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

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Abstract

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

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

JEL Classification: E44, E52, N22, R38, G28

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1 Introduction

The residential mortgage market in the United States is one of the largest capital markets in the world and by far the dominant source of credit for American households. The mortgage market finances housing, which is a key component of both household wealth and aggregate spending, see e.g. Leamer (2007). Many accounts of the causes and propagating factors of the 2007/08 financial crisis assign an important role to a boom and bust in the availability of mortgage credit.[1] The US mortgage market is also subject to heavy government involvement through various federal agencies, including the housing government sponsored enterprises (GSEs). In the decades preceding the 2007/08 crisis, the combined agencies accumulated a large share of the total outstanding US mortgage debt on their balance sheets. In this paper, we investigate whether such agency portfolio purchases of mortgage assets influence the availability and cost of housing credit, and whether there are spill-overs 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, Freddie Mac and Fannie Mae, 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 purchasing activity reflect changes in housing credit demand and many other influences. Some of the correlation between agency balance sheets on the one hand and credit growth or mortgage rates on the other is therefore likely to reflect reverse causality.

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

[1] See e.g. Mian and Sufi (2009), Justiniano, Primiceri and Tambalotti (2014) or Di Maggio and Kermani (2015).

borrowing authority, direct appropriations and capital injections by the Treasury, or interventions that expand the pool of mortgages eligible for purchase by the agencies, such as changes in conforming loan limits or authorizations to enter new segments of the mortgage market.

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

Our second and complementary identification approach is based on instrumenting measures of agency purchasing activity with orthogonalized innovations in Fannie and Freddie excess stock returns. This alternative strategy is analogous to Fisher and Peters (2010), who use excess return innovations in major US defense stocks as a measure of news shocks to military spending. Positioned last in a causal ordering behind credit aggregates, interest rates and other macro variables, we find that residual variation in Fannie and Freddie excess stock returns predicts agency mortgage purchases. We use this residual variation as an alternative instrumental variable to estimate the response of credit aggregates to shocks to agency mortgage purchases.

In the absence of financial market frictions, changes in the purchasing activity of government agencies should have no impact on the volume of mortgage credit, and lead to perfect crowding out of private holdings. In the data, we find instead that agency purchases 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

[2]The full narrative analysis is available in a companion paper, see Fieldhouse and Mertens (2016).

stock of mortgage debt of around one dollar. The expansionary effects on housing credit are accompanied by reductions in mortgage interest rates, which fall by 10 to 15 basis points for more than a year following a increase in agency mortgage purchases of one percent of trend originations.

Agency purchases also affect prices in other asset markets, and influence residential investment. We find for instance that the 10-year Treasury rate and the 3-month T-bill rate both decline when the agencies increase their purchases of mortgages. A key policy objective behind President Hoover's introduction of housing credit policies in the 1930s was to stimulate the construction sector. We find evidence that supports this role of the agencies in that new housing starts rise temporarily 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 less robust evidence of any significant impact on the unemployment rate or personal sector income.

Our perhaps most surprising finding concerns the relationship between housing credit policies and conventional monetary policy. We find that the narratively identified housing credit policy shocks have forecasting power for the residual "shock" component of the Romer and Romer (2004) decomposition of funds rate target changes, while the reverse is not true. Instead, we find that the cyclically motivated housing credit policy changes lean against the wind by accommodating contractionary monetary shocks identified through the Romer and Romer (2004) measure. Further, we find that the quantitative effects of housing credit policy and conventional monetary shocks are very similar along many dimensions. These findings suggest that both may share similar transmission channels, and that the interplay between monetary and credit policy deserves more attention.

The remainder of the paper is structured as follows. Section 2 provides background and data on mortgage purchases as credit policy in the United States. Section 3 describes our narrative identification approach. Section 4 contains our results regarding the impact of agency mortgage purchases on housing credit. Section 5 examines the effects on asset markets and macroeconomic aggregates. Section 6 discusses the relationship with conventional monetary policy. Finally, Section 7 concludes.

2 Mortgage Purchases as Credit Policy in the United States

The US government intervenes in the mortgage market in many ways. We focus attention on the federal involvement in the purchasing of residential mortgages. The first significant use of this type of policy dates back to the Great Depression. The sharp and sustained downturn in credit markets motivated Congress to create the Home Owners' Loan Corporation in 1933. Financed by bonds, the Corporation purchased delinquent mortgages from lenders and refinanced these mortgages into fully-amortizing fixed rate loans with long maturities to lower monthly payments for distressed mortgagors. In 1938, Congress created Fannie Mae to support a secondary market for government-guaranteed mortgages. Fannie's authority to acquire mortgage debt was increased greatly after WWII to support the construction sector and promote homeownership among veterans. The late 1960s saw the creation of Ginnie Mae to provide continued support the market for government-guaranteed mortgages, while Fannie Mae obtained permission to enter the conventional market.[3] In 1970, the newly created Freddie Mac joined Fannie Mae in developing a nationwide secondary market for conventional mortgages and further enhancing the flow of credit to mortgage lenders.

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

[3] Conventional mortgages are loans that are not directly guaranteed or insured by the federal government.

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

The post-WWII period witnessed a marked expansion in mortgage debt, rising from around 10 percent of GDP at the end of WWII to more than 80 percent by 2008, before steadily declining in the wake of the 2007/08 financial crisis. Originations of new mortgages are volatile, procyclical, and average around 20 percent of outstanding debt at an annualized rate.[6] By any measure, the government agencies have over time become large players in the mortgage market. Between 1980 and 2006, total purchases in the secondary market by Fannie and Freddie alone average around 40 to 50 percent of originations. The majority of these acquisitions are 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, roughly 20 percent owned by Fannie and Freddie alone. In early September 2008, Fannie and Freddie were taken into conservatorship and were required to gradually wind-down their balance sheets by two thirds. The Federal

[4] Other agencies include the Homeowners' 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 shown may occasionally exceed 100 percent.

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

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

The focus of this paper is on the portfolio purchases by the housing agencies, shown in blue in the lower right panel in Figure 1. Prior to the Fed's QE programs, Fannie and Freddie accounted for the bulk of agency mortgage acquisitions. Even as privately owned corporations, Fannie and Freddie have been key agents of federal housing policy and differ from traditional financial intermediaries in a number of important ways. First, they have always maintained authorization to borrow from the Treasury. While this authorization was limited and never formally exercised, it sufficed to create the widely held belief that the US government would never allow a GSE to default. This perception, eventually justified by the government takeover of Fannie and Freddie in 2008, meant that interest rates on agency bonds have typically been close to Treasury rates. Secondly, 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.[7] Regulatory oversight of the GSEs was traditionally light compared to that of private banks, and the GSEs generally enjoyed much less stringent capital and reporting requirements. For instance, despite being publicly listed companies, Fannie and Freddie were exempt from filing with the Security and Exchange Commission until the early 2000s. Finally, for much of their existence, the GSEs have also benefitted from various forms of preferential tax treatment.

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 the Secretary of the Department of

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

Housing and Urban Development. 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.

To our knowledge, there are few attempts at identifying the dynamic effects of agency purchases on mortgage credit or residential investment. Starting with Hendershott and Shilling (1989), a large number of studies have documented a significant interest rate spread between conforming and similar non-conforming loans, which suggests that the GSEs affect the cost of mortgage credit. An older 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). More recently, Naranjo and Toevs (2002) find a negative long run relationship between GSE purchases and mortgage rates, while Gonzalez-Rivera (2001) does not. The closest study to ours is by Lehnert, Passmore and Sherlund (2008), who use generalized impulse response analysis in VAR models and time-series data from 1993 to 2005. They find no evidence that higher GSE purchases are associated with lower mortgage rates. We base our causal claims on arguably better identification strategies and a larger time frame.

Our paper is also related to the many analyses of the large-scale MBS purchases by the Federal Reserve under the QE programs. Most event studies looking at high frequency financial data conclude that these purchases lowered secondary market mortgage yields.[9] Exploiting cross-sectional variation, a few recent studies also uncover evidence for a positive impact on mortgage lending.[10] By exploiting the much longer

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

[9] See e.g. Gagnon et al. (2011), Kishnamurthy and Vissing-Jorgenson (2011), Patrabansh, Doerner and Asin (2014) and Hancock and Passmore (2011, 2014). Stroebel and Taylor (2012) instead find no effects of the MBS purchases under QE1.

[10] Di Maggio, Kermani and Palmer (2016) for instance find that, after the first QE intervention, originations of mortgages qualifying for inclusion in securities eligible for purchase by the Fed increased substantially more than those of non-qualifying mortgages. Darmouni and Rodnyanski (2016) find that banks with larger mortgage positions increased lending relative to banks with smaller positions, and Chakraborty, Goldstein and MacKinlay (2016) find that banks with MBS exposure increased their mortgage origination share relative to other banks.

history of government involvement in the purchasing of mortgages, our paper provides additional evidence on whether these types of credit policy interventions can affect mortgage lending and economic activity.

3 Identifying Causal Effects of Agency Mortgage Purchases

3.1 Endogeneity Problems

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

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

The right panel of Figure 2 shows the average real levels of mortgage holdings centered around the peak of credit cycles. This peak is the quarter preceding the start of credit crisis episodes based on the datings in Eckstein and Sinai (1986) and subsequent updates.[11] 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

[11] 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) (1990 commercial real estate crunch), Lehnert, Passmore and Sherlund (2008) (1998 Russian default/LTCM crisis) and Bordo and Haubrich (2010) (2007/08 Financial Crisis).

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 shows that, on average, agencies increase their share of the market in cyclical downturns and credit crunches. This remains true when we omit the 2007/08 crisis and the Fed interventions. There are a number of reasons why the agencies jointly maintain or expand purchases during cyclical downturns. A public mission to provide stability to mortgage markets is mandated in the charters of the GSEs. Credit crises also offer particularly profitable opportunities for the GSEs because lending spreads widen for GSEs relative to private intermediaries due to the implicit guarantee. Finally, the federal government often undertakes deliberate regulatory or legislative actions to enable agency expansions during downturns. The fact that agency purchases tend to accelerate when mortgage spreads are elevated and/or credit is tight induces a negative relationship with mortgage credit aggregates. This negative association needs to be accounted for in order to determine the causal effects of agency mortgage purchases.

