. Actual purchases (middle panel) follow a very similar trajectory as commitments, but with a lag of a few months, demonstrating that the policy changes act as news shocks for actual purchases. The right panel shows that the higher pace of mortgage purchases is followed by a persistent and statistically significant increase in the agencies' retained portfolio.

The specifications allowing a lead response to the events suggest that our indicator accurately captures the timing of the change in purchasing activity. It is also encouraging that the size of the estimated response of agency mortgage holdings converges to around one percent within 24 months of the policy event, which is

consistent with our scoring of the projected impact of the policy changes.

5 The Cumulative Effects of Agency Mortgage Purchases on Mortgage Credit

We estimate the cumulative impact of agency mortgage purchases on credit aggregates by using the non-cyclically motivated policy changes as an instrument for agency purchasing activity. As shown in Figure 1, the growth in mortgage debt over our sample period has on average exceeded growth in GDP, while agency holdings have increased at an even faster pace. Because of these differential trends, expressing the impact on credit aggregates and other variables in terms of elasticities can be misleading.[16] To address these issues, we run local projections-IV regressions similar to those used by Ramey and Zubairy (2016) to estimate cumulative government spending multipliers.

Our results are based on local projections for horizon h and outcome variable y_t of the form

$$\frac{y_{t+h} - y_{t-1}}{X_t} = \alpha_h + \gamma_h \frac{\sum_{j=0}^{h} p_{t+j}}{X_t} + \varphi_h(L) Z_{t-1} + u_{t+h} \tag{2}$$

where p_t is either the volume of commitments or actual purchases by the agencies in month t. Both y_t and p_t are expressed in constant dollars using the core PCE price index. For every horizon h, the change in y_t as well as the cumulative change in commitments or purchases p_t is expressed as a ratio of X_t, a deterministic trend in real personal income obtained by fitting a third degree polynomial of time to the log of personal income deflated by the core PCE price index.[17] For stock variables, the dependent variable is the change in the stock between $t-1$ and period $t+h$, scaled by X_t. For credit flow measures, we construct y_t by cumulating the flows f_t such that $y_{t+h} - y_{t-1} = \sum_{j=0}^{h} f_{t+j}$.

Each regression includes a full year of monthly lags of a number of control variables Z_t, such that $\varphi_h(L)$ is a lag polynomial of order 11. The controls include variables with predictive content for the dependent variables, and always include lagged values of y_t/X_t (or f_t/X_t for flow variables), as well as lags of agency

[16] Both the news aspect and the scaling issues also occur in other contexts, in particular in the measurement of the effects of fiscal policy interventions, see for instance Ramey (2011), Mertens and Ravn (2012), and Ramey and Zubairy (2016).

[17] The results do not differ meaningfully when we use polynomials of different order. In online appendix A.1, we also show that the results are robust to using a trend in mortgage originations instead of personal income.

net purchases and commitments as a ratio of X_t. In addition Z_t contains lagged growth rates of the core PCE price index, a nominal house price index and total mortgage debt, the log level of real mortgage originations, housing starts, and lags of several interest rate variables: the 3-month T-bill rate, the 10-year Treasury rate, the conventional mortgage interest rate, and the BAA-AAA corporate bond spread. Finally, we add lags of two cyclical indicators: the unemployment rate and the growth rate of real personal income. All growth rates are quarter-over-quarter. The data appendix provides full details on the sources and construction of the time series. In online appendix A.1, we discuss results for a number of alternative control (sub)sets.

The coefficient γ_h in (2) measures the multiplier associated with an additional dollar in commitments or purchases made between period t and $t+h$. This multiplier is the total cumulative dollar change in y_t between period t and $t+h$. We estimate γ_h by two-stage least squares (2SLS) using the dollar impact estimates of the non-cyclically motivated policy events reported in Table 2, deflated by the core PCE price index and expressed as a ratio of X_t, as the instrument. Our baseline estimates use an effective sample of 480 monthly observations, starting in January 1967.[18] In online appendix A.1, we look at different sample periods.

The central identifying restriction is exogeneity of the instrument, which requires that the residuals in (2) and the narrative measure are uncorrelated. To the extent that the lagged controls are informationally equivalent to all relevant impulses to the dependent variables occurring prior to time t, the regression residuals correspond to their horizon h forecast errors. The latter depend only on unpredictable shocks occurring between period t and $t+h$. Our instrument is based on the projected impact of policy events constructed from ex ante information. These estimates should therefore be uncorrelated with shocks occurring after time t. The identifying restriction then boils down to the assumption of orthogonality between the instrument and all shocks in month t other than the one associated with the policy event itself. If the control set does not fully capture all impulses prior to date $t-1$, then the exogeneity requirement is stricter and the instrument must be uncorrelated with the history of relevant impulses to the left hand side variables. The omission of the cyclically motivated events aims at dropping policy actions that may be correlated with all other time t shocks.

[18] With local projections, every successive horizon $h = 0, 1, 2...$ requires a separate regression with h leads of observations beyond the end point of the sample, see Jordà (2005) for a discussion. For $h > 0$, we add the required observations beyond December 2006 such that the number of observations remains constant at $T = 480$ for every h.

Our narrative classification retains the non-cyclically motivated events for which correlation with contemporaneous shocks is unlikely, while the lagged controls provide additional insurance that the confounding effects of any remaining correlations with prior shocks are eliminated, see also Ramey (2016).

5.1 First-Stage Diagnostics

We first assess the strength of our narrative instrument. The left panel of Figure 5 shows the Newey and West (1987) robust F-statistics on the excluded instrument in the first-stage regressions for horizons $h = 0$ to $h = 60$, which are of the form

$$\frac{\sum_{j=0}^{h} \mathrm{p}_{t+j}}{X_t} = \tilde{\alpha}_h + \tilde{\gamma}_h \frac{\tilde{m}_t}{X_t} + \tilde{\varphi}_h(L)\mathrm{Z}_{t-1} + \tilde{u}_{t+h} \tag{3}$$

where $\tilde{m}_t$ is the non-cyclical narrative policy indicator expressed in real dollars. The figure shows the F-statistics when using either cumulative commitments or purchases as the measure of agency activity p_t.

The results indicate that the narrative measure is a reasonably strong instrument for agency purchasing activity for horizons between 4 to 48 months after the policy events, with robust F-test statistics exceeding or close to 10. The F-statistics are low for very short horizons, which is natural given the implementation lags and our timing according to the arrival of news about impending regulatory changes. Beyond horizons of 48 months, the F-statistics fall to lower levels, which is also not surprising as other influences on agency purchases accumulate with the forecast horizon. Given these results we restrict attention to the 4- to 48-month horizon. The F-statistics are very similar when we instrument for either purchases or commitments.

The right panel of Figure 5 depicts IV estimates of the dollar change in agency purchases for every dollar of commitments issued over the various time horizons based on the regressions in (2) using cumulative agency purchases as the outcome variable and cumulative commitments as the independent variable. The fine lines denote 95 percent Newey and West (1987) confidence intervals. Because of the time delays associated with secondary market transactions, the pass-through from commitments to purchases is high but smaller than unity for shorter horizons. After about one year the relationship becomes one-for-one with very

narrow confidence intervals. The interpretation of the credit multiplier estimates presented next therefore depends somewhat on the denominator used, but only for horizons of less than one year. At longer horizons, there is essentially no difference between using commitments or purchases as the agency action measure.

5.2 Cumulative Credit Multipliers

According to the Meltzer-Greenspan view, the portfolio activities of the agencies have no meaningful impact on housing or household debt. Without credit market imperfections, the ownership of mortgage debt is irrelevant. Any change in agency mortgage holdings has no impact on total mortgage debt, but leads instead to perfect crowding out of private holdings. If, on the other hand, there are frictions impeding on the private flow of credit to residential borrowers, agency activity may not be neutral for the volume of mortgage lending. We now examine whether agency mortgage purchases indeed impact housing credit, and test the neutrality hypothesis using the local projections in (2) and the narrative policy instrument.

Figure 6 shows the impact of an increase in either agency commitments or purchases, together with the 95 percent Newey and West (1987) confidence bands. There is a marked difference between the short and long-run effects. In the short run, the results are consistent with neutrality: The upper left panel shows that a dollar purchased increases agency mortgage holdings initially by almost a dollar. The short-run effect of a dollar increase in commitments on agency holdings is lower at around 60 cents, which is expected given the time delay between commitments and purchases. The right panel shows that private holdings decline initially by roughly the same amount as the increase in agency holdings, although the confidence bands are wide.[19] The middle panels in Figure 6 show that as the dollar in mortgage debt changes from private to agency ownership, there are initially no significant changes in originations or mortgage debt.

Over longer horizons, however, there is clear evidence against the notion that agency purchases are neutral for mortgage credit. The cumulative impact on total mortgage originations increases with the horizon and becomes statistically significant after 6 months. Over the course of 3 years and beyond, there is a

[19]This almost surely reflects the fact that our measure of private holdings is partially based on interpolation of quarterly data. Private holdings are measured by subtracting agency holdings from total mortgage debt. Total mortgage debt is constructed using monthly data on originations and an interpolation of implied quarterly repayment rates. See the data appendix for more detail.

cumulative increase in originations of 3 dollars or more for every dollar purchased by the agencies. The estimated long-run multipliers for total originations are highly statistically significant and nearly identical for commitments and purchases. The point estimates for the impact on the stock of mortgage debt at shorter horizons are roughly in line with the range reported in Smith, Rosen, and Fallis (1988). The increase in mortgage debt becomes statistically significant after three to four years and in the longer run reaches a level of around one dollar. As the time horizon grows, the increase in agency holdings slowly dissipates toward levels expected before the expansion. Similarly, the negative impact on the level of private mortgage holdings vanishes over time and eventually turns into an increase, although not one that is statistically significant.

The results in the middle row of Figure 6 imply that agency portfolio expansions lead to a substantial rise in mortgage lending activity. Originations take place when borrowers refinance, purchase an existing home, or purchase a new home. Unless there are changes in house prices or homeownership, the first two transactions typically lead only to small net changes in mortgage debt because a similar amount of mortgage debt is repaid. Since the increase in originations is a multiple of the net change in debt, it is likely driven mostly by a rise in transactions of the first two types, with new home purchases playing a more important role beyond horizons of two years. The bottom row of Figure 6 distinguishes between refinancing originations in the left panel, and home purchase originations in the right.[20] Refinancing originations indeed respond faster and by a substantially larger amount than purchase originations. Refinancing originations see a statistically significant increase beyond 6 months, and within 3 years are higher by roughly 3 dollars per dollar of agency purchases. Home purchase originations rise more slowly and are statistically significantly higher after 18 months, increasing by nearly one dollar within 4 years. The rise in purchase originations occurs somewhat faster than the rise in total mortgage debt, suggesting that existing home sales respond before new home sales. The longer-run cumulative change in purchase originations is comparable to the increase in mortgage debt, which suggests a positive impact on residential construction. In the impulse response analysis below, we indeed find evidence for an increase in housing starts. We also document positive effects on homeownership rates and, although less clearly, on home prices, both of which also contribute to the rise in mortgage

[20]Data prior to 1990 is approximated using the refinancing share of S&Ls, see data appendix. Unfortunately, we were unable to find data distinguishing between originations for new and existing home sales with a sufficient time span.

debt. The bulk of the effect on originations is nevertheless due to refinancing.[21]

Given the procyclicality of mortgage originations, the large positive effect on originations makes it unlikely that the estimates are severely contaminated by the countercyclical actions of the agencies over the sample. The decrease in private holdings and the delayed effect on originations also suggest that the estimates are not merely picking up increased supply of mortgages to the secondary market, as would occur if private lenders simply passed on newly originated loans to the agencies; if this were the case, originations would rise before or roughly simultaneously with agency purchases and without a decline in private holdings. It is precisely in this direction that the results change when we instead estimate γ_h in (2) by ordinary least-squares (OLS). To illustrate this, Figure 7 compares the OLS and 2SLS responses of mortgage originations. Regardless of whether the baseline or full set of controls is included, the OLS estimates suggest that the bulk of the increase in originations occurs within a few months. Given the decision lags and time delays associated with making new mortgage loans, the delayed and gradual rise in originations that appears after instrumentation is much more consistent with a causal interpretation. The comparison in Figure 7 is generally informative about the endogeneity concerns in practice. Systematic GSE expansions during times of high primary mortgage demand or high private sector credit supply would lead to an upward bias using OLS, while the stabilizing actions of the agencies lead to a downward bias. Since the OLS estimates exceed the 2SLS estimates for horizons up to 2 years, the former appears the dominant practical concern in our sample.[22]

6 Impulse Response Analysis of News Shocks to Agency Purchases

To evaluate the effects of agency purchases on residential investment and homeownership, as well as analyze the response of interest rates and other macro aggregates, in this section we conduct an impulse response analysis of shocks to agency mortgage purchases. Given the gradual and anticipated nature of agency balance sheet expansions, our goal is to identify the response to shocks to expectations of future agency purchasing

[21] This is consistent with Di Maggio et al. (2016), who document an increase in refinancing activity by 170% during the Fed's first QE program.

[22] In online appendix A.1, we elaborate on the role of instrumenting, and we discuss additional results on agency securitization. We also verify robustness in several dimensions, such as the choice of scaling variable X_t, the sample choice, the set of controls, as well as the exclusion of specific policy events in the narrative instrument. The expansionary effects of agency purchases on mortgage credit are shown to be robust to many details of the analysis.

activity. We adopt a local projections approach and use the narrative instrument for identification. We also present results for an alternative instrumentation strategy that exploits information in GSE stock prices.

6.1 Empirical Specification with the Narrative Instrument

For a given monthly outcome variable y_t, we estimate the response at horizon h based on

$$y_{t+h} - y_{t-1} = \alpha_h + \delta_h \left(\frac{12}{8} \times \frac{\sum_{j=0}^{7} p_{t+j}}{\tilde{X}_t} \right) + \varphi_h(L) Z_{t-1} + u_{t+h} \tag{4}$$

The right hand side variable of interest measures annualized agency commitments made over an 8 month period, expressed as a ratio of $\tilde{X}_t$, a long-run trend in annualized originations. The latter is obtained by fitting a third degree polynomial of time to the log of real originations obtained using the core PCE price index as the deflator. The control variables Z_{t-1} are the same as in equation (2) estimating dollar cumulative effects. When an outcome variable is not included in the benchmark control set, we always add 12 monthly lags of that variable as additional controls (in growth rates for trending variables and in levels for other variables).

The regression in (4) estimates the month $h \geq 0$ response to a time 0 news shock to agency purchases. Expected agency purchases are proxied by agency commitments made over the next 8 months. We choose an 8 month horizon to measure expected future commitments because at this horizon the robust F-statistic associated with the narrative instrument in the first-stage regression is the largest, and equals 11.68. The results are very similar for somewhat shorter or longer horizons. To address endogeneity, we use the indicator of non-cyclical policy events, deflated by the core PCE price index and scaled by trend originations $\tilde{X}_t$, as the instrument. The IV estimates of δ_h in (4) can be interpreted as the response associated with a one percentage point increase in the agency flow market share that becomes anticipated h periods before. For perspective, the average market share in terms of portfolio purchases was approximately 7 percent between 1967 and 1990, and about 15 percent between 1990 and 2006, see Figure 1.

6.2 Empirical Specification with the GSE Excess Returns Instrument

Although our narrative instrument is a good predictor of agency purchasing activity, it is based on relatively few policy events. It is therefore always possible that our findings are driven by the small sample size. To gain confidence that this is not the case, as well as address other potential concerns with the narrative identification method, we also pursue an alternative approach inspired by Fisher and Peters (2010). These authors interpret innovations in excess stock returns of major defense contractors as news shocks about future military spending. Fisher and Peters (2010) obtain these innovations by ordering the excess returns last in a recursively identified structural vector autoregressive system. The recursive scheme assumes that none of the macro aggregates included in the analysis are affected on impact by the news shock, while excess stock returns react contemporaneously to all macroeconomic shocks. We follow a similar strategy to identify the response to news shocks to agency purchases.[23]

Passmore (2005) estimates that 44 percent to 89 percent of Fannie and Freddie's stock market value is derived from their special GSE status, and that the GSEs would hold far fewer mortgages in portfolio and have higher capital ratios if they were purely private. Any news about changes in the policies guiding the GSEs' portfolios business and leverage is thus likely to affect their market value. To construct an alternative measure of news of agency purchasing activity, we identify innovations in the excess return of GSE stock based on similar recursivity assumptions as Fisher and Peters (2010). To implement these assumptions, we estimate the response at horizon h through the following regression:

$$y_{t+h} - y_{t-1} = \alpha_h + \delta_h \left(\frac{12}{8} \times \frac{\sum_{j=0}^{7} \mathrm{p}_{t+j}}{\tilde{X}_t} \right) + \zeta_h W_t + \varphi_h(L) Z_{t-1} + u_{t+h} \tag{5}$$

Relative to (4), this specification adds the contemporaneous controls W_t, which includes the interest rate variables (3-month T-bill, 10-year Treasury, the conventional rate, BAA spread), the log of real originations, the log changes in mortgage debt, real house prices, the core PCE price index and personal income, the log of housing starts, and the unemployment rate. When we rotate in another variable, we also include it in W_t. One other modification relative to (4) is that the log of the GSE stock price-to-S&P 500 ratio is added to Z_t.

[23] Different from Fisher and Peters (2010), we use local projections-IV. Online appendix A.5 shows that the SVAR approach yields similar results.

The response coefficient δ_h in (5) is estimated using 2SLS, where the first stage is a regression of the log change in the GSE stock price-to-S&P 500 ratio on W_t and Z_{t-1}. This specification imposes that shocks to expected agency purchases have no contemporaneous impact on the variables in W_t. The instrument used in the 2SLS estimation of (5) is therefore the monthly innovation in the GSE excess stock return, orthogonalized to the monthly innovations in the variables in W_t. By assumption, other endogenous influences on GSE excess returns, such as shocks to household demand for mortgages, are eliminated by allowing excess returns to respond contemporaneously to mortgage credit, interest rates, prices, and the cyclical indicators.

Figure 8 plots the standardized cumulative sum of these innovations, together with the non-cyclical narrative indicator for reference. The GSE excess returns shocks are followed by statistically significant increases in agency purchasing activity. The F-statistic for the GSE excess returns instrument is the highest for agency commitments at a horizon of 5 months, and equals 8.55.[24] To provide further evidence that GSE stock prices reflect changes in agency purchasing activity, Figure 9 plots the response of the GSE stock price-to-S&P 500 ratio to a one pp. increase in the expected future agency market share, measured by agency commitments as a ratio of trend originations. This response is estimated by (4) using the narrative policy indicator as the instrument, and reveals a clear relative increase in GSE stock prices that is statistically significant at horizons of 4 to 12 months. Fieldhouse and Mertens (2017) also provide narrative evidence that announcements of policy changes affecting Fannie and Freddie are generally associated with adjustments in their stock prices.

Because the GSE excess returns instrument contains monthly observations, it potentially contains more information about variation in agency purchases than the narrative policy indicator.[25] Our narrative indicator contains, for instance, little information for the 1990s because of the scarcity of quantifiable and binding regulatory changes. However, this period witnessed a rapid expansion of GSE balance sheets and may be particularly important for learning the effects of agency purchases. As is well known, however, equity prices

[24] For simplicity, we keep the horizon for cumulating commitments in equation (5) at 8 months, the same as in equation (4). The value of the first-stage robust F-statistic for this horizon is 7.68. Changing the horizon for cumulating commitments in specification (5) to 5 months does not lead to any meaningful changes in the results.

[25] Assuming the GSE excess returns shocks contain all of the information about agency purchase shocks, it becomes possible to estimate the variance contribution of these shocks to any endogenous variables of interest. In online appendix A.5, we do this in the context of an SVAR model.

are volatile, and the GSE excess return shocks are, on the other hand, also relatively noisy. While the GSE excess returns shocks clearly have predictive power for agency commitment activity, the first-stage F-statistics are somewhat lower than for the narrative instrument. Another caveat is that the GSE excess return shocks may also pick up unanticipated variation in the scale of the GSEs' securitization business. Nevertheless, we view this identification strategy as a useful alternative to the narrative approach. The next sections show that both instruments generally lead to very similar impulse response estimates.

6.3 Effects on Mortgage Credit and Interest Rates

Figure 10 displays the responses of mortgage credit and interest rates to news about higher future purchases. Each of the panels shows the point estimates and confidence bands for the first 24 months after an increase in anticipated agency purchases by one percentage point of trend originations. The responses in blue are based on the narrative instrument, while those in red are based on the GSE excess returns instrument.

The first row in Figure 10 displays the responses of real originations and mortgage debt to the agency purchase shock. Based on the narrative instrument, mortgage originations start rising after a few months and reach peak increases of 4 percent to 5 percent between 12 and 18 months after the shock. With a slightly longer delay, the stock of mortgage debt also gradually rises to levels that are about 0.3 percent higher after two years. Using the GSE excess returns instrument, the rise in originations occurs slightly more rapidly but is more transitory. The peak increase in originations is around 4 percent and occurs between 10 and 14 months. The size and shape of the rise in the stock of mortgage debt is also very similar across instruments. The expansions in both the stock and gross flow of mortgage credit following a positive shock to agency purchases are statistically significant for multiple periods for both instruments. The results again indicate that agency purchases stimulate mortgage lending significantly. Online appendix A.3 shows that the impulse response analysis also confirms that refinancing originations account for a large share of the increase.

The second row in Figure 10 shows the impact on interest rates on 30-year fixed rate mortgages in the primary market. The left panel illustrates the interest rate effect on newly originated conventional conforming mortgages, whereas the right panel contains the impact on interest rates of mortgages guaranteed by the

Federal Housing Administration. According to the narrative instrument, the mortgage rates in the primary market are largely unaffected in the initial months after the increase in agency mortgage purchase commitments. As the agencies' purchasing activity picks up, however, both mortgage rates gradually decline and are lower by around 10 basis points after 6 months. The declines in mortgages rates appear quite persistent, and help explain the increase in refinancing activity. When using the GSE excess returns instrument, by construction there is no impact on interest rates in the first month. After 6 to 18 months, both mortgage rates are lower by 10 to 15 basis points. For both instruments, the declines in mortgage rates are statistically significant for multiple periods. This decrease in mortgage cost is consistent with agency purchases affecting the aggregate supply of housing credit, for instance because of portfolio rebalancing effects or because private mortgage lenders are capital constrained. Agency purchases also alleviate any constraints faced by private intermediaries, for instance because the higher prices of mortgage assets improve their net worth, or because the sale of mortgages in exchange for agency debt lowers their risk-weighted leverage.

The issuance of agency debt to finance the mortgage purchases potentially puts upward pressure on interest rates on other debt instruments. Such pressure may be limited if significant amounts of agency debt are purchased by foreign investors, as has been the case since the mid-1980s, or by the Federal Reserve, as was the case in the early years of our sample, see Haltum and Sharp (2014). Depending on the level of segmentation in financial markets, the rebalancing and other effects may also spill over to other asset markets and cause the yields on substitutes to mortgages to fall. These include other high duration instruments such as long-term Treasuries and corporate bonds. In addition, lower mortgage rates lead to more prepayments, which do not carry any penalty in the United States. There is considerable evidence that lower effective durations cause mortgage investors to bid up the price of higher duration instruments, see for instance Boudoukh et al. (1997), Perli and Sack (2003), Hanson (2014), and Malkhozov et al. (2016). The broader impact on long-term yields is therefore ex ante not clear.

