THE MACROECONOMIC EFFECTS OF GOVERNMENT ASSET PURCHASES: EVIDENCE FROM POSTWAR US HOUSING CREDIT POLICY*

ANDREW FIELDHOUSE
KAREL MERTENS†
MORTEN O. RAVN

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 also influence prices in other asset markets, stimulate residential investment, and expand homeownership. We compare these effects to those of conventional monetary policy shocks, and we provide evidence on the interactions between housing credit and monetary policies. *JEL Codes*: E44, E52, N22, R38, G28. *Word Count:* 13,921.

I. 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

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†*Contact*: mertens.karel@gmail.com, tel: +(214) 922-6000

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

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.

Our strategy to isolate changes in agency purchasing activity free of confounding influences 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 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 pur-

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

chasing activity. Similar to the approach in Ramey and Zubairy (2017) 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.

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 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. Key policy objectives behind the housing credit policies first introduced in the 1930s included boosting the availability of housing credit, increasing residential investment, and elevating homeownership over the long run, all recurrent motivations for subsequent policy interventions. 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 federal 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.

In the appendix, we also pursue an alternative identification strategy based on instrumenting agency purchases with shocks to Fannie and Freddie excess stock market returns. This approach 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. The results validate the findings obtained from the narrative approach.

II. 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 for 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

[3] Another major housing GSE is the Federal Home Loan Bank System, chartered during the Depression to provide wholesale

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 Fannie Mae entered the business. 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.

Figure I 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 I 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

liquidity to member mortgage lending institutions. We use the term 'GSE' to refer to Fannie and Freddie.

[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.

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 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 I . 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 Securities and Exchange Commission until the early 2000s.

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

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 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.

III. 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

[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.

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, 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 analysis allows us to study the dynamic causal impact on 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,

[9] Naranjo and Toevs (2002), who use vector error-correction (VEC) and GARCH (generalized autoregressive conditional heteroskedastic) models and study 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.

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

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 (2017) 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. Our narrative policy indicator and the GSE excess return shocks discussed in the appendix 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. GSE portfolio purchases are not funded with reserves, but with 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.

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.

IV. Identifying Causal Effects of Agency Mortgage Purchases

IV.A. 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 I , 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. The agency response to varying growth in the mortgage market induces a positive relationship between agency balance sheets and overall mortgage lending activity. Failure to correct for this source of reverse causality is likely to lead to an overestimation of the impact of agency activity on credit availability.

A different endogeneity concern operating in the opposite direction 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. To illustrate this, Figure II shows the average real levels

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

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 II 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 II 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 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. Failure to account for this negative association is likely lead to an underestimation of the causal effects of agency mortgage purchases.

[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.

IV.B. Narrative Analysis of Policy Changes Affecting Agency Mortgage Holdings

Our 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. Because 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 instrument 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.

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 I provides an overview of the historical primary sources used in the narrative analysis.

1. 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 mortgages 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 agreements entered 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 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 use sections of the *Economic Report of the President* and *Annual Report of the Board of Governors of the Federal Reserve*, as well as the

[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.

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 any 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.

2. 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 on agency mortgage holdings. 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 within the first year of taking effect. 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 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

[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.

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 I. 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.

3. 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.

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 to 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.

4. 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 I). 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 actions, 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, homeownership, 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.

5. 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.[15] 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 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 V. and VI. the sample is truncated at December 2006 to deliberately exclude the financial crisis and the Fannie and Freddie conservatorship period. As shown in Figure I , the three housing agencies that we analyze account for the large majority of government agency mortgage holdings between 1967 and 2006.

IV.C. The Narrative Measures of Policy Changes

Table II 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), the timing (arrival of news and effective date), 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 after monthly aggregation.

Figure III 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

[15] Using a maximum lag of 12 months adds only one relatively minor event in 1968 with virtually no effect on the results. Including *all* events yields an instrument that is considerably weaker for purchases at shorter horizons. In practice, a larger maximum lag additionally includes only a couple of increases in affordable housing goals announced 18 months ahead of taking effect.

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.[16] 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.

V. The Cumulative Effects of Agency Mortgage Purchases on Mortgage Credit

To assess whether agency purchases influences mortgage lending activity, in this section we present estimates of the cumulative impact on various mortgage credit aggregates. We obtain these estimates by Jordà (2005) local projections estimated by two-stage least squares (2SLS), similar to the methodology proposed in Ramey and Zubairy (2017) to estimate cumulative government spending multipliers, using the non-cyclically motivated policy changes as an instrument for agency purchasing activity. This approach yields easily interpretable results in terms of dollar changes in credit variables, and is well-suited to handle the news aspect of policy announcements.[17]

The first stage in the 2SLS procedure consists of regressions of cumulative agency purchases on the narrative instrument. Recall that agencies typically make advance commitments to buy loans from mortgage providers, and subsequently effectuate these as loans are delivered to the secondary market. Because of potential time delays, we consider monthly data on both the advance net purchase commitments made by

[16] 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.

[17] Expressing the impact in terms of elasticities is not feasible since net purchases and net purchase commitments take on negative values in the sample, and is also potentially misleading given the differential growth trends in income, mortgage debt, and agency mortgage holdings.

the agencies as well as the effective net portfolio purchases as indicators of agency purchasing activity. Specifically, we estimate the following regressions for different horizons h:

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

where p_t is either the volume of net commitments or actual purchases by the agencies in month t, expressed in constant dollars using the core PCE price index, and $\sum_{j=0}^{h} \mathrm{p}_{t+j}$ is the cumulative sum of purchases or commitments made over the next h-month period. The variable m_t on the right-hand side is the non-cyclical narrative policy indicator from Table II, expressed in constant dollars. We express both as ratios 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.[18] The first-stage regressions also include lagged controls, Z_{t-1}, which are defined below.

The cumulative impact on a credit aggregate y_t over a given horizon h is estimated by local projections of the form

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

where y_t is expressed in constant dollars using the core PCE price index, and as a ratio of X_t. 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 $y_{t+h} - y_{t-1} = \sum_{j=0}^{h} f_{t+j}$. The coefficient γ_h in (2) measures the multiplier associated with an additional dollar in commitments or purchases made between period $t-1$ and $t+h$. This multiplier is the total cumulative dollar change in y_t over the same horizon. We estimate γ_h by 2SLS, i.e. by replacing $\sum_{j=0}^{h} \mathrm{p}_{t+j}/X_t$ with predicted values from the first stage in (1). The baseline estimates reported in the rest of this section use an effective sample of 480 monthly observations, starting in January 1967.[19] In the online appendix, we present results for different sample periods.

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

[19] 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.

Each of the regressions in (1) and (2) include 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 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 the online appendix, we discuss results for a number of alternative control (sub)sets.

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 contemporaneous exogeneity, i.e. orthogonality between the instrument and all shocks in month t other than the one associated with the policy event itself, see Stock and Watson (2017). If the control set does not fully capture all impulses prior to date t, 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. 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) and Stock and Watson (2017).

V.A. First-Stage Results

We first investigate whether the narrative policy changes indeed lead to significant changes in agency purchasing activity by assessing the strength of our narrative instrument. The left panel of Figure IV shows the Newey and West (1987) robust F-statistics on the excluded instrument in each of the first-stage regressions (1) for horizons $h = 0$ to $h = 60$. The figure shows the F-statistics both when we use 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. This is natural given the presence of implementation lags and our timing of the policy changes according to the first 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 4-48 month horizon.

The left panel of Figure IV shows that the F-statistics are very similar when we instrument for either purchases or commitments. The right panel of Figure IV 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.

V.B. 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 V shows the impact of an increase in either agency commitments or purchases on mortgage credit aggregates, 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 upper 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.[20] The middle panels in Figure V 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 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.

[20] 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 online data appendix for more detail.

The results in the middle row of Figure V 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 V distinguishes between refinancing originations in the left panel, and home purchase originations in the right.[21] 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 debt. The bulk of the effect on originations is nevertheless due to refinancing.[22]

A comparison of the 2SLS and OLS estimates of the credit multipliers is informative about which of the sources of endogeneity bias discussed in Section IV.A. dominates in practice. A priori the direction of the bias in the OLS estimates is ambiguous. Systematic GSE expansions during times of high primary market mortgage demand or high private sector credit supply are likely to bias the OLS estimates upward relative to the true effects. The systematic stabilizing actions of the agencies or their regulators, on the other hand, instead lead to a downward bias. By using only the predicted variation in agency purchases resulting from GSE regulatory changes, the 2SLS estimates aim to eliminate the upward or downward bias resulting from any systematic patterns in regular GSE purchasing behavior. The restriction to non-cyclically

[21] 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.

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

motivated regulatory changes further eliminates the additional potential downward OLS bias due systematic countercyclical actions by policymakers in response to economic and financial conditions. Recall also that the inclusion of the lagged financial and cyclical controls generally weakens the exogeneity requirement on the instrument, up to the point where the non-cyclical policy interventions need only be contemporaneously uncorrelated with other determinants of the credit aggregates, see Stock and Watson (2017).

Figure VI compares the OLS and 2SLS estimates of the cumulative impact on total mortgage originations. Given the strong procyclicality of originations, the large and consistently positive OLS and 2SLS estimates make it unlikely that either estimates are severely contaminated by the countercyclical actions of the agencies over the sample. However, Figure VI also shows that, regardless of whether the baseline or full set of controls is included, the OLS estimates exceed the 2SLS estimates for horizons up to 2 years. Moreover, the OLS estimates are roughly independent of the horizon, implying that the bulk of the increase in originations occurs within a few months. The 2SLS estimates instead show a delayed and more gradual increase in originations. This pattern suggests that the dominant source of bias in the OLS estimates is the systematic process of private lenders passing on loans to the agencies very shortly after origination. A GSE policy of maintaining market share, for instance, would be consistent with originations rising before or roughly simultaneously with agency purchases, and without a decline in private holdings. The delayed and more gradual effect on originations that emerges after instrumentation, together with a short-run decrease in private holdings, suggests that the 2SLS estimates are not picking up increased supply of mortgages to the secondary market. Given the decision lags and time delays associated with making new mortgage loans, the delayed and gradual rise in originations after instrumenting seems instead much more consistent with a causal interpretation.

In the online appendix, 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.

VI. 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 activity. We adopt a local projections approach and use the narrative instrument for identification.

VI.A. Empirical Specification

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

$$y_{t+h} - y_{t-1} = \alpha_h + \delta_h \left(\frac{12}{8} \times \frac{\sum_{j=0}^{7} \mathrm{p}_{t+j}}{\tilde{X}_t} \right) + \varphi_h(L) Z_{t-1} + u_{t+h}. \tag{3}$$

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. The first-stage regression is the same as in (1), but with $(12/8)\sum_{j=0}^{7} \mathrm{p}_{t+j}/\tilde{X}_t$ as the dependent variable and $m_t/\tilde{X}_t$ as regressor. 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 (3) 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 (3) 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 I .

VI.B. Effects on Mortgage Credit and Interest Rates

Figure VII displays the responses of mortgage credit and interest rates to news about higher future purchases. Each of the panels shows the point estimates and 68 and 95 percent confidence bands for the first 24 months after an increase in anticipated agency purchases by one percentage point of trend originations.

The first row in Figure VII displays the responses of real originations and mortgage debt to the agency purchase shock. 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. 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. The results again indicate that agency purchases stimulate mortgage lending significantly. Online appendix A.II shows that the impulse response analysis also confirms that refinancing accounts for a large share of the increase in originations.

The second row in Figure VII 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 pane contains the impact on interest rates of mortgages guaranteed by the Federal Housing Administration. 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, are statistically significant for multiple periods, and help explain the increase in refinancing activity. A 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. 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 VII 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 at the 95 percent level between 3 and 6 months after the shock. The right panel in the bottom row of Figure VII 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. 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 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 VII. below, we investigate the role of monetary policy and its interactions with housing credit policy in greater detail.

Figure VIII shows additional results on the effects on other interest rates and credit spreads. The first two panels 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 percent confidence bands around the responses are relatively wide, and the responses are only marginally significant. The declines in corporate bond yields are also quantitatively smaller than mortgage and Treasury rates. The third panel in the first row of Figure VIII 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 disappearing after 7 or 8 months. 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 final two panels of Figure VIII 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 finding that increases in agency mortgage purchases produce a boom in mortgage lending and declining interest rates is robust. Figure IX 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 following the accounting scandals. 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. We also obtained 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.[23] 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

[23]The results are available in the online appendix.

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, in the appendix we report additional results based on using shocks to GSE excess stock returns as an alternative instrument for agency purchasing activity. This different approach is inspired by Fisher and Peters (2010), who use innovations in defense stocks to identify the effects of news shocks to military spending. The special GSE status is likely to account for the bulk of Fannie's and Freddie's market value and portfolio size, see e.g. Passmore (2005). We can therefore expect that idiosyncratic movements in GSE stock prices reflect unanticipated changes in the value of their GSE status and expected purchasing activity. Controlling for market-wide and real estate sector returns, as well as a wide range of other macroeconomic and financial factors, 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. The resulting impulse response estimates, which are discussed in the appendix, lead to very similar conclusions as those based on the narrative instrument.

VI.C. Effects on Housing and Other Macro Aggregates

Next, we assess the evidence for the broader macroeconomic effects of government asset purchases. Figure X shows the responses of a range of monthly macro aggregates to an agency purchase shock. As in Figure VII , the responses are to an anticipated increase in purchases by one percentage point of trend originations, estimated by the regression in (3) and using the narrative instrument. 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. [24]

The first panel in Figure X 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

[24] 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.

levels afterwards. 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.[25] The top middle panel in Figure X plots the impact on real house prices, as measured by the Freddie Mac house price index deflated by the core PCE price index. 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 increase in house prices is quantitatively relatively small and imprecisely estimated. Thus, we have no clearcut evidence of any strong impact of agency mortgage purchases on house prices. The size of the point estimates imply that only some of the dollar increase in gross mortgage credit flows can be explained by increases in house prices.

The top right panel in Figure X 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. There is a sustained increase in homeownership by around 5 basis points beyond a horizon of 10 months. While there is considerable uncertainty in the estimates, the responses are 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 X 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. There is an initial rise and a subsequent decline in the unemployment rate around a year after the shock, but the magnitudes of these changes are small and not statistically significant.

The alternative GSE excess returns identification strategy discussed in the appendix yields overall comparable results, including a statistically significant rise in housing starts, as well as a significant and persistent rise in homeownership.[26] Our overall conclusion, therefore, is that there is evidence that agency mortgage purchases stimulate residential investment and homeownership, and some indication of a positive effect on

[25] The more immediate effects on residential construction are consistent with the more delayed impact on mortgage debt in Figure VII . 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.

[26] The main exception is that the GSE excess returns instrument yields no evidence for any significant rise in house prices.

personal consumption expenditures. The confidence bands in Figure X are, however, relatively wide, and the power of our instruments to detect a macroeconomic impact of agency mortgage purchases beyond the housing sector is limited.

VII. 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 XI reports the estimated response of the federal funds rate to an agency purchase shock obtained using the methods of the previous section. Based on 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 at conventional levels after 4 to 12 months.

We obtain similar declines in short-term interest rates 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.III). We therefore conclude that there is evidence that agency mortgage purchases are accompanied by accommodative monetary policy. A possible alternative interpretation is that our identification scheme erroneously picks 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.[27] 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 XI depicts the estimated response of the cumulative Romer and Romer (2004) shocks to an agency purchase shock using the regressions in (3). With a few months delay, the

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

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 also reflects an independent reaction to credit market conditions and/or credit policies.

To investigate whether monetary policy affects housing credit policy, the right panel in Figure XI reports the response of the cumulated narrative measures of credit policy changes in Table II, deflated by the core PCE price index and expressed as a percentage of trend originations, to a monetary shock. The response to a monetary shock is obtained by similar regressions as in equation (3), 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.[28] The results indicate 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 (3) also has very little effect on the results, see online appendix A.III. 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 XII 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). These responses are again obtained by local projections as in (3), but with the contemporaneous 3-month T-bill rate as the right-hand side variable and the Romer and Romer (2004) residuals as the instrument. 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 XII are shifted forward by 4 months such that the maxi-

[28] 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.

mum interest declines for each of the policy shocks coincide. The bands shown are the 95 percent Newey and West (1987) confidence intervals.

Figure XII 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.[29] 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 XII . 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 online appendix A.II, 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 XII). 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 statistically significant. Apart from the different response of originations and homeownership, however, it

[29] 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.

does appear as if credit policy operates through similar transmission channels as conventional monetary policy.

In online appendix A.V, 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 percent 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 XIII 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 (3). 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.[30] 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 XIII shows the counterfactual responses in red and the earlier baseline estimates in blue, in both cases with 95 percent Newey and West (1987) bands.

The results from the counterfactual experiment in Figure XIII suggests that conventional monetary policy plays an important role in explaining the effects of agency purchase shocks. 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, and the

[30]The impact of monetary shocks on the outcome variables is obtained as in Figure XII , 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.

positive effect on housing starts disappears entirely. 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. In addition, the path of short-term interest rates appears largely irrelevant for the increase in the homeownership rate that follows an expansion in agency purchases. In the appendix, we report results for the same counterfactual experiment when we use GSE excess returns shocks for identifying responses to anticipated agency purchases. The results indicate a smaller role for conventional monetary policy in explaining the drop in long-term interest rates or the positive effect on housing starts. Otherwise, the findings are comparable to those obtained using the narrative instrument in Figure XIII .

VIII. 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 discussed in the appendix based on GSE excess returns innovations as an instrument for purchasing activity yields overall very similar results.

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 ap-

pears 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 approach does not easily allow an assessment of the historical contribution of structural shocks without further assumptions. Future work can verify whether credit policy shocks are important causal factors in past housing or credit cycles, in particular during the most recent housing boom and bust.[31] Another interesting avenue for future research is to verify whether the macroeconomic impact of agency mortgage purchases has grown with the rise in the stock of mortgage debt, and whether it varies importantly with the broader financial conditions. 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 (2017), 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 assess the impact of government mortgage guarantees and securitization.