3.2 Narrative Analysis of Policy Changes Affecting Agency Mortgage Holdings

Our principal strategy to control for reverse causality in the relationship between agency mortgage purchases and credit conditions is to study outcomes after major regulatory events impacting agency mortgage holdings. In a companion paper, Fieldhouse and Mertens (2016), we provide a detailed analysis of significant credit policy events since the Great Depression, together with estimates of their quantitative importance and a classification according to their main objective. By focusing on policy interventions by the federal government, we control for purchasing activity that results from the agencies' regular response to market developments. Because policymakers often respond to conditions in mortgage and housing markets, we further exclude interventions with short run stabilization motives as a primary objective. The end result of the narrative analysis is a record of policy changes that we use as an instrumental variable for agency purchasing activity. Here we provide a brief summary of the narrative analysis in Fieldhouse and Mertens (2016) as well as a description of the instrument.

3.2.1 Overview of Methodology

Historical Sources We use primary sources whenever possible when searching for regulatory changes of the agencies. Since a number of different policymakers can change the parameters under which the government agencies must operate, we look at a variety of sources. These include those of the President and the Cabinet, particularly the Secretary of the Treasury and Secretary of the Department of Housing and Urban Development, as well as regulatory agencies in the executive branch, Congress, and the Federal Reserve Board of Governors. Principal sources include the legislative text of public laws, the US Code, the Federal Register, the Budget of the United States Government, the Economic Report of the President, and periodical reports of agencies and regulators.[12]

When estimating the quantitative aspects of the policies, we exploit information released by the Congressional Budget Office , Government Accountability Office, Congressional Research Service, and the Treasury Department that contain detailed analyses of policy changes, background information, and/or balance sheet data for the agencies in question. We also used information from the annual or periodic reports of the government agencies and regulators. Committee report language also occasionally includes projected effects of a policy change. The ProQuest Congressional Publications Database, HeinOnline's Federal Register Library, Congressional Quarterly Almanac, and newspapers and newsletters were also used for documenting pertinent news surrounding policy changes, their timing as well as implementation dates.

The principal sources for identifying policy motives include Congressional committee reports and hearings, Presidential speeches and signing statements, the Budget, the Economic Report of the President, the Federal Reserve Bulletin and Annual Report of the Board of Governors of the Federal Reserve, the CQ Almanac, and newspapers, financial newswires, and mortgage industry newsletters. For legislated policies, the accompanying reports of the US Senate Committee on Banking, Housing and Urban Affairs and the US House Financial Services Committee typically detail the Committee's motivation and any pertinent economic context. Major housing policy laws are typically accompanied by a Presidential signing statement explaining

[12]The latter include annual reports of the Department of Housing and Urban Development, Office of Federal Housing Housing Enterprise Oversight, and the Federal Housing Finance Agency.

the bill's motivation, context, and intended impact. Final rules published in the Federal Register almost always include a detailed background and overview of the proposed rule, public comments submitted, and modifications to the final rule, if applicable.

Identifying Significant Policy Changes Starting from all regulatory and legislative actions, we restrict attention to 'significant' policy events. An intervention is deemed significant if it would be expected to either directly impact the agencies' permissible or mandated level of net commitments, net purchases and mortgage holdings, or if it would considerably expand the pool of mortgages eligible for purchase. Policies with a potential direct influence on net purchase volumes include, for instance, leverage regulations, direct appropriations or borrowing authority earmarked for purchases, portfolio limits, or the infusion or retirement of Treasury capital. Interventions expanding the pool of eligible mortgages include discretionary changes in conforming loan limits or regulatory authorizations to enter new segments of the mortgage market.

A further requirement is that policy changes must be sufficiently material that primary sources either explicitly cite projections of their likely impact or could be used indirectly to quantify such impact. This means that we exclude regulatory changes that did not impose or alleviate constraints on agency activity. For instance, when adjustments to statutory debt-to-capital limitations or affordable housing requirements are viewed as non-binding by most accounts and this appears consistent with the agencies' standing balance sheet and composition of purchases, we assign a zero impact. Occasionally a law or public rule sets in place changes in funding authorizations or balance sheet requirements effective multiple years after announcement. Such changes with long delays are hard to deal with when mixed with events with much shorter delays and we therefore restrict attention to those policies taking effect within nine months of being made public. We also ignore any laws or regulations that merely extend prior authorizations, or that are particularly difficult to quantify.[13]

[13]Examples of the latter are events such as the introduction of automatic indexation of conforming loan limits in 1980 or the opening of Freddie Mac to public ownership in 1989. While both actions were undoubtedly important in determining agency market share in the longer run, we could not find any straightforward assessment of the more immediate impact on agency purchase activity, and we therefore omit them from the list of significant policy interventions.

Quantification and Timing For each of the policy events, we obtain an ex ante estimate of the projected impact on the agencies' capacity to purchase mortgages in terms of annualized billions of dollars using information available in contemporaneous sources. Direct appropriations are the most straightforward policies to quantify, at most requiring a pro-rata adjustment bridging annualized effect from funding change at the date of effect to the date of enactment. Public capital injections are quantified as a multiple of one more than the prevailing leverage ratio, to capture the potential increase on the asset side of the balance sheet supported by related debt issues plus the working capital itself. 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. To quantify potential impacts of discretionary conforming loan limit changes, we rely on estimates from Congressional committee reports accompanying legislation and home price index adjustments.[14] For other more difficult-to-quantify policies, we inspect ex ante quotes from committee reports, market analysts, regulators, or agency executives regarding the projected impact on purchasing activity. For relatively large, open-ended changes unlikely to be fully realized on impact, such as leverage ratio increases or permanent appropriations, potential impacts 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 effect.

We date each policy intervention to the month in which, to our best judgment, it became publicly anticipated rather than the month in which it was formally announced or became effective. For regulatory changes we typically use the month in which the proposed rules were first published in the Federal Register or reported in the press, as opposed to the date of the final rule's publication or effect. Legislative changes are often dated when the provision including the policy change was introduced in the House, Senate, or conference version of a bill, rather than upon subsequent enactment. For Fannie Mae and Freddie Mac, we also cross-referenced excess stock returns, defined as the GSE's daily share price changes over that of the S&P 500 index, with major financial news to ensure a news component was being priced into policy changes and to help us verify the timing of policy changes.

[14] Reports often cited the extent to which a large conforming loan increase would restore a GSE's current dollar market activity, and we quantify the policy change as the difference between current purchase volumes and the home-price index adjusted purchase volume of the benchmark year's activity being restored.

Classification by Motivation The principal purpose of the narrative analysis is to single out policies that are free of influences from the prevailing business cycle and financial conditions at the time of the policy change. In doing so, we parse historical documents, paying particular attention to the motives invoked by policymakers or the press, to the nature of the legislative vehicles or regulatory process, to the timing with respect to known periods of economic and financial stress and to whether the policy change is explicitly temporary or permanent in nature.

The motivations for policy changes almost exclusively fall into one or more of four broad categories: Business or financial cycle motives, social policy objectives, structural budgetary motives, or more ideological political pursuits. Policies classified as cyclically motivated tend to emphasize short-term outcomes and are usually drafted and enacted quickly. Examples of language suggestive of cyclical motivations include "*emergency, crisis, recession, credit shortage, credit crunch, housing starts, employment, construction, downturn, depressed, stimulus, boost*", etc. Policymakers are typically quite explicit about cyclical concerns and objectives, overwhelmingly so when policies are implemented in close proximity to recessions or credit crunches.

Legislative policies classified as principally unrelated to the business or financial cycle emphasize longer-term outcomes and tend to be slower-moving bills and deliberate overhauls of housing policy. The various National Housing Acts, Housing and Urban Development Acts, and Housing and Community Development Acts often meet this description, being slowly crafted and subject to lengthy negotiations, with a focus on broad, long-term objectives such as homeownership and inequality. Examples of language indicative of non-cyclical motivations include "*long-term, farsighted, comprehensive, low-income, affordable housing, American Dream, privatization, budget deficit, reduce borrowing, off-budget*," etc. Interventions classified as non-cyclically motivated tend to be actions shaped by prior law or precedent and prompted by events unrelated to the business or financial cycle.

Based on our reading of the historical record, it is relatively straightforward to distinguish cyclically motivated policies from policy changes with other motivations. It is harder to establish a single precise rationale for the non-cyclical actions, which can be motivated by a mix of structural budget deficits, social policy,

or other political objectives. Such policy changes tend to be enacted in deliberate and comprehensive bills, and while a specific regulatory change may have a clearly stated motive, its legislative vehicle usually promotes a range of other non-cyclical objectives as well. These bills are also frequently characterized by a greater deal of compromise and back-and-fourth between the House and Senate or between Congress and the White House, presenting more opportunity for varying and complementary objectives. For our purpose a more precise distinction between these objectives is less relevant, and we therefore adopt a simple binary classification according to which interventions are either cyclically motivated or not.

Sample We restrict attention to policy events after January 1967. This starting point is in part determined by the availability of time series used in the empirical analysis. This choice also selects a period of relative institutional stability as it coincides roughly with the beginning of the privatized GSE era, the emergence of a nationwide secondary market for conventional mortgages, as well as the creation of Ginnie and Freddie. We focus entirely on the mortgage portfolio activity of Fannie, Freddie and Ginnie, ignoring less significant entities for which monthly data is not easily available. We also include the purchases by the Federal Reserve and the Treasury in the recent financial crisis, but most of the analysis in Sections 4 and 5 excludes the crisis/conservatorship period. As shown in Figure 1, the traditional housing agencies that we include account for the vast majority of agency mortgage holdings prior to the financial crisis.

3.2.2 The Narrative Measures of Policy Changes

Table 1 lists the policy events resulting from the narrative analysis. Each intervention is described by the agencies affected, by its annualized projected impact (in billions of US dollars), timing, and motivation. The monthly sample contains 47 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 13 cyclically and 17 non-cyclically motivated policy events.

Figure 3 depicts the interventions as a percentage of the average annualized level of originations in the preceding 12 months. The left (right) panel shows the changes classified as unrelated to the business or

credit cycle (cyclically motivated). For reference, each figure also shows credit crisis episodes in grey. The cyclically motivated interventions almost all occur during credit crunches (and 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 all classified as cyclically motivated.[15] The only post-2006 events that we consider non-cyclical are the removal of Fannie and Freddie portfolio caps in February 2008, which was contingent on the timely filing of financial reports after earlier accounting scandals at both agencies, and a 2012 Treasury decision to accelerate the mandated decline in portfolio caps under the conservatorship agreement with Fannie and Freddie. Among the interventions that we consider not cyclically motivated, the three largest (relative to average originations) are the October 1977 combination of a conforming loan limit increase and the expansion of the Brooke-Cranston Tandem program, an increase in Fannie Mae's debt-to-capital limit in December 1982 and the tightening of Fannie Mae capital requirements in September 2004 in the wake of the accounting scandals. We refer to Fieldhouse and Mertens (2016) for a detailed discussion of these events.