The left panel of the bottom row in Figure 10 shows the estimated response of the 10-year Treasury rate. The results are very similar to those for the long-term mortgage rates just discussed: The 10-year Treasury rate responds little the first couple of months, but as the agency mortgage purchases commence, it declines

in a gradual and persistent manner by up to 5 to 10 basis points. The drop is significant between 3 and 6 months after the shock. The results are similar for the two instruments but confidence intervals are wider using excess returns. In online appendix A.2, we discuss additional results on the effects on other interest rates and credit spreads.[26] Overall, the results indicate that there are significant spill-overs from agency actions in mortgage markets to other longer-term asset markets.

The right panel in the bottom row of Figure 10 reports the impact on the 3-month T-bill rate. The results are qualitatively similar to those for the long-term rates discussed above. Quantitatively, we find some indication of a larger drop in short-term rates than in the longer term rates. Based on the narrative instrument, and with a delay of a few months, the T-bill rate drops persistently by 15 to 20 basis points with a partial reversion taking place at longer forecast horizons. The results using the GSE excess return instrument yields again similar results (although quantitatively smaller). The negative response of short-term interest rates indicates that a potentially important explanation for the expansion in mortgage lending and the decline in mortgage rates is a more accommodative stance of monetary policy. In Section 7 below, we investigate the role of monetary policy and its interactions with housing credit policy in greater detail.

The finding that increases in agency mortgage purchases produces a boom in mortgage lending and declining interest rates is robust. In online appendix A.4, we report very similar results for samples that omit the Volcker years, or for the subsample starting in October 1982, the end of the period of non-borrowed reserve targeting by the Federal Reserve. Thus, the results are not driven by differences in Federal Reserve operating procedures in the 1970s or by the inclusion of the Volcker period. There is narrative evidence that political pressure to support the GSEs was exerted with some success in the late 1960s and 1970s, leading for instance the Federal Reserve to purchase significant amounts of agency debt, see Haltum and Sharp (2014). In the post-1982 sample, however, it seems less likely that political pressure to support government housing policies can explain an accommodative monetary policy response. Finally, the results also do not appear to be particularly sensitive to the inclusion of any individual policy event, see online appendix A.4.

[26] We find, for instance, that the spreads between mortgage rates and 10-year Treasury rates decline. The statistical significance of these reductions however is at the 10 percent level and therefore more marginal, suggesting that positive spill-over effects on the demand for long-term Treasuries are relatively important. We also find that agency mortgage purchases lead to lower long-term interest rates on corporate bonds, and to a narrowing of the BAA-AAA bond spread.

6.4 Effects on Housing and Other Macro Aggregates

Next, we assess the evidence for the broader macroeconomic effects of government asset purchases. Figure 11 shows the responses of a range of monthly macro aggregates to an agency purchase shock, together with 95 percent Newey and West (1987) confidence bands. As in Figure 10, the responses are to an anticipated increase in purchases by one percentage point of trend originations, estimated using either the narrative instrument (blue) or the GSE excess returns instrument (red). We consider the following additional outcome variables at the monthly frequency: housing starts, real house prices, the homeownership rate, real personal consumption expenditures, real personal income, and the unemployment rate.[27]

The first panel in Figure 11 shows the effects on residential investment, as measured by monthly housing starts. Based on the narrative instrument, the number of new housing starts rises to levels that are roughly 1 to 2 percent higher after about 6 months. Housing starts remain elevated for about a year and drop off to prior levels afterwards. Using the GSE excess returns instrument, housing starts pick up more quickly and remain around 2 percent higher between 4 and 12 months after the shock. For both instruments, the size and shape of the response of housing starts is similar and statistically significant for multiple periods. We thus find evidence that the expansion in the stock of mortgage debt following a shock to agency purchases is associated with higher levels of residential investment.[28]

The top middle panel in Figure 11 plots the impact on real house prices, as measured by the Freddie Mac house price index deflated by the core PCE price index. Using the narrative instrument, we find that real house prices rise gradually but very persistently over time, with a point estimate that becomes significantly positive at longer forecast horizons only. The GSE excess returns instrument, in contrast, does not reveal a significant change in house prices at any horizon. Thus, we have no clearcut evidence of an impact of agency mortgage purchases on house prices. Moreover, the point estimates imply that very little of the increase in

[27] All these variables, except the unemployment and the homeownership rate, are included logs and all nominal variables are deflated by the core PCE price index. The homeownership rate is only available at quarterly frequency, and the monthly series in this case simply consists of the quarter values. See the data appendix for precise definitions and sources.

[28] The more immediate effects on residential construction are consistent with the more delayed impact on mortgage debt in Figure 10. This is because financing in the building phase is typically through a short-term construction loan that is converted into a residential mortgage loans only after the borrower takes up occupancy of the house.

the dollar volume of mortgage credit is explained by increases in house prices.

The top right panel in Figure 11 shows the response of the homeownership rate, as measured by the Census Bureau, which is often cited as one of the primary motivations for housing credit policy. Using the narrative instrument, there is a sustained increase in homeownerhip by around 5 basis points beyond a horizon of 10 months. Based on the GSE excess returns instrument, homeownerhip also rises by a similar magnitude, but the increase occurs somewhat more rapidly. While there is considerable uncertainty in the estimates, the responses are in both cases statistically significant at the 95 percent level for multiple months, indicating that agency activity indeed has an effect on homeownership. This also implies that the expansion in the stock of mortgage debt is in part driven by an increase in homeownership.

The remaining panels in Figure 11 show the responses of consumption expenditures, personal income, and the unemployment rate. Using the narrative instrument, we find that an increase in agency mortgage purchases stimulates consumption very modestly and with a delay of more than a year. Personal sector income and the unemployment rate are approximately unchanged over the entire forecast horizon. The increase in consumption is imprecisely estimated and none of the impulse responses are significantly different from zero at the 95 percent level. The point estimates are somewhat different for the GSE excess returns instrument and show an increase in personal consumption expenditures similar to that estimated using the narrative instrument, but with a much shorter delay of 3-4 months. There is a decline in the unemployment rate around a year after the shock. Standard errors are, however, large for this instrument as well.

In sum, we find evidence that agency mortgage purchases stimulate residential investment and homeownership, and some indication of a positive effect on personal consumption expenditures. The confidence bands in Figure 11 are, however, relatively wide, and the power of our instruments to detect a macroeconomic impact of agency mortgage purchases beyond the housing sector is rather limited.

7 Housing Credit Policy vs. Conventional Monetary Policy

In the previous section, we found that increases in agency mortgage purchases lead to an expansion in mortgage credit and to declines in short- and long-term interest rates. A natural question to ask is to what extent these effects reflect conventional monetary policy actions, and how monetary and credit policies interact more broadly. The left panel in Figure 12 reports the estimated response of the federal funds rate to an agency purchase shock using the methods of the previous section. According to the narrative instrument, there is a delayed and transitory decline in the funds rate by up to 30 basis points after 6 months. This decrease is statistically significant after 4 to 12 months. The GSE excess returns instrument also yields a temporary decline in the funds rate, but it is smaller in size and not statistically significant.

We obtain similar results for the post 1982 subsample, after excluding the non-borrowed reserves targeting period, or after omitting larger policy events from the narrative instrument (see online appendix A.4). There is therefore evidence that agency mortgage purchases are accompanied by accommodative monetary policy. A possible alternative interpretation is that both identification schemes erroneously pick up the influence of recessionary shocks causing downward adjustments in the Federal Reserve's interest rate target. However, if this were the case, we would not expect to find increases in strongly procyclical variables such as mortgage originations or housing starts. To gain more insight into the nature of the funds rate response, we make use of the decomposition by Romer and Romer (2004) of changes in the intended funds rate at FOMC meetings into a *systematic* and a residual *shock* component.[29] The systematic component is measured by the explained variation in a regression of target changes on changes in Greenbook forecasts of inflation, output growth, and unemployment. Monetary policy shocks are measured by the residuals in the regression, and capture the remaining variation in target changes not explained by changes in the Greenbook forecasts.

The middle panel in Figure 12 depicts the estimated response of the cumulative Romer and Romer (2004) shocks to an agency purchase shock using the regressions in (4) and (5). With a few months delay, the narrative instrument yields a significant and persistent decline by up to 10 basis points. The funds rate decline is therefore not explained by inflation and output considerations alone, and possibly reflects also an inde-

[29] We use the updates by Wieland and Yang (2016) to extend the sample of the original series.

pendent reaction to credit market conditions and/or credit policies. We note, however, that the GSE excess returns instrument does not yield a similar significant decline in the Romer and Romer (2004) residual.

To investigate whether monetary policy affects housing credit policy, the right panel in Figure 12 reports the response of the cumulated narrative measures of credit policy changes in Table 2, deflated by the core PCE price index and as a percentage of trend originations, to a monetary shock. There is no evidence for monetary policy shocks impacting the non-cyclical measure of agency purchase shocks, as our narratively identified housing credit policy instrument is not itself predictable by the Romer and Romer (2004) residuals. This provides assurance that our narrative instrument does not erroneously pick up the effects of monetary policy shocks. Similarly, adding the current and lagged values of the Romer and Romer (2004) shocks as additional control variables in (4) also has very little effect on the results, see online appendix A.4. The *cyclical* housing policy measure (in red), on the other hand, does show a statistically significant decline following an expansionary monetary policy shock, which illustrates the importance of accounting for the endogeneity of credit policies. Consistent with an objective of stabilizing credit flows, we thus find that housing credit policies on average act to offset the effects of monetary policy disturbances.

To further judge the extent to which agency purchase shocks operate through more conventional monetary transmission channels, Figure 13 compares the impact of a traditional monetary policy shock (in red) with the response to the agency purchase shock identified using the narrative instrument (in blue). The response to a monetary shock is obtained by similar regressions as in equation (4), but replacing the agency market share on the right hand side with the contemporaneous level of the 3-month T-bill rate, and using the Romer and Romer (2004) shock measure as an instrument.[30] In the figure, the impact of the interest rate shock is scaled such that the maximum decline in the 3-month T-bill rate is the same as for the agency purchase shock identified with the narrative instrument. For easier comparison, the responses to the monetary policy shock in Figure 13 are shifted forward by 4 months such that the maximum interest declines for each of the policy shocks coincide. As before, the bands are 95 percent Newey and West (1987) intervals.

[30]Conditional on including an informationally sufficient set of lagged variables as controls, valid identification under this approach requires only contemporaneous exogeneity of the Romer and Romer (2004) shocks. The predictability of the Romer and Romer (2004) shocks by agency purchase shock therefore does not necessarily invalidate the identification of the response to monetary shocks.

Figure 13 reveals that conventional monetary policy shocks and credit policy shocks have qualitatively similar effects on many of the variables shown. Although each of the policies involves purchases of different types of assets with different sources of financing, both generate a decline in long-term interest rates, a rise in originations and mortgage debt, and an increase in housing starts. Consistent with most of the existing empirical literature, an expansionary monetary shock leads to increases in consumption and income and a decline in the unemployment rate.[31] The monetary shock responses provide a familiar reference point for judging the quantitative impact of agency purchase shocks. After scaling the estimates to imply the same decline in the short-term interest rate and accounting for the more immediate effects of a funds rate target shock on short-term interest rates, many responses to each of the policy shocks are similar in terms of magnitude and timing.

There are, however, also some notable differences between the responses in Figure 13. The first is that agency purchases lead to a rise in originations that is roughly twice as large as that of the interest rate shock. There is little indication that a conventional monetary policy shock causes a significant rise in real house prices, while the decline in long-term interest rates is slightly more pronounced and persistent after an agency purchase shock. Both the rise in housing starts and mortgage debt, on the other hand, are very similar for both policy shocks. Taken together, the results indicate that agency purchases have a larger effect on mortgage repayments than conventional interest rate policy. In appendix A.3, we compare the responses of refinance and purchase originations. Whereas purchase originations respond very similarly to both shocks, refinancing originations react more strongly to the agency purchase shock, and account for the entire difference in the effect on total originations.

Another notable difference between credit policy and traditional interest rate shocks is the effect on the homeownership rate (right panel, third row in Figure 13). Unlike the response to an agency purchase shock, there is no indication that a conventional interest rate shock has any positive effect on homeownership. In most months, the estimated effect on homeownership instead is negative, though small and generally not sta-

[31] The response to both shocks also feature a similar 'price puzzle', i.e. a decline in the price level as measured by the PCE price index. Results are available on request.

tistically significant. Apart from the different response of originations and homeownership, however, it does appear as if credit policy operates through similar transmission channels as conventional monetary policy.

In online appendix A.5, we compare agency activity and conventional monetary shocks in terms of their contribution to fluctuations in credit aggregates and interest rates. Because our local projections approach is not well suited for this purpose, we assess the variance contributions in an SVAR setting using the GSE excess returns identification strategy and the Romer and Romer (2004) residuals as a proxy for monetary shocks. The main finding is that GSE excess returns shocks explain up to 15% and 10% of the medium-run forecast error variance of mortgage originations and housing starts, respectively, which is roughly comparable to the contribution of monetary policy shocks. In addition, while shocks to monetary policy are substantially more important for the variance of interest rates in the short run, the role of GSE excess returns shocks for long-term interest rates exceeds the role of monetary policy shocks at longer horizons. The SVAR-based analysis overall indicates that the contribution of credit policy shocks to fluctuations in housing and credit markets is non-negligible.

To explore the potential effects of agency mortgage purchases when conventional interest rate policy does not respond, for instance because it is constrained by the zero lower bound, Figure 14 reports the results from a counterfactual experiment in which the short-term interest rate is assumed to remain constant. As before, the responses are to an increase in anticipated agency purchases by one percentage point of trend originations, as in (4) and (5). However, we now additionally assume the realization of a sequence of monetary shocks such that the 3-month T-bill rate remains unchanged at every horizon.[32] An important caveat with this experiment is that the short-term rate remains constant because of successive monetary surprises rather than an anticipated policy response. As such, the results are clearly subject to the Lucas critique. Figure 14 shows the counterfactual responses in red and the earlier baseline estimates in blue, in both cases with 95 percent Newey and West (1987) bands. Panel A shows the results when using the narrative instrument to identify the effects of agency purchase shocks, and panel B when we use the GSE excess returns instrument.

[32]The impact of monetary shocks on the outcome variables is obtained as in Figure 13, i.e. by using the Romer and Romer (2004) shocks as an instrument in local projections on the 3-month T-bill rate and the control variables.

The results from the counterfactual experiment in Figure 14 indicate that conventional monetary policy plays an important role in explaining the effects of agency purchase shocks. Under both identification schemes, the rise in originations is only about half as large when short-term interest rates remain constant, and there is no longer any sign of an increase in the stock of mortgage debt. The drop in long-term interest rates is much reduced with the narrative instrument, but remains more clearly present with the excess returns instrument. The positive effect on housing starts is smaller using the GSE excess returns instrument, and disappears entirely with the narrative instrument. The combination of expansionary monetary and credit policy therefore seems particularly important for stimulating residential investment. Even with constant interest rates, however, purchases of mortgage assets continue to have statistically significant effects on mortgage lending, regardless of the instrument. In addition, the path of short-term interest rates appears largely irrelevant for the increase in the homeownership rate following a shock to agency purchases.

8 Concluding Remarks

The postwar period witnessed a remarkable expansion in residential mortgage debt. During the same period, an increasing share has come to reside on what is ultimately the balance sheet of the federal government. In this paper, we provide evidence that government mortgage purchases influence the volume and cost of mortgage lending. In order to tackle reverse causality, we make use of a number of policy changes that have impacted the ability of government agencies to acquire mortgage debt. Using policy interventions that we classify as non-cyclically motivated to construct an instrumental variable for (news about) agency mortgage purchases, we find that an increase in these purchases stimulates mortgage originations and debt, and temporarily lowers mortgage rates. Consistent with the evidence in Di Maggio et al. (2016) regarding the effects of the QE interventions, we find that agency purchases have particularly large effects on refinancing activity. We also find a positive impact on housing starts and homeownership, and some indications of positive effects on house prices and consumption expenditures. An alternative identification strategy based on instrumenting with orthogonalized innovations in GSE excess returns yields very similar results overall.

One important aspect of our findings is the apparent similarity and interaction between housing credit policies and conventional interest rate policy. We find that greater agency mortgage purchases lead to broad

declines in short and long-term interest rates. Our measure of non-cyclically motivated credit policy changes predicts the Romer and Romer (2004) monetary policy shock measure, and expansionary credit policy appears to be accommodated by monetary policy. In contrast, we find that credit policy adjusts in order to offset the effects of monetary disturbances. It may therefore be necessary to account for credit policy to understand the effects of monetary policy. Agency purchase shocks have relatively larger effects on mortgage originations and refinancing activity than interest rate shocks, and influence homeownership regardless of the path of short-term interest rates. The quantitative effects of credit and monetary policy shocks on many other variables, including residential investment, are otherwise remarkably similar.

There are several interesting avenues for future research: Unlike theoretical or multivariate statistical models, our local projections/IV-approach does not allow an assessment of the historical contribution of structural shocks without further assumptions. In online appendix A.5, we apply our GSE excess returns identification strategy in an SVAR setting, and we find that the contribution to the short-run variability of mortgage credit and housing starts is substantial and similar to that of monetary policy shocks. Future work can verify in more detail whether credit policy shocks are important causal factors in past housing or credit cycles, in particular during the most recent housing boom and bust.[33] Our results can be used to help evaluate the credit policy interventions in the recent financial crisis, the possible impact of unwinding the Fed's current mortgage holdings, or the various proposals for GSE reform. We have made no attempt at understanding more precisely the nature or implications of the credit frictions and transmission channels through which housing credit policies operate. Future work may apply similar cross-sectional identification strategies as Di Maggio et al. (2016), Darmouni and Rodnyansky (2016), or Chakraborty, Goldstein, and MacKinlay (2016) to other housing credit policy events documented in our narrative analysis. Finally, it is possible to apply a similar analysis to government mortgage guarantees and securitization.

[33]The expansion of the GSE's market share from the early 1990s to mid-2004 was dramatic, but came to a grinding halt when, following revelations of accounting fraud, regulators imposed capital surcharges on Fannie and Freddie in the fall of 2004 and eventually portfolio caps in mid-2006.

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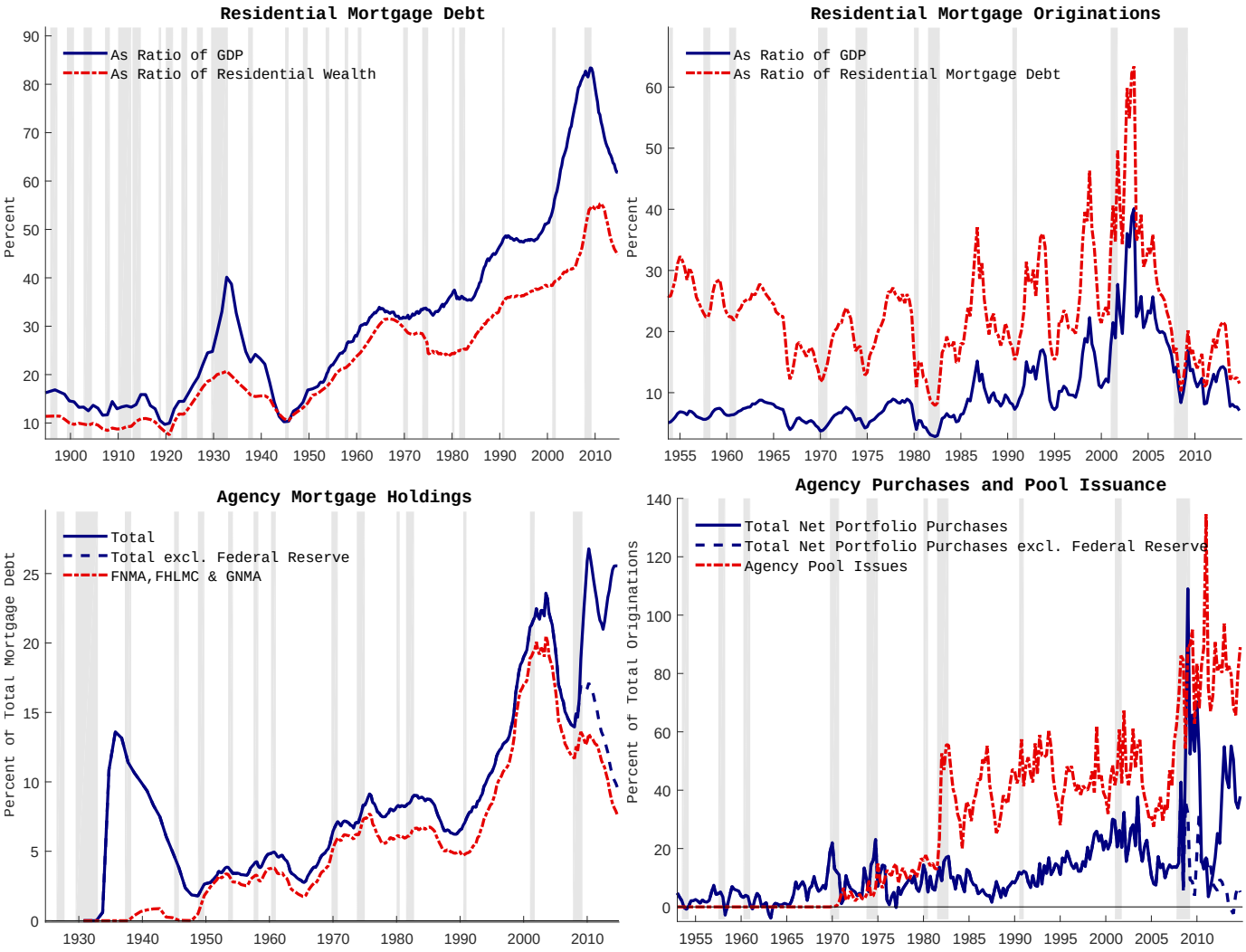


Figure 1 Mortgage Debt, Annualized Originations, and Agency Market Shares

Notes: Residential mortgage debt and originations include home as well as multifamily mortgages. Agency holdings include holdings of both whole loans and pools. Agency purchases are net purchases for portfolio investment, whereas pool issues approximate purchases backing new issuance of mortgage pools (mortgage-backed securities). The grey bars are NBER-dated recessions. Sources: see data appendix.