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[31] 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.

SUPPLEMENTAL MATERIAL

An Online Appendix for this article as well as data and code replicating the tables and figures in this paper can be found at *The Quarterly Journal of Economics* online. The companion narrative analysis background paper, Fieldhouse and Mertens (2017), can be found at the National Bureau of Economic Research online.

REFERENCES

Arcelus, Francisco and Allan H. Meltzer, "The Markets for Housing and Housing Services," *Journal of Money, Credit and Banking*, 5 (1973), 78–99.

Bassett, William F., Mary Beth Chosak, John C. Driscoll, and Egon Zakrajšek, "Changes in Bank Lending Standards and the Macroeconomy," *Journal of Monetary Economics*, 62 (2014), 23–40.

Bordo, Michael D. and Joseph G. Haubrich, "Credit Crises, Money and Contractions: An Historical View," *Journal of Monetary Economics*, 57 (2010), 1–18.

Boudoukh, Jacob, Matthew Richardson, Richard Stanton, and Robert F. Whitelaw, "Pricing Mortgage-Backed Securities in a Multifactor Interest Rate Environment: A Multivariate Density Estimation Approach," *The Review of Financial Studies*, 10 (1997), 405–446.

Chakraborty, Indraneel, Itay Goldstein, and Andrew MacKinlay, "Monetary Stimulus and Bank Lending," University of Miami manuscript, 2016.

Congressional Research Service, "A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003," Washington, D.C: U.S. Government Printing Office, 2004.

Cúrdia, Vasco and Michael Woodford, "The Central-Bank Balance Sheet as an Instrument of Monetary Policy," *Journal of Monetary Economics*, 58 (2011), 54–79.

Darmouni, Olivier and Alexander Rodnyansky, "The Effects of Quantitative Easing on Bank Lending Behavior," *Review of Financial Studies*, forthcoming 2017.

Davis, Morris A. and Jonathan Heathcote, "The Price and Quantity of Residential Land in the United States," *Journal of Monetary Economics*, 54 (2007), 2595–2620.

Di Maggio, Marco and Amir Kermani, "Credit-Induced Boom and Bust," forthcoming, *Review of Financial Studies*, 2016.

Di Maggio, Marco, Amir Kermani, and Christopher Palmer, "How Quantitative Easing Works: Evidence on the Refinancing Channel," Columbia Business School Research Paper No. 16-1, 2016.

Eckstein, Otto and Allen Sinai, "The Mechanisms of the Business Cycle in the Postwar Era", in The American Business Cycle: Continuity and Change, Robert J. Gordon, ed. (Chicago, IL: NBER and The University of Chicago Press, 1986).

Fama, Eugene F. and Kenneth R. French, "Common Risk Factors in the Returns on Stocks and Bonds", *Journal of Financial Economics*, 33 (1993), 3–56.

Fieldhouse, Andrew and Karel Mertens, "A Narrative Analysis of Mortgage Asset Purchases by Federal Agencies," NBER Working Paper No. 23165, 2017.

Fisher, Jonas D.M. and Ryan Peters, "Using Stock Returns to Identify Government Spending Shocks," *The Economic Journal*, 120 (2010), 414–436.

Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack, "The Financial Market Effects of the

Federal Reserve's Large-Scale Asset Purchases," *International Journal of Central Banking*, 7 (2011), 3–43.

Gertler, Mark and Nobuhiro Kiyotaki, "Financial Intermediation and Credit Policy in Business Cycle Analysis," in Handbook of Monetary Economics, Volume 3A, Benjamin M. Friedman and Michael Woodford, eds. (San Diego, CA: North-Holland, 2010).

Gilchrist, Simon and Egon Zakrajšek, "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 102 (2012), 1692–1720.

Greenspan, Alan, "Government-Sponsored Enterprises," Remarks by Chairman Alan Greenspan to the Conference on Housing, Mortgage Finance, and the Macroeconomy, Federal Reserve Bank of Atlanta, Atlanta, Georgia, May 19, 2005.

González-Rivera, Gloria, "Linkages Between Secondary and Primary Markets for Mortgages," *The Journal of Fixed Income*, 11 (2001), 29–36.

Haltum, Renee and Robert Sharp, "The First Time the Fed Bought GSE Debt," Federal Reserve Bank of Richmond Economic Brief 14-04, 2014.

Hancock, Diana and Wayne Passmore, "Did the Federal Reserve's MBS Purchase Program Lower Mortgage Rates?," *Journal of Monetary Economics*, 58 (2011), 498–514.

———— , "How Does the Federal Reserve's Large-Scale Asset Purchases (LSAPs) Influence Mortgage-Backed Securities (MBS) Yields and U.S. Mortgage Rates?," *Real Estate Economics*, 43 (2015), 855–890.

Hanson, Samuel G., "Mortgage Convexity," *Journal of Financial Economics*, 113 (2014), 270–299.

Hendershott, Patric H. and Kevin E. Villani, "The Federally Sponsored Credit Agencies: Their Behavior and Impact," in Capital Markets and the Housing Sector: Perspectives on Financial Reform, Robert M. Buckley, John A. Tucillo, and Kevin Villani, eds. (Cambridge, MA: Ballinger Publishing Co., 1977).

Hendershott, Patric H. and Kevin E. Villani, "Residential Mortgage Markets and the Cost of Mortgage Funds," *Journal of the American Real Estate and Urban Economics Association*, 8 (1980), 50–76.

Hendershott, Patric H. and James D. Shilling, "The Impact of the Agencies on Conventional Fixed-Rate Mortgage Yields," *Journal of Real Estate Finance and Economics*, 2 (1989), 101-115.

Jaffee, Dwight M. and Kenneth T. Rosen, "Estimates of the Effectiveness of Stabilization Policies for the Mortgage and Housing Markets," *The Journal of Finance*, 33 (1978), 933-946.

Jordà, Òscar, "Estimation and Inference of Impulse Responses by Local Projections," *American Economic Review*, 95 (2005), 161–182.

Justiniano, Alejandro, Giorgio E. Primiceri, and Andrea Tambalotti, "Credit Supply and the Housing Boom," NBER Working Paper No. 20874, 2015.

Kaufman, Herbert M., "FNMA and the Housing Cycle: Its Recent Contribution and Its Future Role in a Deregulated Environment," in The Federal National Mortgage Association in a Changing Economic Environment, Supplement to a Report by the Comptroller General of the United States. (Washington, D.C.: U.S. Government Accountability Office, 1985).

Krishnamurthy, Arvind and Annette Vissing-Jørgensen, "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," *Brookings Papers on Economic Activity*, 2 (2011), 215–265.

Leamer, Edward E., "Housing IS the Business Cycle," NBER Working Paper No. 13428, 2007.

Lehnert, Andreas, Wayne Passmore, and Shane M. Sherlund, "GSEs, Mortgage Rates, and Secondary Market Activities," *Journal of Real Estate Finance and Economics*, 36 (2008), 343-363.

Malkhozov, Aytek, Philippe Mueller, Andrea Vedolin, and Gyuri Venter, "Mortgage Risk and the Yield Curve," *The Review of Financial Studies*, 29 (2016), 1220–1253.

Meltzer, Allan H., "Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Markets," *The Journal of Finance*, 29 (1974), 763–777.

Mian, Atif and Amir Sufi, "The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis," *Quarterly Journal of Economics*, 124 (2009), 1449–1496.

Mian, Atif, Amir Sufi, and Emil Verner, "How Do Credit Supply Shocks Affect the Real Economy? Evidence from the United States in the 1980s," Princeton University manuscript, 2017.

Naranjo, Andy and Alden Toevs, "The Effects of Purchases of Mortgages and Securitization by Government Sponsored Enterprises on Mortgage Yield Spreads and Volatility," *Journal of Real Estate Finance and Economics*, 25 (2002), 173–195.

Newey, Whitney K. and Kenneth D. West, "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55 (1987), 703–708.

Owens, Raymond E. and Stacey L. Schreft, "Identifying Credit Crunches," Federal Reserve Bank of Richmond Working Paper 93-02, 1993.

Patrabansh, Saty, William M. Doerner, and Samuel Asin, "The Effect of Monetary Policy on Mortgage Rates," FHFA Working Paper 14-2, 2014.

Passmore, S. Wayne, "The GSE Implicit Subsidy and the Value of Government Ambiguity," *Real Estate Economics*, 33 (2005).

Peek, Joe, Eric S. Rosengren, and Geoffrey M.B. Tootell, "Identifying the Macroeconomic Effects of Loan Supply Shocks," *Journal of Money, Credit and Banking*, 35 (2003), 931–946.

Perli, Roberto, and Brian P. Sack, "Does Mortgage Hedging Amplify Movements in Long-Term Interest Rates?," *The Journal of Fixed Income*, 13 (2003), 7–17.

Ramey, Valerie A., "Identifying Government Spending Shocks: It's All in the Timing," *Quarterly Journal of Economics*, 126 (2011), 1–50.

———— , "Macroeconomic Shocks and Their Propagation," in Handbook of Macroeconomics, Volume 2A, John B. Taylor and Herald Uhlig, eds. (San Diego, CA: North-Holland, 2016).

Ramey, Valerie A. and Sarah Zubairy, "Government Spending Multipliers in Good Times and in Bad: Evidence from U.S. Historical Data," forthcoming Journal of Political Economy, 2017.

Romer, Christina D. and David H. Romer, "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz," in NBER Macroeconomics Annual 1989, Volume 4, Olivier Jean Blanchard and Stanley Fischer, eds. (Cambridge, MA: The MIT Press, 1989).

———— , "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review*, 94 (2004), 1055–1084.

———— , "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks," *American Economic Review*, 100 (2010), 763–801.

Shiller, Robert J., Irrational Exuberance, 3rd ed. (Princeton, NJ: Princeton University Press, 2015).

Shumway, R.H. and D.S. Stoffer, "An Approach to Time Series Smoothing and Forecasting Using the EM Algorithm," *Journal of Time Series Analysis*, 3 (1982), 253–264.

Smith, Lawrence B., Kenneth T. Rosen, and George Fallis, "Recent Developments in Economic Models of Housing Markets," *Journal of Economic Literature*, 26 (1988), 29–64.

Stock, James H. and Mark W. Watson, "Identification and Estimation of Dynamic Causal Effects in Macroeconomics", Harvard University manuscript, 2017.

Stroebel, Johannes and John B. Taylor, "Estimated Impact of the Federal Reserve's Mortgage-Backed Securities Purchase Program," *International Journal of Central Banking*, 8 (2012), 1–42.

Wieland, Johannes F. and Mu-Jeung Yang, "Financial Dampening," University of California, San Diego manuscript, 2016.

TABLE I

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 Corp.	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 II
NARRATIVE MEASURES OF POLICY CHANGES

Policy Description	Agency	Impact	News	Effective	Classification
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

Notes. 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).

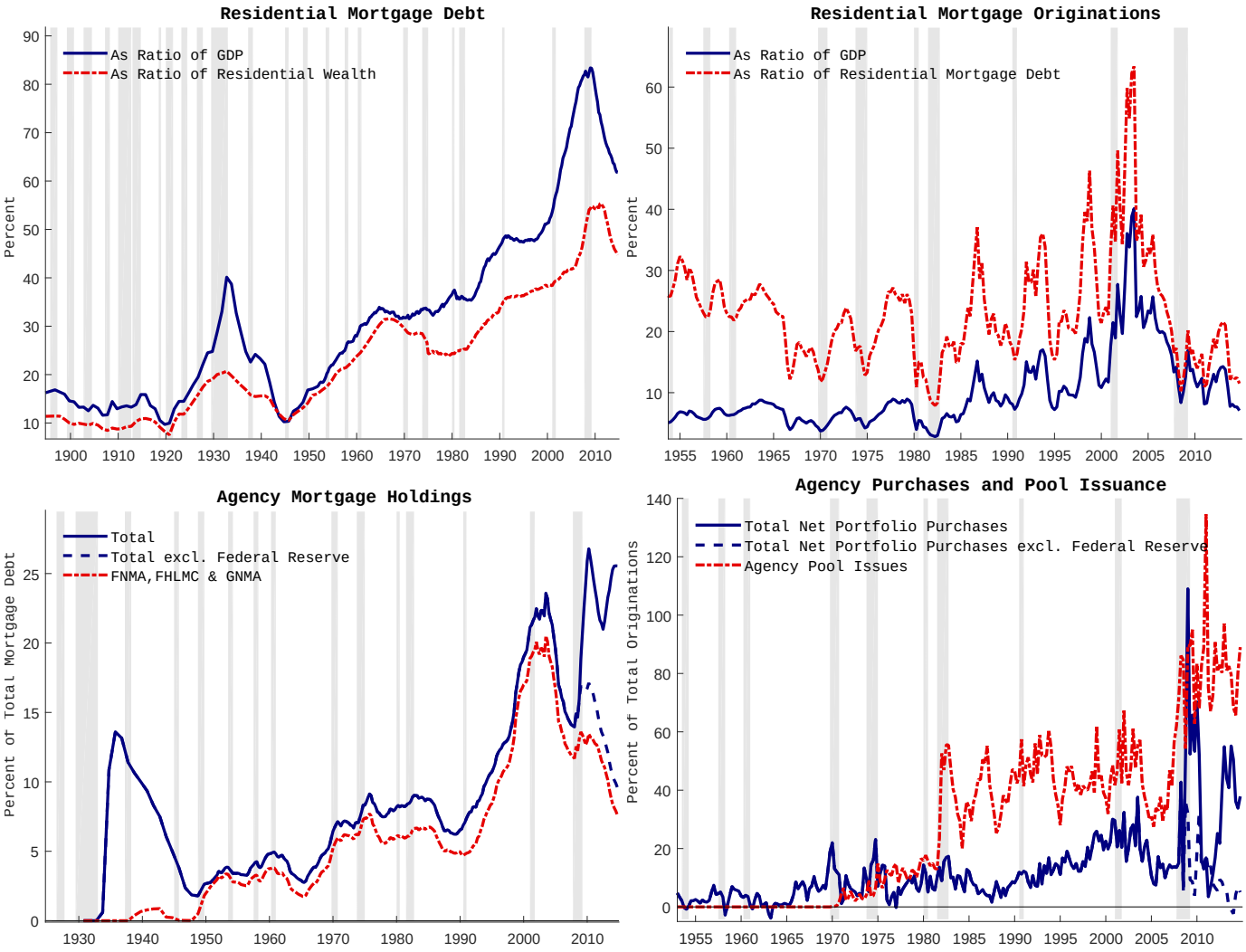


FIGURE I Mortgage Debt, Annualized Originations, and Agency Market Shares

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 issuance approximate purchases backing new mortgage pools (mortgage-backed securities). The grey bars are NBER-dated recessions. Sources: see data appendix.

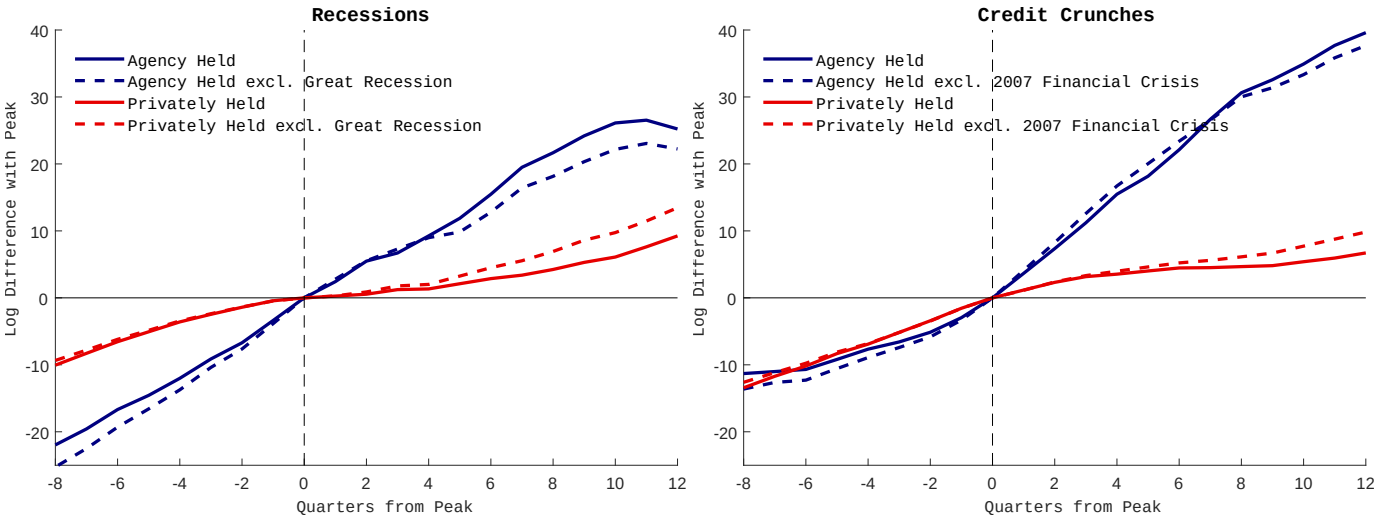


FIGURE II Real Mortgage Debt by Holder in Recessions and Credit Crunches

Mortgage debt is deflated by the core PCE price index. The left panel shows the average of 9 NBER recessions starting 1957Q2, 1960Q1, 1969Q4, 1973Q4, 1980Q1, 1981Q3, 1990Q3, 2001Q1, 2007Q4. The right panel shows the 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.