Do the policy changes that we have narratively identified lead to actual changes in agency purchases and retained mortgage portfolios? To investigate this, it is important to take into account that there may be significant delays between the policy events and their impact on the agency portfolios. Recall that agencies initially sign advance commitments to buy loans from mortgage providers and subsequently effectuate these as loans are originated in the primary market. We regress three activity indicators, net mortgage purchase commitments made by the agencies, the actual net purchases of mortgages, and the stock of agency mortgage holdings, on the indicator for non-cyclical policy events m_t:

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

We use monthly observations from January 1967 to December 2014 in log first differences of current dollars. Because monthly purchase flows are relatively volatile, we run the regressions for a 36 month backward moving average of these variables. The event indicator m_t is the non-cyclically motivated narrative measure

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

scaled by the average level of agency mortgage holdings over the prior 12 months. All regressions include the current value of m_t as well as three years of lags. For each activity measure, we estimate two versions of (1), one in which we set $l = 0$ and one in which $l = 12$. The second version includes a full year of leads of m_t, which allows us to verify the plausibility of our timing of the interventions. Figure 4 shows the estimated dynamics of the agency activity measures around the policy events, obtained as the sum of the slope coefficients β_j over various horizons, together with 95 percent Newey and West (1987) confidence bands.

The policy change indicator strongly predicts significant changes in agency purchase commitments (left panel) which pick up at date 0 and peak at a 3 to 4 percent higher level roughly two years out. Actual purchases (middle panel) follow a very similar trajectory as commitments, but with a lag of a few months demonstrating that the policy change behaves likes a news shock for actual purchases but not for commitments. The right panel shows that the higher pace of mortgage purchases is followed by a persistent and statistically significant increase in the agencies' retained portfolio.

The specifications allowing a lead response to the events suggest that our indicator accurately captures the timing of the change in purchasing activity. It is also encouraging that the size of the estimated response of agency mortgage holdings converges to around one percent within 24 months of the policy event (our scoring of the policy changes from historical sources on the basis of their projected impact targeted a cumulated impact on mortgage holdings of one percent within two years). We conclude that our non-cyclical policy indicator predicts significant changes in the agencies' purchasing activity for portfolio purposes.

4 The Cumulative Effects of Agency Mortgage Purchases on Mortgage Credit

We now proceed to estimating the cumulative impact of agency mortgage purchases on credit aggregates by using the non-cyclically motivated policy changes as an instrument for agency purchasing activity. As shown in Figure 1, the growth in mortgage debt over our sample period has on average exceeded growth in GDP, while agency holdings have increased at an even faster pace. Because of these differential trends,

expressing the impact on credit aggregates and other variables in terms of elasticities can be misleading.[16] To address these issues, we run local projections-IV regressions similar to those used by Ramey and Zubairy (2016) to estimate cumulative government spending multipliers.

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

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

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

Each regression includes a full year of monthly lags of a number of control variables Z_t, such that $\varphi_h(L)$ is a lag polynomial of order 11. The controls include variables with predictive content for the dependent variables, and always include lagged values of y_t/X_t (or f_t/X_t for flow variables), as well as lags of agency 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, i.e. relative to the value 3 months prior. The data appendix provides full details on the sources and construction of the time series. In online appendix A.1, we discuss results for a number of

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

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

alternative control (sub)sets.

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

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

[18] With local projections, every successive horizon $h = 0, 1, 2...$ requires a separate regression with h leads of observations beyond the end point of the sample, see Jorda (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.

4.1 First Stage Diagnostics

We first assess the strength of our narrative instrument. The left panel of Figure 5 shows the Newey and West (1987) robust F-statistics on the excluded instrument in the first stage regressions for horizons $h = 0$ up to $h = 60$. The figure shows the F-statistics for both the cases where we use cumulative commitments or purchases as the measure of agency activity.

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

The right panel of Figure 5 depicts IV estimates of the dollar change in agency purchases for every dollar of commitments issued over the various time horizons based on the regressions in (2) using cumulative agency purchases as the outcome variable and cumulative commitments as the independent variable (broken lines are 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 approximately 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.

4.2 Cumulative Credit Multipliers

We now examine how agency mortgage purchases impact on housing credit. Without credit frictions, the ownership of mortgage debt is irrelevant. Any exogenous change in agency mortgage holdings should have no impact on total mortgage debt and originations, and perfectly crowd out private mortgage holdings. We test this neutrality hypothesis using the local projections in (2) and the narrative policy instrument.

Figure 6 shows the impact of an increase in either commitments or purchases, together with the 95 percent Newey and West (1987) confidence bands. There is a marked difference in the short and long run effects of agency purchases. In the short run, the data is consistent with the neutrality hypothesis: The upper left panel shows that a dollar spent on purchases increases agency mortgage holdings on impact by almost a dollar. The short run effect of a dollar in commitments on agency holdings is lower at around 60 cents, which is expected given the time delay between commitments and purchases. Consistent with this, the right panel shows that private holdings decline initially by roughly the same amount as the increase in agency holdings, although the confidence bands are wide.[19] The lower panels in Figure 6 show that as the dollar in mortgage debt changes from private to agency ownership, there are initially no significant short run changes in neither origination volume nor in total mortgage debt outstanding.

Over longer horizons, however, there is clear evidence against the neutrality hypothesis. The cumulative impact on mortgage originations increases with the horizon and becomes statistically significant after 6 months. Over the course of 3 years and beyond, the estimates indicate a cumulative increase in originations of 3 dollars or more for every dollar purchased by the agencies. The estimated long run multipliers for originations are highly statistically significant and nearly identical for commitments and purchases. The impact on the stock of mortgage debt becomes statistically significant after three to four years and reaches a level of around one dollar. As the time horizon grows, the increase in agency holdings slowly dissipates to levels expected before the expansion. Similarly, the negative impact on the level of private mortgage hold-

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

ings vanishes over time and eventually turns into an increase, although not one that is statistically significant.

The results in the second row of Figure 6 imply that agency portfolio expansions lead to a substantial rise in mortgage lending activity. Originations take place when a borrower refinances, purchases an existing home, or purchases a newly constructed home. The first two transactions typically lead only to relatively small net changes in mortgage debt because they occur simultaneously with the repayment of a similar amount of mortgage debt. Since the volume of originations is a multiple of the net change in debt, the rise in originations is likely to be mostly driven by a rise in transactions of the first two types, with new home purchases playing a more important role beyond horizons of two years. Given the procyclicality of mortgage originations, the large positive effect on originations makes it unlikely that the estimates are severely contaminated by the countercyclical actions of the agencies over the sample. The decrease in private holdings and the delayed effect on originations also suggest that the estimates are not merely picking up increased supply of mortgages to the secondary market (as would occur if private lenders simply passed on newly originated loans to the agencies).[20]

In online appendix A.1 we further analyze the role of instrumenting with the narrative indicator and we provide additional results on agency mortgage securitization. We also verify the robustness of the results 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.

5 Impulse Response Analysis of News Shocks to Agency Purchases

To further evaluate the effects of agency purchases on mortgage credit as well as to 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. Similar

[20] If this were the case, originations would rise simultaneously with purchases and there would be no decline in private mortgage holdings. In online appendix A.1, we show that it is precisely in this direction that the results change when we do not use the narrative instrument and use OLS instead.

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

5.1 Empirical Specifications

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. 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 in the near future. 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 adress endogenity, 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 1.

Although our narrative instrument is a good predictor of agency purchasing activity, it is based on relatively few policy events. It is therefore always possible that our findings are driven by the small sample size.

To gain confidence that this is not the case, we also adopt an alternative strategy inspired by Fisher and Peters (2010). These authors interpret innovations in excess stock returns of major defense contractors as news shocks about future military spending. Fisher and Peters (2010) obtain these innovations by ordering the excess returns last in a recursively identified structural vector autoregressive system. The recursive scheme assumes that none of the macro aggregates included in the analysis are affected on impact by the news shock, while excess stock returns react contemporaneously to all macroeconomic shocks.

We follow a similar strategy in order to estimate an alternative measure of shocks to agency purchasing activity. The main idea is that GSE profits are increasing in leverage, and that news about GSE balance sheet expansions therefore leads to idiosyncratic movements in stock prices. We identify innovations in the excess return of Fannie and Freddie stock based on similar recursivity assumptions as Fisher and Peters (2010). To implement these assumptions using the local projections, we estimate the response at horizon h through the following regression:

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

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

The response coefficient δ_h in (4) is estimated using 2SLS, where the first stage is a regression of the log change in the GSE stock price-to-S&P 500 on W_t and Z_{t-1}. This imposes that shocks to expected agency purchases have no contemporaneous impact on the variables in W_t, which is the equivalent of ordering the GSE excess return behind the variables in W_t in a recursively identified structural VAR. The instrument used in the 2SLS estimation of (4) is therefore the monthly innovation in the GSE excess stock return, orthogonal-

ized to the monthly innovations in the variables in W_t. By assumption, other endogenous sources of variation in excess returns, such as shocks to the demand of mortgage credit, are eliminated by allowing excess returns to respond endogenously to mortgage credit, interest rates, prices and the cyclical indicators. For simplicity, we keep the horizon for cumulating commitments at 8 months. The value of the first stage robust F-statistic for this horizon is 7.68.[21] This is lower than for the narrative instrument, but nevertheless indicates that the orthogonalized excess return innovations have predictive power for agency commitment activity.

5.2 Effects on Mortgage Credit and Interest Rates

Figure 7 displays the responses of mortgage credit and interest rates to news about higher future purchases. Each of the panels shows the point estimates for the first 24 months after an increase in anticipated agency purchases by one percentage point of trend originations, together with 95 percent Newey and West (1987) confidence bands. The responses in blue are based on the narrative instrument, while those in red are based on the GSE excess returns instrument.

The first row in Figure 7 displays the responses of the mortgage credit aggregates (real originations and mortgage debt) to the agency purchase shock. Based on the narrative instrument, mortgage originations start rising after a few months and reach peak increases of 4 percent to 5 percent between 12 and 18 months after the shock. With a slightly longer delay, the stock of mortgage debt also gradually rises to levels that are about 0.3 percent higher after two years. Using the GSE excess returns instrument, the rise in originations occurs slightly more rapidly but is more transitory. The peak increase in originations is around 4 percent and occurs between 10 and 14 months. The size and shape of the rise in the stock of mortgage debt is also very similar across instruments. The expansions in both the stock and gross flow of mortgage credit following a positive shock to agency purchases are statistically significant for multiple periods for both instruments. The results again indicate that agency purchases stimulate mortgage lending significantly.