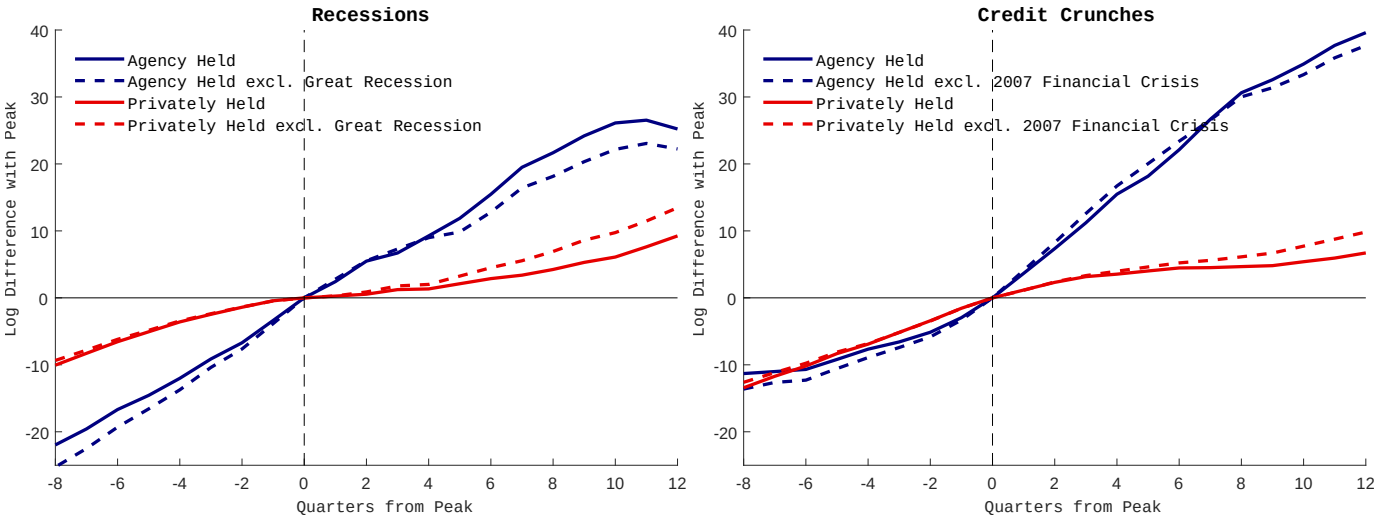


Figure 2 Real Mortgage Debt by Holder in Recessions and Credit Crunches

Notes: Mortgage debt is deflated by the core PCE price index. Left panel: average of 9 NBER recessions starting 1957Q2, 1960Q1, 1969Q4, 1973Q4, 1980Q1, 1981Q3, 1990Q3, 2001Q1, 2007Q4. Right panel: average of credit crunches beginning one quarter after the following dates: 1955Q3, 1959Q1, 1965Q4, 1968Q4, 1972Q4, 1978Q1, 1980Q4, 1990Q1, 1998Q2, 2007Q2. See data appendix for sources.

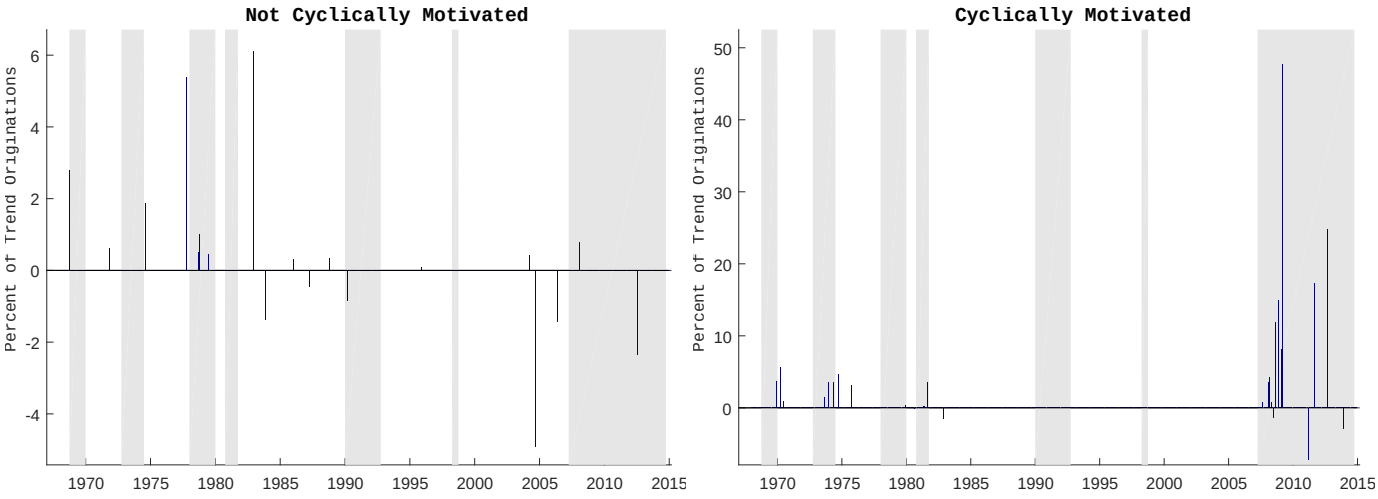


Figure 3 Measures of Policy Events Affecting Agency Mortgage Holdings: Jan 1967 to Dec 2014

Notes: The figure shows projected changes in the consolidated agency mortgage portfolio as a percentage of average annualized mortgage originations over the prior twelve months. The left panel shows changes classified as unrelated to the business or financial cycle. The right panel shows changes classified as primarily motivated by cyclical considerations. For sources and classification see Fieldhouse and Mertens (2017). Shaded areas are credit crunch periods, see data appendix for chronology.

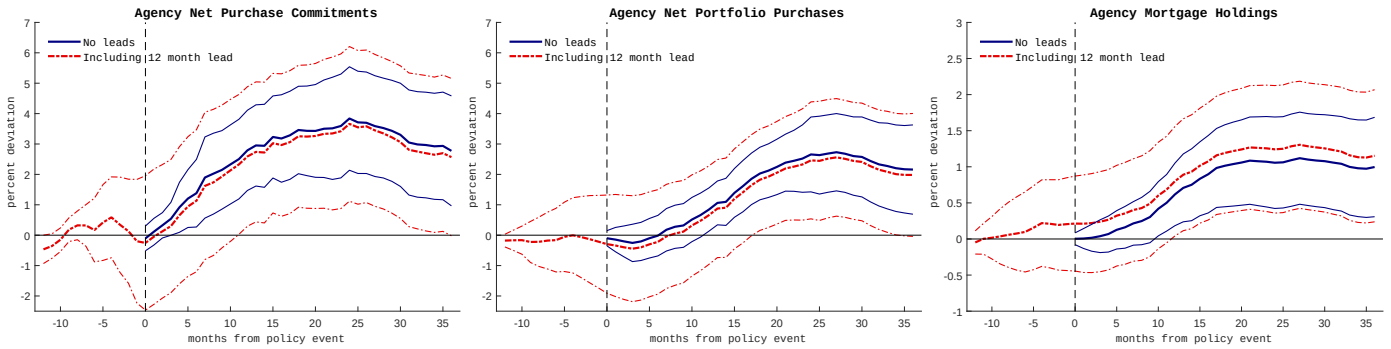


Figure 4 Agency Purchases and Holdings Before and After Non-Cyclical Policy Events

Notes: Response estimated from a regression in first differences on the contemporaneous value and 36 lags of the non-cyclically motivated narrative measure scaled by the average level of agency mortgage holdings over the prior 12 months. Finer lines are 95% Newey and West (1987) confidence bands.

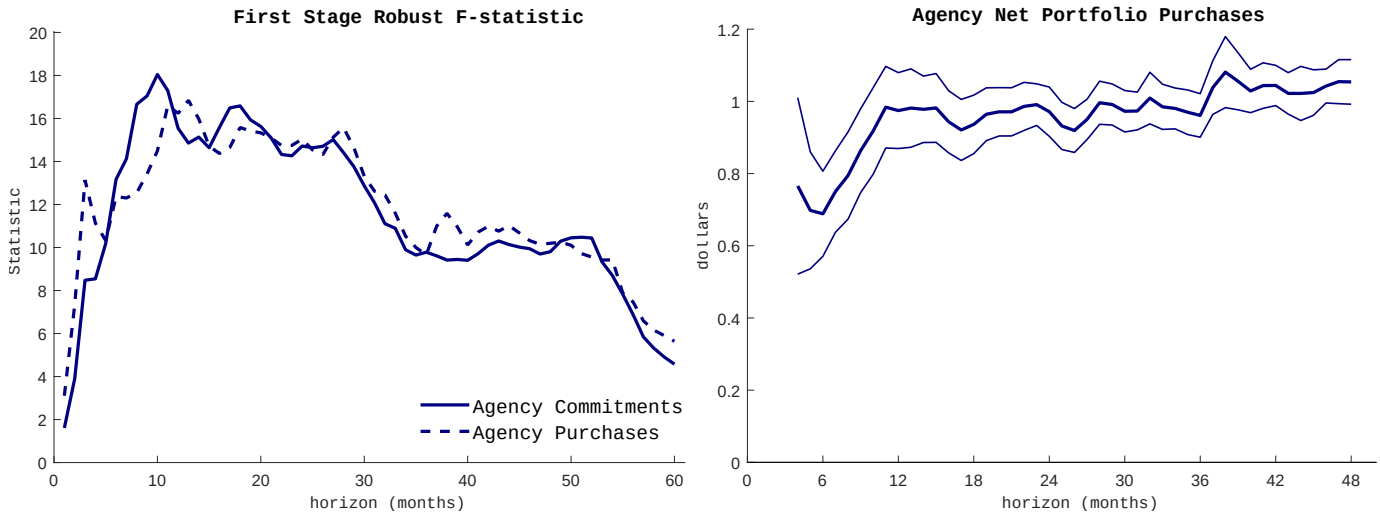


Figure 5 Preliminary Diagnostics

Notes: The left panel shows Newey and West (1987) robust F-statistics of the first-stage regressions of cumulative agency commitments and purchases, respectively, on the narrative instrument. The right panel shows the estimated dollar increase in agency purchases per dollar increase in commitments. Finer lines in the right panel are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

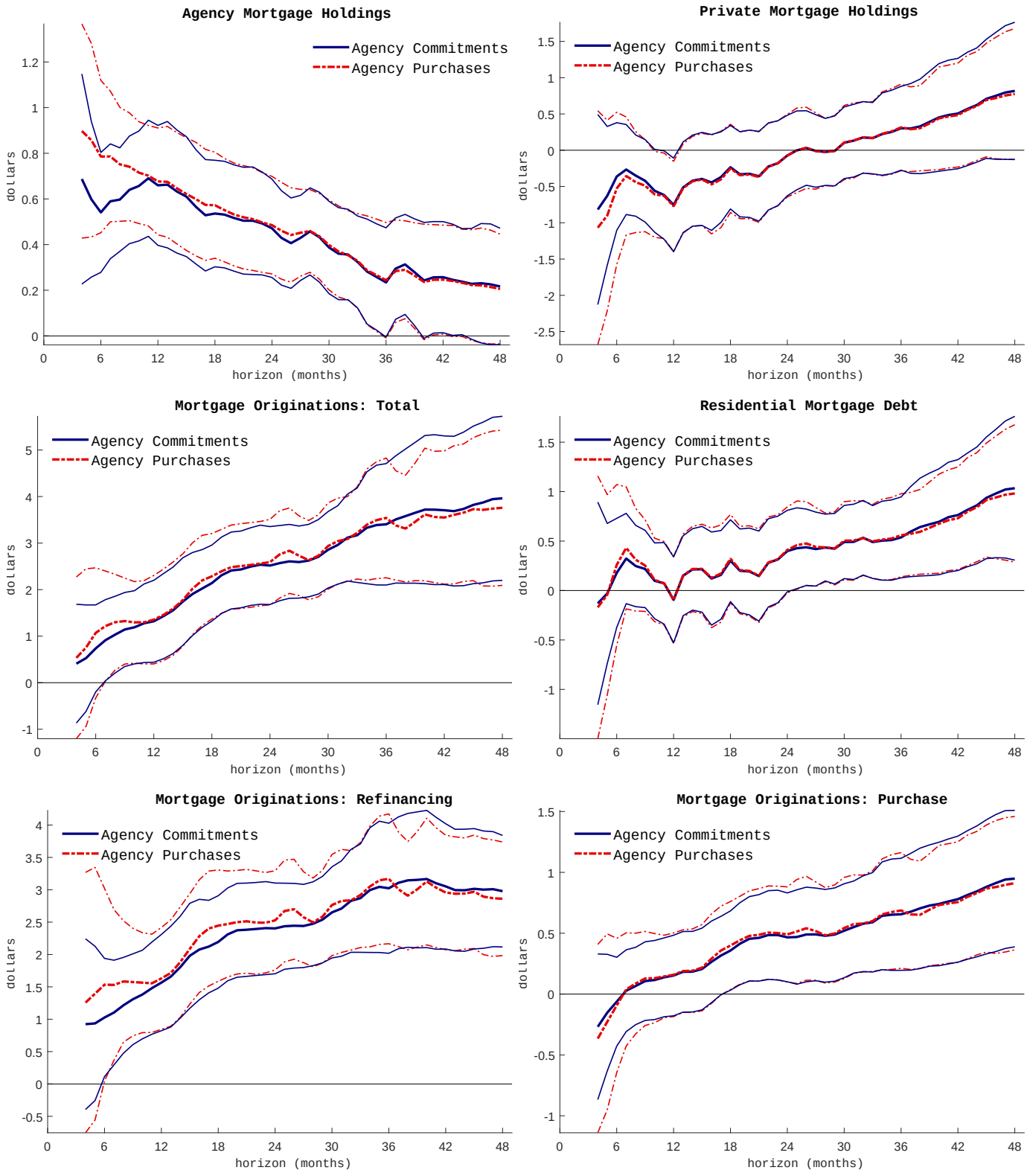


Figure 6 Estimated Balance Sheet Adjustments and Mortgage Credit Multipliers Associated with Agency Mortgage Purchases

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. Estimates are from local projections-IV regressions, see equation (2). Finer lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006. In the bottom row panels, the sample excludes May 1985 to Dec 1986 because of missing data on refinance shares, see data appendix.

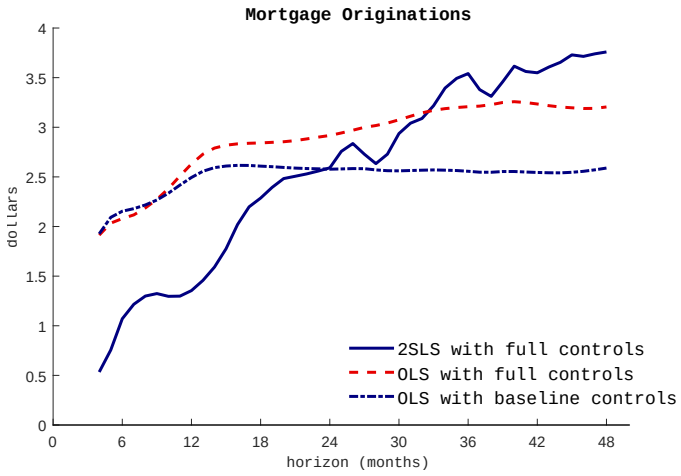


Figure 7 The Role of Instrumentation

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases cumulated over the reported horizon in months. The benchmark estimates are from local projections as in equation (2), comparing OLS and 2SLS estimates. The specification with baseline controls excludes the interest rate and cyclical controls.

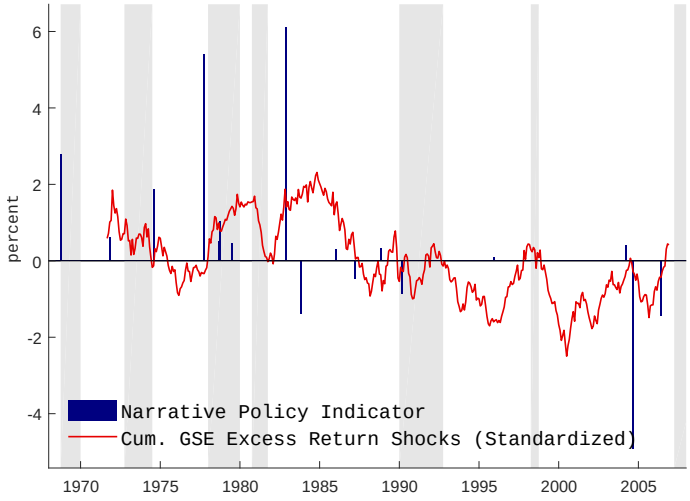


Figure 8 Cumulative GSE Excess Returns Shocks

Notes: The figure shows the standardized cumulative sum of the orthogonalized GSE excess returns innovations, as well as the indicator for non-cyclical policy changes for reference. The GSE excess returns shock is obtained as the residual in a regression of the log of the GSE stock price-to-S&P 500 ratio on twelve lags of this ratio, all of the benchmark lagged control variables, as well as the contemporaneous values of the control variables with the exception of the agency purchase/commitment ratios. The first observation for the GSE excess returns shock is Aug 1971, which reflects the month in which Fannie Mae stock was traded for the first time on the New York Stock Exchange (Aug 1970) plus the model lag length of 12 months.

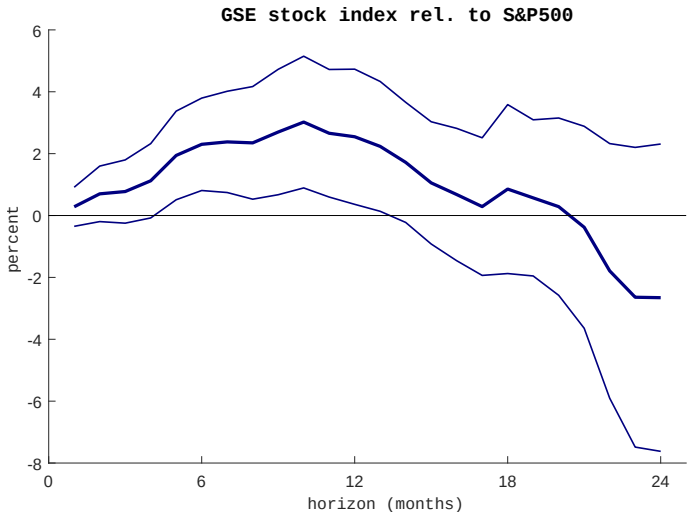


Figure 9 Impulse Response to a Shock to Anticipated Agency Purchases

Notes: The figure shows the response of the log GSE stock price-to-S&P 500 ratio to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4). Finer lines are 95% Newey and West (1987) confidence bands. Sample: Aug 1971 to Dec 2006.

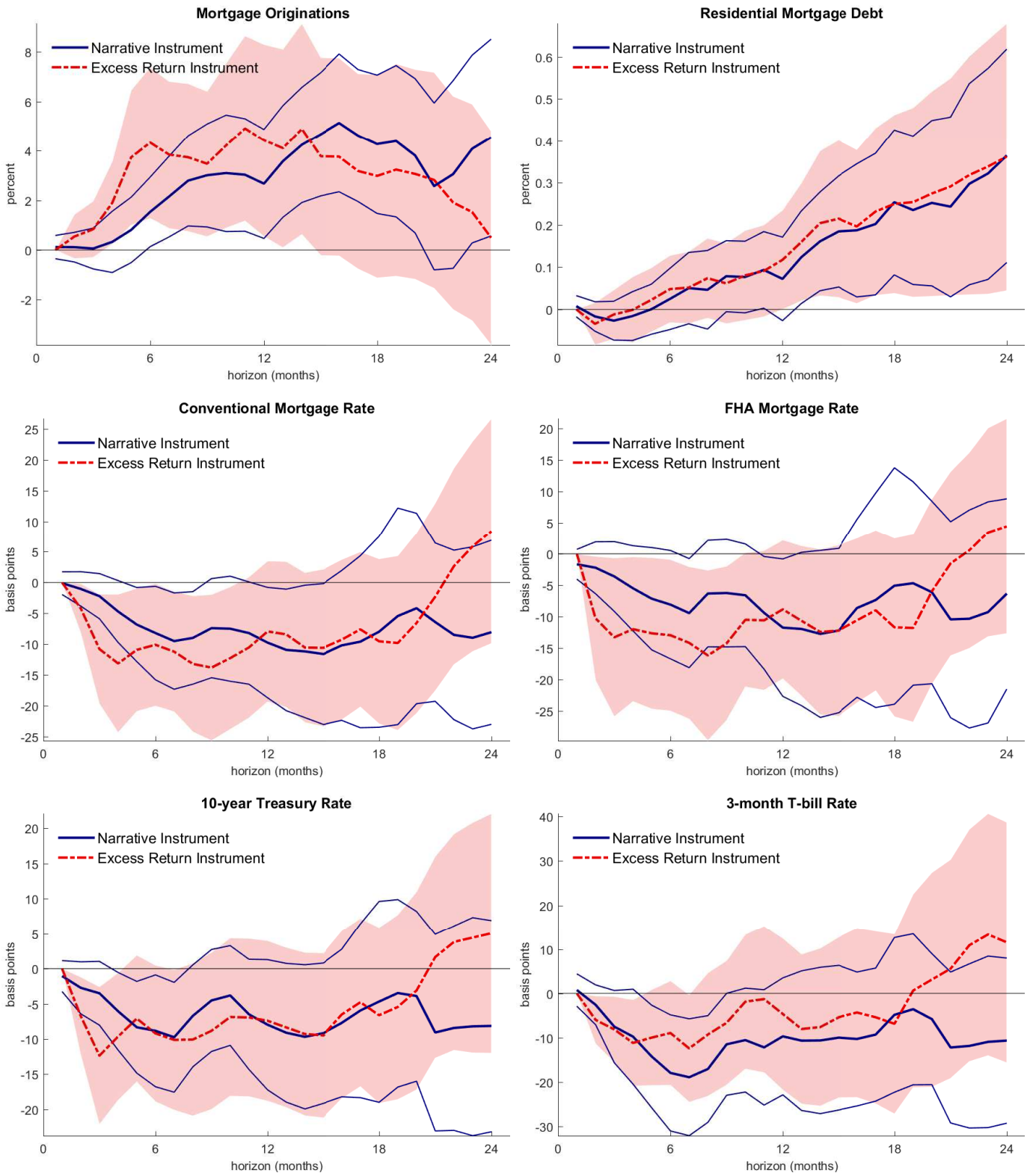


Figure 10 Impulse Responses to a Shock to Anticipated Agency Purchases

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

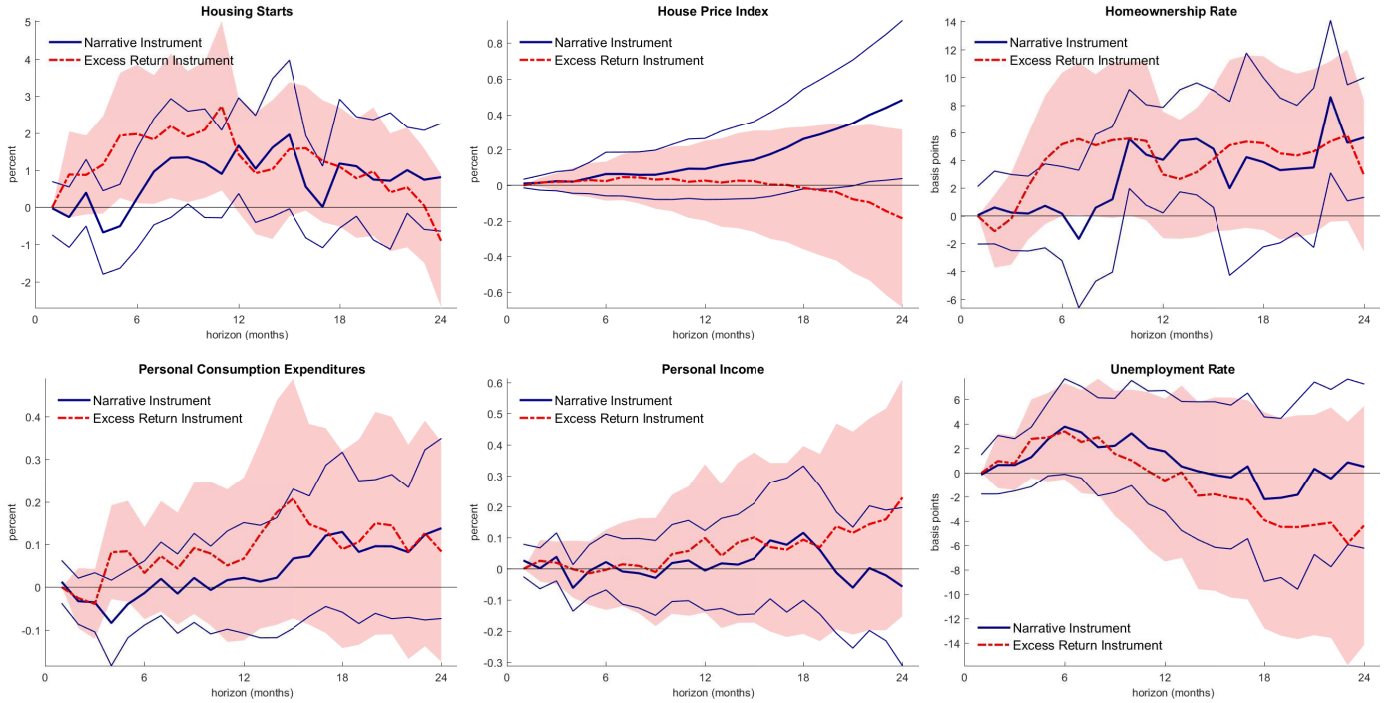


Figure 11 Impulse Responses to a Shock to Anticipated Agency Purchases

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

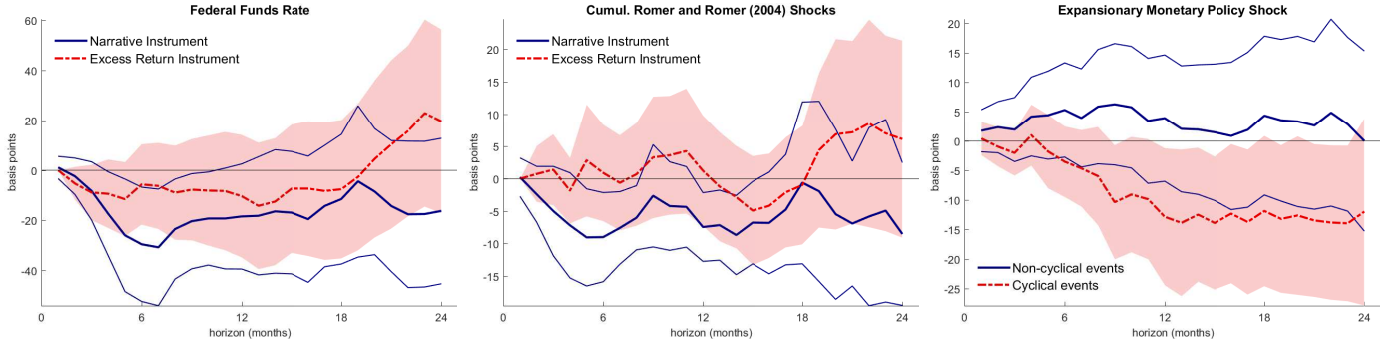


Figure 12 Interactions between Monetary and Credit Policies

Notes: Left and middle panel: The figure shows responses for a one pp. increase in agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Right panel: The figure shows responses to a monetary shock obtained as in Figure 11. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