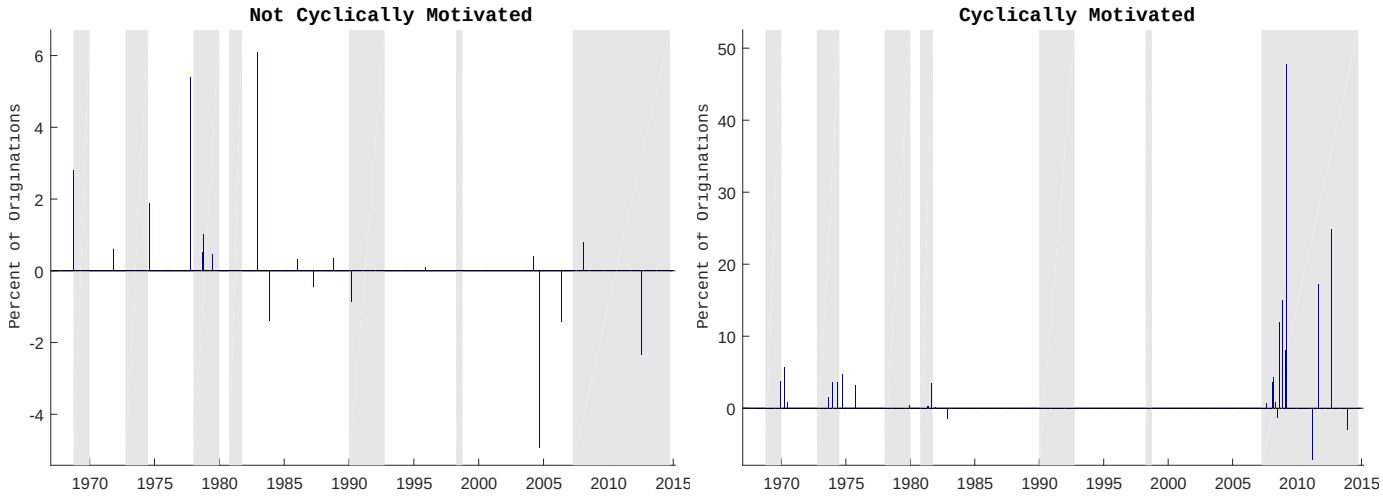


FIGURE III Measures of Policy Events Affecting Agency Mortgage Holdings: Jan 1967 to Dec 2014

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 the chronology.

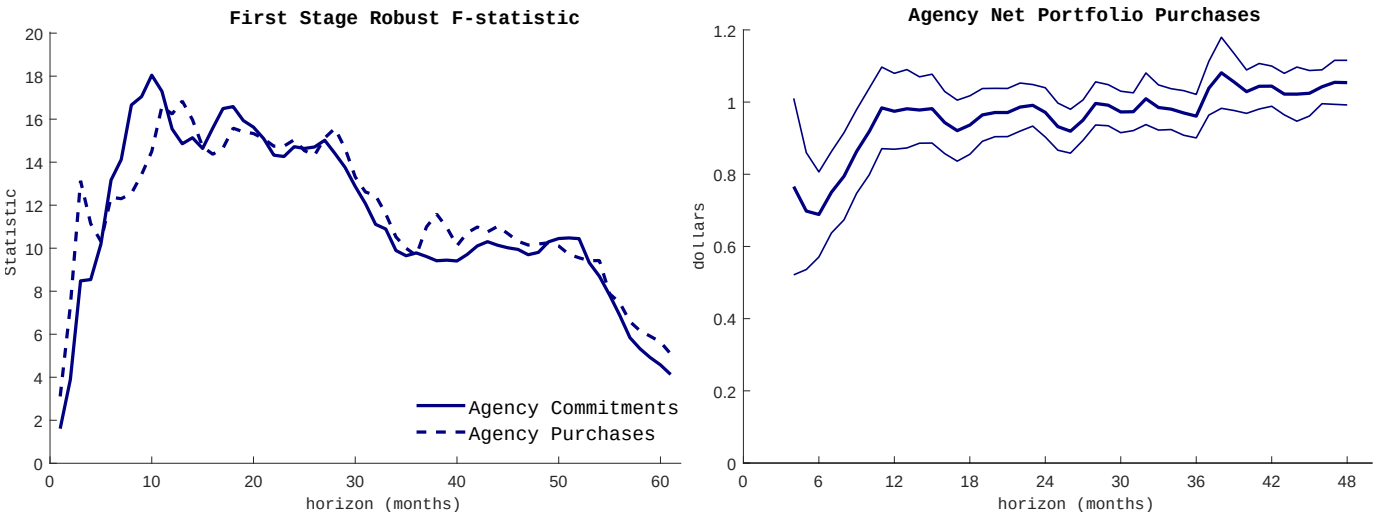


FIGURE IV Preliminary Diagnostics

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, see eq. (1). 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.

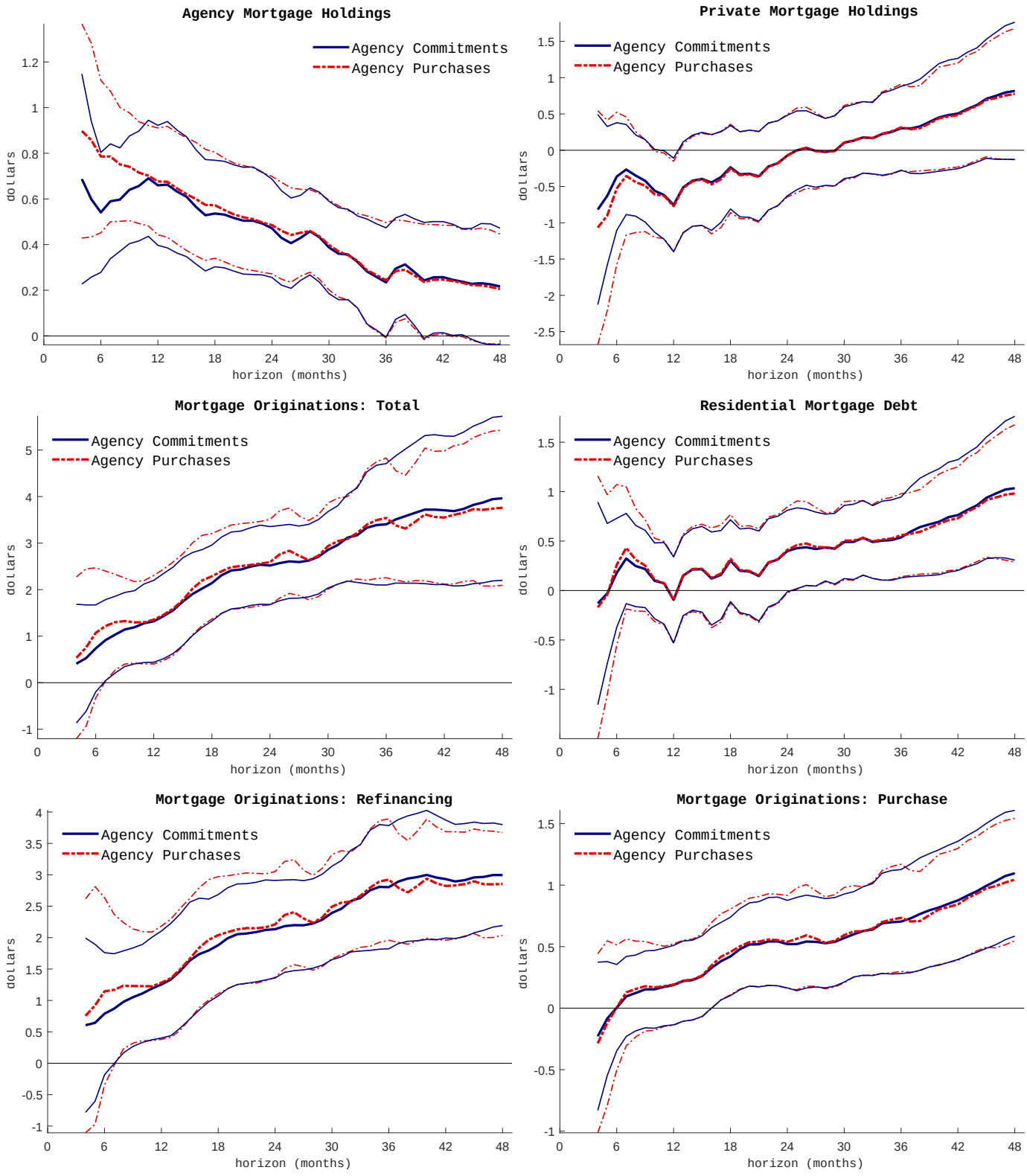


FIGURE V Estimated Balance Sheet Adjustments and Mortgage Credit Multipliers Associated with Agency Mortgage Purchases

The figure shows dollar changes in the variable listed 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 eq. (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.

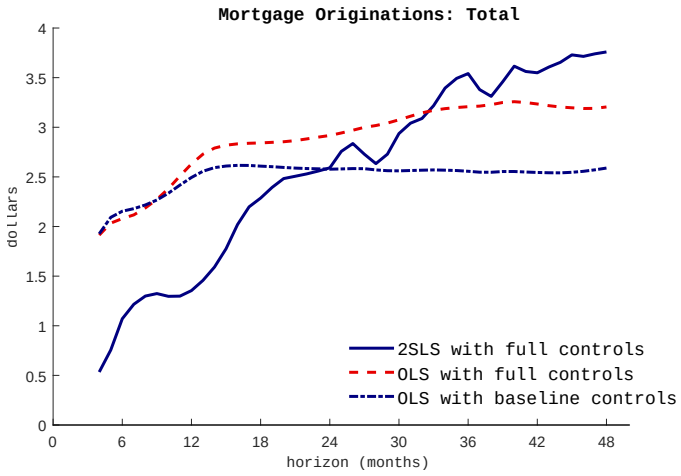


FIGURE VI The Role of Instrumentation

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.

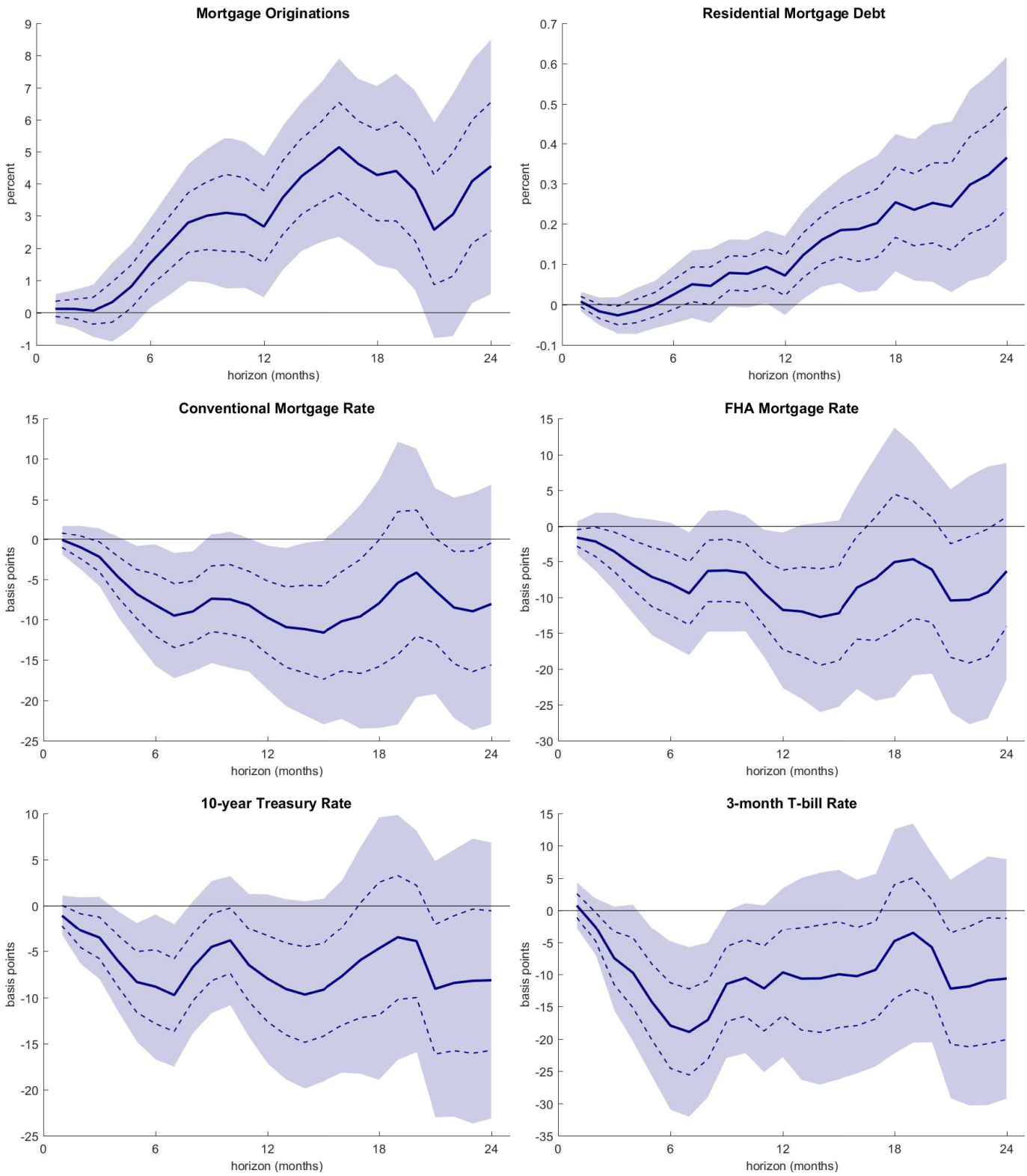


FIGURE VII Impulse Responses to a Shock to Anticipated Agency Purchases

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 eq. (3). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

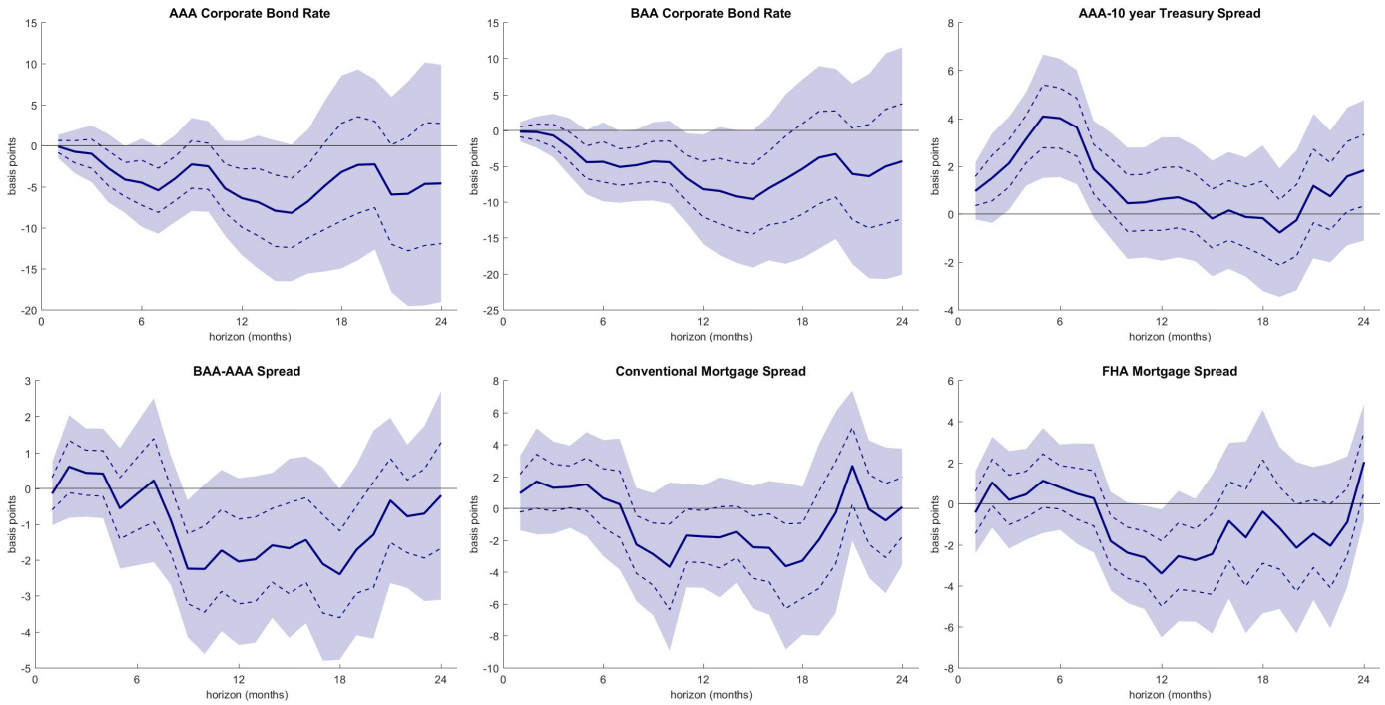


FIGURE VIII Impulse Responses to a Shock to Anticipated Agency Purchases

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 eq. (3). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

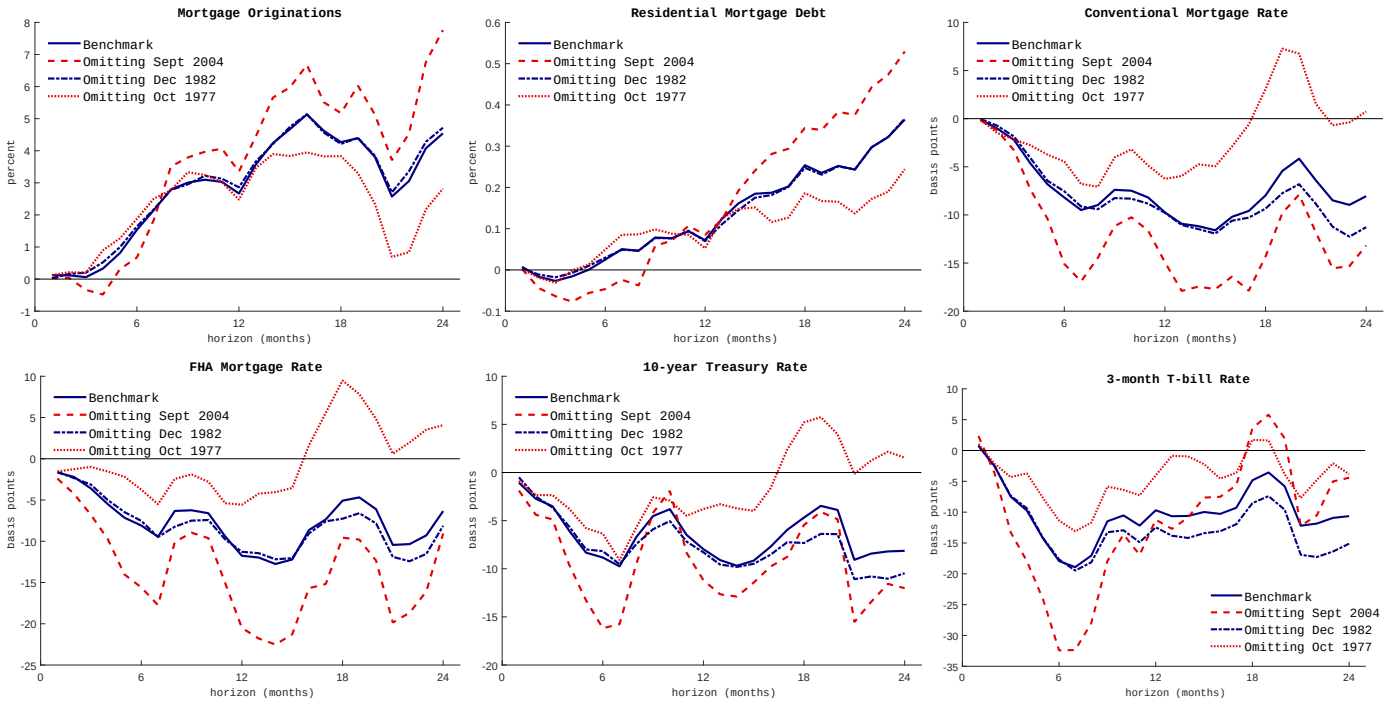


FIGURE IX Impulse Responses when Omitting Largest Policy Events

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 subsets of the narrative policy indicator, see eq. (3). Sample: Jan 1967 to Dec 2006.