The second row in Figure 7 shows the impact of the agency purchase shock on interest rates on 30-year fixed rate mortgages in the primary market. The left panel illustrates the interest rate effect on newly orig-

[21] The F-statistic for the GSE excess return instrument is maximized at a horizon of 5 months at a value of 8.55. Changing the horizon for cumulating commitments in specification (4) to 5 months does not lead to any meaningful changes in the results.

inated conventional conforming mortgages, whereas the right panel contains the impact on interest rates of mortgages guaranteed by the Federal Housing Adminstration. According to the narrative instrument, the mortgage rates in the primary market are largely unaffected in the initial couple of 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. By construction, there is no impact on interest rates in the first month when using the GSE excess returns instrument, but consistently with the narrative instrument, both mortgage rates fall by 10 to 15 basis points between 6 and 18 months after the shock. For both instruments, the declines in mortgage rates are statistically significant for multiple periods.

The results above appear consistent with mortgage credit policies impacting the market mainly through the supply of housing credit. Portfolio rebalancing is one possible way in which agency mortgage purchases can affect the supply side.[22] Purchases by Fannie and Freddie are mostly financed by agency debt instruments that closely substitute for Treasuries both in terms of liquidity and in terms of (perceived) safety. When agency purchase mortgages and sell debt, portfolio rebalancing would then trigger a decline in mortgage rates as private investors bid up the price of mortgages. But there are several alternative credit supply channels. Private mortgage lenders may face capital constraints because of regulations or binding incentive constraints.[23] Because the GSEs are more highly leveraged than private lenders, the aggregate lending capacity increases with the agency market share. Agency purchases that drive up the price of mortgages may improve the net worth position of private mortgage lenders, while the exchange of mortgages for agency debt lowers their risk-weighted leverage ratios. An increase in agency purchasing activity may improve liquidity in the secondary mortgage market and reduce liquidity premia. It goes beyond the scope of this paper to separately identify which of these channels may be more important.

The right panel of the bottom row in Figure 7 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

[22] Following the large scale purchases by the Federal Reserve and many other central banks constrained by an effective lower bound, the literature has advanced several channels through which such purchases may have an impact, see for instance Kishnamurthy and Vissing-Jorgenson (2011) for an overview.

[23] See for instance the theoretical models in Gertler and Kiyotaki (2010) or Curdia and Woodford (2011).

rate responds little the first couple of months but as the agency mortgage purchases commence, it declines in a gradual and persistent manner by up to 5 to 10 basis points. The drop is significant between 3 and 6 months after the shock. The results are similar for the two instruments but confidence intervals are wider using excess returns.[24] In online appendix A.2, we discuss additional results on the effects on other interest rates and credit spreads.[25] Overall, the results indicate that there are significant spill-overs from agency actions in mortgage markets to other longer term asset markets.

The left panel in the bottom row of Figure 7 reports the impact on a short-term interest rate, the 3-month T-bill rate. The results are similar qualitatively to those for the long-term rates discussed above. Quantitatively, we find some indication of a larger drop in short-term rates than in the longer term rates. Based on the narrative instrument, and with a delay of a few months, the T-bill rate drops persistently by 15 to 20 basis points with a partial reversion taking place at longer forecast horizons. The results using the GSE excess return instrument yields again similar results (although quantitatively smaller). The negative response of short term interest rates indicates that a potentially important explanation for the expansion in mortgage lending and the decline in mortgage rates is a more accommodative stance of monetary policy. In Section 6 below, we will investigate the role of monetary policy and its interactions with housing credit policy in greater detail.

The finding that an increases in agency mortgage purchases produces a boom in mortgage lending and declining long and short term interest rates is robust. In online appendix A.3, we report very similar results for a sample that starts in October 1982, the end of the period of non-borrowed reserve targeting by the Federal Reserve. Thus, the results are not driven by differences in Federal Reserve operating procedures in the 1970s or by the inclusion of the Volcker period. There is narrative evidence that political pressure

[24]The additional 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. 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.

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

to support the GSEs was exerted with some success in the late 1960s and 1970s, leading for instance the Federal Reserve to purchase significant amounts of agency debt.[26] In the post-1982 sample, however, it is far less likely that political pressure to support government housing policies can explain an accommodative monetary policy response. Finally, the results also do not appear to be particularly sensitive to the inclusion of any individual policy event, see online appendix A.3.

5.3 Effects on Housing and Other Macro Aggregates

Next, we assess the evidence for the broader macroeconomic effects of government asset purchases. Figure 8 shows the responses of a range of monthly macro aggregates to an agency purchase shock, together with 95 percent Newey and West (1987) confidence bands. As in Figure 7, the responses are to an anticipated increase in purchases by one percentage point of trend originations, estimated using either the narrative instrument (blue) or the GSE excess returns instrument (red). We consider the following additional outcome variables available at the monthly frequency: housing starts, real house prices, real personal consumption expenditures, the unemployment rate, real personal income, and the nominal price level.[27]

The first panel in Figure 8 shows the effects on residential investment, as measured by monthly housing starts. Based on the narrative instrument, the number of new housing starts rises to levels that are roughly 1 to 2 percent higher after about 6 months. Housing starts remain elevated for about a year and drop off to prior levels afterwards. Using the GSE excess returns instrument, housing starts pick up more quickly and remain around 2 percent higher between 4 and 12 months after the shock. For both instruments, the size and shape of the response of housing starts is similar and statistically significant for multiple periods. There is thus robust evidence that the expansion in the stock of mortgage debt following a shock to agency purchases is associated with higher levels of residential investment. The more immediate effects on residential construction are consistent with the more delayed impact on mortgage debt in Figure 7. 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] See Haltum and Sharp (2014).

[27] All these variables except the unemployment rate are included logs and all nominal variables are deflated by the core PCE price index. See the data appendix for precise definitions.

The top middle panel in Figure 8 plots the impact on real house prices, as measured by the Freddie Mac house price index deflated by the core PCE price index. Using the narrative instrument, we find that real house prices rise gradually but very persistently over time with a point estimate that becomes significantly positive at longer forecast horizons only. The GSE excess returns instrument, on the other hand, does not reveal a significant change in house prices at any horizon. Thus, we have no clearcut evidence of an impact of agency mortgage purchases on house prices, and the point estimates imply that very little of the increase in the dollar volume of mortgage credit is explained by increases in house prices.

The remaining four panels in Figure 8 show the responses of consumption expenditures, personal income, the unemployment rate, and the nominal price level. 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, and there is a sustained decline in the nominal price level. The increase in consumption and the drop in the price level are, however, imprecisely estimated and none of the impulse responses are significantly different from zero at the 95 percent level. The point estimates are somewhat different for the GSE excess returns instrument and show an increase in personal consumption expenditures similar to that estimated using the narrative instrument, but with a much shorter delay of 3-4 months. There is a decline in the unemployment rate around a year after the shock, while the price level is unaffected. Standard errors are, however, large for this instrument as well.

In sum, we find clear evidence that agency mortgage purchases stimulate residential investment, and some indication of a positive effect on personal consumption expenditures. The confidence bands in Figure 8 are, however, relatively wide, and therefore the power of our instruments to detect a macroeconomic impact of agency mortgage purchases beyond residential investment is rather limited.

6 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. The left panel in Figure 9 reports the estimated response of the federal funds rate to an agency purchase shock using the same methodology as in the previous section. According to the narrative instrument, there is a delayed and transitory decline in the funds rate by up to 30 basis points after 6 months. This decrease is statistically significant between 4 and 12 months after the shock. Using the GSE excess returns instrument also yields a temporary decline in the federal funds rate, but it is smaller in size and less precisely estimated.

There is therefore evidence that agency mortgage purchases are accompanied by accommodative monetary policy. A possible alternative interpretation is that both of our identification schemes erroneously pick up the influence of recessionary shocks causing downward adjustments in the Federal Reserve's interest rate target. However, if this were the case, we would not expect to find increases in strongly procyclical variables such mortgage originations or housing starts. To gain more insight into the nature of the estimated funds rate response we make use of the decomposition by Romer and Romer (2004) of changes in the intended federal funds rate at FOMC meetings into a *systematic* component and a residual *shock* component.[28] The systematic component is measured by the explained variation in a regression of target changes on changes in the Greenbook forecasts of inflation, output growth, and the unemployment rate. The shocks to monetary policy are measured by the residual in the same regression, which will capture any remaining variation in target changes that is not explained by changes in the Greenbook forecasts.

The middle panel in Figure 9 depicts the estimated response of the cumulated Romer and Romer (2004) shocks to an agency purchases shock (using the regressions in (3) and (4)). The narrative instrument yields a significant and persistent decline in the cumulated monetary policy shock measure by up to 10 basis points in the first year with a few months delay. To investigate whether causality runs both ways, the right panel reports the response of the cumulated narrative measures of credit policy changes in Table 1, deflated by the

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

core PCE price index and as a percentage of trend originations, to a monetary shock. We find no evidence of monetary policy shocks impacting on the non-cyclical measure of agency mortgage purchases shocks such that our narratively identified housing credit policy instrument is not itself predictable by the Romer and Romer (2004) monetary policy shocks. The *cyclical* housing policy measure (in red), on the other hand, does show a statistically significant decline to an expansionary monetary policy shock. It thus appears that, if anything, credit policies tend to lean against monetary policy. Finally, we note that the GSE stock returns instrument does not yield any significant decline in the Romer and Romer (2004) residual.

The fact that the narrative instrument predicts the Romer and Romer (2004) residuals indicates that part of the credit expansion following greater agency mortgage purchases may derive from a loosening of monetary policy. To further judge the extent to which agency purchase shocks operate through more conventional monetary transmission channels, Figure 10 makes a comparison with the effects of an traditional monetary policy shock (in red) and the response to the agency purchase shock identified using the narrative instrument (in blue). The impact of 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. The impulse response coefficients are identified using the Romer and Romer (2004) measure for monetary policy shocks, updated by Wieland and Yang (2016), 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 identical as for the agency purchase shock identified with the narrative instrument. For easier comparison, the responses to the monetary policy shock in Figure 10 are shifted forward by 4 months such that the maximum interest declines for each of the policy shocks coincide. As before, the bands are 95 percent Newey and West (1987) intervals.

Figure 10 reveals that conventional monetary policy shocks and credit policy shocks have qualitatively very similar effects on 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, a expansionary monetary shock leads to increases in consumption and income, a decline in the unemployment rate as well as a 'price puzzle', i.e. a decline in the price level. 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, many responses to each of the policy shocks are similar in terms of magnitude and timing.

The most prominent difference between the responses in Figure 10 is that agency purchases lead to an increase in originations that is roughly twice as large as the monetary policy 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 suggest that agency purchases have a larger effect on mortgage repayments through greater refinancing activity and/or more existing home sales. Apart from this, it does appear as if credit policy operates through similar transmission channels as conventional monetary policy.