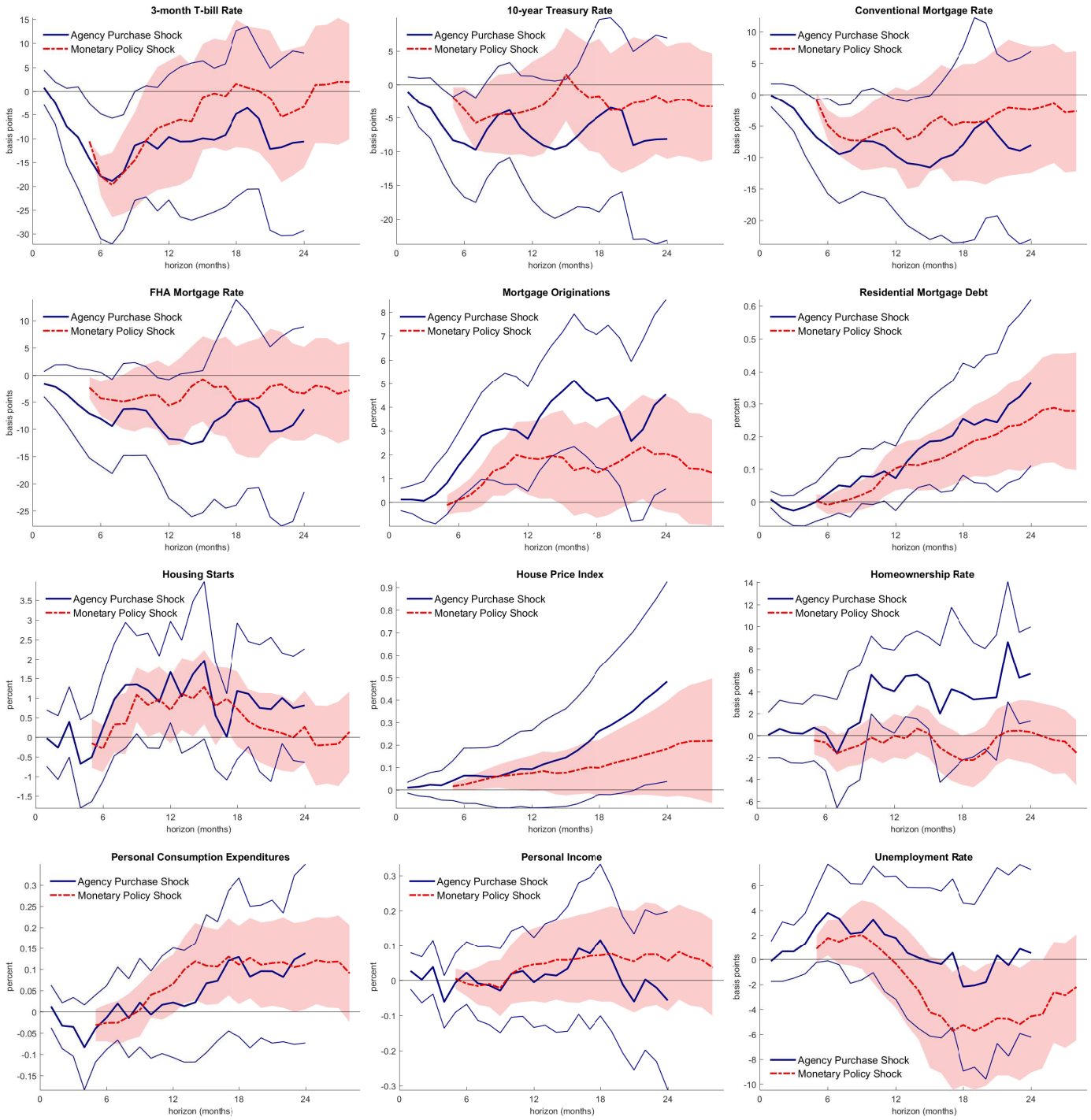


Figure 13 Responses to A Shock to Anticipated Agency Purchases Versus a Monetary Policy Shock

Notes: The figure shows responses to a one pp. increase in the expected future agency market share as well as the response to a monetary policy shock. Estimates are from local projections-IV regressions instrumenting agency commitments with the narrative policy indicator, see equation (4), and instrumenting the 3 month T-bill rate with the Romer and Romer (2004) monetary policy shock measure. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

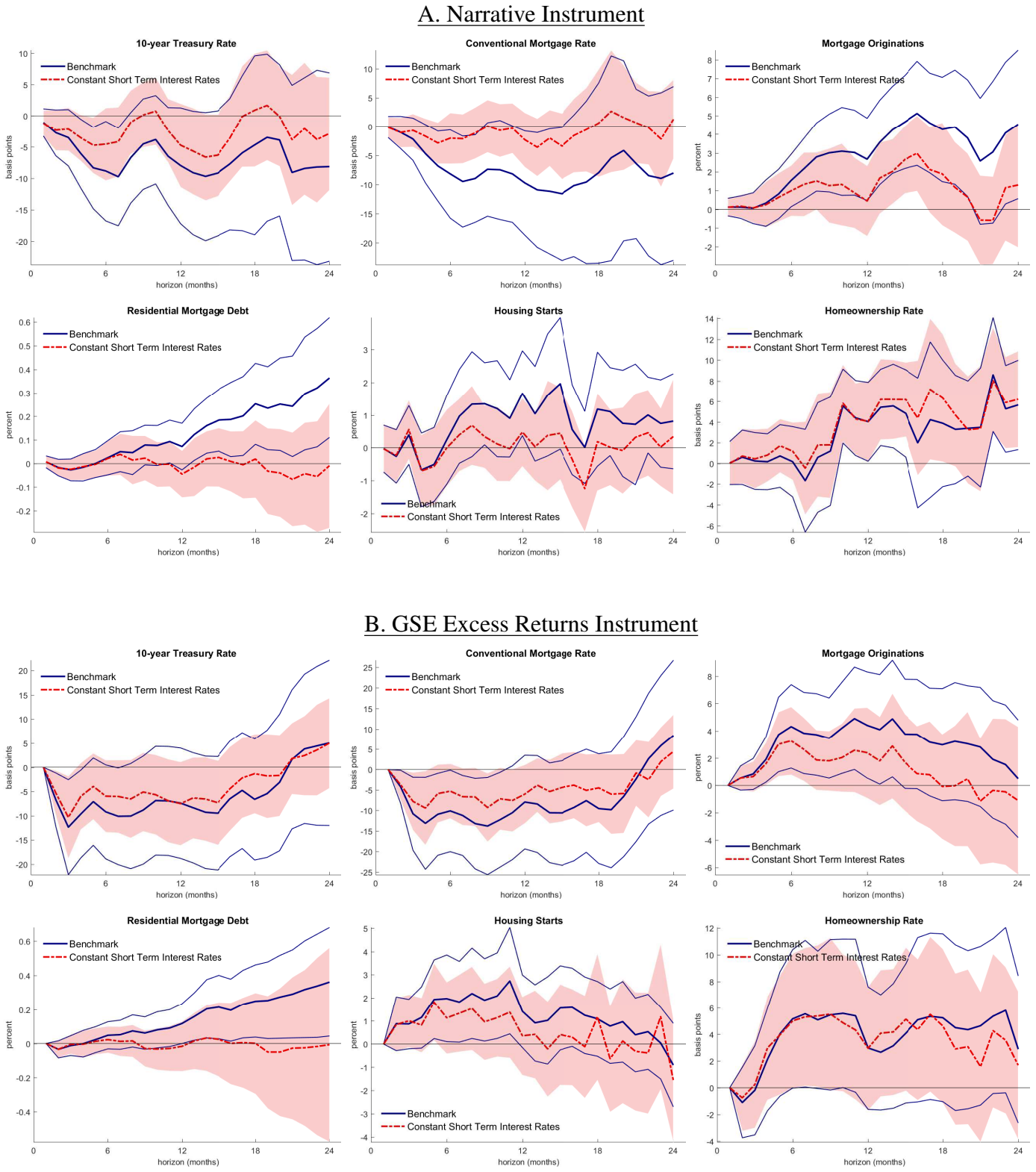


Figure 14 Shock to Anticipated Agency Purchases: Counterfactual with Constant Short-Term Rate

Notes: The figure shows responses to a one pp. increase in the expected future agency market share and a sequence of monetary shocks such that the 3-month T-bill rate remains constant. Estimates are from local projections-IV regressions instrumenting agency commitments with the narrative policy indicator. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

Table 1: Sources for Narrative Analysis

Government Publications	
Board of Governors	Annual Report, Press releases, *Federal Reserve Bulletin*
Congressional Budget Office	*The Housing Finance System and Federal Policy: Recent Changes and Options for the Future* (1983), *Controlling Risks of Government-Sponsored Enterprises* (1991)
Congressional Quarterly	*Congressional Quarterly Almanac*
Congressional Research Service	*A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003* (2004), *The Conforming Loan Limit* (2008)
Council of Economic Advisors	*Economic Report of the President*
Department of Housing and Urban Development	HUD news releases, *The Secondary Market in Residential Mortgages* (1982), *1986 Report to Congress on the Federal National Mortgage Association* (1987), *The National Homeownership Strategy: Partners in the American Dream* (1995), *Privatization of Fannie Mae and Freddie Mac: Desirability and Feasibility* (1996), *Profiles of GSE Mortgage Purchases in 2001-2004* (2008)
Department of the Treasury	Press releases and statements, *Report of the Secretary of the Treasury on Government-Sponsored Enterprises* (1990), *Government Sponsorship of the FNMA and the FHLMC* (1996)
Federal Home Loan Mortgage Corporation	Press releases and statements, Annual Report, Form 10-K
Federal Housing Finance Administration	Press releases and statements, *Mortgage Market Notes*
Federal National Mortgage Association	Press releases and statements, Annual Report, Form 10-K, *Monthly Volume Summary*, *Information Statement*, *MBSenger*, *Offering Circular*, *Background and History of the Federal National Mortgage Association* (1969, 1973)
Financial Crisis Inquiry Commission	*Final Report of the Financial Crisis Inquiry Commission* (2011)
Government Accountability Office	*The Federal National Mortgage Association in a Changing Environment* (1985), *GSEs: A Framework for Limiting the Government's Exposure to Risk* (1991), *Housing Enterprises: Potential Impacts of Severing Government Sponsorship* (1996), *HUD's Mission Oversight Needs to be Strengthened* (1998)
US Congress	Hearing transcripts and reports: Committees on Appropriations, Committees on Banking and Currency, Committee on Banking, Finance and Urban Affairs, and Committee on Banking, Housing and Urban Affairs
Office of Federal Housing Enterprise Oversight	Press releases and statements, Annual Report, *Mortgage Market Notes*, *Mortgage Markets and the Enterprises*, *Evaluating the Capital Adequacy of Freddie Mac and Fannie Mae* (1998), *Special Examination Reports* (2003, 2004, 2006)
Office of the Federal Register	*Federal Register*
Office of Management and Budget	*Budget of the United States Government*
The President's Commission on Housing	*The Report of The President's Commission on Housing* (1982)
Press and Online Sources	*ABA Banking Journal*, *American Banker*, *The American Presidency Project*, *The Bond Buyer*, *Dow Jones Capital Market Reports*, *Dow Jones News Service*, *Dow Jones Newswires*, *Financial Times*, *MarketWatch*, *National Mortgage News*, *The New York Times*, *Reuters News*, *The Wall Street Journal*, *The Washington Post*
Overview Books and Articles	
Bartke	*Fannie Mae and the Secondary Mortgage Market* (1971), *Home Financing at a Crossroads: A Study of the Federal Home Loan Mortgage Corporation* (1973)
Elliot, Feldberg, and Lehnert	*The History of Cyclical Macroprudential Policy in the US* (2013)
Greenspan	*The Age of Turbulence: Adventures in a New World* (2007)
Haar	*Federal Credit and Private Housing: The Mass Financing Dilemma* (1960)
Hagerty	*The Fateful History of Fannie Mae: New Deal Birth to Mortgage Crisis Fall* (2012)
Hoffman and Cassell	*Mission Expansion in the Federal Home Loan Bank System* (2010)
Hunter	*The FNMA: Its Response to Critical Financing Requirements of Housing* (1971)
McLean	*Shaky Ground: The Strange Saga of the US Mortgage Giants* (2015)

Notes: For detailed bibliographical references, see Fieldhouse and Mertens (2017).

Table 2: Narrative Measures of Policy Changes

Policy Description	Agency	Impact	News	Effective	Classification
HUDA 1968: Special Assistance	GNMA	+$0.25 billion	Aug. 1968	July 1969	Non-Cyclical
HUDA 1968: Increased Debt-to-Capital Ratio	FNMA	+$1.39 billion	Oct. 1968	Oct. 1968	Non-Cyclical
Increased Debt-to-Capital Ratio	FNMA	+$1.13 billion	Dec. 1969	Dec. 1969	Cyclical
HUDA 1969: Special Assistance	GNMA	+$0.75 billion	Dec. 1969	Dec. 1969	Cyclical
Treasury-Guaranteed Capitalization	FNMA	+$2.6 billion	Apr. 1970	Apr. 1970	Cyclical
EHFA 1970: Special Assistance	GNMA	+$0.38 billion	July 1970	July 1970	Cyclical
Conforming Mortgage Program Approval	FNMA	+$0.4 billion	Nov. 1971	Feb. 1972	Non-Cyclical
FHA/VA Tandem Authorization	GNMA	+$1.5 billion	Sep. 1973	Sep. 1973	Cyclical
FHA/VA Tandem Authorization	GNMA	+$3.3 billion	Jan. 1974	Jan. 1974	Cyclical
Subsidized Mortgage Purchase Program	FHLMC	+$1.5 billion	May 1974	May 1974	Cyclical
FHA/VA Tandem Authorization	GNMA	+$1.65 billion	May 1974	May 1974	Cyclical
HCDA 1974: Conforming Loan Limit	FNMA	+$1.14 billion	Aug. 1974	Aug. 1974	Non-Cyclical
HCDA 1974: Conforming Loan Limit	FHLMC	+$0.46 billion	Aug. 1974	Aug. 1974	Non-Cyclical
EHPA 1974: Tandem Program	GNMA	+$3.88 billion	Oct. 1974	Oct. 1974	Cyclical
FY1976 Approps: Tandem Program	GNMA	+$2.5 billion	Oct. 1975	Oct. 1975	Cyclical
HCDA 1977: Conforming Loan Limit	FNMA	+$4.82 billion	Oct. 1977	Oct. 1977	Non-Cyclical
HCDA 1977: Conforming Loan Limit	FHLMC	+$0.21 billion	Oct. 1977	Oct. 1977	Non-Cyclical
HCDA 1977: Tandem Program Expansion	GNMA	+$3.75 billion	Oct. 1977	Oct. 1977	Non-Cyclical
FY1979 Approps: Special Assistance	GNMA	+$1.0 billion	Sep. 1978	Oct. 1978	Non-Cyclical
HCDA 1978: Mortgagee Expansion	FHLMC	+$2.0 billion	Oct. 1978	May 1979	Non-Cyclical
FY1980 Approps: Special Assistance	GNMA	+$1.0 billion	July 1979	Nov. 1979	Non-Cyclical
HCDA 1979: Conforming Loan Limit	FHLMC	+0.86 billion	Dec. 1979	Dec. 1979	Cyclical
FY1981 Approps: Special Assistance	GNMA	-$0.2 billion	Sep. 1980	Dec. 1980	Cyclical
ARM Program Approval	FHLMC	+$0.37 billion	May 1981	July 1981	Cyclical
ARM Program Approval	FNMA	+$0.4 billion	June 1981	Aug. 1981	Cyclical
Second Mortgage Program Approval	FNMA	+$5.0 billion	Sep. 1981	Nov. 1981	Cyclical
FY1982 Approps: Special Assistance	GNMA	+$0.17 billion	Dec. 1981	Dec. 1981	Cyclical
Increased Debt-to-Capital Ratio	FNMA	+$6.25 billion	Dec. 1982	Dec. 1982	Non-Cyclical
FY1983 Approps: Special Assistance	GNMA	-$1.47 billion	Dec. 1982	Dec. 1982	Cyclical
FY1984 Supp. Approps: Tandem Repeal	GNMA	-$2.92 billion	Nov. 1983	Nov. 1983	Non-Cyclical
Second Mortgage Program Approval	FHLMC	+$1.0 billion	Jan. 1986	Jan. 1986	Non-Cyclical
Decreased Debt-to-Capital Ratio	FNMA	-$2.7 billion	Apr. 1987	Dec. 1987	Non-Cyclical
Public Listing: Stock Split Capitalization	FHLMC	+$1.62 billion	Nov. 1988	Nov. 1988	Non-Cyclical
FHEFSSA 1992: Capital Requirements	FNMA	-$4.25 billion	Mar. 1990	Mar. 1990	Non-Cyclical
Affordable Housing Goals of 1995	FHLMC	+$0.61 billion	Dec. 1995	Jan. 1996	Non-Cyclical
Affordable Housing Goals of 2004	FNMA	+$7.6 billion	Apr. 2004	Jan. 2005	Non-Cyclical
Affordable Housing Goals of 2004	FHLMC	+$7.6 billion	Apr. 2004	Jan. 2005	Non-Cyclical
Accounting Scandal: Capital Surcharge	FNMA	-$141.4 billion	Sep. 2004	Sep. 2004	Non-Cyclical
Portfolio Growth Limit Imposed	FHLMC	-$42.8 billion	June 2006	July 2006	Non-Cyclical
Portfolio Limit Increase	FNMA	+$17.15 billion	Sep. 2007	Sep. 2007	Cyclical
Portfolio Limit Increase	FHLMC	+$2.14 billion	Sep. 2007	Sep. 2007	Cyclical
ESA 2008: Jumbo Loan Limit	FNMA	+$41.57 billion	Feb. 2008	Apr. 2008	Cyclical
ESA 2008: Jumbo Loan Limit	FHLMC	+$41.57 billion	Feb. 2008	Apr. 2008	Cyclical
Removal of Portfolio Limit	FNMA	+$9.28 billion	Feb. 2008	Mar. 2008	Non-Cyclical
Removal of Portfolio Limit	FHLMC	+$9.05 billion	Feb. 2008	Mar. 2008	Non-Cyclical
Reduced Capital Surcharge	FNMA	+$53.33 billion	Mar. 2008	Mar. 2008	Cyclical

Policy Description	Agency	Impact	News	Effective	Classification
Reduced Capital Surcharge	FHLMC	+$43.33 billion	Mar. 2008	Mar. 2008	Cyclical
Reduced Capital Surcharge	FNMA	+$17.75 billion	May 2008	May 2008	Cyclical
HERA 2008: Jumbo Loan Limit	FNMA	-$13.34 billion	July 2008	Jan. 2009	Cyclical
HERA 2008: Jumbo Loan Limit	FHLMC	-$13.34 billion	July 2008	Jan. 2009	Cyclical
Conservatorship: Portfolio Limit Increase	FNMA	+$67.5 billion	Sep. 2008	Sep. 2008	Cyclical
Conservatorship: Portfolio Limit Increase	FHLMC	+$66.75 billion	Sep. 2008	Sep. 2008	Cyclical
MBS Purchase Program Launch	Treasury	+$80.0 billion	Sep. 2008	Sep. 2008	Cyclical
QE1 Launch	Fed	+$250.0 billion	Nov. 2008	Dec. 2008	Cyclical
ARRA 2009: Jumbo Loan Limit	FNMA	+$13.34 billion	Feb. 2009	Feb. 2009	Cyclical
ARRA 2009: Jumbo Loan Limit	FHLMC	+$13.34 billion	Feb. 2009	Feb. 2009	Cyclical
HASP: Portfolio Limit Increase	FNMA	+$50.0 billion	Feb. 2009	May 2009	Cyclical
HASP: Portfolio Limit Increase	FHLMC	+$50.0 billion	Feb. 2009	May 2009	Cyclical
QE1 Expansion	Fed	+$750.0 billion	Mar. 2009	Mar. 2009	Cyclical
MBS Purchase Program Sales	Treasury	-$120.0 billion	Mar. 2011	Mar. 2011	Cyclical
Agency MBS Reinvestment	Fed	+$262.0 billion	Sep. 2011	Sep. 2011	Cyclical
Third SPSPA Amendment	FNMA	-$22.16 billion	Aug. 2012	Aug. 2012	Non-Cyclical
Third SPSPA Amendment	FHLMC	-$22.16 billion	Aug. 2012	Aug. 2012	Non-Cyclical
QE3 Launch	Fed	+$480.0 billion	Sep. 2012	Sep. 2012	Cyclical
QE3 Taper	Fed	-$60.0 billion	Dec. 2013	Jan. 2014	Cyclical

Acronyms (in chronological appearance): Housing and Urban Development Act (HUDA); Emergency Home Finance Act (EHFA); Housing and Community Development Act (HCDA); Emergency Home Purchase Act (EHPA); fiscal year (FY); adjustable-rate mortgage (ARM); Federal Housing Enterprises Financial Safety and Soundness Act (FHEFSSA); Economic Stimulus Act (ESA); Mortgage-backed securities (MBS); Housing and Economic Recovery Act (HERA); quantitative easing (QE); American Recovery and Reinvestment Act (ARRA); Home Affordability and Stability Plan (HASP); and Senior Preferred Stock Purchase Agreements (SPSPA).