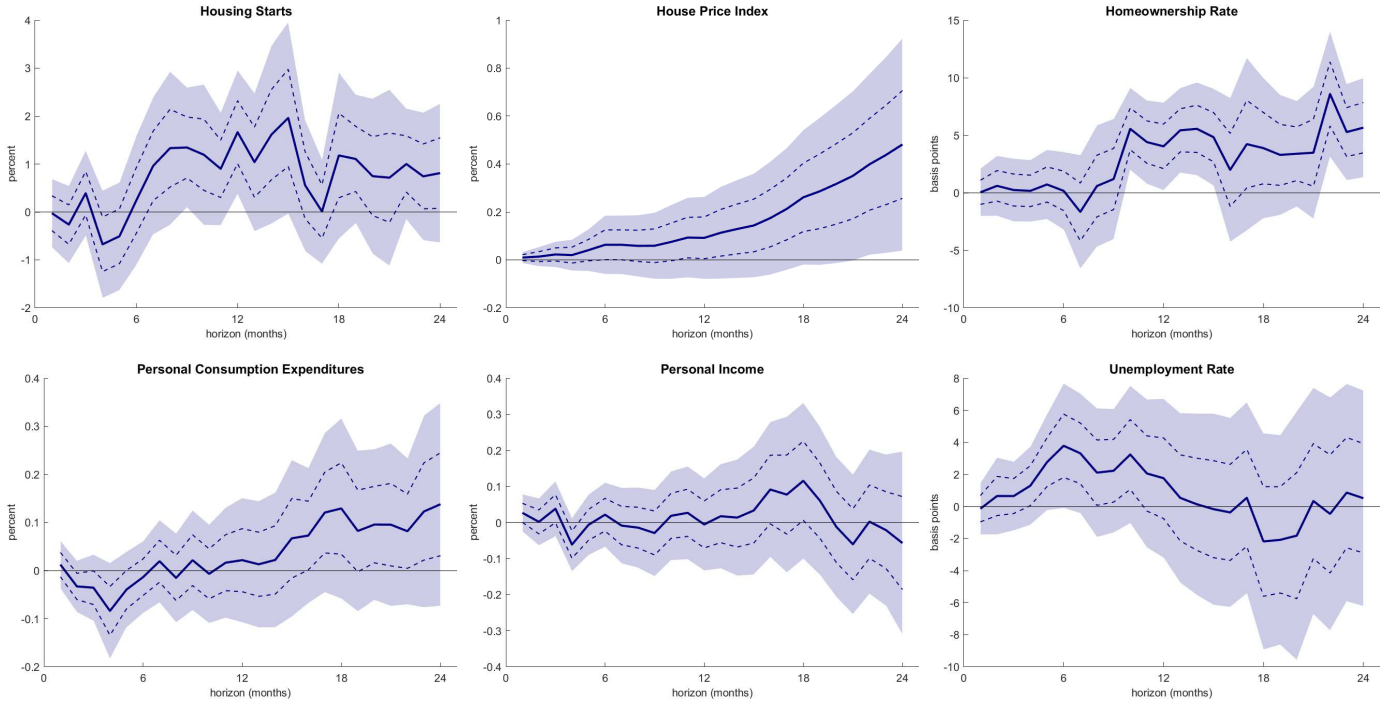


FIGURE X Impulse Responses to a Shock to Anticipated Agency Purchases

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 (3). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

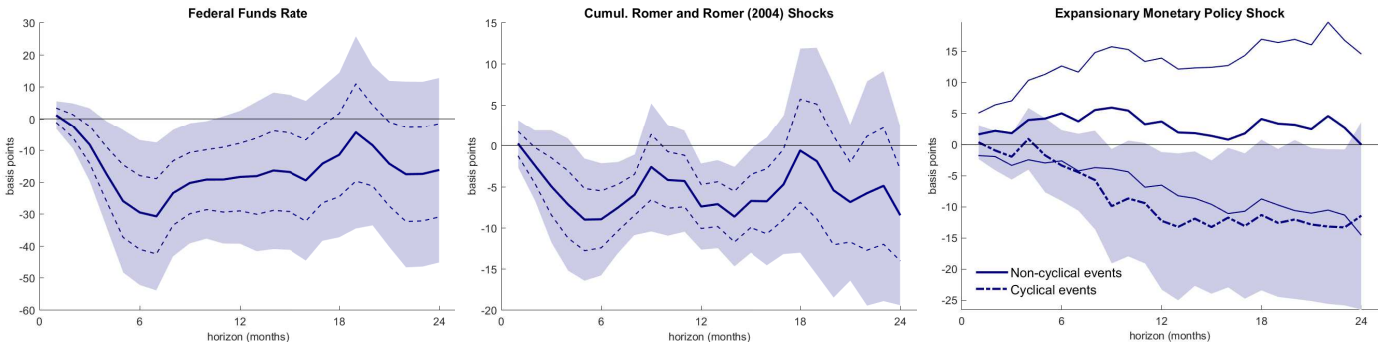


FIGURE XI Interactions Between Monetary and Credit Policies

The left and middle panels show 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 (3). Finer lines are 68% and 95% Newey and West (1987) confidence bands. The right panel shows responses to a monetary shock obtained by local projections-IV regressions on the 3-month T-bill rate and instrumenting with the Romer and Romer (2004) monetary policy shock measure. Finer lines and shaded areas in the right panel are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

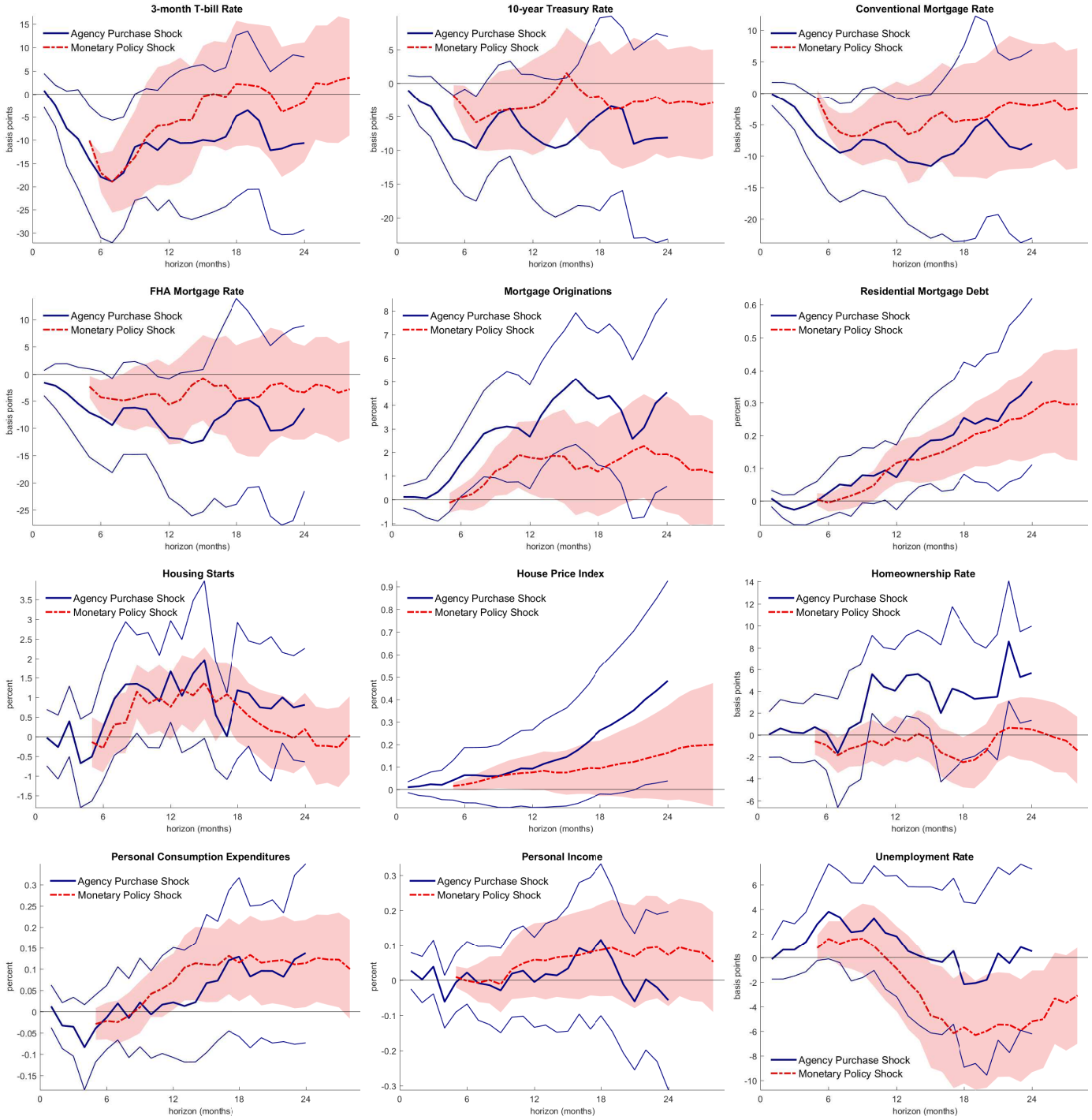


FIGURE XII Responses to a Shock to Anticipated Agency Purchases Versus a Monetary Policy Shock

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 (3), 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.

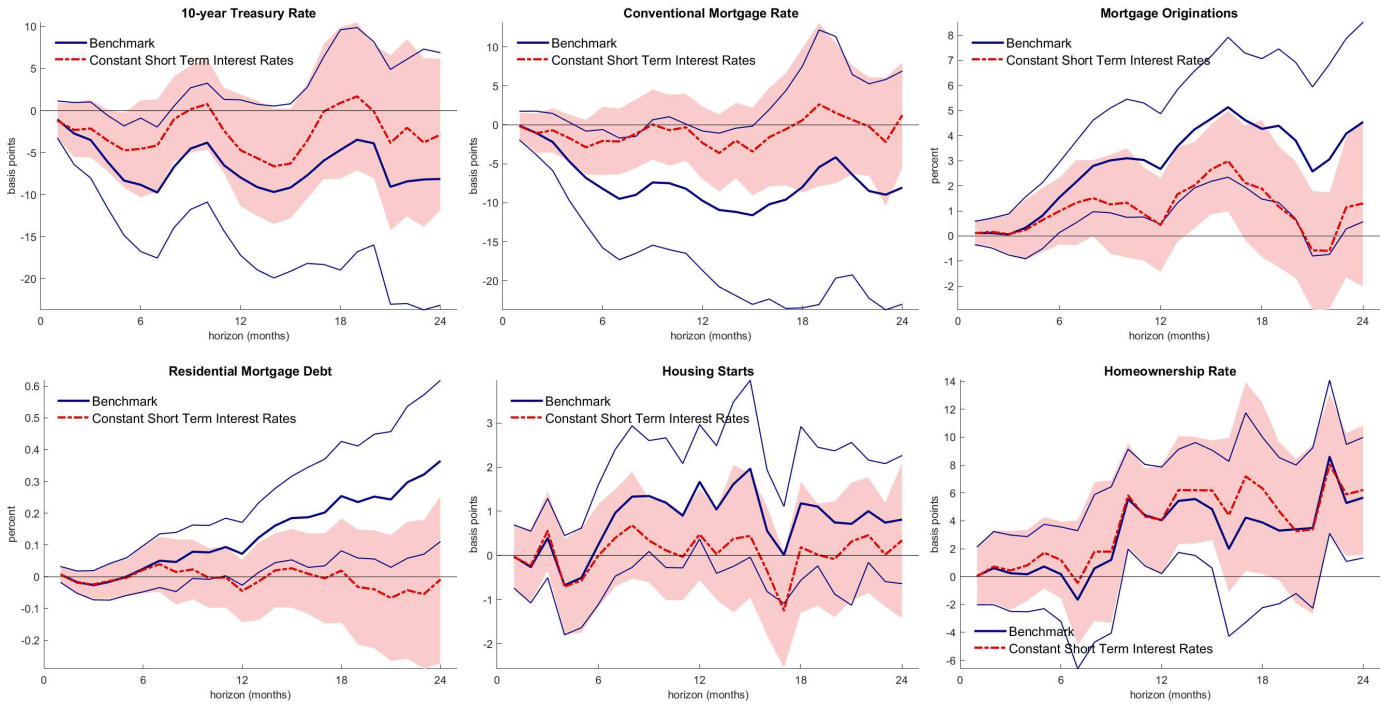


FIGURE XIII Shock to Anticipated Agency Purchases: Counterfactual with Constant Short-Term Rate

The figure shows responses to a one pp. increase in the expected future agency market share as in the benchmark of eq. (3), as well as those augmented with 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, and the 3-month T-bill rate with the Romer and Romer (2004) monetary policy shock measure, respectively. Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

Appendix I: Historical Background

This appendix provides some more historical background to the evolution of agency market shares depicted in Figure I .[32] During the Depression, the Home Owners' Loan Corporation took ownership of nearly 15 percent 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.

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. In 1989, Freddie was turned into a publicly traded company with therefore 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 Securities 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 Federal Housing Finance Agency and the 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 percent, increased to 15 percent in 2012, until they reaching $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.

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

Appendix II: An Alternative Identification Strategy Using GSE Excess Returns

Although our narrative instrument is a good predictor of agency purchasing activity, it is based on relatively few policy events. To gain confidence that our results are not driven by the small sample size, as well as to address other potential concerns with the narrative identification method, in this appendix we present results based on a complementary identification approach. Under this alternative approach, we instrument measures of agency purchasing activity with innovations in Fannie and Freddie excess stock returns. This strategy is inspired by Fisher and Peters (2010), who use excess return innovations in major US defense stocks as a measure of news shocks to military spending.

The special advantages granted by federal housing credit policy are likely to account for much of Fannie and Freddie's market value and portfolio size. This is supported by Passmore (2005), who estimates that 44 percent to 89 percent of Fannie's 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. Based on this, we can expect that idiosyncratic movements in Fannie's and Freddie's stock prices reflect unanticipated changes in the value of the GSE status and expected purchasing activity. More specifically, any news about changes in the policies guiding the GSEs' portfolios business and leverage will affect their market value relative to the private sector. Fieldhouse and Mertens (2017) provide narrative evidence that announcements of housing credit policy changes are generally associated with adjustments in GSE stock prices. Below, we use our narrative indicator of federal housing credit policy changes to confirm that news about policy interventions affecting GSE balance sheets indeed affect Fannie's and Freddie's stock market valuation. After accounting for the usual covariance with real estate and banking sectors and the market as a whole, and after controlling for credit aggregates, interest rates, and other macro variables, we find that residual variation in Fannie and Freddie stock returns predicts agency mortgage purchases. This motivates us to use shocks to GSE excess returns as an alternative instrumental variable for agency mortgage purchasing activity.

Empirical Specification using the GSE Excess Returns Instrument

GSE excess returns shocks er_t^{GSE} are defined as the residual in the following regression:

$$ER_t^{GSE} = \tilde{\alpha} + \tilde{\zeta} W_t + \tilde{\varphi}(L) Z_{t-1} + er_t^{GSE} \tag{4}$$

where ER_t^{GSE} is the log ratio of the GSE stock price index over the market index.[33] The vector W_t contains a number of contemporaneous controls, including several excess return measures from the Fama-French data library. In our benchmark specification, we include excess returns for the market index and a real estate portfolio. In the online appendix, we also look at specifications adding excess returns on banking or finance sector portfolios or the Fama and French (1993) size and value factors, with little impact on the results. Besides the return variables, W_t also includes contemporaneous values of the control variables used for the narrative specifications, i.e. 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. For the results below, when we rotate in another variable, we also include it in W_t. Finally, the vector Z_t with lagged controls is the same as in (3), but we also add lags of ER_t^{GSE} as well as (cumulative) Fama-French excess

[33] The GSE stock price index from 1970 through 1988 is based on Fannie stock. Post 1988 it is the geometric average of Fannie and Freddie stock (from Bloomberg). The market and sector return variables are based on value-weighted portfolios and exclude dividends, and were downloaded from the data library on the homepage of Kenneth French at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.

market returns.[34] All results involving GSE stock returns are based on monthly data from September 1970 to December 2006. The start of the effective sample is September 1971, reflecting the twelve lags and the fact that Fannie stock was traded for the first time on the NYSE on August 31, 1970.