To assess 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 11 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) and (4). 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.[29] 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 11 shows the counterfactual responses in red and the earlier baseline estimates in blue, in both cases with 95 percent Newey and West (1987) bands. Panel A shows the results when using the narrative instrument to identify the effects of the agency purchase shocks, and panel B when we use the GSE excess returns instrument.

The results from the counterfactual experiment in Figure 11 indicate that conventional monetary policy plays

[29]The impact of monetary shocks on the outcome variables is obtained as in Figure 10, 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.

an important role in explaining the effects of agency purchase shocks. Under both identification schemes, the rise in originations is only about half as large when short term interest rates remain constant, and there is no longer any sign of an increase in the stock of mortgage debt. The drop in long term interest rates is much reduced with the narrative instrument, but remains more clearly present with the excess returns instrument. Finally, the positive effect on housing starts is smaller using the GSE excess returns instrument, and disappears entirely with the narrative instrument. Even with constant interest rates, however, purchases of mortgage assets appear to have statistically significant effects on mortgage originations.

7 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 are not neutral, and influence the volume of mortgage lending. In order to tackle reverse causality, we made use of a number of policy changes that have impacted on the ability of government agencies to acquire mortgage debt. Using policy changes that we classify as not cyclically motivated to contruct 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. We also find a positive impact on housing starts, and indications of positive effects on house prices and consumption expenditures. An alternative identification strategy based on instrumenting with orthogonalized innovations in GSE excess returns overall yields very similar results.

One surprising finding of our analysis is the apparent close similarity and interaction between housing credit policies and conventional monetary policy. We find that greater agency mortgage purchases lead to broader declines in long and short term interest rates. Our measure of non-cyclically motivated credit policy changes predicts monetary policy shocks as constructed by Romer and Romer (2004), while cyclically motivated housing credit policy changes tend to lean against monetary policy. Moreover, we find that the quantitative effects of agency mortgage purchases and conventional monetary policy are remarkably similar. These findings suggest that credit policy deserves more attention in the study of monetary policy.

There are several other interesting avenues for future research: Unlike theoretical or multivariate statistical models, the local projections/IV-approach does not allow an assessment of the historical contribution of structural shocks. Future work can verify whether agency purchase shocks are important causal factors in past housing or credit cycles. This may have been the case for the most recent housing boom and bust. The expansion of GSE market share from the early 1990s to mid 2004 was dramatic, but came to a grinding halt when, following revelations of accounting fraud, Fannie and Freddie's regulators imposed capital surcharges in the fall of 2004 and eventually portfolio caps in mid-2006. Although there are some important differences between the Fed's large scale MBS purchases and the actions of the agencies prior to 2008, our analysis should nevertheless also be useful for evaluating the QE programs. Similarly, our results are informative for assessing the possible impact of unwinding the Fed's current mortgage holdings, or for evaluating various proposals for GSE reform. Our findings challenge the hypothesis that government ownership of mortgage debt is neutral, but we have made no attempt at understanding the nature or implications of the credit frictions that are responsible. Finally, it is possible to apply a similar analysis to government mortgage guarantees. We leave this to future work.

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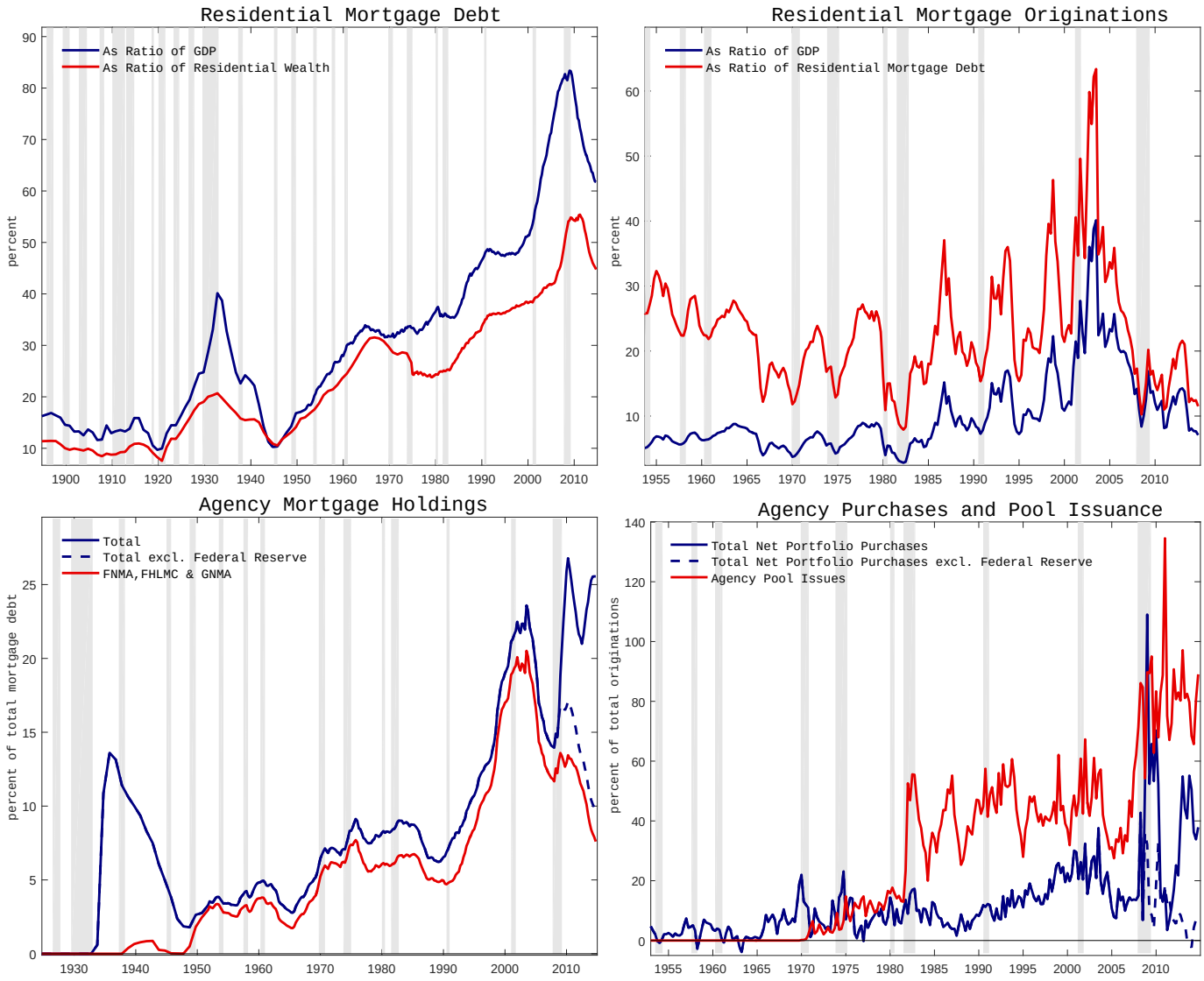

Figure 1 Mortgage Debt, Annualized Originations and Agency Market Shares

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

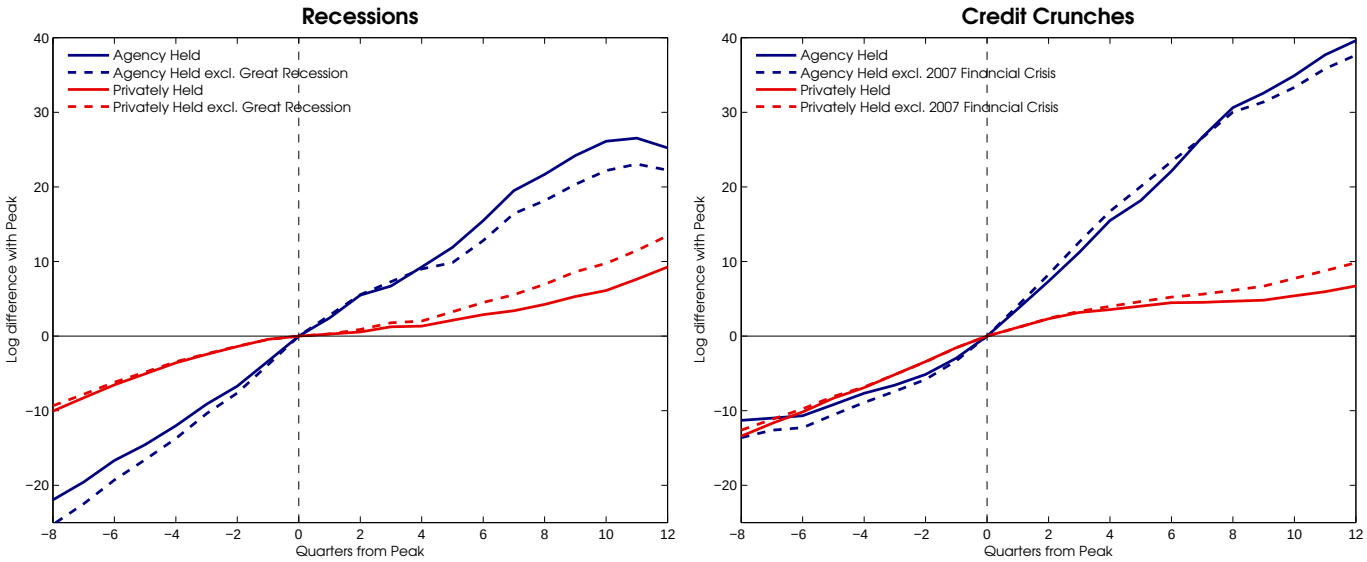

Figure 2 Real Mortgage Debt by Holder in Recessions and Credit Crunches

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

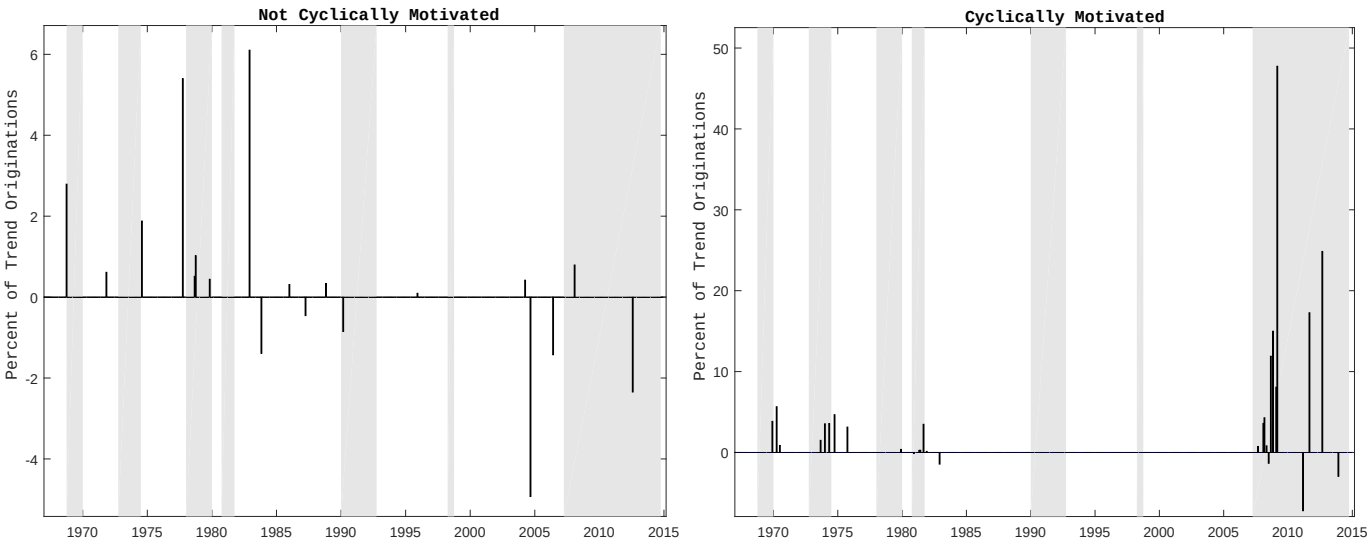

Figure 3 Measures of Policy Events Affecting Agency Mortgage Holdings: Jan 1967 to Dec 2014