Historical Background

This appendix provides some more historical background to the evolution of agency market shares depicted in Figure 1.[34] During the Depression, the Home Owners' Loan Corporation took ownership of nearly 15% of mortgage debt. Housing and homeownership reemerged as a priority at the end of WWII, which is reflected in the strong growth of Fannie holdings in the late 1940s until the Korean War again shifted priority away from housing. A struggling Fannie was rechartered as a mixed private-public ownership corporation in 1954. In 1968, Fannie Mae was split into a publicly listed private corporation and a government-owned Ginnie Mae. In the 1970s, Fannie expanded almost without interruption and the agencies mortgage holdings reached close to 10 percent of total mortgage debt. However, Fannie's large debt-financed balance sheet incurred heavy losses after interest rates rose sharply in 1979. Profitability was only restored through a strategy of aggressive portfolio expansion and by entering the securitization business. At its creation in 1970, ownership of Freddie Mac was restricted to the savings and loans, which had no interest in creating a competitor. As a result, Freddie focused on the securitization of conventional loans, maintaining only a relatively modest mortgage portfolio for warehousing until the late 1980s. In the second half of the 1980s, rising delinquencies and a more hostile attitude of the Reagan administration towards the GSEs led to a reduction in the agencies' market share.

[34] Table 1 contains references to various books an articles that contain more comprehensive overviews.

Various reforms in the aftermath of the 1980s S&L crisis set the stage for a prolonged rise in agency activity in the 1990s and early 2000s, and by 2002, the agencies held close to one quarter of the total outstanding mortgage debt on their portfolios. Before, in 1989 Freddie was turned into a publicly traded company with the same profit incentives for balance sheet growth as Fannie, while the Federal Home Loan Banks were granted permission to invest in MBS. Prudential regulations were tightened for private banks, but remained light for the GSEs despite a 1992 reform. The agencies increasingly retained their own and acquired each other's MBS, as opposed to selling them to private investors. As part of an ambitious homeownership strategy, the Clinton administration was supportive of the efforts by Fannie and Freddie to develop automated underwriting systems and ramped up affordable housing goals for their purchases.

The rapid rise in agency ownership of mortgage debt increasingly became a cause of concern with public officials, and in the wake of the Enron scandal Fannie and Freddie were required to start filing reports with the Security and Exchange Commission. Allegations of accounting fraud in 2003 prompted an investigation by regulators, leading to capital surcharges in the fall of 2004 and settlements that included portfolio caps in 2006. This contributed to a sharp fall in the agencies' market share, which declined 10 percentage points from 2003 to 2007. During the turmoil in mortgage markets in 2007, the portfolio caps and capital surcharges were relaxed, allowing the agencies to step up purchasing activity. In early September 2008, Fannie and Freddie were taken into conservatorship by the FHFA and Treasury Department.

The 2008 conservatorship agreement allowed for continued GSE balance sheet growth in the short run, but also mandated a long-run wind-down of their portfolios at an annual rate of 10%, increased to 15% in 2012, until they reach a $250 billion each. The day after the agreement, the Treasury announced its own MBS purchase program, while the Federal Reserve's MBS program was launched a few weeks later. As a result of the Fed and Treasury programs, the combined agency ownership share regained levels similar to the early 2000s despite a gradual decline in holdership by the traditional housing agencies. In contrast, Fannie and Freddie have been allowed to grow their MBS guarantee book essentially without limits. Since the financial crisis, the vast majority of conforming loans originated have been acquired, guaranteed, and sold off in MBS by the agencies.

Data Sources and Construction

Data underlying Figure 1: *Residential Mortgage Debt* post-1945 is the sum of home mortgages and multifamily residential mortgages from the Federal Reserve's Financial Accounts of the United States. Pre-1945 data is spliced using Series N-151 (Nonfarm Residential Mortgage Debt) from the Historical Statistics of the United States (1960 edition). *Nominal GDP* post-1929 is from the National Income and Product Accounts, spliced using series Ca-10 from the Historical Statistics of the United States (Table Ca9-19, Millenial Edition). The data for *Housing Wealth* post-1930 is from Davis and Heathcoate (2007) available at and updated by the Lincoln Institute of Land Policy, `http://www.lincolninst.edu/research-data/data`. Pre-1930 data is spliced using Series N-129 (Total Nonfarm Residential Wealth) from the Historical Statistics of the United States (1960 edition).

Agency Mortgage Holdings is the sum of the retained mortgage portfolios of Fannie Mae, Freddie Mac, Ginnie Mae, the FHLBanks, the Treasury Department, the Federal Reserve, and a number of other government agencies. Both holdings of whole loans and mortgage pools are included.

> Fannie Mae: Monthly data on Fannie's retained mortgage portfolio from 1950 to 2003 is from various issues of the Federal Reserve Bulletin, which stopped reporting GSE portfolio statistics in 2003. From

then onwards, the data is from Fannie's monthly volume summary cross-checked with the annual reports from OFHEO/FHFA for consistency. Prior to 1950, the data is based on fiscal year data from a Fannie publication titled "*FNMA Background and History*" (1969 and 1973 editions), as well as Series N-159 from the Historical Statistics of the United States (1960 edition).

Freddie Mac: Monthly data on Freddie's retained mortgage portfolio from 1970 to 2003 is from various issues of the Federal Reserve Bulletin, and after 2003 from Freddie's monthly volume summary cross-checked with the annual reports from OFHEO/FHFA for consistency.

Ginnie Mae: Quarterly data on Ginnie's home and multifamily mortgage from the Financial Accounts of the United States. Monthly data is available from 1968 to 1974 from various issues of the Federal Reserve Bulletin.

FHLBanks: Data on FHLB mortgage holdings is from various issues of FHFA annual reports (annual from 1992 to 2007 and quarterly since 2008). Pre-1992 annual data is from a 1993 CBO study titled "*The Federal Home Loan Banks in the Housing Finance System*" (p. 15).

Treasury: Data from the Treasury Department `https://www.treasury.gov/resource-center/data-chart-center/Pages/mbs-purchase-program.aspx`

Federal Reserve: Data from the Federal Reserve's Financial Accounts of the United States.

Other Agencies: The home and multifamily holdings of the Veterans Administration, the Federal Housing Adminstration, the Federal Farmers Home Administration, the Resolution Trust Corporation, the Federal Deposit Insurance Corporation and Public Housing Administration are all obtained from the Financial Accounts of the United States. Data from the Home Owner's Loan Corporation (which in the Financial Accounts is included with Fannie Mae) is series N-158 from the Historical Statistics of the United States (1960 edition).

The upper left panel of Figure 1 shows annual data up to 1952 and quarterly data afterwards. Missing quarterly data on FHLB holdings is obtained by linear interpolation of annual data.
Residential mortgage originations shown in the lower left panel of Figure 1 is the quarterly aggregate of the monthly series described below.

Agency Net Portfolio Purchases and Pool Issues is the sum of net portfolios purchases of both whole loans as well as mortgage pools, and of issues of mortgage pools respectively, by Fannie Mae, Freddie Mac, Ginnie Mae, the FHLBanks, the Treasury Department, the Federal Reserve, and a number of other government agencies:

Fannie Mae: Monthly data on Fannie's net portfolio purchases from 1953 to 1998 is from various issues of the Federal Reserve Bulletin (portfolio purchases less sales). More recent data is from Fannie's monthly volume summary cross-checked with the annual reports from OFHEO/FHFA for consistency. While data on purchases is available over the entire sample, data on portfolio sales is missing for 1986 and 1988-1997. We impute the missing observations using data on Fannie's commitments to purchase and sell, actual purchases, and the net change in the retained portfolio. The imputation is done by Kalman smoothing in a state space model estimated by maximum likelihood as in Shumway and Stoffer (1982) using monthly data from 1980 to 2014. The model used is a vector autoregressive process for the net portfolio purchase rate, retained mortgage portfolio growth, and the ratio of purchases and net commitments to the retained portfolio. Data on Fannie pool issues from 1993 is from Lehnert,

Passmore, and Sherlund (2008), extended to 2014 using Fannie's monthly volume summaries. Pre-1993 monthly data is obtained by subtracting Freddie and Ginnie pool issues from total net purchases by agency mortgage pools from monthly releases by the Department of Housing and Urban Development from the Survey of Mortgage Lending Activity (obtained through the National Archives and Records Administration).

Freddie Mac: Monthly data on Freddie's net portfolio purchases from 1993 onwards is from Lehnert, Passmore, and Sherlund (2008) and Freddie's monthly volume summaries. Data before 1984 is obtained by subtracting Freddie pool issues from total wholesale loan purchases available from the Federal Reserve Bulletin. Data between 1984 and 1993 is imputed using data on Freddie holdings and repayment rates in Fannie's portfolio. The imputation is done by Kalman smoothing in a state space model estimated by maximum likelihood as in Shumway and Stoffer (1982) using monthly data from 1980 to 2014. The model used is a vector autoregressive process for Freddie's net portfolio purchase rate, retained mortgage portfolio growth and repayment rates in Fannie's retained portfolio. Monthly data on Freddie pool issuance is from the journal of the Federal Home Loan Bank Board (various issues, 1971-1980), the Federal Reserve Bulletin (1980-1998), and the monthly volume summaries (1998 onwards).

Ginnie Mae: Monthly data on Ginnie's net portfolio purchases from 1968 to 1971 is from various issues of the Federal Reserve Bulletin. Subsequent data is imputed by assuming that repayment rates for mortgages packaged in pools backed by Ginnie are the same as for mortgages held in portfolio. Monthly data on Ginnie pool issues since 1968 was provided to us directly by the Department of Housing and Urban Development.

FHLBanks: Data on net purchases by the FHLBanks is imputed using net changes in holdings and assuming that the combined repayment rate on mortgages debt in Fannie, Freddie and Ginnie pools is identical to the repayment rate on mortgages in mortgage-backed securities held by the FHLBanks.

Treasury: Data on MBS purchases is from the Treasury Department `https://www.treasury.gov/resource-center/data-chart-center/Pages/mbs-purchase-program.aspx`.

Federal Reserve: Data on MBS purchases using the date of settlement, available from the Board of Governors `https://www.federalreserve.gov/newsevents/reform_mbs.htm` and the Federal Reserve Bank of New York `https://www.newyorkfed.org/markets/ambs/ambs_schedule.html`.

Other Agencies: Data on combined net purchases by the other agencies is imputed using net changes in holdings and by assuming that the combined repayment rate on mortgages debt in Ginnie pools is identical to the repayment rate on mortgages in mortgage-backed securities held in portfolio.

The lower right panel of Figure 1 shows quarterly data from 1952 onwards.

Data underlying Figure 2: *Agency mortgage holdings* is the quarterly series from Figure 1. *Private mortgage holdings* is total residential mortgage debt from Figure 1 less agency holdings. Both series are deflated by the price index for personal consumption expenditures excluding food and energy from NIPA (series PCEPILFE from the FRED database at the Federal Reserve Bank of St. Louis). The chronology for pre-1986 credit crunches is from Eckstein and Sinai (1986). The dating of post-1986 crunches is based on Owens and Schreft (1993) for the 1990 commercial real estate crunch), Lehnert, Passmore, and Sherlund (2008) for the 1998 Russian default/LTCM crisis, and Bordo and Haubrich (2010) for the 2007 Financial Crisis.

Monthly agency data: The monthly series for *consolidated agency mortgage holdings* and *net portfolio purchases* sums the monthly series for Fannie, Freddie, Ginnie, the Federal Reserve, and the Treasury described above (see data underlying Figure 1). All series are seasonally adjusted using the X-13 program from the Census Bureau.
Agency purchase commitments are the sum of the following series:

Fannie Mae: Monthly data on the stock of total outstanding unfulfilled commitments from 1953 to 1990 is available from various issues of the Federal Reserve Bulletin. To obtain net purchase commitments made during the month, we add net purchases to the net change in commitments outstanding. From 1990 onwards we use net commitments (issued less to sell) from the Federal Reserve Bulletin (up to 2003) and Fannie's monthly volume summaries (2003 onwards).

Freddie Mac: Monthly data on Freddie's net portfolio commitments (issued less to sell) is from Freddie's monthly volume summaries from 1998 onwards. For observations before 1998, we use Freddie net portfolio purchases.

Federal Reserve: Data on MBS purchases using the trade date, available from the Board of Governors `https://www.federalreserve.gov/newsevents/reform_mbs.htm` and the Federal Reserve Bank of New York.

No data for net commitments is available for Ginnie Mae and the Treasury, and we simply use the series for net portfolio purchases.

Monthly mortgage market data: The *conventional mortgage rate* is the 30-year fixed-rate conventional conforming mortgage rate. From 1971 onwards, the conventional rate is the monthly average commitment rate from the Freddie Mac primary mortgage market survey. Pre-1971 data is from the Federal Housing Adminstration (FHA)/Departement of Housing and Urban Development (HUD) series for the primary conventional market rate, available from the Federal Reserve Bulletin (various issues).
The *FHA mortgage rate* is the 30-year fixed-rate FHA-guaranteed mortgage rate. Rate data for FHA-mortgages offered in the secondary market from 1963 is provided by FHA/HUD and is available from various issues of the Federal Reserve Bulletin. Earlier data is from the NBER's macrohistory database (series m13045). The series has a handful of missing observations and was discontinued in 2000. We impute data by Kalman smoothing in a VAR/state space model estimated by maximum likelihood as in Shumway and Stoffer (1982) using several closely related interest rate series over the 1976-2014 period: the conventional 30-year rate (FHA/HUD as well as the Freddie Mac series), the 3-month and 10-year Treasury rates, and yields on Ginnie Mae securities (from the Federal Reserve Bulletin as well as the MTGEGNSF Index from Bloomberg). A couple of missing observations prior to 1976 were imputed in a similar fashion using data on the 3-month and 10-year Treasury rates, on interest rate data provided by Saul B. Klaman's 1961 NBER publication "The Postwar Residential Mortgage Market", and on interest rate ceilings on FHA loans applicable at the time. The 10-year and 3-month Treasury rates are from the FRED database (GS10 and TB3MS).

The primary source of monthly data on *residential mortgage originations* are monthly news releases from the Survey of Mortgage Lending Activity (SMLA) conducted by HUD from 1970 to 1997, accessed through the National Archives and Records Administration (Tables 2 and 3: total originations of long term mortgage loans for 1-to-4 nonfarm homes and multifamily residential properties). The monthly series is interpolated after 1997 using quarterly data on originations (series USMORTORA in Datastream) and weekly data on mortgage applications (series MBAVBASC on Bloomberg), both from the Mortgage Bankers' Association

(MBA). The interpolation is done through Kalman smoothing of an estimated VAR/state space model as in Shumway and Stoffer (1982). Observations before 1965 are based on data of total new non-farm mortgages of $20,000 or less recorded from the Federal Home Loan Bank Board and available from the NBER's macro-history database (series m02173). To obtain an estimate of total originations, we assume that the share of originations of $20,000 or less in all originations is the same as the share in originations by Savings & Loans associations. Data on S&L originations (total and $20,000 or less) is available from various issues of the Savings and Home Financing Sourcebooks, a publication by the Federal Home Loan Bank Board up prior to 1990. Data between 1965 and 1970 is imputed using total originations by S&L associations based on Kalman smoothing in a VAR/state space model estimated as in Shumway and Stoffer (1982) using monthly data from 1954 to 1985. The series is seasonally adjusted using the X-13 program from the Census Bureau. Unfortunately, the monthly SMLA releases do not contain information on the purpose of the mortgage loans. However, the Savings and Home Financing Sourcebooks published prior to 1990 contain monthly data on refinancing originations by S&L banks (although observations from May 1985 to December 1986 are missing). After 1990, quarterly totals of refinancing originations are available from the MBA (series USMORRVLA in Datastream). As an estimate of the share of refinancing loans, we use the monthly shares at S&L banks before 1990, and the quarterly shares from the MBA afterwards. Our monthly series on *refinance* and *purchase originations* are obtained by applying the estimated share of refinancing to our series for total residential mortgage originations.

The monthly series for *mortgage debt* is based on interpolation of the quarterly mortgage debt series from the Financial Accounts of the United States (see Figure 1) using the series on monthly originations. The series is constructed by linear interpolation of the implied quarterly repayment rates. The final series is seasonally adjusted using the X-13 program from the Census Bureau.

Other monthly variables The series on (seasonally adjusted) *housing starts* is from the Census Bureau and obtained through the FRED database at the Federal Reserve Bank of St. Louis (series HOUST). *House prices* post-1975 are measured by the Freddie Mac house price index (FMHPI) available at `http://www.freddiemac.com/finance/house_price_index.html`. The data are extended before 1975 by splicing with the home purchase component of the BLS Consumer Price Index (PHCPI from FRED), obtained from Shiller (2015), and seasonally adjusted using the X-13 program from the Census Bureau. The series is deflated by the *nominal price level*, measured by the core PCE price index to obtain a real house price index (series PCEPILFE from FRED). To the best of our knowledge, no monthly data on the *homeownership rate* is available. We therefore simply use quarterly values of series RHORUSQ156N from FRED. Monthly *personal consumption expenditures* is from NIPA (series PCE from FRED). Monthly *personal income* is from NIPA (series PI from FRED). The *unemployment rate* is series UNR from FRED. The *short and long-term nominal interest rate*s 3-month and 10-year Treasury rates are series TB3MS and GS10 from FRED. The *GSE stock price index* post 1988 is the geometric average of stock price indices for Fannie Mae and Freddie Mac (from Bloomberg), and the Fannie stock price index from 1970 through 1988. The *S&P 500 index* is the nominal index from Shiller (2015) deflated by the nominal price level. The *BAA and AAA corporate bond rates* are the Moody's seasoned BAA and AAA yields (series BAA and AAA from FRED).

A Appendix for Online Publication: Additional Results and Robustness Checks

A.1 Cumulative Credit Multipliers

This section discusses a number of robustness checks of the results presented in Section 5 regarding the cumulative effects of agency purchases.

Scaling by Trend Originations The baseline specification in (2) uses a trend in personal income as the scaling variable. Figure A.1 reports the results when we instead use a long run trend in annualized mortgage originations. The latter is obtained by fitting a third degree polynomial of time to the log of real mortgage originations obtained using the core PCE price index as the deflator. This is potentially consequential for the results because of trend growth of the mortgage market relative to the economy. However, the figure shows that the results remain generally similar to the baseline in Figure 6. Cumulative originations do not increase in the short run, but are higher by 4 dollars after 3 to 4 years, while mortgage debt rises in the long run by almost one dollar. The bulk of the new originations are for refinance purposes, while originations for home purchases are higher by 1 to 1.5 dollars after 3 to 4 years.

Agency Pool Issuance Figure A.2 reports the cumulative dollar change in agency issuance of mortgage pools, i.e. MBS. In contrast to originations or total mortgage debt, the choice of scaling variable is important for the cumulative impact on agency MBS issuance. Scaling by trend income implicitly assigns a larger relative weight to policy changes that occur later in the sample. The left panel of Figure A.2 shows that at relatively short horizons, agency MBS issuance rises by roughly the same dollar amount as the increase in agency mortgage holdings, see Figure 6. The fact that private mortgage holdings also decrease by roughly the same amount implies that the agency portfolio purchases are predominantly of MBS, while there are no additional MBS sales to private investors. As the horizon increases, cumulative MBS issuance rises to close to 2 dollars after three to four years. The increase in MBS issuance coincides closely with the rise in originations. Cumulative MBS issuance converges to around 40% to 50% percent of the cumulative rise in originations, which is about the typical agency securitization share since the mid-1980s. The right panel of Figure A.2 shows in contrast no short-run impact on MBS issuance when the scaling variable is a trend in originations, implying that the agency portfolio purchases are instead of whole loans. MBS issuance

gradually rises, but the total cumulative increase is a smaller share of the total increase in originations. This pattern is more similar to agency behavior before the growth of mortgage securitization in the mid-1980s.

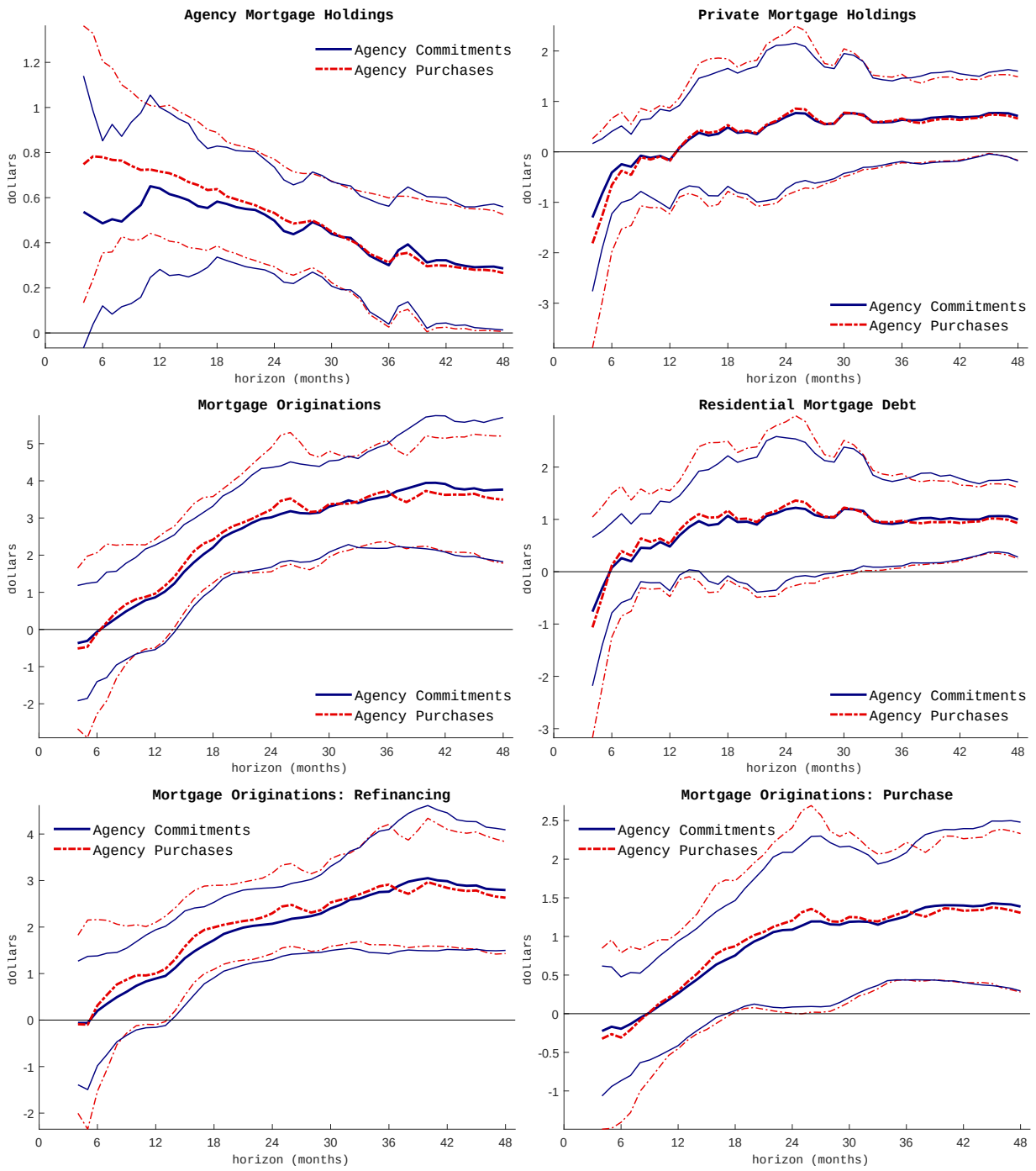


Figure A.1 Cumulative Estimates Using Trend Originations as the Scaling Variable

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. Estimates are from local projections-IV regressions, see equation (2). Finer lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006. In the bottom row panels, the sample excludes May 1985 to Dec 1986 because of missing data on refinance shares.