The left panel in Figure XIV plots the (standardized) estimated innovations $\widehat{er}_t^{GSE}$, together with the non-cyclical narrative indicator for reference. To provide evidence that GSE stock prices reflect policy-induced changes in agency purchasing activity, the right panel in Figure XIV plots the cumulative response of GSE excess returns measures to a one pp. increase in the expected future agency market share, measured by agency commitments as a ratio of trend originations. The response, which is estimated by (3) using the narrative policy indicator as the instrument, reveals a clear and significant rise in the GSE stock prices after accounting for the comovement with the overall market and real estate sector as well as for all other macro and financial factors included as controls.

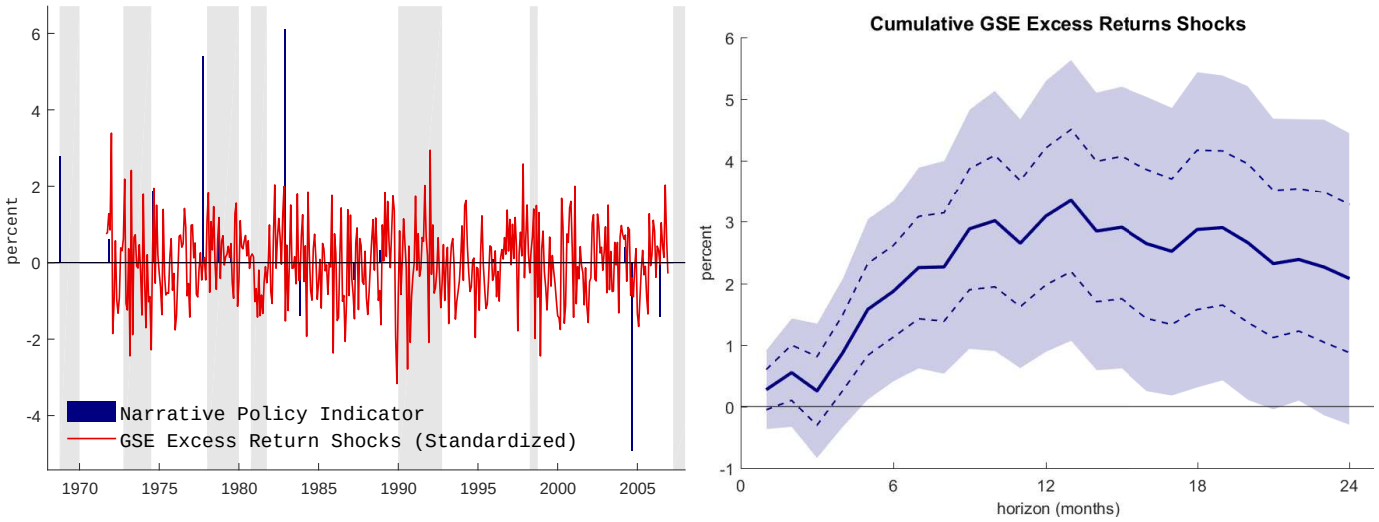


FIGURE XIV GSE Excess Returns Shocks $\widehat{er}_t^{GSE}$ and Response to Anticipated Agency Purchases Shock

The left panel shows the estimated residuals in the GSE excess returns regression in (4), as well as the indicator for non-cyclical policy changes. Shaded areas are credit crunch periods, see data appendix for the chronology. The right panel shows the cumulative response of $\widehat{er}_t^{GSE}$ 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 non-cyclical narrative policy indicator, see equation (3). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Sep 1970 to Dec 2006.

To obtain the effect of a shock to anticipated agency purchases, we estimate the following regressions:

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

where 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 response coefficient δ_h in (5) is estimated using 2SLS using ER_t^{GSE} as the instrumental variable. Because (5) includes the same regressors W_t and (lags of) Z_t as in (4), this is equivalent to using the estimated values of er_t^{GSE} as the instrumental variable. However, including the same controls as in (4) and instrumenting with ER_t^{GSE} makes it straightforward to obtain the correct standard errors. For simplicity, we keep the horizon for cumulating commitments in equation (5) at 8 months, the same as in equation (3). The value of the first-stage

[34] Further adding real estate sector excess returns to Z_t had no material impact on the results.

robust F-statistic for this horizon is 7.09. The GSE excess returns shocks are therefore followed by statistically significant increases in agency purchasing activity. Figure XV shows the F-statistics associated with both commitments and effective purchases for horizons up to 60 months. The F-statistic for the GSE excess returns instrument is the highest for agency commitments at a horizon of 10 months, and equals 7.96. Changing the horizon for cumulating commitments in specification (5) to 10 months does not lead to any meaningful change in the results.

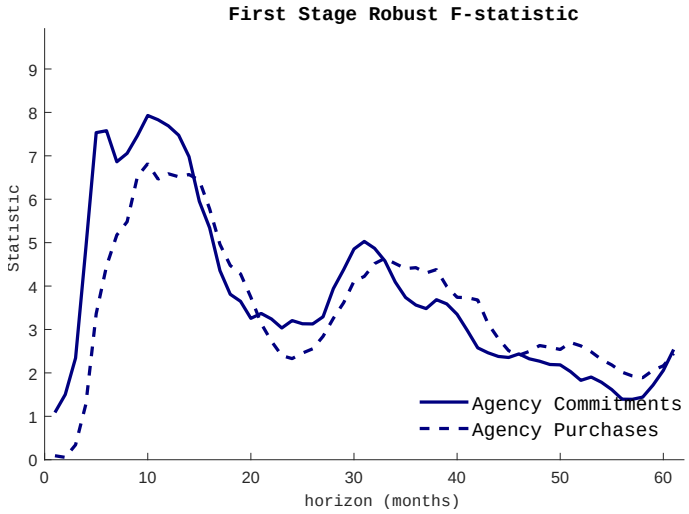


FIGURE XV First-Stage Diagnostics for GSE Excess Returns Instrument

The figure shows Newey and West (1987) robust F-statistics of the first-stage regressions of cumulative agency commitments and purchases, respectively, for the GSE excess returns variable ER_t^{GSE} with the controls W_t and (lags of) Z_t. Sample: Sep 1970 to Dec 2006.

The excess returns identification approach is analogous to Fisher and Peters (2010), who interpret innovations in excess stock returns of major defense contractors as news shocks about future military spending. They obtain these innovations by ordering the excess returns last in a recursively identified structural vector autoregressive system (SVAR). The recursive scheme assumes that none of the endogenous macro aggregates included in the analysis are affected on impact by the news shock, while excess stock returns react contemporaneously to all macroeconomic shocks. Because the monthly innovation er_t^{GSE} is orthogonalized to the innovations to all of the variables included in W_t, the 2SLS regression in (5) similarly imposes that shocks to expected agency purchases have no contemporaneous impact on the variables in W_t. By assumption, this step eliminates other endogenous influences by allowing the GSE excess returns to respond contemporaneously to market or real estate sector returns, in addition to the innovations in mortgage credit, interest rates, prices, and the cyclical indicators. While the assumption of a zero contemporaneous effect on these variables seems ex ante restrictive, it is not rejected by the narrative instrument, see Figures VII , VIII , and X . In the online appendix, we implement the same strategy in a recursive SVAR as in Fisher and Peters (2010), which yields estimates that are very similar those of Figure XVI . In the SVAR, the contribution to the short-run variability of mortgage credit and housing starts is substantial and similar to that of monetary policy shocks.

Because the GSE excess returns instrument has monthly observations, it contains potentially more information about variation in agency purchases than the narrative policy indicator.[35] Our narrative indicator

[35] Assuming the GSE excess returns shocks contain all of the information about agency purchase shocks, it becomes possible to

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 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 returns 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.

Results using GSE Excess Returns Shocks as an Alternative Instrument

Figure XVI summarizes the responses of mortgage credit, interest rates, and other macro variables to news about higher future purchases identified using the GSE excess returns shocks instrument. The impulse responses are directly comparable to those reported in Figures VII and X for the narrative instrument. The GSE excess returns shocks generally yield responses that are less delayed and more transitory for some variables. The main finding, however, is that they are overall remarkably similar in size and direction across both identification strategies.

The first row in Figure XVI shows statistically significant increases in mortgage originations following a shock to agency purchases. The rise in total originations occurs slightly more rapidly, and is more transitory than with the narrative instrument. The peak increase in originations is, on the other hand, very similar in size to that in Figure VII , and occurs between 10 and 14 months at around 4 percent. As with the narrative instrument, both home purchase and refinancing originations rise, but the rise in refinancing activity is particularly pronounced. The leftmost panel in the second row shows that the rise in the stock of mortgage debt is also very similar to that in Figure VII . As in our benchmark results, agency purchases lead to a statistically significant rise in housing starts, which are around 2 percent higher between 4 and 12 months after the shock. There is also a significant and persistent rise in homeownership. The third row in Figure XVI shows that the conventional mortgage rate is lower by 10 to 15 basis points after 6 to 18 months. The declines in the 10-year and 3-month Treasury rates are also similar to our benchmark results.

The bottom row in Figure XVI reveals some differences with our benchmark narrative instrument. The left panel shows a more pronounced increase in consumer spending following the GSE excess returns shock, as well as a clear decline in the unemployment rate. The responses of consumption, unemployment, and personal income (not displayed) are even marginally statistically significant. In contrast to Figure X , there is, on the other hand, no indication that house price are affected significantly by agency purchases.

The results produced by this alternative identification strategy are also similar for other variables not shown in Figure XVI . The GSE excess returns instrument, for instance, also yields a temporary decline in the federal funds rate, although it is smaller in size and not statistically significant. We note, on the other hand, that the GSE excess returns instrument does not yield a similar significant decline in the Romer and Romer (2004) residual, and also leads to different conclusions regarding the role of traditional interest rate policies. Figure XVII compares the estimated responses to those under the counterfactual with constant short-term interest rates, as in Figure XIII . In contrast to the findings based on the narrative instrument, the drop in long-term interest rates remains clearly present after holding short-term interest rates fixed when we use GSE excess returns shocks for identification. The same is true for the positive effect on housing starts and, to a lesser extent, for the rise in mortgage debt. As in Figure XIII , purchases of mortgage assets continue to have statistically significant effects on mortgage lending, and short-term interest rates appear

estimate the variance contribution of these shocks to any endogenous variables of interest. In the online appendix, we do this in the context of an SVAR model.

irrelevant for the effect on homeownership.

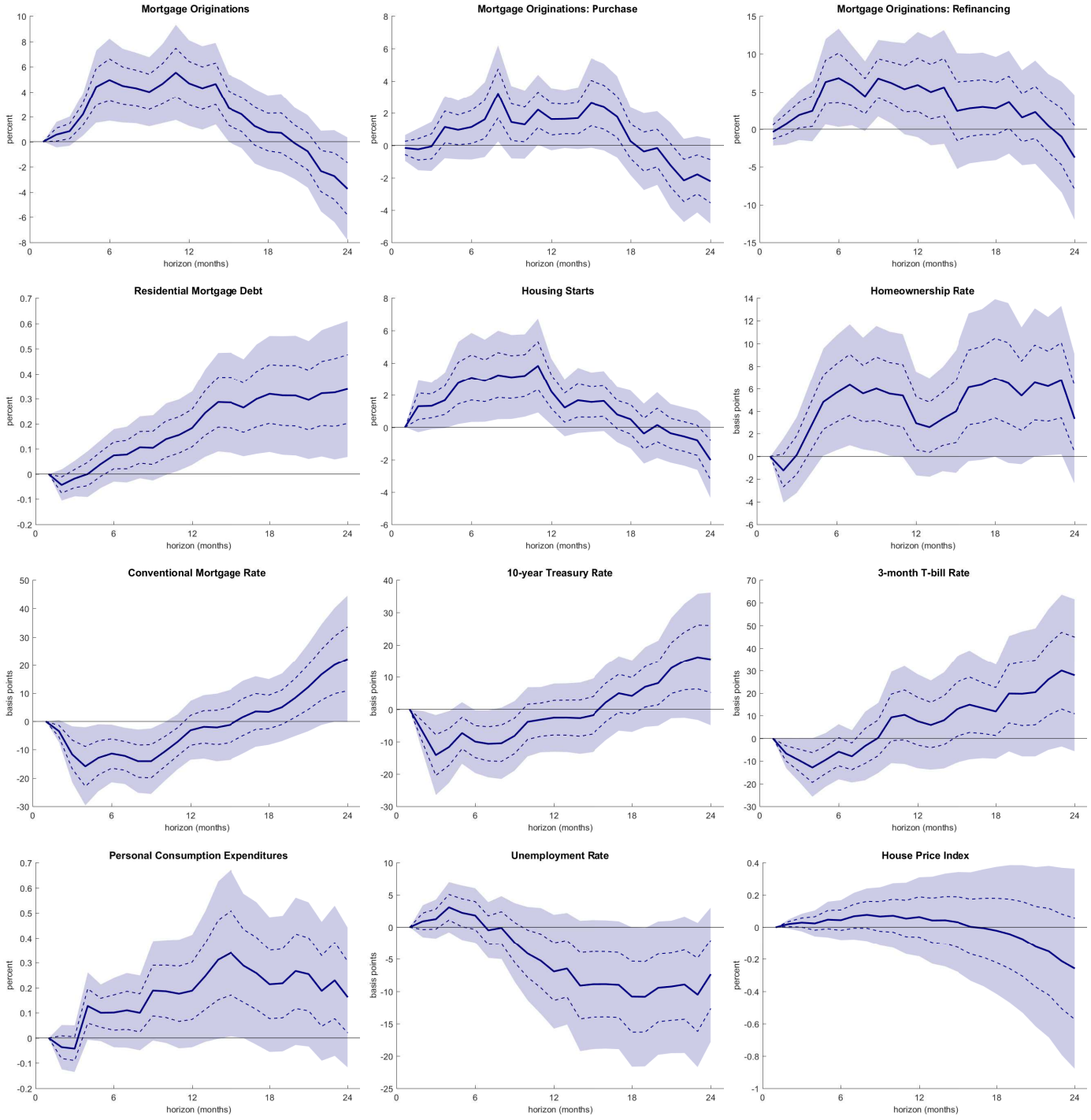


FIGURE XVI Shock to Anticipated Agency Purchases: Responses Using GSE Excess Returns Instrument

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 GSE excess stock returns innovations, see equation (5). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Sep 1970 to Dec 2006.

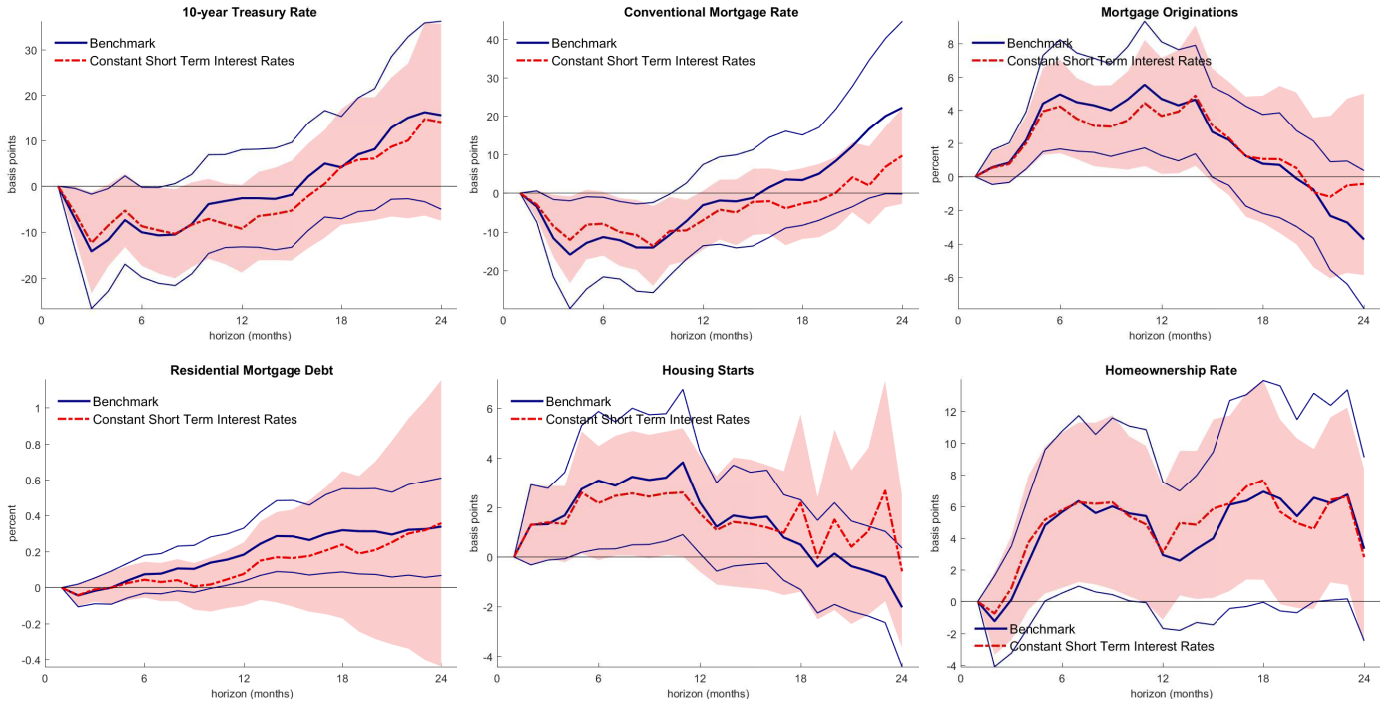


FIGURE XVII Counterfactual with Constant Short-Term Rate Using GSE Excess Returns Instrument

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 GSE excess stock returns shocks and 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: Sep 1970 to Dec 2006.

Appendix III: Data Sources and Construction

Data underlying Figure I : *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, Millennial 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 Administration, 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 Owners' 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 I 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 I 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 mortgage 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 is 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 I shows quarterly data from 1952 onwards.