Notes: The figure shows projected changes in the consolidated agency mortgage portfolio as a percentage of average annualized mortgage originations over the prior twelve months. The left panel shows changes classified as unrelated to the business or financial cycle. The right panel shows changes classified as primarily motivated by cyclical considerations. For sources and classification see Fieldhouse and Mertens (2016). Shaded areas are credit crunch periods, see data appendix for chronology.

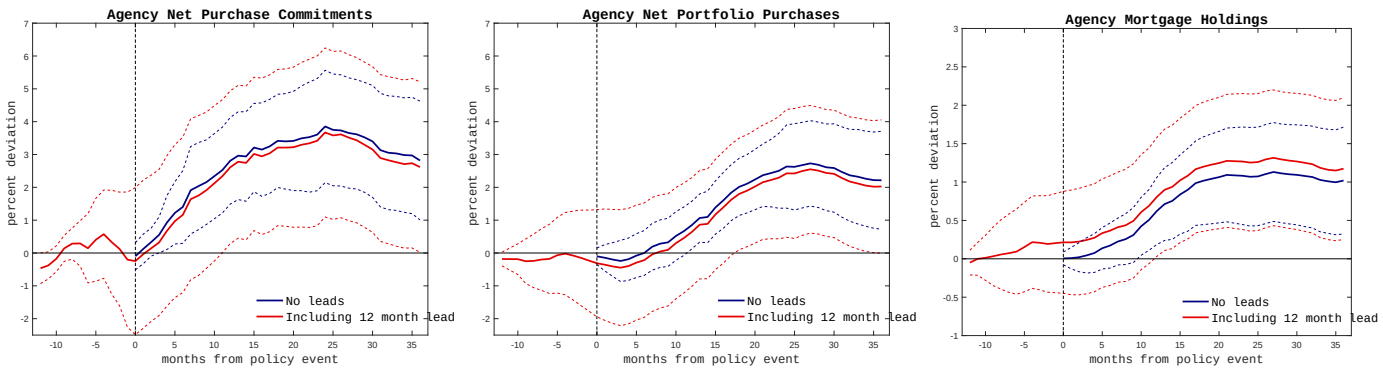

Figure 4 Agency Purchases and Holdings Before and After Non-Cyclical Policy Events.

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

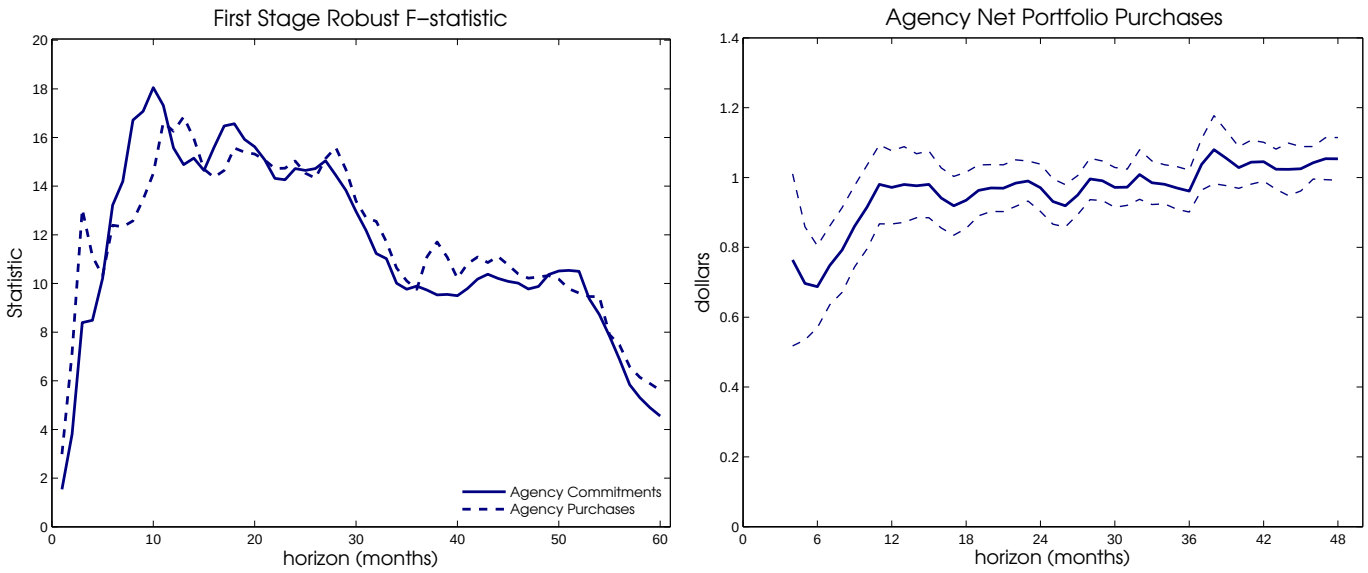

Figure 5 Preliminary Diagnostics

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

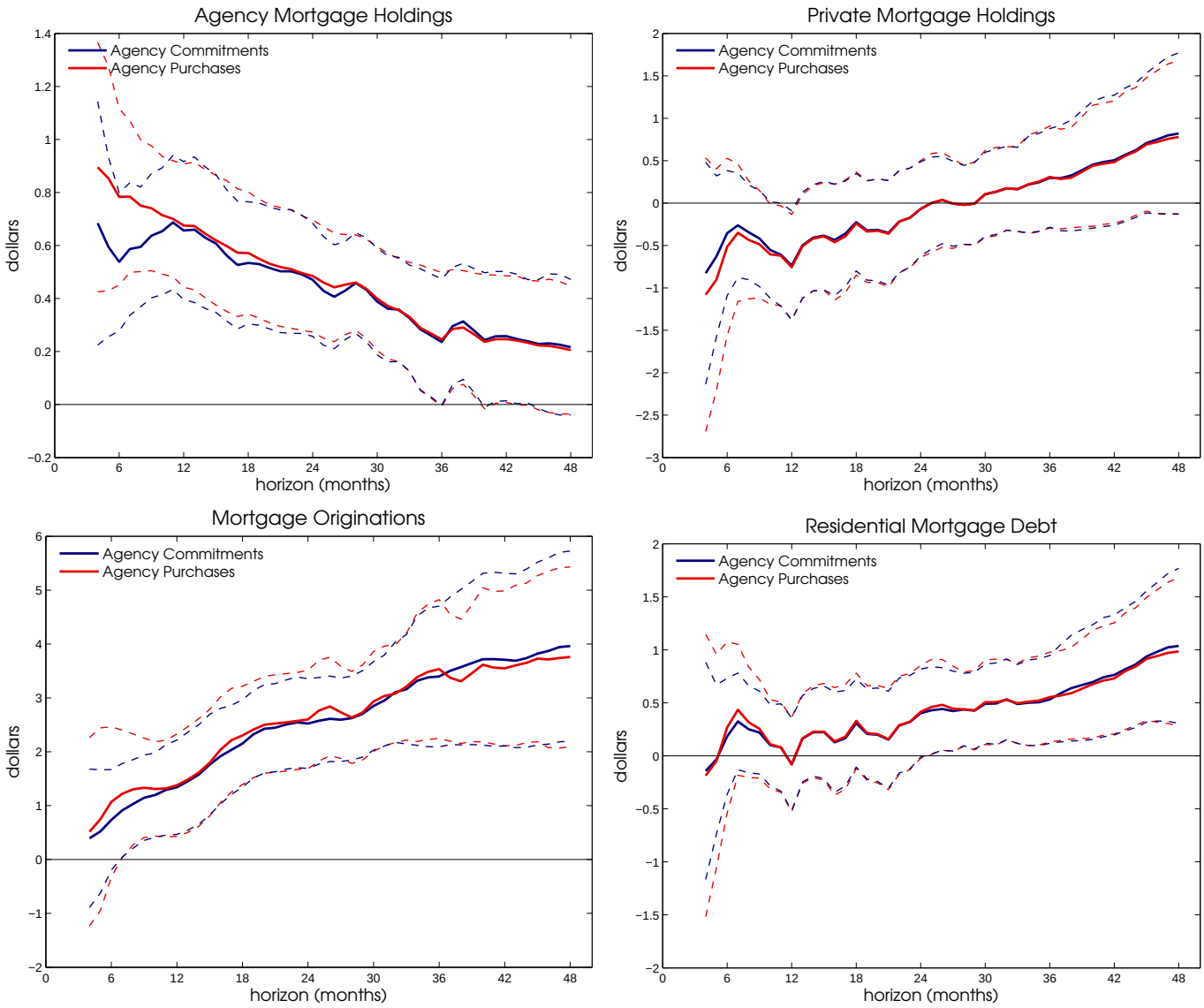

Figure 6 Estimated Balance Sheet Adjustments and Mortgage Credit Multipliers associated with Agency Mortgage Purchases.