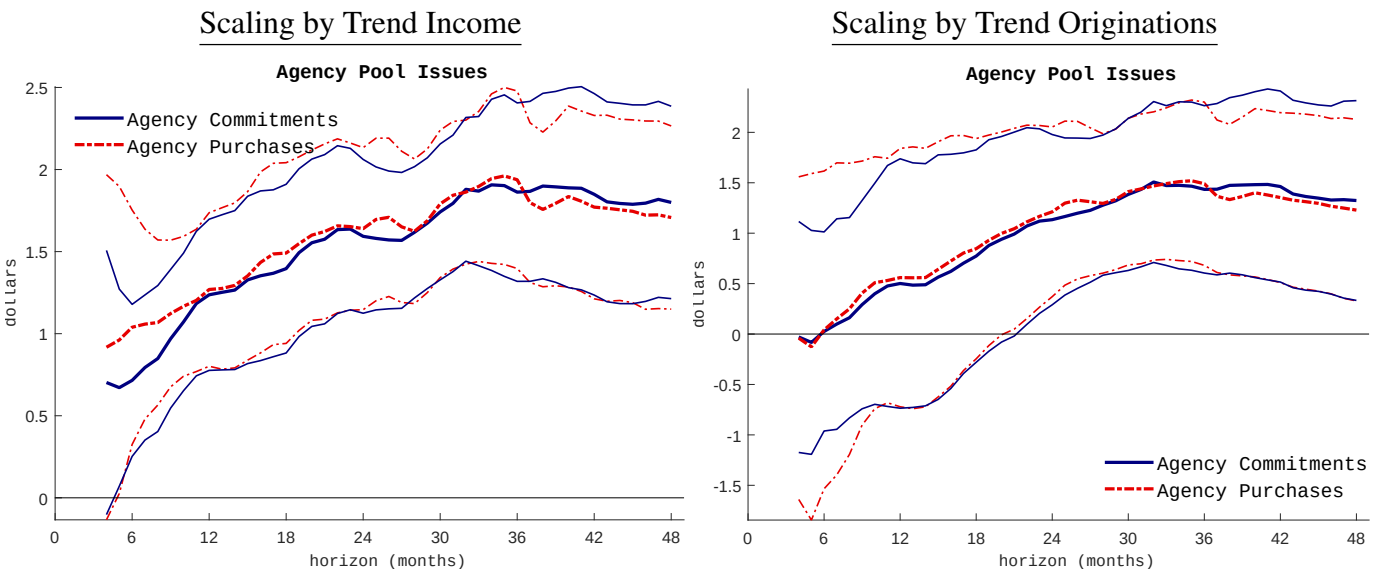


Figure A.2 Total Mortgage Pool Issuance Associated with Agency Mortgage Purchases

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. Estimates are from local projections-IV regressions, see equation (2), using non-cyclical policy events as the instrument. Finer lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

Other Robustness Checks Table A.1 clarifies how the results depend on instrumentation and the choice of controls. Estimates from the benchmark specifications of Section 5 using net commitments and purchases are reported in columns [6] and [7], respectively. Given the similarity of the results, the other columns all report multipliers associated with commitments only. To assess the role of instrumentation, column [5] reports the OLS estimates for the benchmark specification. Columns [3] to [4] display the OLS and IV estimates when the cyclical indicators (unemployment and income growth) are omitted. Columns [1] and [2] further omit the interest rate controls. Finally, column [8] shows the IV estimates when we use all policy events, both cyclical and non-cyclical, to construct the instrument. To better visualize the role of instrumentation by the narrative instrument, Figure A.3 displays the cumulative effects on agency holdings and mortgage originations estimated by OLS and 2SLS for all horizons.

We highlight the following patterns from the results in Table A.1. First, the point estimates across the IV regressions are all quite similar. Controlling for interest rates is the most consequential. When leaving out interest rates in [2], we find somewhat smaller increases in mortgage originations and debt. The results are essentially unchanged by including the cyclical controls (unemployment and income growth). Interestingly,

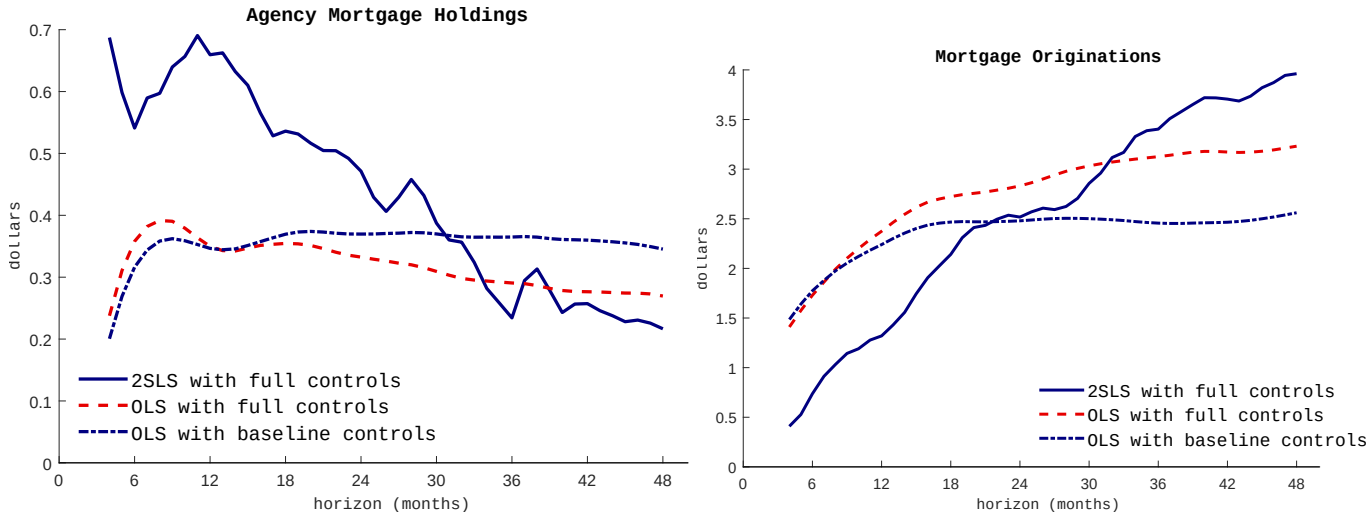
and conditional on including the richest control set as in our benchmark specification, the results remain similar when we also include the cyclically motivated policy events in the instrument, see column [8]. This is in our view not too surprising. Based on our reading of the various historical policy actions, see Fieldhouse and Mertens (2017), recognition and decision lags likely exceed one month in practice. With a sufficiently rich set of lagged controls, including the cyclical actions may therefore not lead to any meaningful violation of the exogeneity requirements. Instrumentation with policy events, however, is important for the results. The OLS estimates in columns [1], [3], and [5] differ substantially in size and display very different time patterns from the IV counterparts in columns [2], [4], and [6]: Agency holdings rise immediately and more or less independently of the horizon, private holdings do not fall significantly over shorter horizons, and originations are higher by an amount that is much less dependent on the horizon. The OLS estimates are likely contaminated by reverse causality, as this pattern is more consistent with private lenders simply passing on newly originated loans to the agencies rather than selling existing loans off their balance sheets. Figure A.3 further illustrates this by depicting the full set of OLS and 2SLS estimates for agency holdings and mortgage originations. Regardless of whether the baseline or full set of controls are included, the bulk of the increase in mortgage originations per dollar change in commitments occurs within the first 12 months (panel A), and within even a much shorter window when the regressor is agency purchases. Such a pattern indicates a much stronger contemporaneous relation between originations and agency purchases. Given decision lags as well as the time delays associated with the making of new mortgage loans, the delayed and gradual rise in originations that appears after instrumentation is more consistent with a causal interpretation. Figure A.3 also reveals that the total agency mortgage holdings increase by a substantially smaller amount than the dollar purchased or committed, even at relative short horizons. This indicates that agency purchases tend to coincide with higher sales of mortgage assets to private investors and/or with higher repayment rates, both of which are likely to reflect other influences on the private demand for mortgage credit in the primary or secondary market.

Table A.2 verifies the robustness of the results to variations in the sample and to the inclusion of additional indicators of agency activity. For comparison, column [1] repeats the benchmark estimates based on net commitments. For brevity, all other columns are based on using commitments as the measure of agency

purchasing activity. Column [2] extends the end point of the sample from December 2006 to December 2014. Note that in this case the h-th regression in (2) drops the last h observations. Column [3] restricts the sample by setting September 1982 as the starting point, marking the end of the period of non-borrowed reserves targeting by the Federal Reserve. This shorter sample selects a period of more stable monetary policy. Because of the smaller sample, we omit in this case the cyclical controls to reduce the number parameters to be estimated. Columns [4], [5], and [6] show results when we omit in turn each of the three largest policy interventions from the non-cyclical narrative instrument: the October 1977 conforming loan limit increase and expansion of the Brooke-Cranston Tandem program, the December 1982 increase in Fannie Mae's debt-to-capital limit, and the September 2004 tightening of capital requirements. In each case we add the omitted event as a separate dummy variable, including both the contemporaneous value and twelve lags to the control variables. The final two columns include lagged values of two indicators of agency activity as additional controls: the volume of mortgage pool issues (in ratio of X_t) and log ratio of GSE stock prices to the S&P 500 index. In the latter case, the sample starts in September 1971 instead of December 1967, reflecting the fact that Fannie Mae stock started trading on August 31, 1970.

All variations of the baseline specification reported in Table A.2 yield cumulative origination multipliers in the range of 2.5 to 4.5 after 3 to 4 years. Moreover, the impact on originations is consistently highly statistically significant. The estimated cumulative change in mortgage debt also remains in the range of the benchmark specification. The credit multipliers are the lowest when we extend the sample to include the recent financial crisis (column [2]) and when we add GSE excess stock returns to the control set (column [8]). In these cases, the impact on mortgage debt is no longer significant at conventional levels. We also highlight that the inclusion of the September 2004 policy event is important for the precision of the estimates. The instrument that omits the 2004 event is generally weaker and produces wider confidence bands. On the other hand, omitting the 1977 and 1982 events (columns [5] and [6]) does not have a large influence on the results.

A. Per Dollar in Agency Commitments



B. Per Dollar in Agency Purchases

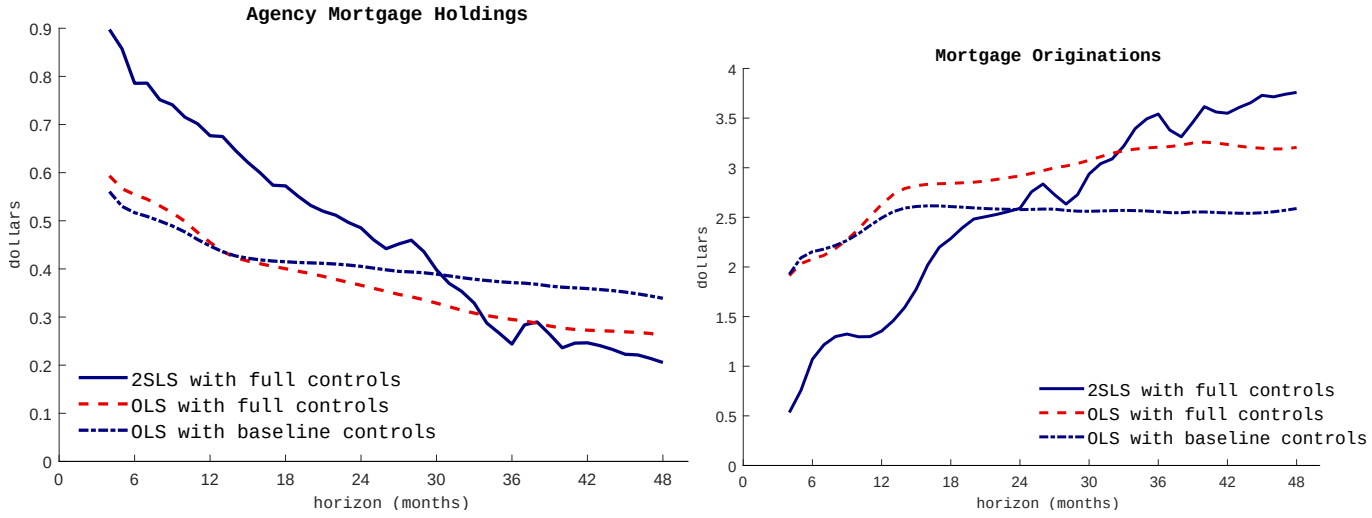


Figure A.3 Comparing OLS and 2SLS Estimates of Mortgage Credit Multipliers

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. The specification with baseline controls excludes the interest rate and cyclical controls.

Table A.1 OLS and IV Estimates of Balance Sheet Adjustments and Mortgage Credit Multipliers

	Months	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Agency Holdings	12	0.35***	0.61***	0.33***	0.68***	0.35***	0.66***	0.68***	0.56***
		(0.19, 0.50)	(0.35, 0.88)	(0.18, 0.48)	(0.43, 0.93)	(0.21, 0.49)	(0.40, 0.92)	(0.44, 0.91)	(0.25, 0.87)
	18	0.37***	0.55***	0.33***	0.58***	0.35***	0.54***	0.57***	0.42***
		(0.25, 0.49)	(0.33, 0.78)	(0.22, 0.44)	(0.35, 0.81)	(0.26, 0.45)	(0.30, 0.77)	(0.34, 0.80)	(0.15, 0.70)
	24	0.37***	0.50***	0.31***	0.51***	0.33***	0.47***	0.49***	0.37***
		(0.26, 0.48)	(0.29, 0.71)	(0.20, 0.42)	(0.29, 0.73)	(0.23, 0.43)	(0.26, 0.69)	(0.27, 0.70)	(0.12, 0.63)
	36	0.36***	0.26**	0.28***	0.26**	0.29***	0.23*	0.24*	0.15
		(0.27, 0.46)	(0.01, 0.51)	(0.18, 0.38)	(0.01, 0.50)	(0.20, 0.38)	(−0.00, 0.47)	(−0.01, 0.50)	(−0.15, 0.44)
	48	0.35***	0.25**	0.26***	0.23*	0.27***	0.22*	0.21*	0.19
		(0.25, 0.44)	(0.00, 0.49)	(0.16, 0.36)	(−0.03, 0.49)	(0.18, 0.36)	(−0.04, 0.47)	(−0.03, 0.45)	(−0.08, 0.46)
Private Holdings	12	−0.16	−0.76**	−0.12	−0.81**	−0.11	−0.75**	−0.77**	−0.68*
		(−0.47, 0.15)	(−1.36, −0.15)	(−0.40, 0.15)	(−1.43, −0.19)	(−0.38, 0.17)	(−1.40, −0.11)	(−1.39, −0.15)	(−1.49, 0.13)
	18	−0.17	−0.43	−0.07	−0.31	−0.07	−0.23	−0.25	0.01
		(−0.41, 0.06)	(−1.01, 0.15)	(−0.29, 0.14)	(−0.94, 0.31)	(−0.28, 0.14)	(−0.81, 0.34)	(−0.86, 0.36)	(−0.70, 0.73)
	24	−0.12	−0.26	0.06	−0.11	0.06	−0.07	−0.07	0.20
		(−0.35, 0.10)	(−0.85, 0.34)	(−0.15, 0.26)	(−0.73, 0.50)	(−0.14, 0.25)	(−0.63, 0.48)	(−0.64, 0.49)	(−0.52, 0.93)
	36	−0.03	0.14	0.27***	0.34	0.30***	0.30	0.31	0.55
		(−0.29, 0.22)	(−0.73, 1.01)	(0.09, 0.45)	(−0.32, 0.99)	(0.11, 0.49)	(−0.27, 0.88)	(−0.28, 0.91)	(−0.17, 1.27)
	48	0.19	0.67	0.55***	0.90*	0.57***	0.82*	0.78*	0.84
		(−0.12, 0.51)	(−0.63, 1.97)	(0.32, 0.78)	(−0.14, 1.94)	(0.33, 0.81)	(−0.13, 1.76)	(−0.13, 1.68)	(−0.18, 1.87)
Mortgage Debt	12	0.18**	−0.14	0.21***	−0.14	0.24***	−0.09	−0.10	−0.12
		(0.02, 0.35)	(−0.54, 0.26)	(0.06, 0.36)	(−0.56, 0.29)	(0.09, 0.40)	(−0.53, 0.34)	(−0.54, 0.34)	(−0.70, 0.46)
	18	0.20***	0.12	0.26***	0.27	0.29***	0.30	0.32	0.44
		(0.06, 0.34)	(−0.31, 0.56)	(0.12, 0.40)	(−0.21, 0.74)	(0.14, 0.43)	(−0.11, 0.72)	(−0.13, 0.77)	(−0.10, 0.97)
	24	0.25***	0.24	0.37***	0.40*	0.39***	0.40*	0.41*	0.58**
		(0.10, 0.39)	(−0.23, 0.71)	(0.23, 0.50)	(−0.08, 0.88)	(0.25, 0.53)	(−0.01, 0.81)	(−0.02, 0.84)	(0.02, 1.13)
	36	0.33***	0.40	0.55***	0.59**	0.59***	0.54**	0.56***	0.70***
		(0.15, 0.51)	(−0.27, 1.08)	(0.43, 0.68)	(0.12, 1.07)	(0.46, 0.73)	(0.13, 0.95)	(0.14, 0.98)	(0.18, 1.21)
	48	0.54***	0.92*	0.81***	1.13***	0.84***	1.03***	0.98***	1.03**
		(0.30, 0.78)	(−0.16, 1.99)	(0.65, 0.98)	(0.31, 1.95)	(0.67, 1.01)	(0.31, 1.76)	(0.29, 1.68)	(0.24, 1.83)
Originations	12	2.24***	1.33***	2.43***	1.22***	2.37***	1.32***	1.35***	1.45***
		(1.69, 2.79)	(0.42, 2.24)	(1.99, 2.86)	(0.37, 2.07)	(1.94, 2.80)	(0.44, 2.20)	(0.40, 2.31)	(0.41, 2.50)
	18	2.47***	1.87***	2.80***	2.00***	2.72***	2.14***	2.29***	2.50***
		(1.99, 2.94)	(0.99, 2.74)	(2.47, 3.14)	(1.14, 2.85)	(2.38, 3.06)	(1.32, 2.96)	(1.37, 3.20)	(1.55, 3.45)
	24	2.48***	2.03***	2.93***	2.37***	2.83***	2.52***	2.59***	2.94***
		(2.06, 2.90)	(1.17, 2.89)	(2.58, 3.27)	(1.49, 3.26)	(2.49, 3.18)	(1.68, 3.35)	(1.67, 3.51)	(1.92, 3.97)
	36	2.46***	2.83***	3.14***	3.38***	3.13***	3.40***	3.54***	3.62***
		(1.98, 2.94)	(1.39, 4.28)	(2.68, 3.61)	(2.00, 4.77)	(2.63, 3.62)	(2.10, 4.71)	(2.25, 4.83)	(2.15, 5.10)
	48	2.56***	3.38***	3.25***	4.02***	3.23***	3.96***	3.76***	3.92***
		(2.05, 3.07)	(1.34, 5.41)	(2.65, 3.84)	(2.13, 5.90)	(2.64, 3.83)	(2.20, 5.72)	(2.09, 5.43)	(2.02, 5.82)
Dollar increase in:		Comm.	Comm.	Comm.	Comm.	Comm.	Comm.	Purch.	Comm.
Method:		OLS	2SLS-NC	OLS	2SLS-NC	OLS	2SLS-NC	2SLS-NC	2SLS-ALL
Interest rate controls:		No	No	Yes	Yes	Yes	Yes	Yes	Yes
Cyclical controls:		No	No	No	No	Yes	Yes	Yes	Yes

Notes: Numbers are dollar amounts. Estimates are from local projections-IV regressions, see equation (2). OLS: no instrument used; 2SLS-NC, instrument based on non-cyclical policy events; 2SLS-ALL: instrument based on all policy events. 95% Newey and West (1987) confidence bands in parentheses. Asterisks denote 10%, 5%, or 1% significance. Sample: Jan 1967 to Dec 2006.