Data underlying Figure II : *Agency mortgage holdings* is the quarterly series from Figure I . *Private mortgage holdings* is total residential mortgage debt from Figure I 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 I). 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 is available from the Board of Governors https://www.federalreserve.gov/newsevents/reform_mbs.html 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 Administration (FHA)/Department 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 macrohistory 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 I) 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 *BAA and AAA corporate bond rates* are the Moody's seasoned BAA and AAA yields (series BAA and AAA from FRED).

ONLINE APPENDIX FOR THE MACROECONOMIC EFFECTS OF GOVERNMENT ASSET PURCHASES: EVIDENCE FROM POSTWAR US HOUSING CREDIT POLICY

ANDREW FIELDHOUSE
KAREL MERTENS
MORTEN O. RAVN

A ADDITIONAL RESULTS AND ROBUSTNESS CHECKS

A.I Cumulative Credit Multipliers

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

1. Scaling by Trend Originations. The baseline specification in (2) uses a trend in personal income as the scaling variable. Figure A.I 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 V . 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.

2. Agency Pool Issuance. Figure A.II 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.II 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 V . 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% of the cumulative rise in originations, which is about the typical agency securitization share since the mid-1980s. The right panel of Figure A.II 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.

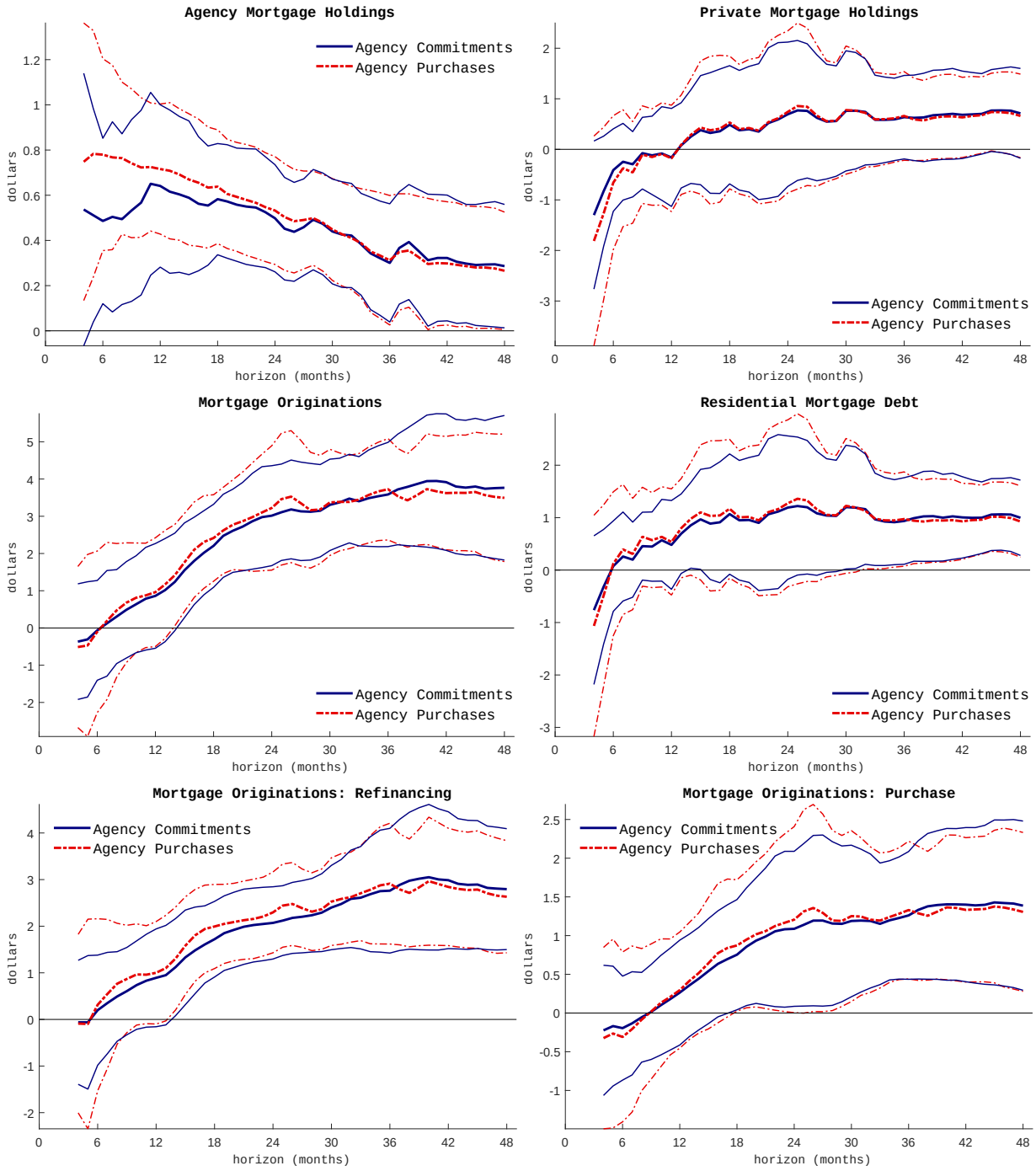


FIGURE A.I Cumulative Estimates Using Trend Originations as the Scaling Variable

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.

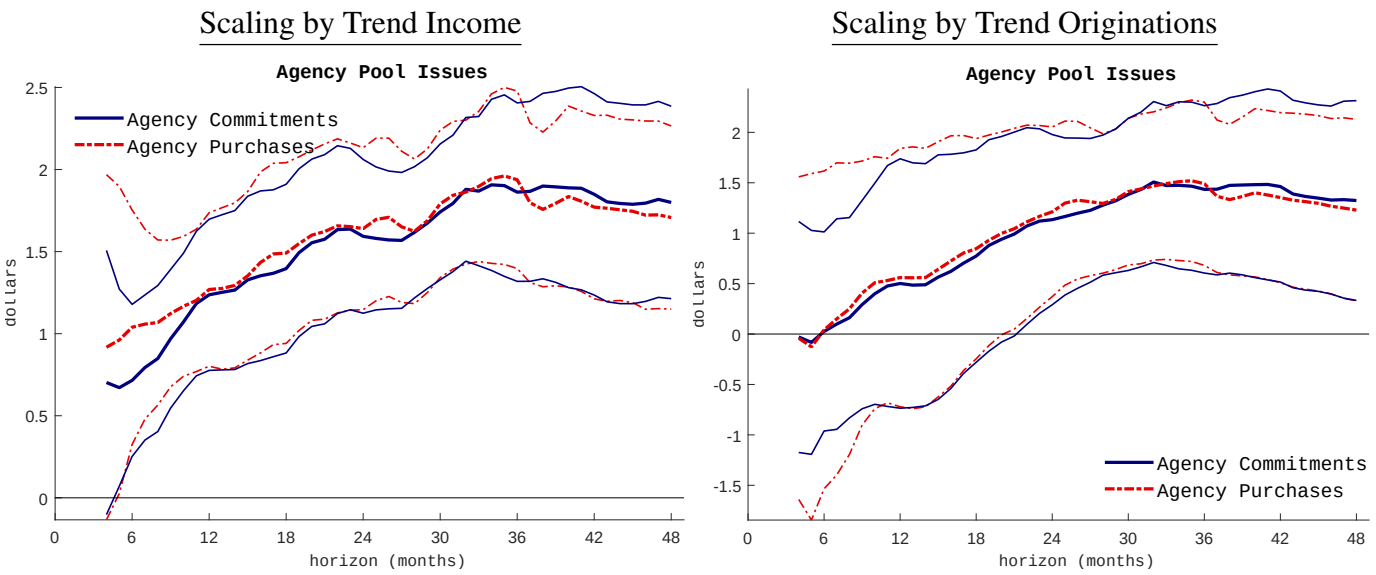


FIGURE A.II Total Mortgage Pool Issuance Associated with Agency Mortgage Purchases

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.

3. Other Robustness Checks. Table A.I clarifies how the results depend on instrumentation and the choice of controls. Estimates from the benchmark specifications of Section V. 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.III 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.I. 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 suggest that any bias arising because the cyclical policy events are correlated with other economic shocks is probably relatively small compared to the other sources of endogeneity bias discussed in Section IV.A.. Another factor that may mitigate the impact of the cyclical policy events are the lagged controls. 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 requirement that the policy events are contemporaneously uncorrelated with economic shocks.

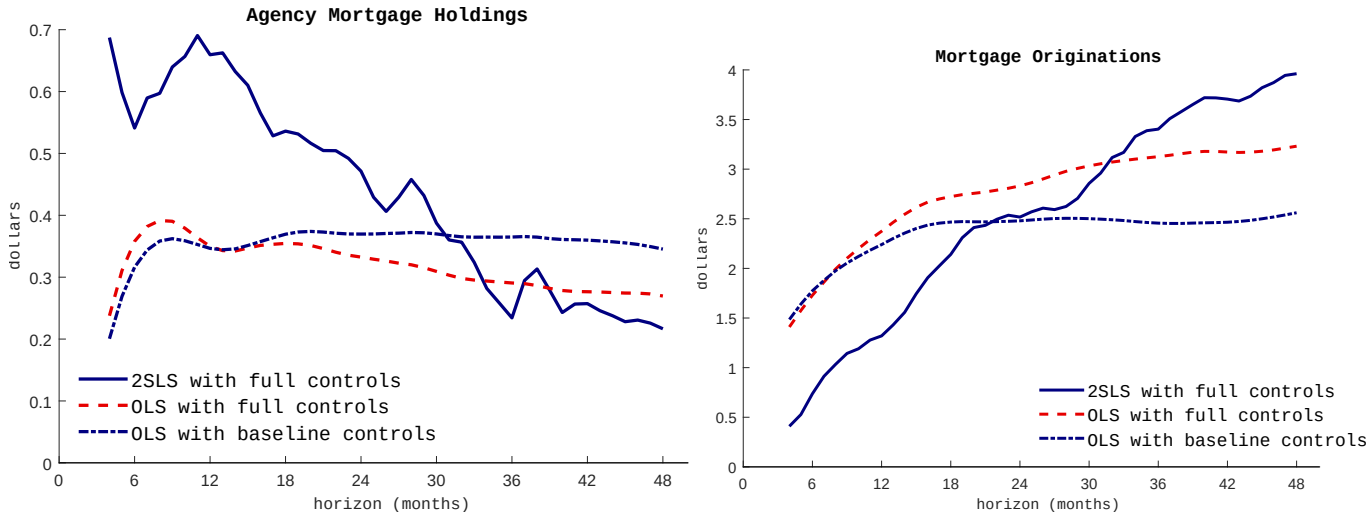
Instrumentation with policy events, however, is important for the results. The OLS estimates in columns [1], [3], and [5] differ substantially in size and display very different time patterns from the IV counterparts in columns [2], [4], and [6]: Agency holdings rise immediately and more or less independently 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.III 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 (panel B). 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.III 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.II 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.II 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 the GSE to S&P 500 stock price ratio 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

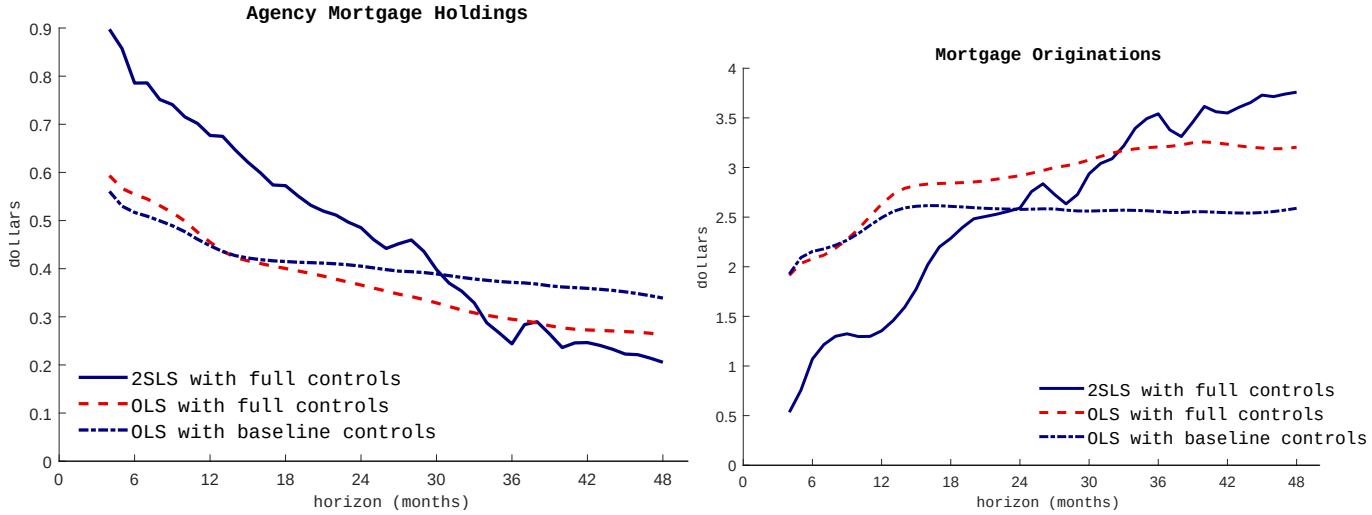


FIGURE A.III Comparing OLS and 2SLS Estimates of Mortgage Credit Multipliers

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.I 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.II CREDIT MULTIPLIERS, SAMPLE AND ROBUSTNESS CHECKS

	Months	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Agency Holdings	12	0.66***	0.76***	0.42***	0.88	0.64***	0.67***	0.72***	0.63***
		(0.40, 0.92)	(0.31, 1.22)	(0.23, 0.61)	(−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***	0.31***	0.78	0.52***	0.53***	0.60***	0.48***
		(0.30, 0.77)	(0.27, 0.96)	(0.16, 0.45)	(−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***	0.26***	0.59	0.45***	0.47***	0.53***	0.43**
		(0.26, 0.69)	(0.28, 0.82)	(0.12, 0.41)	(−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***	0.08	0.32	0.21	0.16	0.21	0.27
		(−0.00, 0.47)	(0.11, 0.53)	(−0.10, 0.25)	(−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	0.09	0.17	0.20	0.15	0.20	0.30
		(−0.04, 0.47)	(−0.10, 0.47)	(−0.12, 0.30)	(−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**	−0.44*	−0.83	−0.72**	−0.83**	−0.94**	−0.95***
		(−1.40, −0.11)	(−2.20, −0.27)	(−0.93, 0.04)	(−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*	0.01	0.31	−0.21	−0.32	−0.31	−0.30
		(−0.81, 0.34)	(−1.40, 0.04)	(−0.28, 0.31)	(−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*	0.19	0.65	−0.04	−0.17	−0.11	−0.25
		(−0.63, 0.48)	(−1.15, 0.09)	(−0.10, 0.47)	(−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	0.56***	0.73	0.36	0.42	0.33	−0.24
		(−0.27, 0.88)	(−0.94, 0.47)	(0.25, 0.86)	(−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	1.12***	1.62	0.87*	1.09*	0.89	0.15
		(−0.13, 1.76)	(−0.79, 1.61)	(0.45, 1.79)	(−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	−0.02	0.05	−0.07	−0.16	−0.22	−0.32
		(−0.53, 0.34)	(−1.10, 0.16)	(−0.37, 0.32)	(−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	0.32***	1.09	0.31	0.20	0.29	0.18
		(−0.11, 0.72)	(−0.57, 0.44)	(0.08, 0.56)	(−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	0.45***	1.25	0.41*	0.29	0.42	0.18
		(−0.01, 0.81)	(−0.46, 0.49)	(0.23, 0.68)	(−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	0.63***	1.05**	0.57***	0.58**	0.54**	0.03
		(0.13, 0.95)	(−0.54, 0.70)	(0.42, 0.85)	(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	1.21***	1.79	1.07***	1.24***	1.09**	0.45
		(0.31, 1.76)	(−0.45, 1.65)	(0.69, 1.73)	(−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	2.09***	−0.23	1.39***	1.32***	1.14*	1.47***
		(0.44, 2.20)	(−1.47, 2.28)	(1.39, 2.78)	(−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*	2.93***	1.56	2.20***	2.00***	2.04***	2.38***
		(1.32, 2.96)	(−0.02, 2.83)	(2.39, 3.47)	(−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***	3.22***	2.79*	2.59***	2.35***	2.55***	2.63***
		(1.68, 3.35)	(0.61, 2.88)	(2.66, 3.77)	(−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***	3.79***	4.43***	3.53***	3.56***	3.70***	2.69***
		(2.10, 4.71)	(1.27, 3.75)	(2.97, 4.61)	(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***	4.30***	5.59	4.07***	4.29***	4.35***	3.06***
		(2.20, 5.72)	(1.47, 5.30)	(2.98, 5.63)	(−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 stock price

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.II 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.IV 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. For reference, the left panel repeats the responses of total mortgage originations shown in Figure VII . 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.IV are consistent with those for the dollar credit multipliers reported in Section V.. Refinancing originations show a gradual increase following the agency purchase shock. Purchase originations also rise, but with a longer delay relative to refinance originations. Purchase originations are initially lower for the first six months or so, before rising between 12 and 24 months. Using the average share of refinancing originations of 25% over the benchmark sample, the estimates in Figure A.IV imply that refinancing originations account for the larger share of the increase in total originations.