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. Estimates are from Local Projections-IV regressions, see equation (2). Broken lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

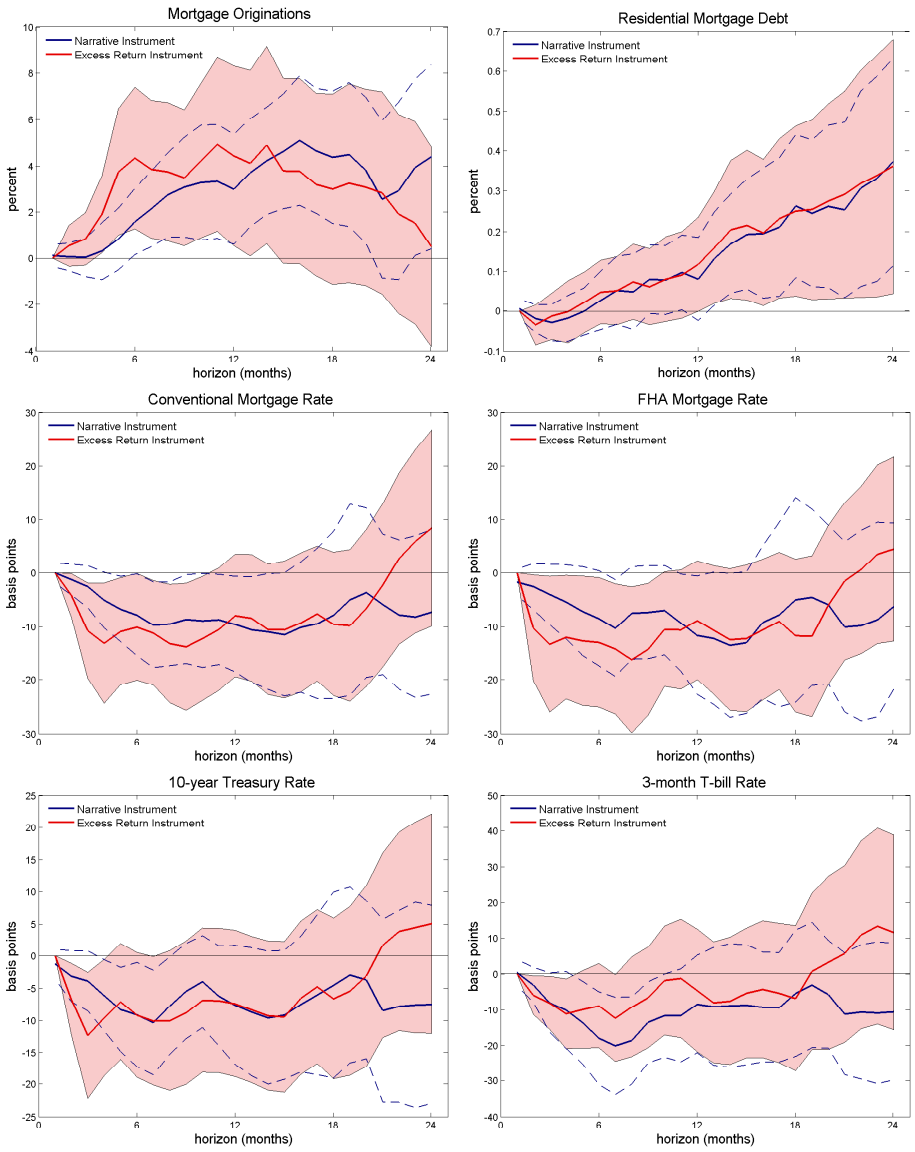

Figure 7 Impulses Responses to A Shock to Anticipated Agency Purchases.

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with the narrative policy indicator, see equation (3), or orthogonalized GSE excess stock returns innovations, see equation (4). Broken lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

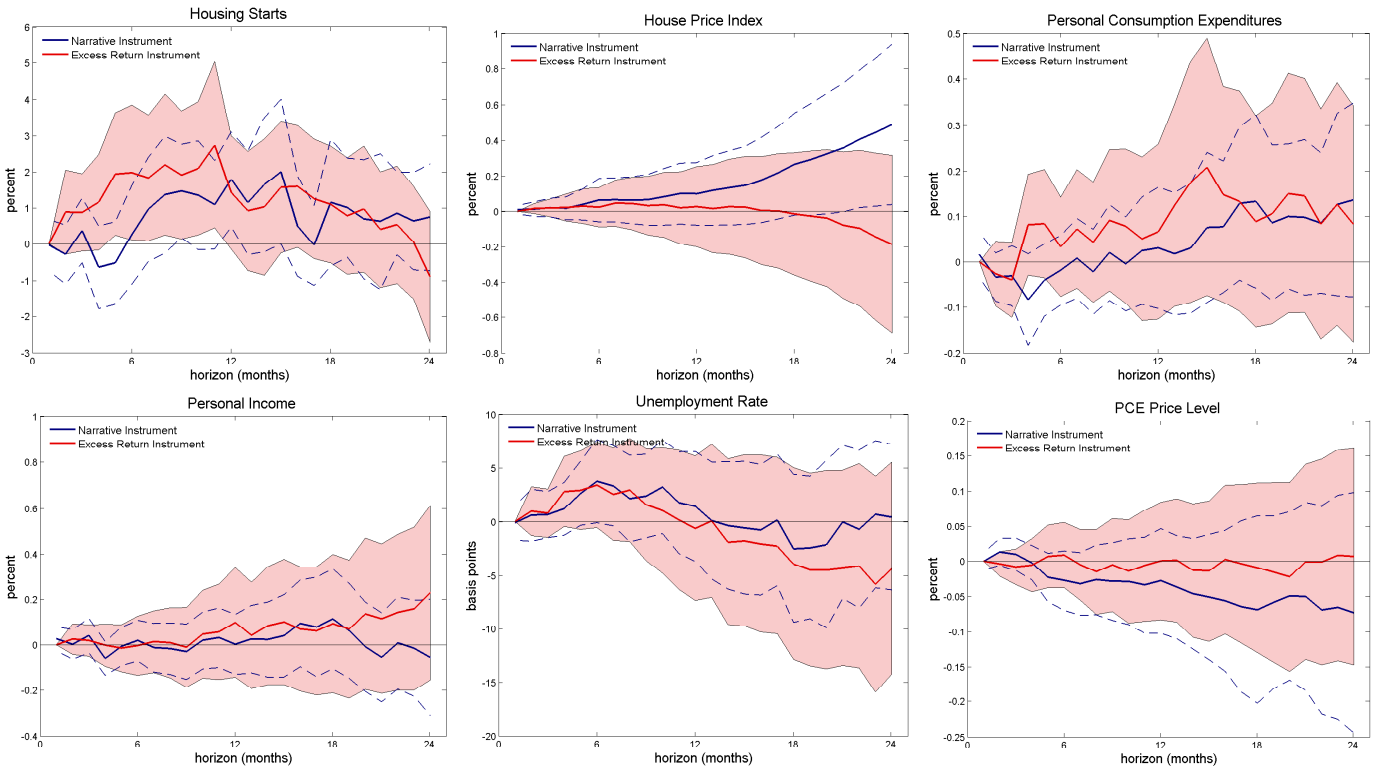

Figure 8 Impulses Responses to A Shock to Anticipated Agency Purchases.

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with the narrative policy indicator, see equation (3), or orthogonalized GSE excess stock returns innovations, see equation (4). Broken lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

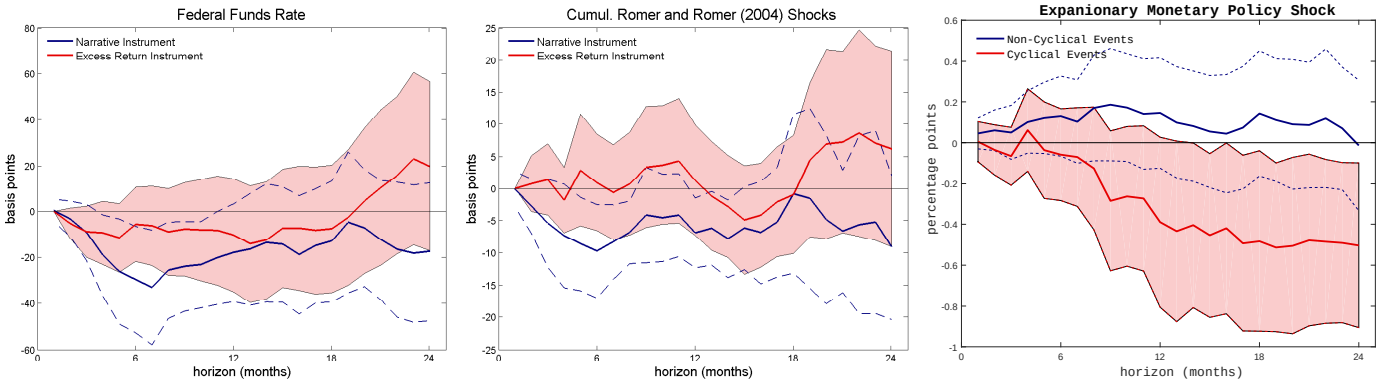

Figure 9 Interactions between Monetary and Credit Policies

Notes: Left and middle panel: The figure shows responses for a one pp. increase in agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with the narrative policy indicator, see equation (3), or orthogonalized GSE excess stock returns innovations, see equation (4). Broken lines are 90% and 95% Newey and West (1987) confidence bands. Right panel: The figure shows responses to a monetary shock obtained as in Figure 8. Broken lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