Table A.2 Credit Multipliers, Sample and Robustness Checks

	Months	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Agency Holdings	12	0.66***	0.76***	0.47***	0.88	0.64***	0.67***	0.72***	0.63***
		(0.40, 0.92)	(0.31, 1.22)	(0.23, 0.71)	(−0.35, 2.11)	(0.38, 0.90)	(0.38, 0.96)	(0.40, 1.04)	(0.32, 0.94)
	18	0.54***	0.62***	0.29***	0.78	0.52***	0.53***	0.60***	0.48***
		(0.30, 0.77)	(0.27, 0.96)	(0.12, 0.46)	(−0.18, 1.75)	(0.29, 0.75)	(0.27, 0.78)	(0.29, 0.90)	(0.12, 0.85)
	24	0.47***	0.55***	0.23**	0.59	0.45***	0.47***	0.53***	0.43**
		(0.26, 0.69)	(0.28, 0.82)	(0.05, 0.42)	(−0.16, 1.35)	(0.23, 0.67)	(0.24, 0.69)	(0.25, 0.82)	(0.04, 0.81)
	36	0.23*	0.32***	−0.09	0.32	0.21	0.16	0.21	0.27
		(−0.00, 0.47)	(0.11, 0.53)	(−0.39, 0.20)	(−0.19, 0.83)	(−0.04, 0.45)	(−0.11, 0.43)	(−0.09, 0.52)	(−0.13, 0.66)
	48	0.22*	0.19	0.07	0.17	0.20	0.15	0.20	0.30
		(−0.04, 0.47)	(−0.10, 0.47)	(−0.30, 0.44)	(−0.82, 1.16)	(−0.07, 0.46)	(−0.15, 0.44)	(−0.14, 0.54)	(−0.08, 0.68)
Private Holdings	12	−0.75**	−1.23**	−0.66*	−0.83	−0.72**	−0.83**	−0.94**	−0.95***
		(−1.40, −0.11)	(−2.20, −0.27)	(−1.33, 0.00)	(−3.34, 1.68)	(−1.36, −0.07)	(−1.58, −0.08)	(−1.70, −0.18)	(−1.67, −0.23)
	18	−0.23	−0.68*	0.05	0.31	−0.21	−0.32	−0.31	−0.30
		(−0.81, 0.34)	(−1.40, 0.04)	(−0.33, 0.43)	(−2.22, 2.83)	(−0.81, 0.39)	(−0.94, 0.29)	(−1.03, 0.41)	(−1.28, 0.67)
	24	−0.07	−0.53*	0.27	0.65	−0.04	−0.17	−0.11	−0.25
		(−0.63, 0.48)	(−1.15, 0.09)	(−0.10, 0.64)	(−1.76, 3.07)	(−0.62, 0.54)	(−0.73, 0.38)	(−0.82, 0.60)	(−1.30, 0.80)
	36	0.30	−0.24	0.87***	0.73	0.36	0.42	0.33	−0.24
		(−0.27, 0.88)	(−0.94, 0.47)	(0.37, 1.36)	(−0.47, 1.93)	(−0.24, 0.97)	(−0.27, 1.11)	(−0.40, 1.05)	(−1.05, 0.57)
	48	0.82*	0.41	1.27**	1.62	0.87*	1.09*	0.89	0.15
		(−0.13, 1.76)	(−0.79, 1.61)	(0.02, 2.52)	(−2.92, 6.17)	(−0.12, 1.87)	(−0.07, 2.26)	(−0.45, 2.23)	(−0.87, 1.18)
Mortgage Debt	12	−0.09	−0.47	−0.19	0.05	−0.07	−0.16	−0.22	−0.32
		(−0.53, 0.34)	(−1.10, 0.16)	(−0.69, 0.30)	(−1.64, 1.74)	(−0.51, 0.36)	(−0.66, 0.35)	(−0.73, 0.28)	(−0.81, 0.17)
	18	0.30	−0.06	0.34*	1.09	0.31	0.20	0.29	0.18
		(−0.11, 0.72)	(−0.57, 0.44)	(−0.01, 0.69)	(−1.30, 3.48)	(−0.13, 0.75)	(−0.21, 0.62)	(−0.23, 0.81)	(−0.55, 0.91)
	24	0.40*	0.02	0.50***	1.25	0.41*	0.29	0.42	0.18
		(−0.01, 0.81)	(−0.46, 0.49)	(0.19, 0.82)	(−1.01, 3.50)	(−0.02, 0.84)	(−0.09, 0.67)	(−0.12, 0.96)	(−0.59, 0.94)
	36	0.54**	0.08	0.77***	1.05**	0.57***	0.58**	0.54**	0.03
		(0.13, 0.95)	(−0.54, 0.70)	(0.43, 1.12)	(0.06, 2.03)	(0.14, 1.00)	(0.09, 1.06)	(0.01, 1.07)	(−0.57, 0.63)
	48	1.03***	0.60	1.34***	1.79	1.07***	1.24***	1.09**	0.45
		(0.31, 1.76)	(−0.45, 1.65)	(0.40, 2.29)	(−1.87, 5.46)	(0.31, 1.84)	(0.33, 2.15)	(0.03, 2.14)	(−0.30, 1.20)
Originations	12	1.32***	0.41	2.08***	−0.23	1.39***	1.32***	1.14*	1.47***
		(0.44, 2.20)	(−1.47, 2.28)	(1.06, 3.11)	(−5.14, 4.69)	(0.51, 2.26)	(0.40, 2.23)	(−0.01, 2.28)	(0.48, 2.46)
	18	2.14***	1.40*	3.00***	1.56	2.20***	2.00***	2.04***	2.38***
		(1.32, 2.96)	(−0.02, 2.83)	(2.34, 3.66)	(−1.86, 4.98)	(1.38, 3.03)	(1.13, 2.88)	(0.88, 3.20)	(1.19, 3.57)
	24	2.52***	1.74***	3.61***	2.79*	2.59***	2.35***	2.55***	2.63***
		(1.68, 3.35)	(0.61, 2.88)	(2.95, 4.28)	(−0.21, 5.79)	(1.73, 3.45)	(1.48, 3.22)	(1.40, 3.70)	(1.05, 4.20)
	36	3.40***	2.51***	4.79***	4.43***	3.53***	3.56***	3.70***	2.69***
		(2.10, 4.71)	(1.27, 3.75)	(3.44, 6.14)	(1.29, 7.57)	(2.17, 4.89)	(2.00, 5.12)	(1.97, 5.44)	(0.92, 4.46)
	48	3.96***	3.39***	4.81***	5.59	4.07***	4.29***	4.35***	3.06***
		(2.20, 5.72)	(1.47, 5.30)	(2.22, 7.40)	(−2.41, 13.60)	(2.22, 5.93)	(2.13, 6.45)	(1.81, 6.90)	(1.23, 4.89)
Sample:		67M1-06M12	67M1-14M12	82M10-06M12	67M1-06M12	67M1-06M12	67M1-06M12	67M1-06M12	71M09-06M12
Modification:		Benchmark	Full Sample	Post-1982 Sample	Omitting Sept 2004	Omitting Dec 1982	Omitting Oct 1977	Controls incl. Pool Issues	Controls incl. GSE excess return

Notes: Numbers are dollar amounts. Estimates are from local projections-IV regressions, see equation (2), using non-cyclical policy events as the instrument. 95% Newey and West (1987) confidence bands in parentheses. Asterisks denote 10%, 5%, or 1% significance.

A.2 Additional Results on Interest Rates and Credit Spreads

This section discusses a number of additional results regarding the effects of news shocks to agency purchases on interest rates and credit spreads. Figure A.4 shows point estimates for the first 24 months after an increase in anticipated purchases by one percentage point of trend originations, together with 95% Newey and West (1987) confidence bands. The responses in blue are based on the regressions in (4) and the narrative instrument. The responses in red are based on the regressions in (5) and the GSE excess returns instrument.

The first two panels in Figure A.4 show the responses of the AAA-rated and BAA-rated long term corporate bond yields. Taken together, the results suggest that agency purchases exert a downward pressure on corporate yields with a timing that coincides with the actual purchasing of mortgage assets by the agencies. The response of the corporate yields is qualitatively similar to those of mortgage and Treasury rates, showing initially no effect, and subsequently a gradual decline. The 95% confidence bands around the responses are relatively wide, and the responses are only marginally significant in the case of the narrative instrument. The declines in corporate bond yields are also quantitatively smaller than mortgage and Treasury rates, in particular for the narrative instrument. The third panel in Figure A.4 shows statistically significant short-run increases in the spread between AAA-rated corporate bonds and 10-year Treasuries. Agency purchases appear therefore to induce the greatest spill-overs on the demand for the relative liquidity and safety of Treasuries, which do not have prepayment risk. The increases are, however, relatively short-lived, with the effects dissappearing after 7 or 8 months in the case of the narrative instrument, and only after a few months in the case of the GSE excess returns instrument. The next panel shows evidence for a drop in the spread between BAA and AAA-rated corporate bonds after 7 or 8 months, suggesting also some positive spill-over effects on the demand for riskier long-term bonds.

The middle and right panels in the second row of Figure A.4 show declines in the spreads of mortgage rates over the 10-year Treasure rates of a few basis points after about 6 months. The declines are at best only marginally significant, indicating that agency purchases have important positive spill-over effects on the demand for long-term Treasuries. The left panel in the bottom row of Figure A.4 shows the response of the spread between the 3-month T-bill rate and the Federal Funds rate. With a delay of a few months, this

spread increases by 5 basis points or more when using the narrative instrument for identification. While this may indicate some upward pressure on short-term interest rates relative to the funds rate target, the increase is not statistically significant at conventional confidence levels. The GSE excess returns instrument does not yield any indication of an impact. Finally, the right panel on the bottom row shows the response of the slope of the Treasury yield curve, measured by the difference between the 10-year and 3-month yields. In the case of the narrative instrument, there is initially no impact on the slope of the yield curve. However, as the agency purchases induce a broad-based decline in both long and short-term interest rates, the slope of the yield curve gradually steepens for the first 8 months. Subsequently, the yield curve flattens relatively quickly and returns to prior levels one year after the new shock. In contrast, the GSE excess returns instrument does not produce any significant impact on the slope of the Treasury yield curve.

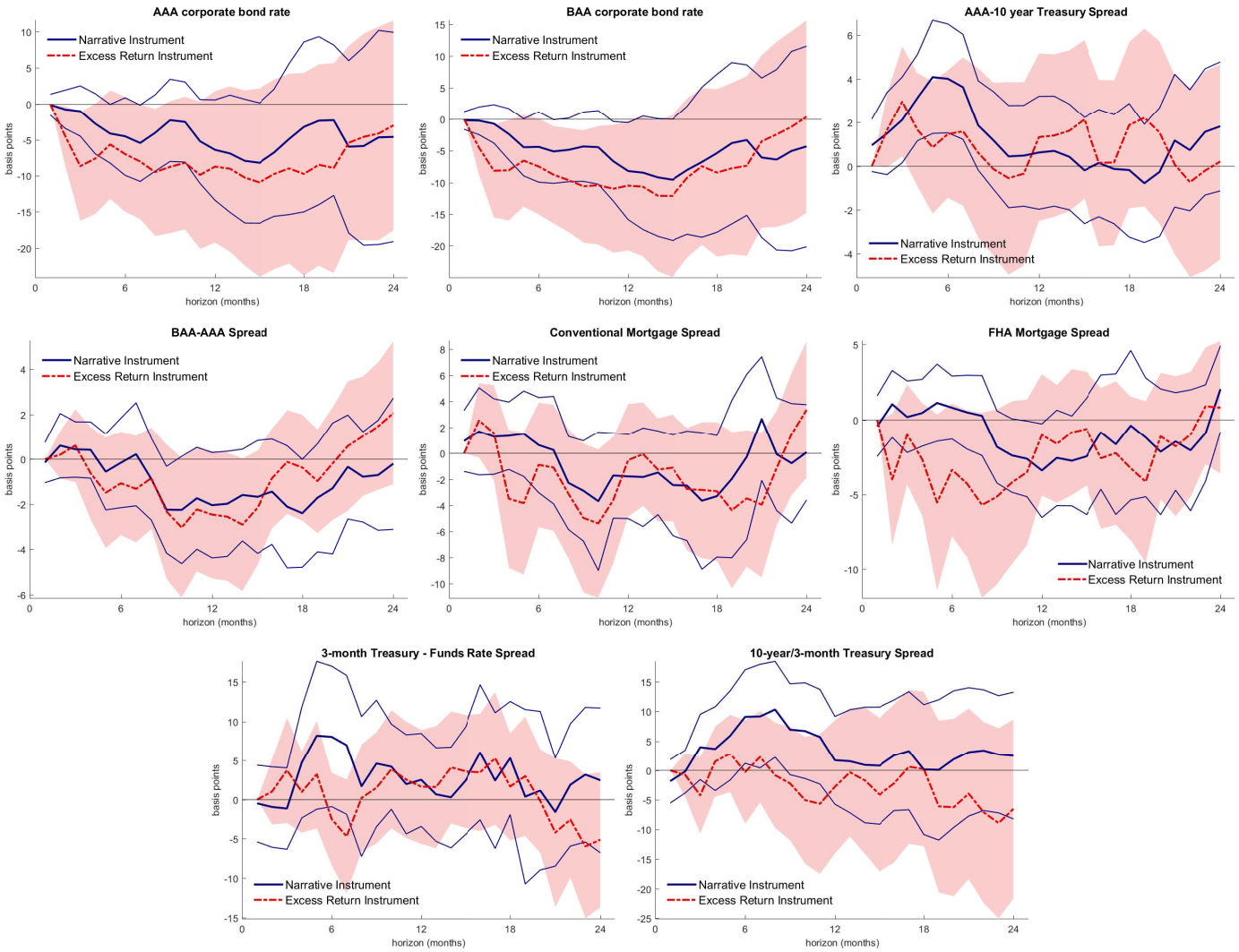


Figure A.4 Impulses Responses to A Shock to Anticipated Agency Purchases

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the (1) narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

A.3 Impulse Responses of Mortgage Originations by Type

This section discusses additional results regarding the effects of news shocks to agency purchases on mortgage originations by type. The available data allows us to distinguish between refinancing and purchase originations (see data appendix). The average share of refinancing originations in the 1967-2006 sample is 25% (and 28% in the 1967-2014 sample). The refinancing share is volatile and ranges from values of 10% during the high nominal interest rates of the late 1970s and early 1980s, to up to 75% during refinancing booms.

Figure A.5 shows point estimates for the first 24 months after an increase in anticipated purchases by one percentage point of trend originations, together with 95% Newey and West (1987) confidence bands. The responses in blue are based on the regressions in (4) and the narrative instrument. The responses in red are based on the regressions in (5) and the GSE excess returns instrument. For reference, the left panel repeats the responses of total mortgage originations shown in Figure 10. The middle panel shows the estimated response of refinancing originations, while the right panel shows the estimated response of originations financing the purchase of a home. We note that for the estimates in these two panels, the sample excludes May 1985 to December 1986 because of missing data on refinance shares, see data appendix.

The results in Figure A.5 are consistent with those for the dollar credit multipliers reported in Section 5. Refinancing originations show a gradual increase following the agency purchase shock, regardless of the instrument used for identification. Purchase originations also rise, but with a longer delay relative to refinance originations. Using the narrative instrument, purchase originations are initially lower for the first six months or so, before rising by similar levels between 12 and 24 months as for the GSE excess returns instrument. Using the average share of refinancing originations of 25% over the benchmark sample, the estimates in Figure A.5 imply that refinancing originations account for the larger share of the increase in total originations.

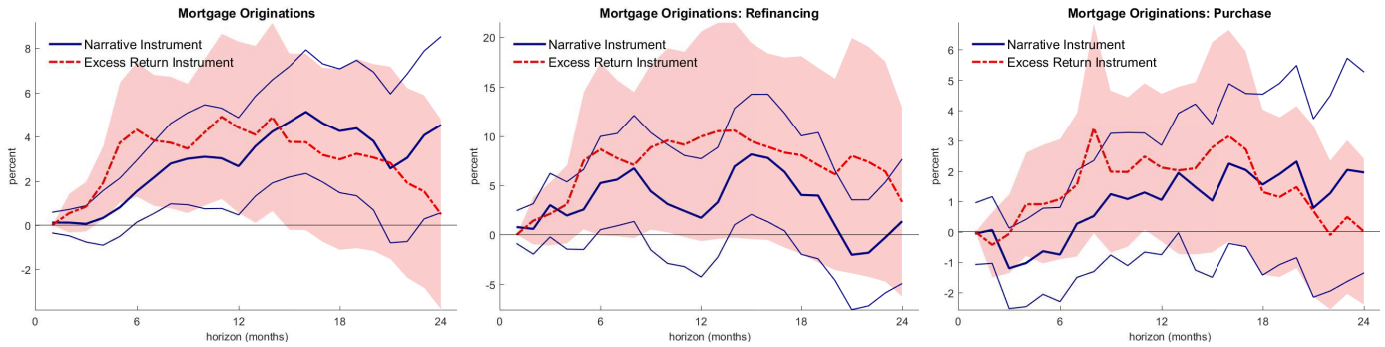


Figure A.5 Impulse Responses to a Shock to Anticipated Agency Purchases

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006. In the middle and right panels, the sample excludes May 1985 to Dec 1986 because of missing data on refinance shares, see data appendix.

Figure A.6 compares the response of originations to a traditional monetary policy shock (in red) with the response to the agency purchase shock identified using the narrative instrument (in blue). Responses to monetary shocks are identified using the Romer and Romer (2004) monetary policy shock measure as an instrument, as explained in Section 7. As in Figure 13, the impact of the interest rate shock is scaled such that the maximum decline in the 3-month T-bill rate is identical as for the agency purchase shock identified with the narrative instrument. The left panel repeats the responses of total mortgage originations shown in Figure 13 and shows that the agency purchase shock generates a larger increase in total originations. The middle panel shows the responses of refinancing originations, while the right panel shows the estimated responses of originations financing the purchase of a home. The results in Figure A.6 indicate that the differential impact on total originations is due to the different impact on refinancing activity. The response of purchase originations (right panel) is very similar in timing and size across both shocks. The response of refinancing originations to monetary policy shock, on the other hand, is much more muted than the response to the agency purchase shocks.

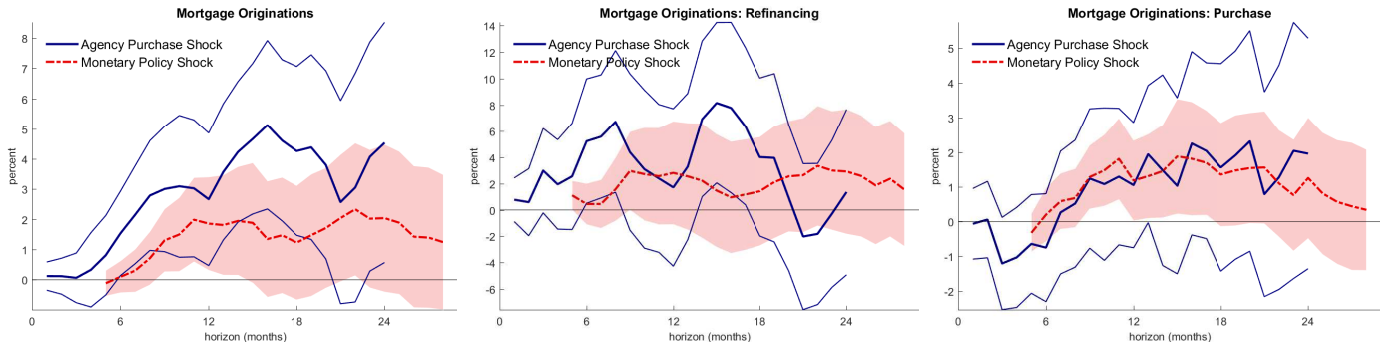


Figure A.6 Responses to A Shock to Anticipated Agency Purchases Versus a Monetary Policy Shock

Notes: The figure shows responses to a one pp. increase in the expected future agency market share as well as the response to a monetary policy shock. Estimates are from local projections-IV regressions instrumenting agency commitments with the narrative policy indicator, see equation (4), and instrumenting the 3 month T-Bill rate with the Romer and Romer (2004) monetary policy shock measure. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006. In the middle and right panels, the sample excludes May 1985 to Dec 1986 because of missing data on refinance shares, see data appendix.

A.4 Impulse Response Analysis: Sensitivity Checks

Omitting the 1977-1982 and NBR-targeting Periods Figure A.7 shows the response to a shock to anticipated agency purchases by one percentage point of trend originations, together with 95% Newey and West (1987) confidence bands. Each figure shows results based on the narrative instrument for two different subsamples. The first subsample omits the period of non-borrowed reserves targeting under the Volcker chairmanship of the Federal Reserve from October 1979 to August 1982. The second subsample omits the 6 years between 1977 and 1982, which are more broadly characterized by relatively high interest rate volatility. Each of the excluded periods contain several sizeable credit policy changes as well as a greater incidence of large monetary policy shocks in the Romer and Romer (2004) measure. Their exclusion allow us to verify the role of these parts of the sample for our results regarding the interactions between the two types of policies. The results in Figure A.7 are qualitatively very similar to those of the full sample, and in both cases include both significant rise in originations as well as declines in short- and long-term interest rates. Compared to the full sample, the rise in the stock of mortgage debt is, however, no longer evident when we omit the 6 years between 1977 and 1982.

Post-1982 Sample Figure A.8 shows the response to a shock to anticipated agency purchases based on a shorter sample that starts in October 1982 instead of December 1967. The Figure reports results for each of the instruments, as in Figure 10. The October 1982 starting period marks the end of the period of non-borrowed reserves targeting by the Federal Reserve and selects a period of more stable and inflation averse monetary policy. Because of the smaller sample, we omit in this case the cyclical controls (personal income and unemployment) to reduce the number parameters to be estimated. The results remain qualitatively very similar to those of the full sample, indicating a rise in originations and declines in short- and long-term interest rates. Compared to the full sample, the rise in the of stock mortgage debt is smaller and no longer statistically significant in the case of the GSE excess returns instrument.

Omitting Policy Events from the Narrative Instrument Figure A.9 shows the response to a shock to anticipated agency purchases for the benchmark specification together with those when we omit in turn each of the three largest policy interventions from the narrative instrument: the October 1977 conforming

loan limit increase and expansion of the Brooke-Cranston Tandem program, the December 1982 increase in Fannie Mae's debt-to-capital limit, and the September 2004 tightening of capital requirements. In each case we add the omitted event as a separate dummy variable, including both the contemporaneous value and twelve lags to the control variables. While there is some variation in the size of the responses, the results remain qualitatively similar to the benchmark narrative estimates. In all cases, there are increases in originations and mortgage debt, and declines in short- and long-term interest rates.

Including Romer and Romer (2004) Shocks as Controls Figure A.10 compares the benchmark narrative impulse response estimates of Figure 10 with those from a specification that includes both the contemporaneous value as well as 12 lags of the Romer and Romer (2004) monetary shock measure as additional controls. Figure A.10 shows that controlling for the Romer and Romer (2004) shocks has little effect on the estimation results.

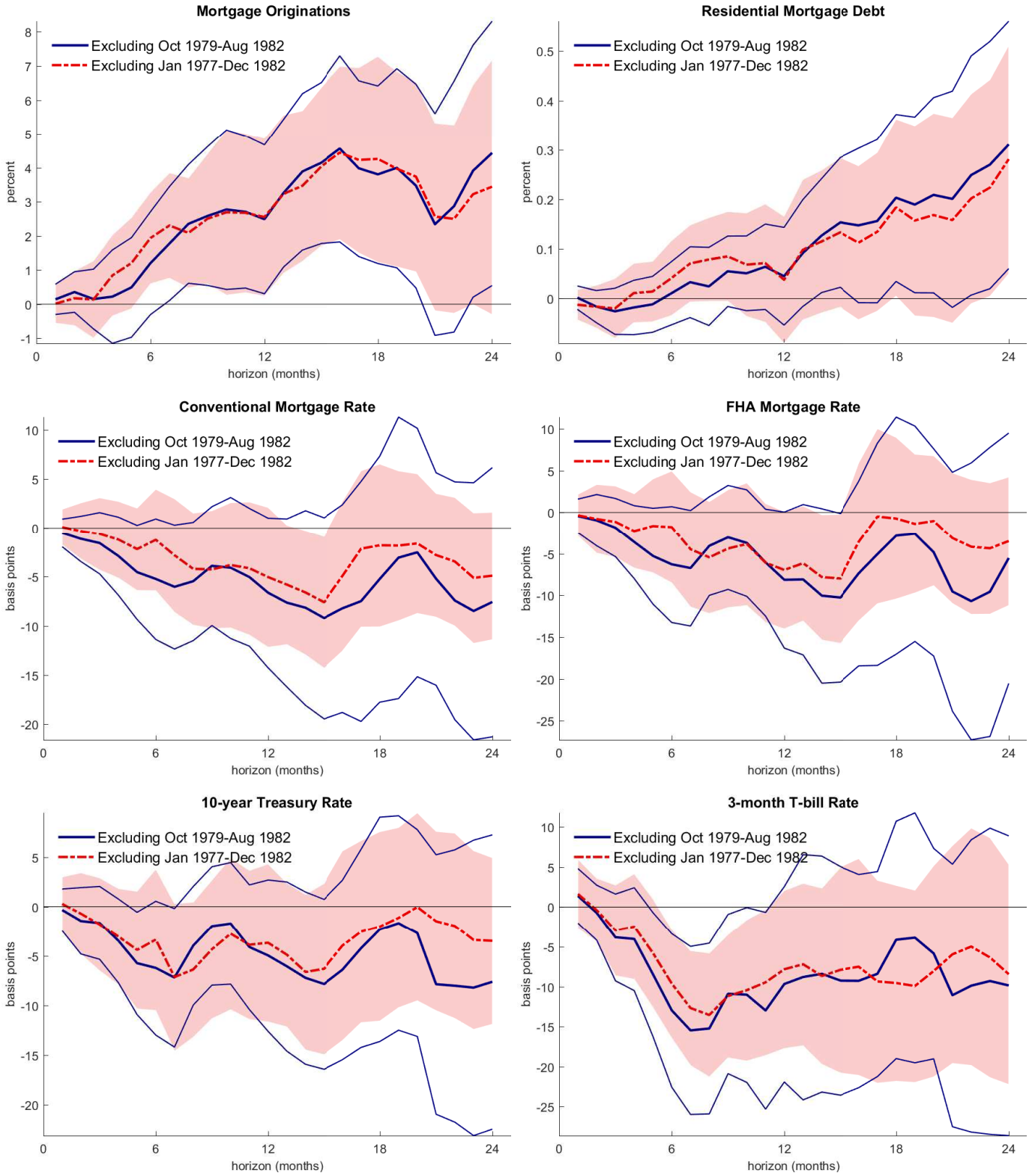


Figure A.7 Impulse Responses Excluding 1977-1982 and NBR Targeting Periods

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006, excluding the period indicated.