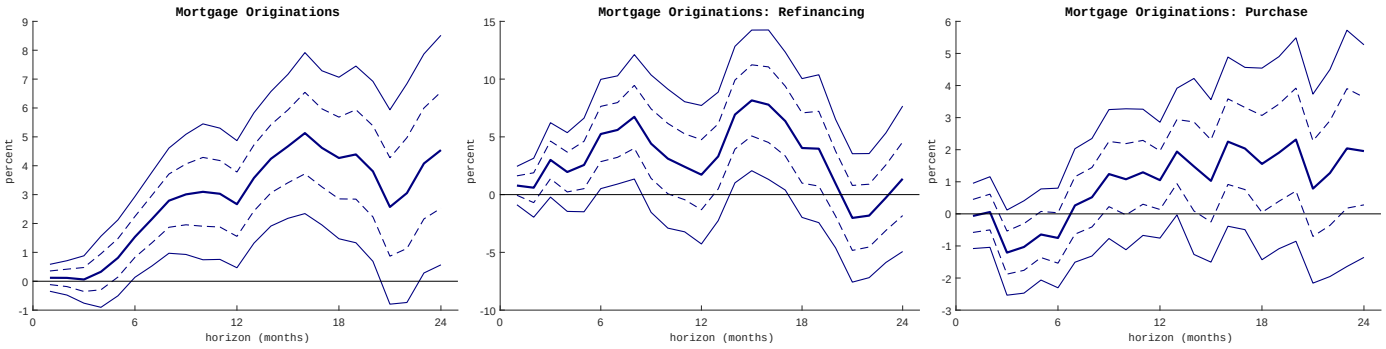


FIGURE A.IV Impulse Responses to a Shock to Anticipated Agency Purchases

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 (3). Finer lines are 68% and 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.V 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 VII.. As in Figure XII , 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 XII 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.V 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.

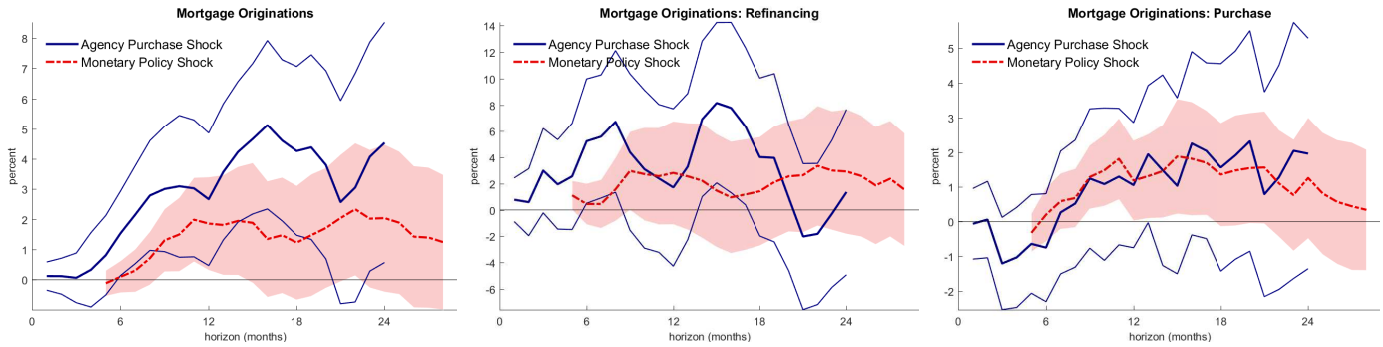


FIGURE A.V Responses to a Shock to Anticipated Agency Purchases Versus a Monetary Policy Shock

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 (3), 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.III Impulse Response Analysis: Sensitivity Checks

1. Omitting the 1977-1982 and NBR-targeting Periods. Figure A.VI 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 sizable 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.VI are qualitatively very similar to those of the full sample, and in both cases include both a 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.

2. Post-1982 Sample. Figure A.VII 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 agency purchases instrumented with the narrative instrument, as in Figure VII . 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 slightly smaller.

3. Including Romer and Romer (2004) Shocks as Controls. Figure A.VIII compares the benchmark narrative impulse response estimates of Figure VII 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.VIII shows that controlling for the Romer and Romer (2004) shocks has little effect on the estimation results.

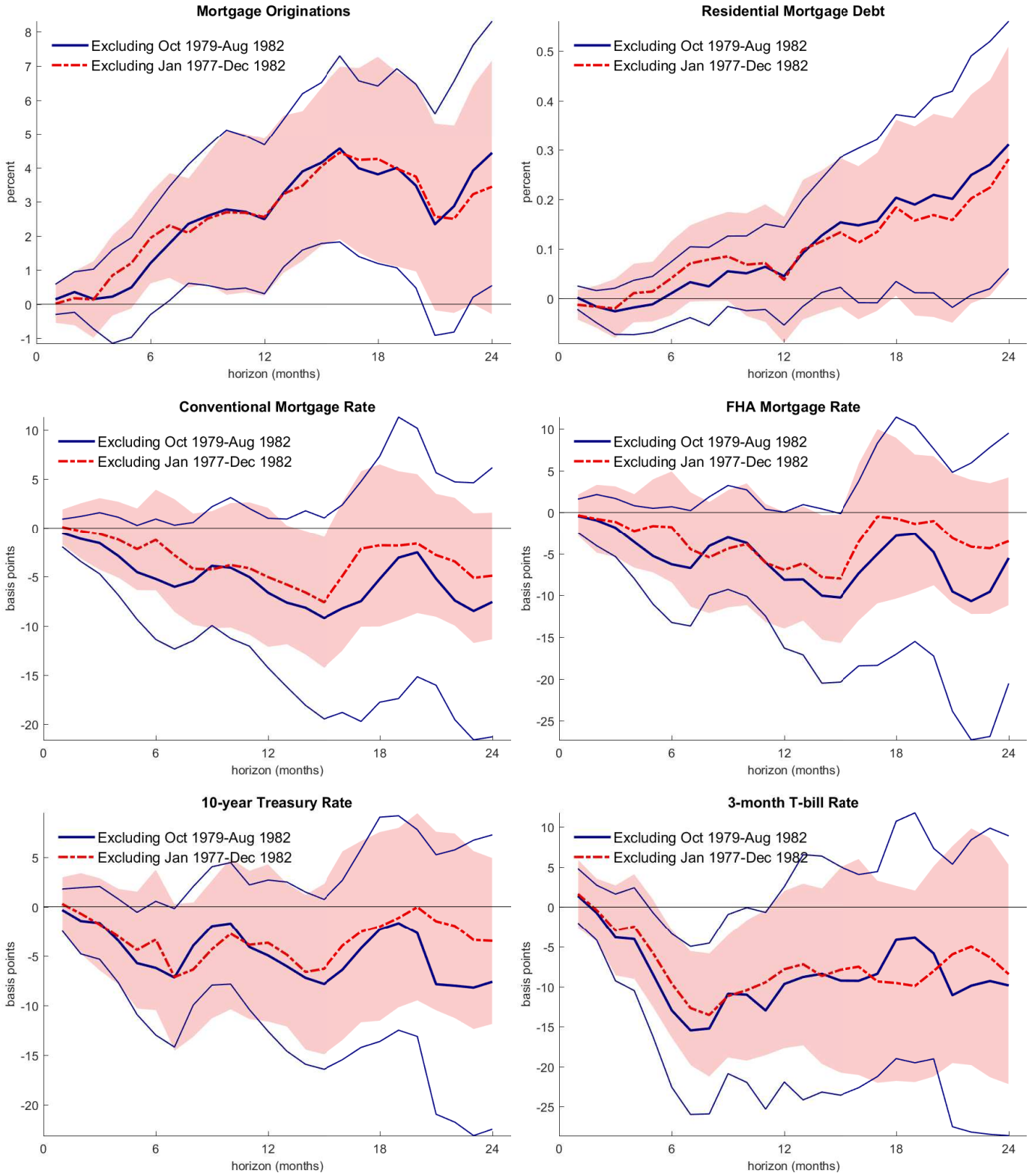


FIGURE A.VI **Impulse Responses Excluding 1977-1982 and NBR Targeting Periods**

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 (3). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006, excluding the period indicated.

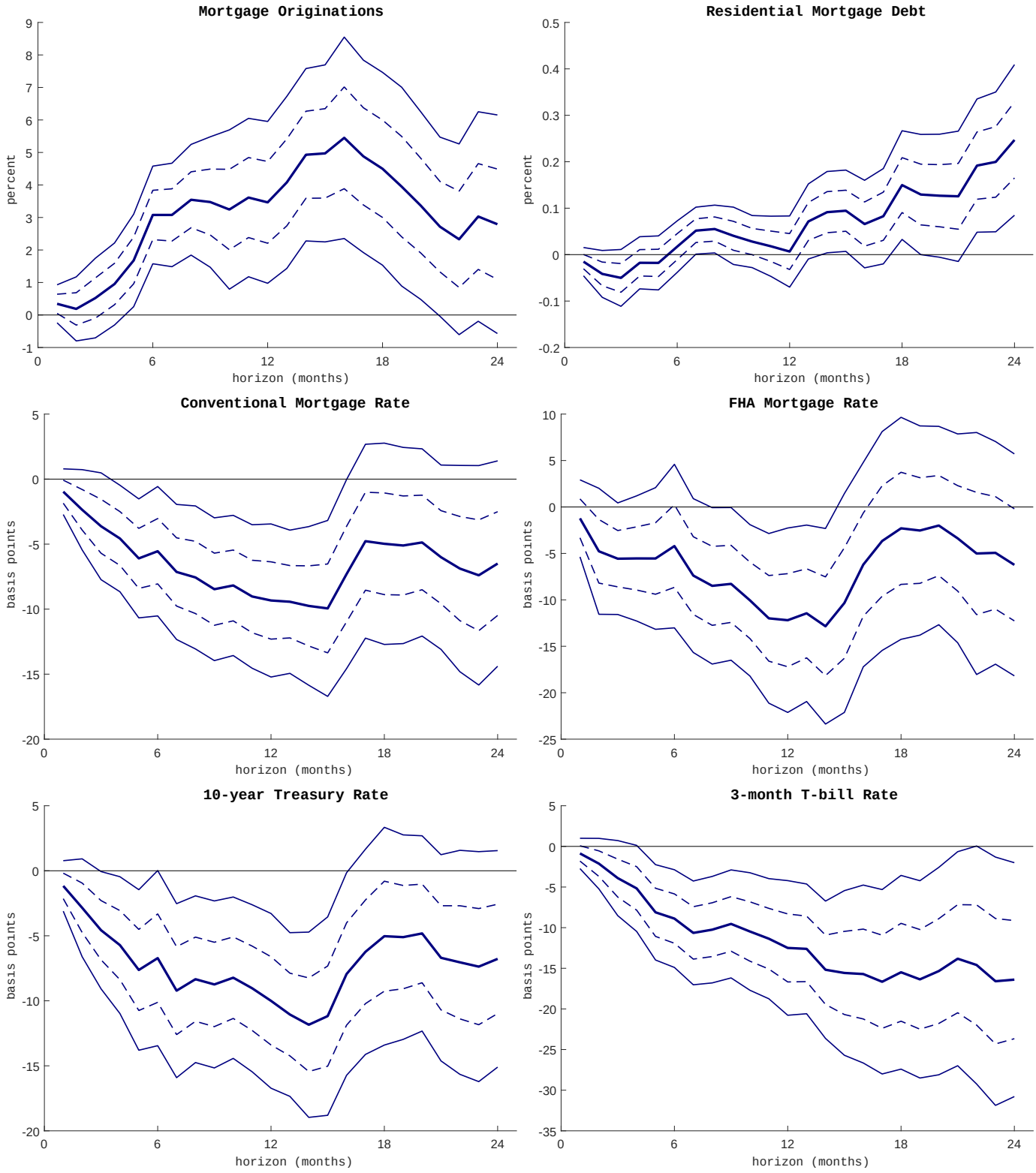


FIGURE A.VII Impulses Responses in the Post-1982 Sample

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 (3). Finer lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Oct 1982 to Dec 2006.

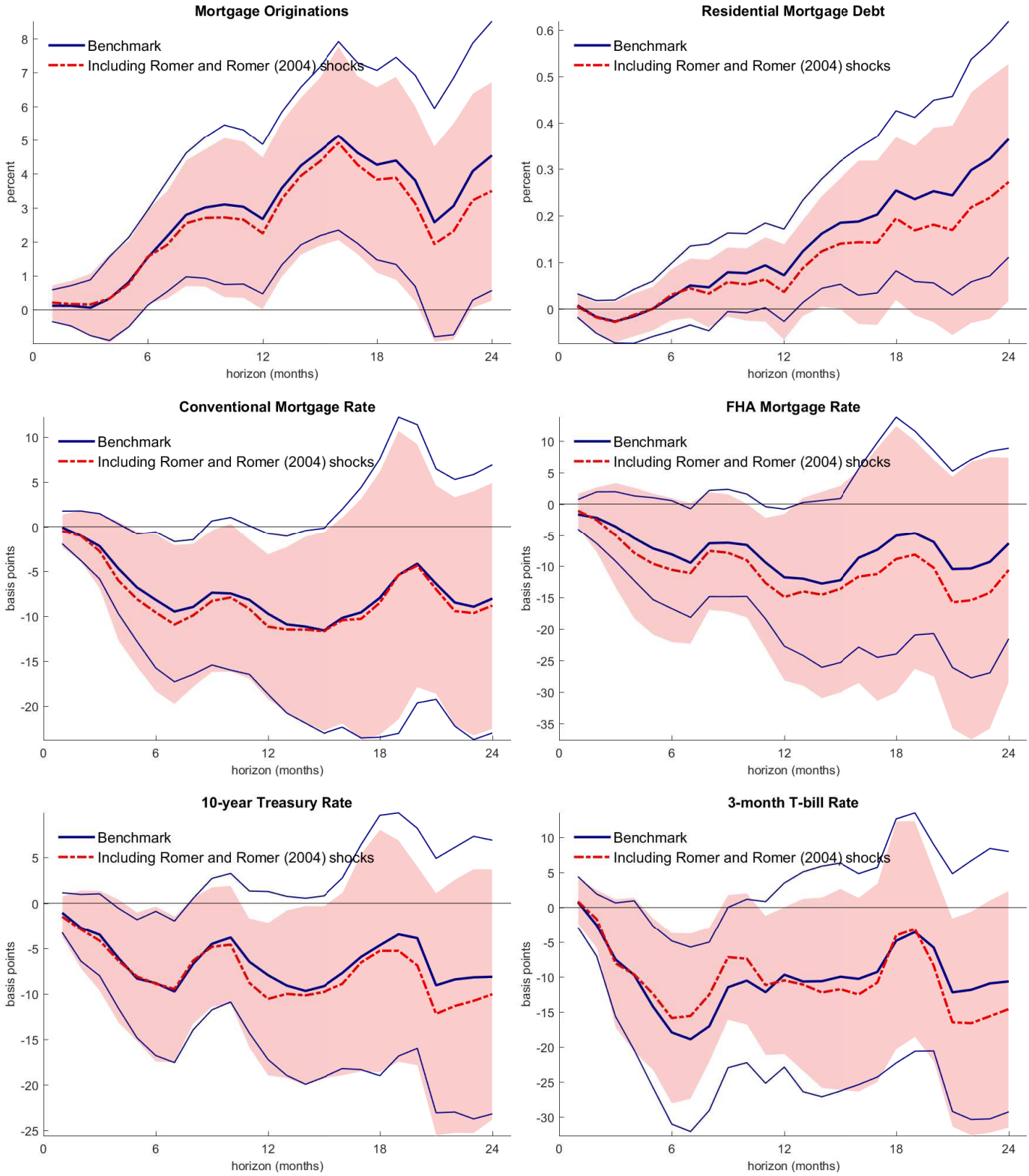


FIGURE A.VIII Controlling for Romer and Romer (2004) Shocks

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 (3). 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.IV Alternative Versions of the GSE Excess Returns Instrument

As described in the appendix of the main paper, the GSE excess returns shocks are defined as the residual in the regression given in (4). Our benchmark specification controls for returns on the market portfolio, as well as on a real estate sector portfolio. This section presents results based on several alternative versions of the excess returns instrument that are obtained by adding additional contemporaneous regressors in the vector W_t relative the benchmark results in the paper. Each of the additional variables are obtained from the data library on the homepage of Kenneth French at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french

Figure A.IX shows the results after adding the excess return on a value-weighted banking sector portfolio, and Figure A.X after adding the excess return on a value-weighted finance sector portfolio. The return variables exclude dividends and are expressed relative to the overall market return. Figure A.XI shows the results after adding the Fama-French value and size factors. All the additional results are very close to those reported in Figure XVI .

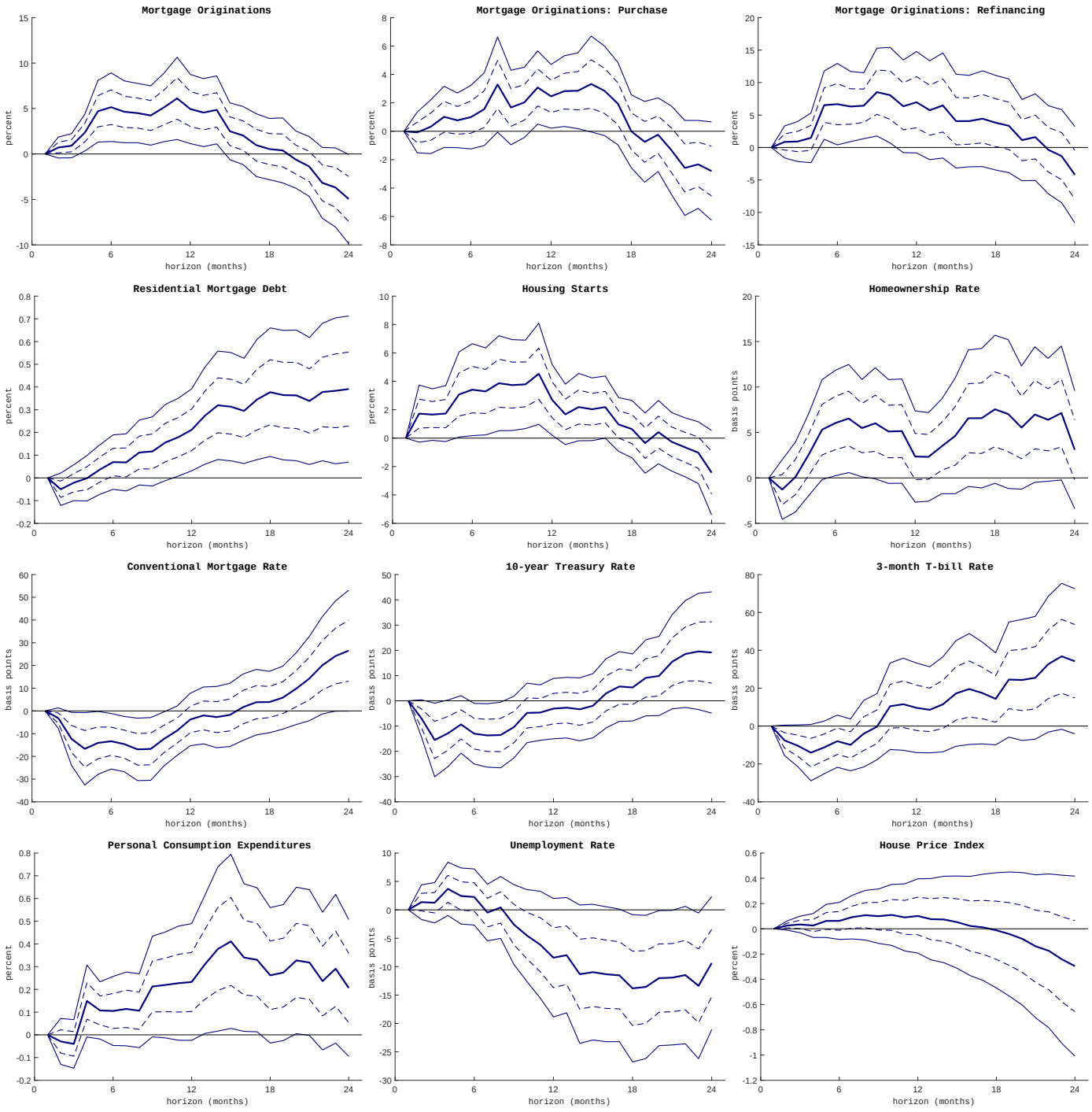


FIGURE A.IX Controlling for Banking Sector Excess Returns

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 GSE excess stock returns innovations, see equation (5). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Sep 1970 to Dec 2006.

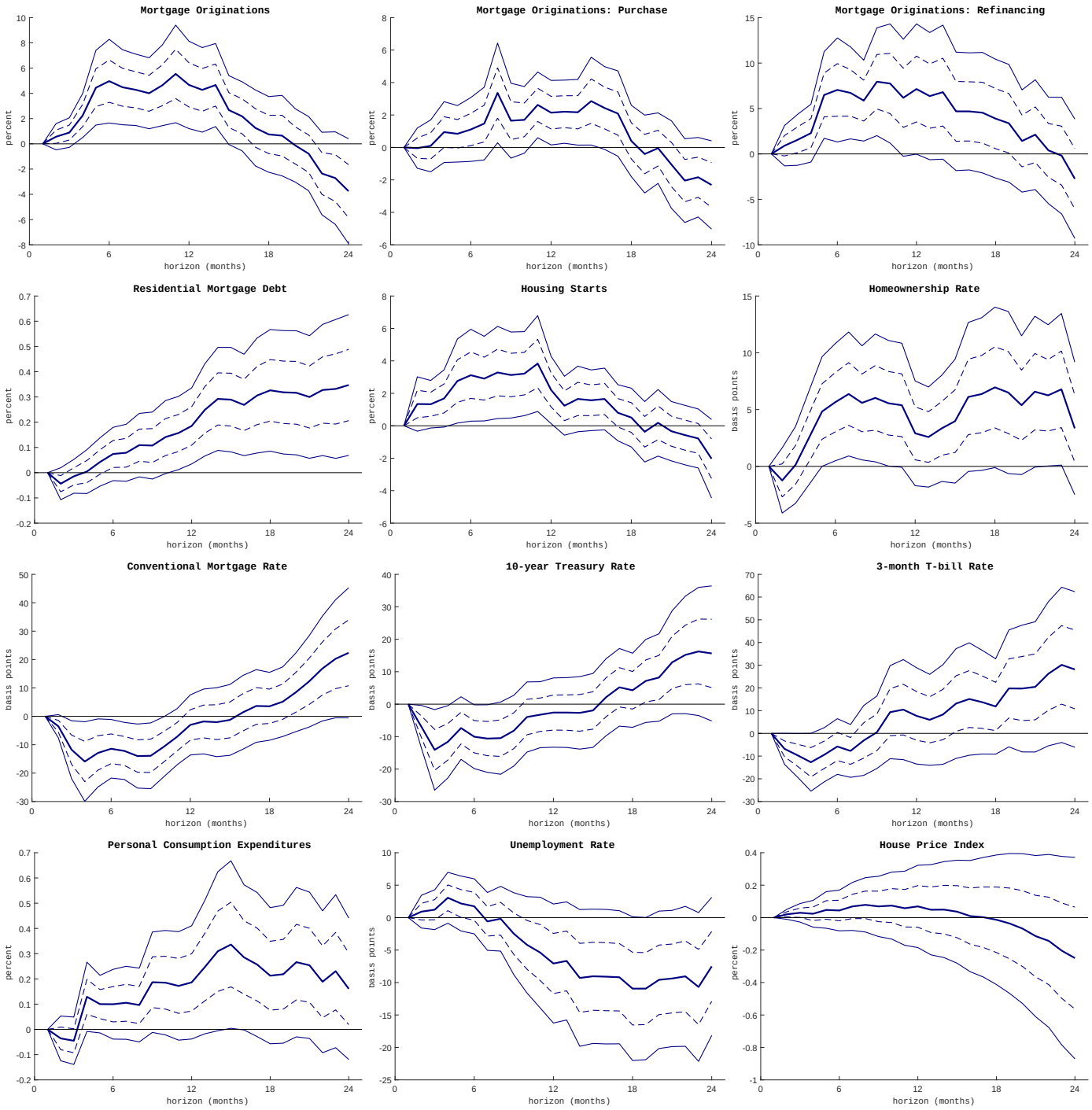


FIGURE A.X Controlling for Finance Sector Excess Returns

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 GSE excess stock returns shocks, see equation (5). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Sep 1970 to Dec 2006.

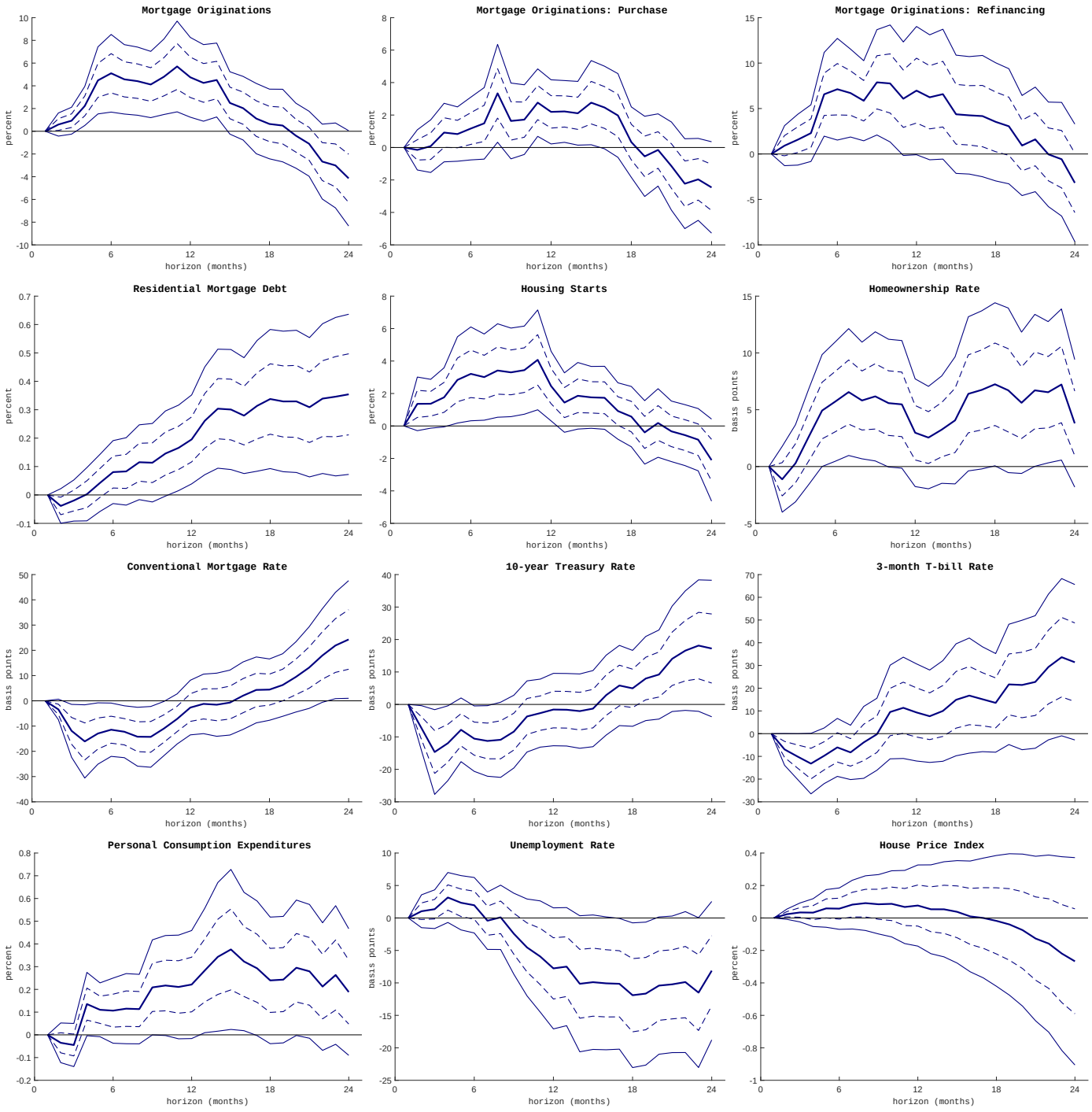


FIGURE A.XI Controlling for Fama and French (1993) Size and Value Factors

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 GSE excess stock returns shocks, see equation (5). Finer lines are 68% and 95% Newey and West (1987) confidence bands. Sample: Sep 1970 to Dec 2006.

A.V 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 (3). 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 GSE excess returns shocks 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 that of 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 cumulative difference in returns between (1) the Fama-French market portfolio and a risk free portfolio, (2) GSE stock and the market portfolio, and (3) the Fama-French real estate and market portfolios. We estimate the VAR by OLS using 12 lags of all the endogenous variables and using monthly data from September 1970 to December 2006.

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 (3) 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.XII 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 VII . 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 A.XII 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. The SVAR estimates are generally very similar to those obtained using LPIV regressions using the GSE excess returns shocks as an instrument for agency mortgage purchases.

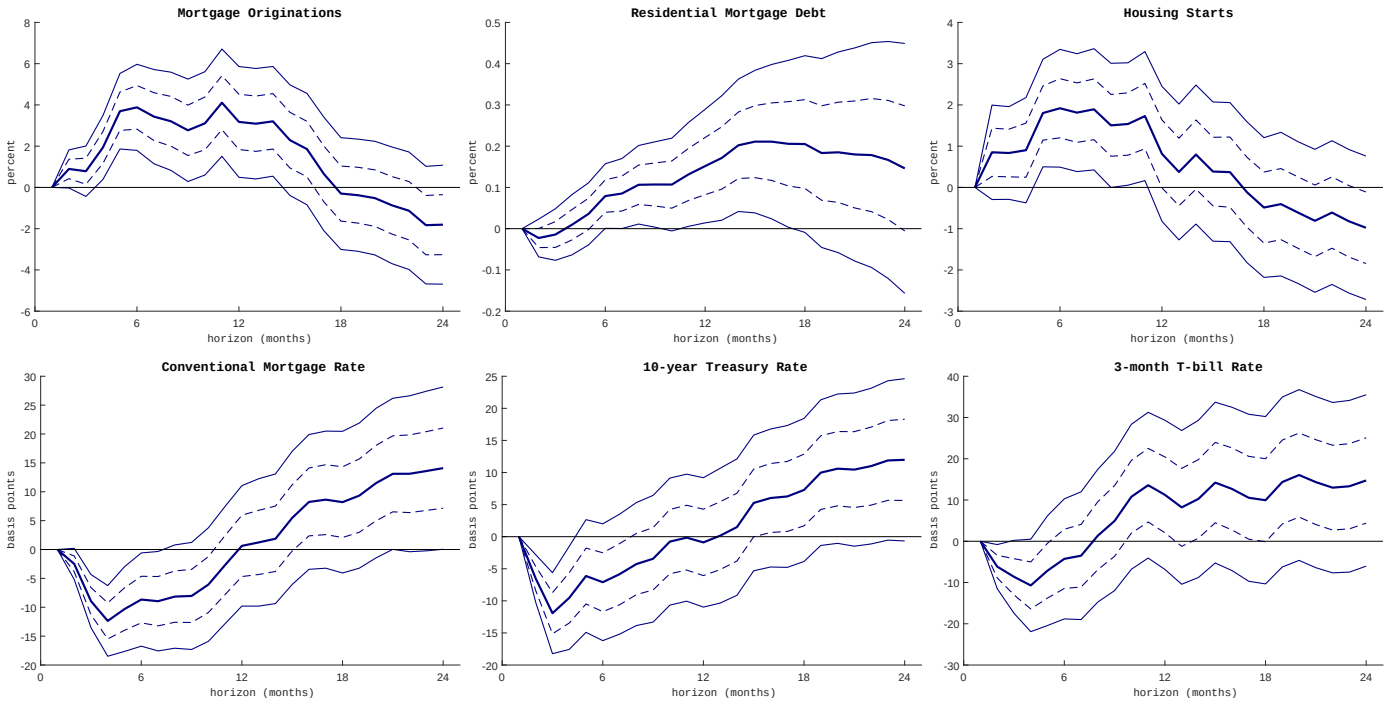


FIGURE A.XII SVAR Impulse Responses to a GSE Excess Returns Shock

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: Sep 1970 to Dec 2006.

An advantage of the SVAR model is that it is straightforward to evaluate the relative importance of shocks in driving fluctuations in the endogenous variables. Figure A.XIII depicts the share of the forecast error variance at various horizons that is due to the identified GSE excess returns shocks. For comparison, Figure A.XIII 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 8% 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.XIII 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 12% 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 6% to 8% of originations, and around 11% 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 14% and 7%, respectively, of the variance in mortgage and 10-year Treasury rates at horizons shorter then 6 months. GSE excess returns shocks are relatively 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.

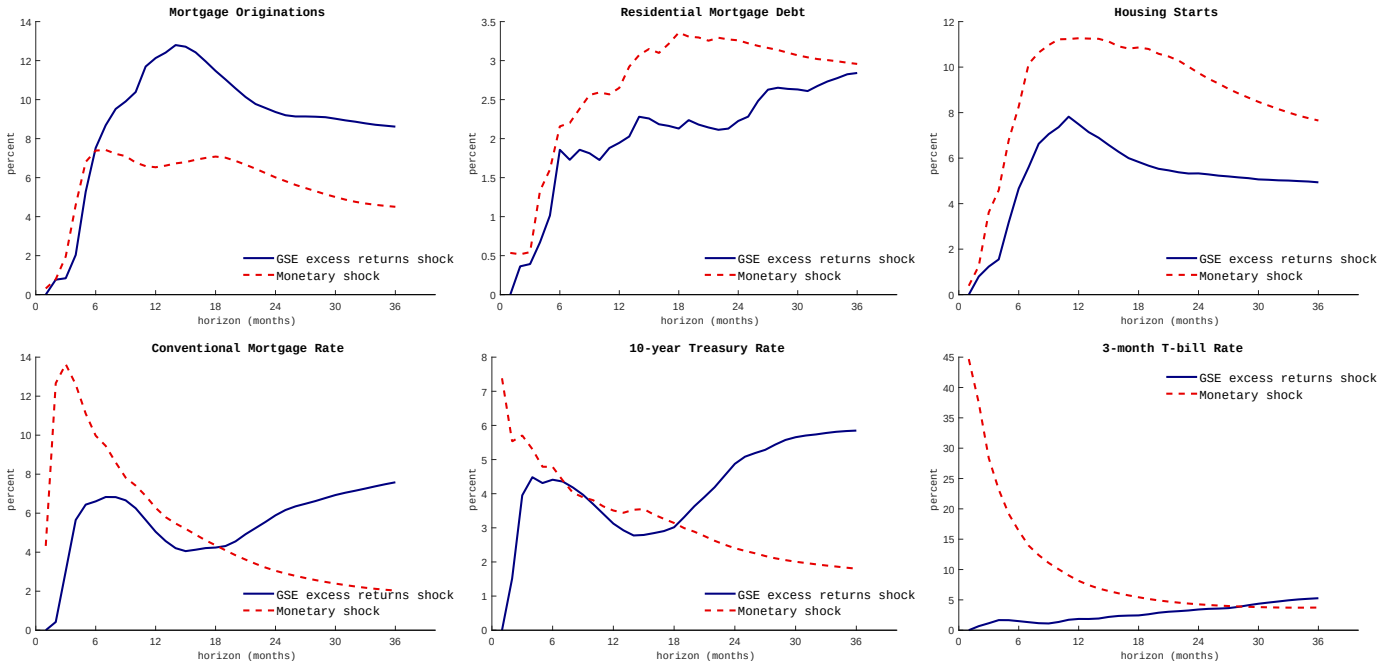


FIGURE A.XIII Forecast Error Variance Contributions of Monetary and GSE Excess Returns Shocks

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 Appendix II. Sample: Sep 1970 to Dec 2006.

REFERENCES

Fama, Eugene F. and Kenneth R. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics*, 33 (1993), 3–56.

Mertens, Karel and Morten O. Ravn, "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States," *American Economic Review*, 103 (2013), 1212–1247.

Romer, Christina D. and David H. Romer, "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review*, 94 (2004), 1055–1084.

Stock, James H. and Mark W. Watson, "Disentangling the Channels of the 2007-2009 Recession," *Brookings Papers on Economic Activity*, 1 (2012), 81–135.