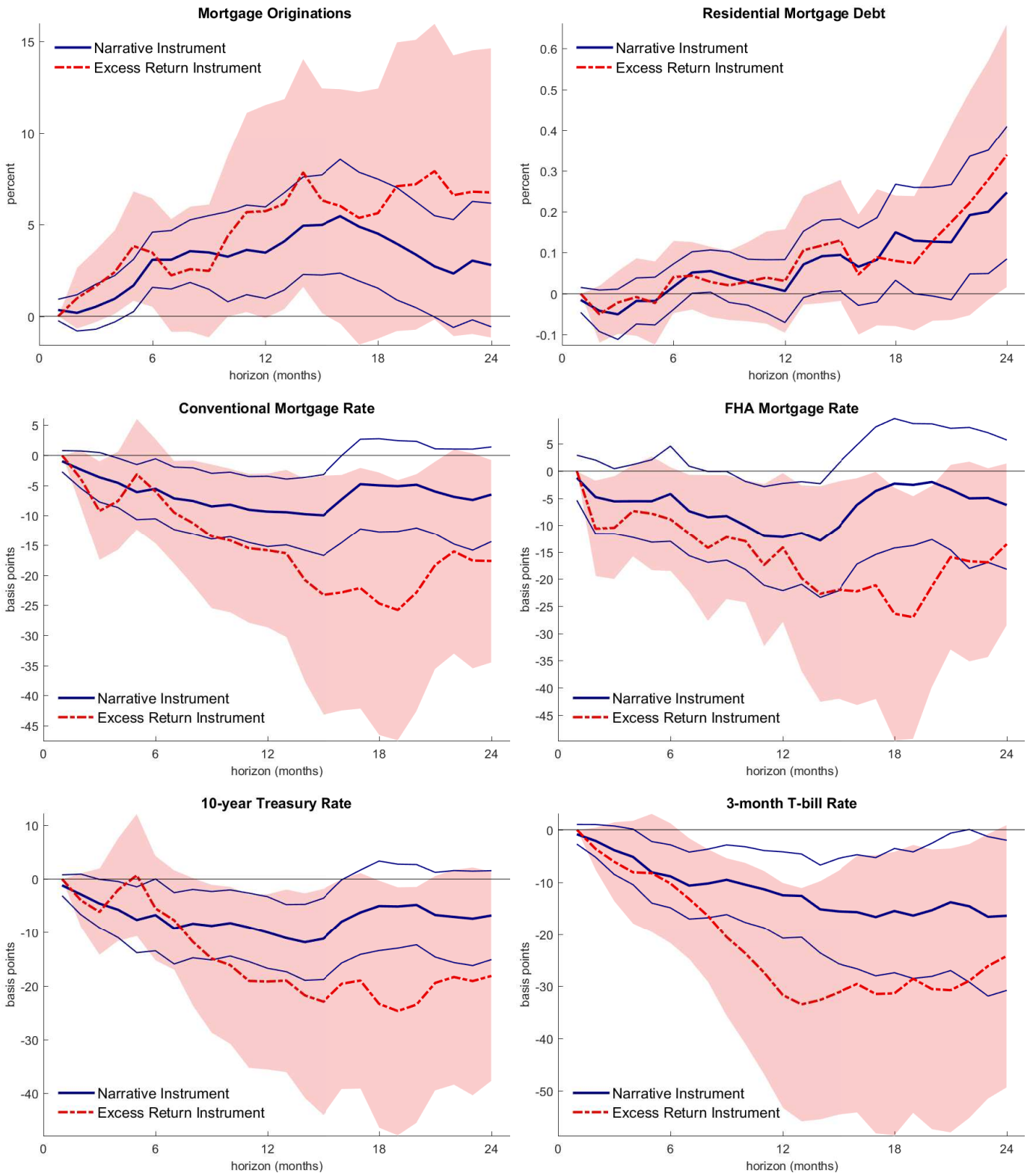


Figure A.8 Impulses Responses in the Post-1982 Sample

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with the (1) narrative policy indicator, see equation (4), or orthogonalized GSE excess stock returns innovations, see equation (5). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Oct 1982 to Dec 2006.

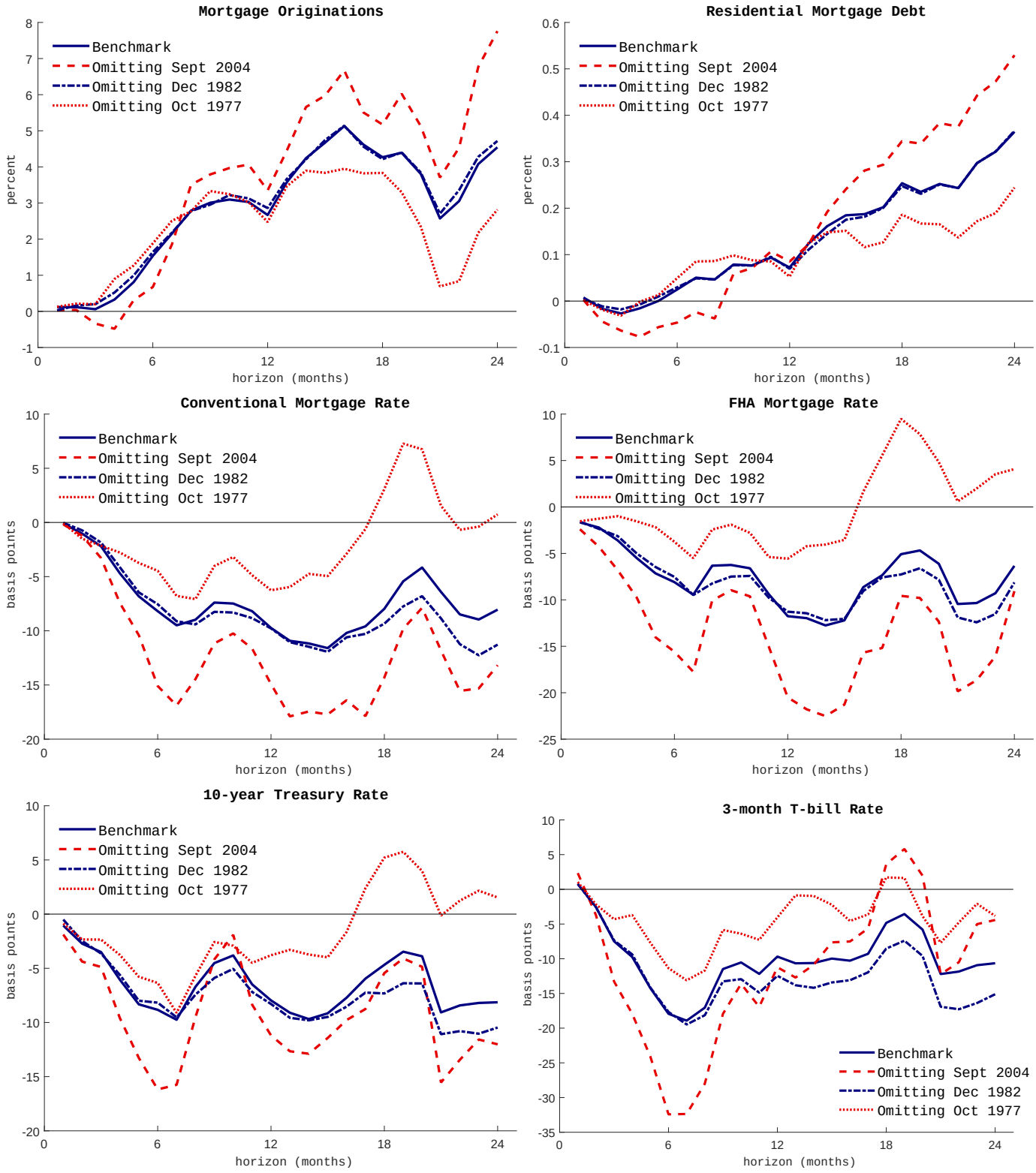


Figure A.9 Impulses Responses when Omitting Largest Policy Events

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from local projections-IV regressions instrumented with different versions of narrative policy indicator, see equation (4).

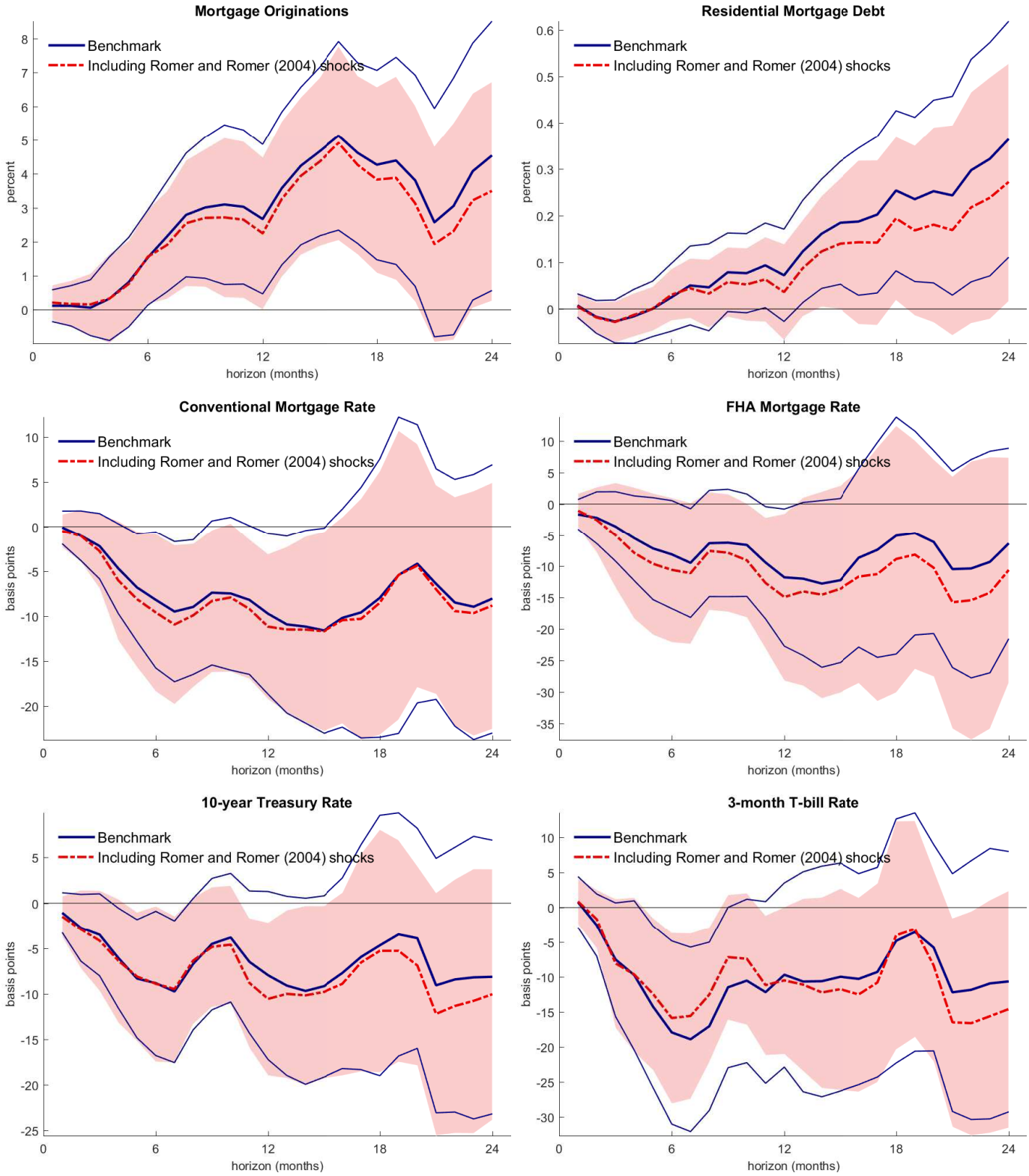


Figure A.10 Controlling for Romer and Romer (2004) Shocks

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Benchmark estimates are from local projections-IV regressions instrumented with the narrative policy indicator, see equation (4). The new specification includes additionally the contemporaneous value and 12 lags of the Romer and Romer (2004) shocks as controls. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

A.5 Forecast Error Contributions from an SVAR Model

The local projections-IV specifications do not allow an assessment of the historical role of structural shocks to housing credit policy, which requires knowledge of the variance contribution of these shocks to the cumulative purchase measures in equations (2) or (4). In order to gain some insight into the importance of GSE activity for the dynamics of credit aggregates and interest rates, this section estimates the variance contribution of the orthogonalized GSE excess returns innovations in a structural vector autoregressive (SVAR) model. The main finding is that the contribution of GSE excess returns shocks to the short-run variability of mortgage credit and housing starts is roughly as important as monetary policy shocks. In addition, shocks to monetary policy are substantially more important for the forecast error variance of interest rates in the short run. The role of GSE excess returns shocks for long-term interest rates exceeds the one of monetary policy shocks at horizons beyond 18 months.

In order to estimate forecast error variance contribution of shocks to GSE activity, we adopt a VAR model for the joint dynamics of the ratio of agency purchases and commitments to trend originations, as well as all of the variables included as controls in the LPIV regressions: the log levels of core PCE and house price indices, the log difference of total mortgage debt, the log levels of real mortgage originations and housing starts, the 3-month T-bill rate, the 10-year Treasury rate, the conventional mortgage interest rate, the BAA-AAA corporate bond spread, the unemployment rate, and the log of real personal income. In addition, the VAR system also includes the log of the S&P 500 index and the log ratio of the GSE stock index to the S&P 500. We estimate the VAR by OLS using 12 lags of all the endogenous variables and using monthly data from August 1971 to December 2006. The start of the sample reflects the month in which Fannie Mae stock was traded for the first time on the New York Stock Exchange, which was August 1970.

The impact of a shock to orthogonalized GSE excess returns is the response to an innovation to the GSE stock index variable, which is obtained by taking the lower triangular Choleski decomposition of the estimated covariance matrix of the VAR residuals, ordering all of the variables except agency purchases/commitments above the GSE stock index variable. This approach imposes the same exclusion restrictions as the LPIV model in (4) within the SVAR context, which amounts to assuming that none of the variables ordered before

the GSE stock index variable responds within the same month to orthogonalized GSE excess returns innovations.

Figure A.11 shows the resulting impulse responses, which for ease of comparison are scaled to imply a similar 6 month impact on originations as the LPIV estimates in Figure 10. The GSE excess returns shocks lead to statistically significant increases in agency net commitments and net purchases (not shown). Consistent with our main findings, Figure 10 shows that originations, mortgage debt and housing starts all rise significantly following a positive innovations in GSE excess returns, while interest rates decline in the short run. One difference between the VAR and the LPIV estimates in Figure 10 is that interest rates rise in the longer run. The SVAR estimates are otherwise generally similar to those obtained using LPIV regressions using the GSE excess returns as an instrument for agency mortgage purchases.

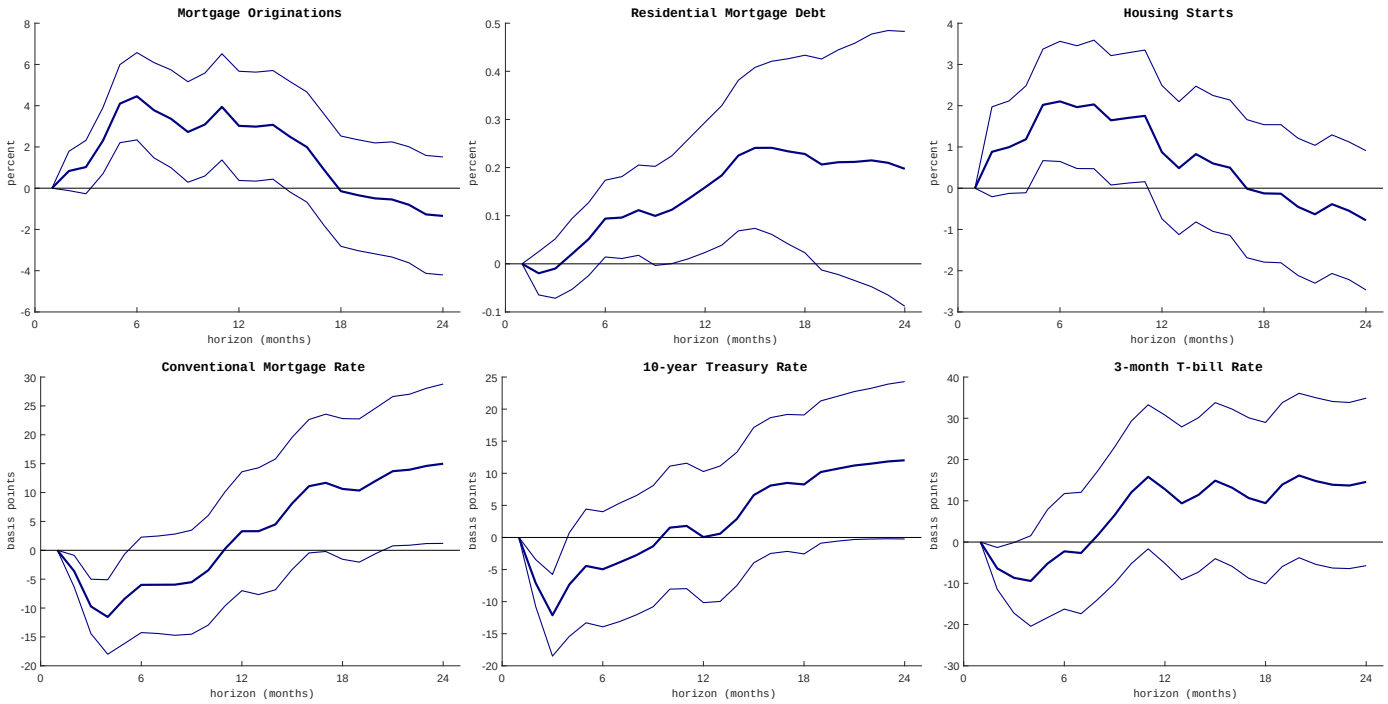


Figure A.11 SVAR Impulse Responses to a GSE Excess Return Shock

Notes: The figure shows SVAR impulse responses to an innovation in orthogonalized GSE excess returns. Finer lines are 95% confidence bands obtained from a residual wild bootstrap using 10,000 replications. Sample: Aug 1970 to Dec 2006.

An advantage of the SVAR model is that it is straightforward to evaluate of the relative importance of shocks

in driving fluctuations in the endogenous variables. Figure A.12 depicts the share of the forecast error variance at various horizons that is due to the identified GSE excess returns innovations. For comparison, Figure A.12 also shows the variance contribution of monetary policy shocks identified using the Romer and Romer (2004) measure as a proxy using the methodology in Stock and Watson (2012) and Mertens and Ravn (2013). We find that the GSE excess returns shocks explain up to 9% of the agency net purchases and commitments forecast variance (not shown). The contribution of monetary policy shocks remains below 2% at all horizons considered. Figure A.12 reveals that both shocks account for a substantial fraction of the forecast variance of originations and housing starts at horizons beyond 6 months. GSE excess returns shocks explain up to 14% of the forecast variance of originations at horizons between 12 and 18 months, and around 7% to 8% of housing starts between 8 and 14 months. In comparison, monetary shocks explain between 8% to 9% of originations, and around 14% of housing starts at similar horizons. Neither of the shocks accounts for much of the forecast variance of the stock of mortgage debt at horizons up to 36 months. Monetary shocks account for a substantial share of the short-run forecast variance of the 3-month T-bill rates, and up to 11%, respectively 7%, of the variance in mortgage and 10-year Treasury rates at horizons around 6 months. GSE excess returns shocks are relative less important for the variability in interest rates at shorter horizons, but become relatively more important than monetary policy shocks in accounting for the uncertainty in long-term interest rates at horizons exceeding 18 months.

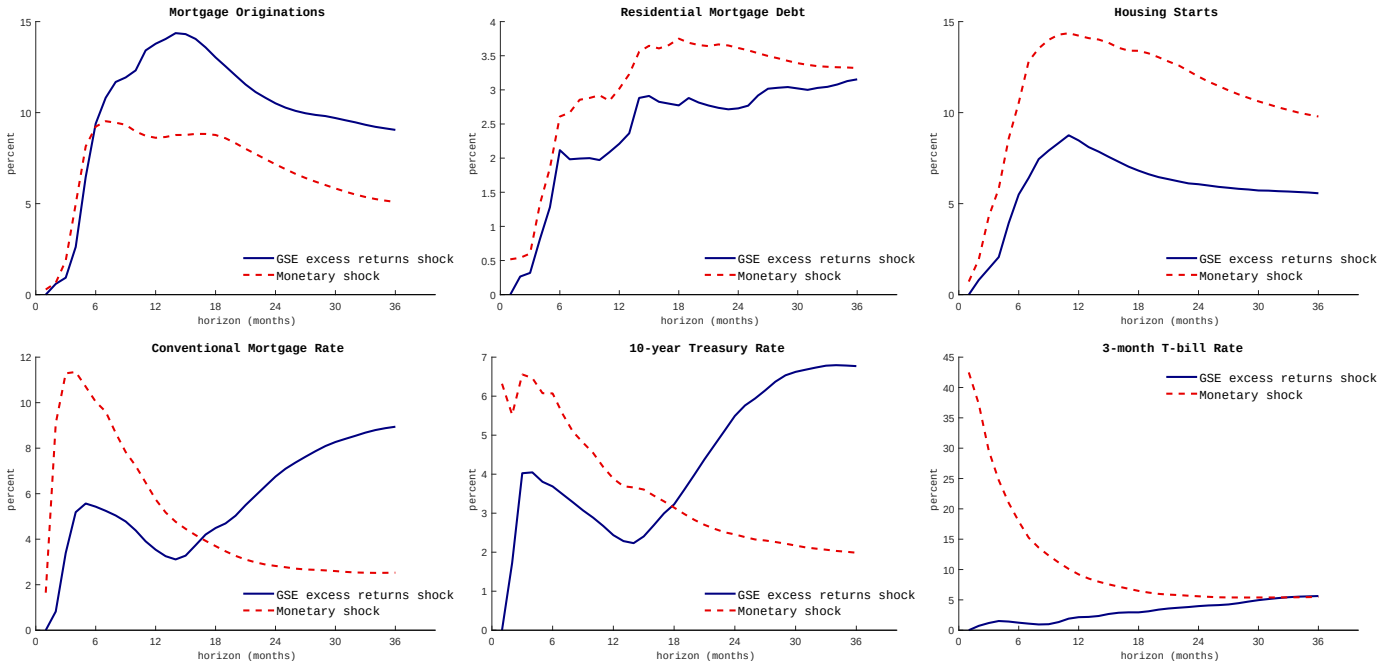


Figure A.12 Forecast Error Variance Contributions of Monetary and GSE Excess Returns Shocks

Notes: The figure shows contributions to the forecast error in the SVAR model. Monetary policy shocks are identified using the Romer and Romer (2004) measure as external instrument. GSE excess returns shocks are identified as described in the text. Sample: Aug 1970 to Dec 2006.

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