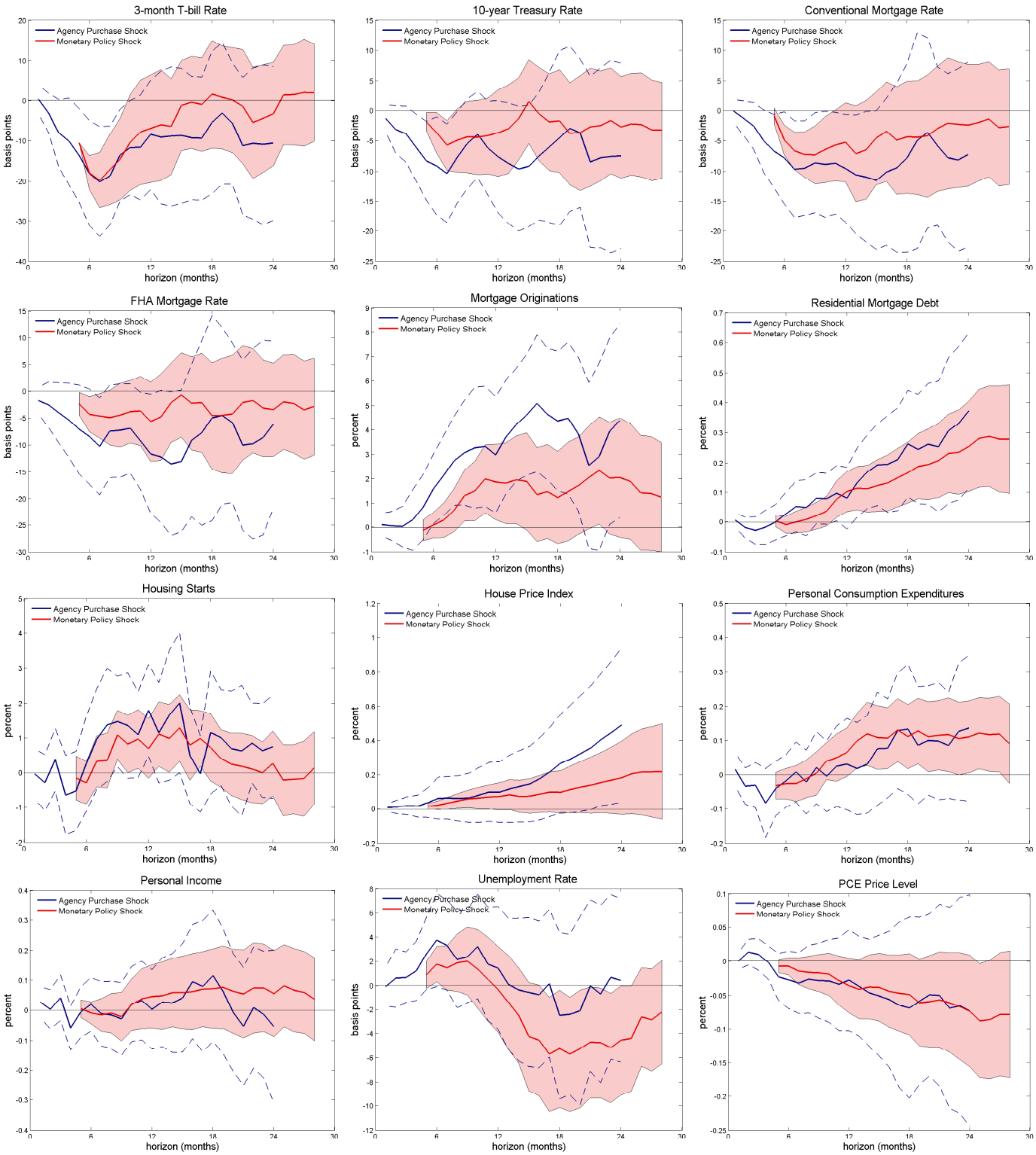

Figure 10 Responses to A Shock to Anticipated Agency Purchases versus a Monetary Policy Shock.

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

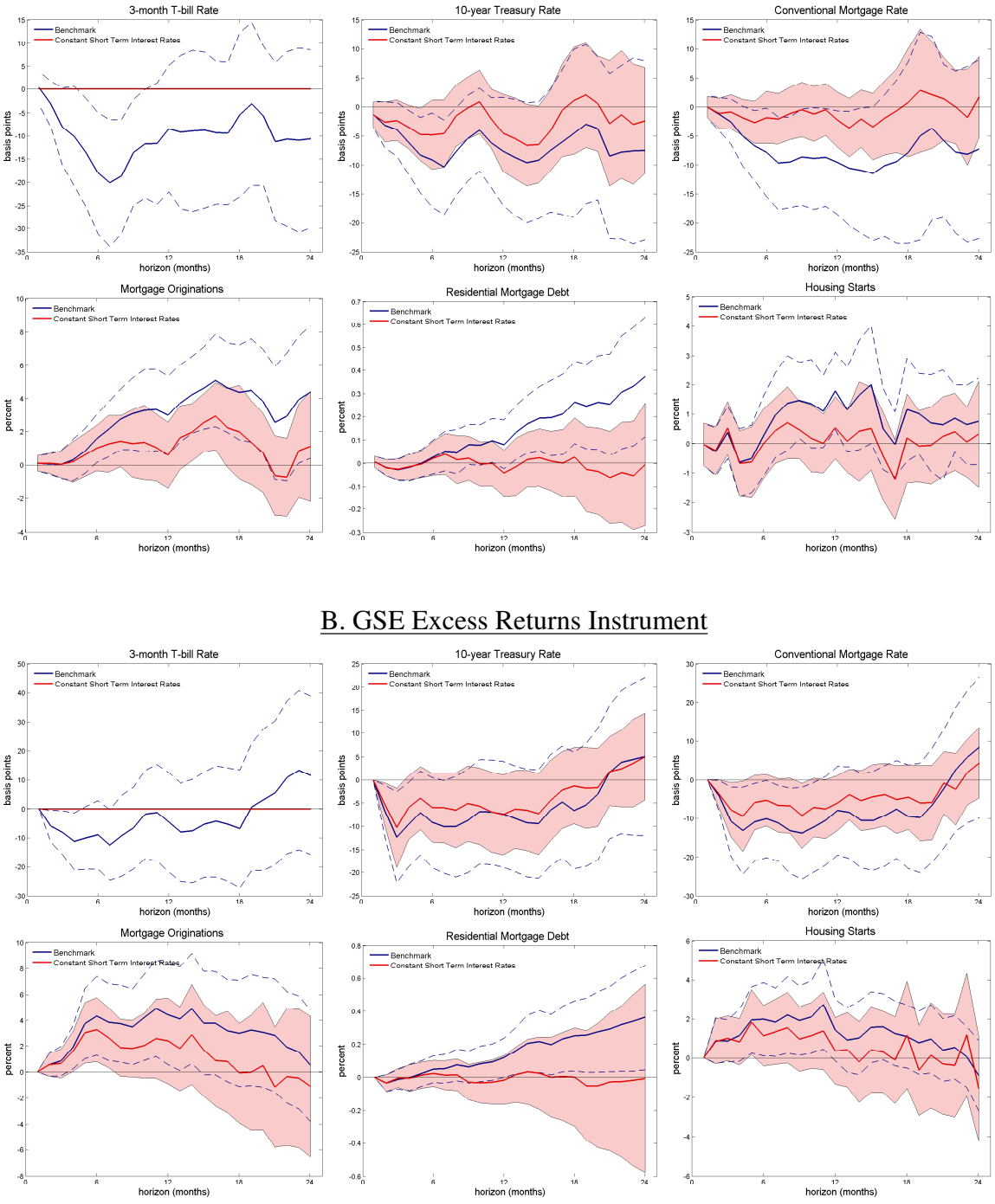

Figure 11 Shock to Anticipated Agency Purchases: Counterfactual with Constant Short Term Rate

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

Table 1: Narrative Measures of Policy Changes

Description	Agency	Annualized Impact	Timing	Classification
HUDA 1968: Increased Debt-to-Capital Ratio	FNMA	+ $1.39 billion	October 1968	Non-Cyclical
Increased Debt-to-Capital Ratio	FNMA	+$1.19 billion	December 1969	Cyclical
HUDA 1969: Special Assistance	GNMA	+$0.75 billion	December 1969	Cyclical
Treasury-Guaranteed Capitalization	FNMA	+$2.6 billion	April 1970	Cyclical
EHFA 1969: Special Assistance	GNMA	+$0.38 billion	July 1970	Cyclical
Conforming Mortgage Program Approval	FNMA	+$0.4 billion	November 1971	Non-Cyclical
FHA/VA Tandem Authorization	GNMA	$1.5 billion	September 1973	Cyclical
FHA/VA Tandem Authorization	GNMA	$3.3 billion	January 1974	Cyclical
Subsidized Mortgage Purchase Program	FHLMC	+$1.5 billion	May 1974	Cyclical
FHA/VA Tandem Authorization	GNMA	$1.65 billion	May 1974	Cyclical
HCDA 1974: Conforming Loan Limit	FNMA	+$1.14 billion	August 1974	Non-Cyclical
HCDA 1974: Conforming Loan Limit	FHLMC	+$0.46 billion	August 1974	Non-Cyclical
EHPA 1974: Tandem Program	GNMA	+$3.88 billion	October 1974	Cyclical
FY1976 Approps: Tandem Program	GNMA	+$2.5 billion	October 1975	Cyclical
HCDA 1977: Conforming Loan Limit	FNMA	+$4.82 billion	October 1977	Non-Cyclical
HCDA 1977: Conforming Loan Limit	FHLMC	+$0.21 billion	October 1977	Non-Cyclical
HCDA 1977: Tandem Program Expansion	GNMA	+$3.75 billion	October 1977	Non-Cyclical
FY1979 Approps: Special Assistance	GNMA	+$1.0 billion	September 1978	Non-Cyclical
HCDA 1978: Mortgagee Expansion	FHLMC	+$2.0 billion	October 1978	Non-Cyclical
FY1980 Approps: Special Assistance	GNMA	+$1.0 billion	November 1979	Non-Cyclical
HCDA 1979: Conforming Loan Limit	FHLMC	+0.86 billion	December 1979	Cyclical
FY1981 Approps: Special Assistance	GNMA	-$0.2 billion	December 1980	Cyclical
ARM Program Approval	FHLMC	+$0.37 billion	May 1981	Cyclical
ARM Program Approval	FNMA	+$0.4 billion	June 1981	Cyclical
Second Mortgage Program Approval	FNMA	+$5.0 billion	September 1981	Cyclical
FY1982 Approps: Special Assistance	GNMA	+$0.17 billion	December 1981	Cyclical
Increased Debt-to-Capital Ratio	FNMA	+$6.25 billion	December 1982	Non-Cyclical
FY1983 Approps: Special Assistance	GNMA	-$1.47 billion	December 1982	Cyclical
FY1984 Supp. Approps: Tandem Repeal	GNMA	-$2.92 billion	November 1983	Non-Cyclical
Second Mortgage Program Approval	FHLMC	+$1.0 billion	January 1986	Non-Cyclical
Decreased Debt-to-Capital Ratio	FNMA	-$2.7 billion	April 1987	Non-Cyclical
Public Listing Stock Split Capitalization	FHLMC	+$1.62 billion	November 1988	Non-Cyclical
FHEFSSA 1992: Capital Requirements	FNMA	-$4.25 billion	March 1990	Non-Cyclical
Affordable Housing Goals of 1995	FHLMC	+$0.61 billion	December 1995	Non-Cyclical
Affordable Housing Goals of 2004	FNMA	+$7.6 billion	April 2004	Non-Cyclical
Affordable Housing Goals of 2004	FHLMC	+$7.6 billion	April 2004	Non-Cyclical
Accounting Scandal: Capital Surcharge	FNMA	-$141.4 billion	September 2004	Non-Cyclical
Portfolio Growth Limit Imposed	FHLMC	-$42.8 billion	June 2006	Non-Cyclical
Portfolio Limit Increase	FNMA	+$17.15 billion	September 2007	Cyclical
Portfolio Limit Increase	FHLMC	+$2.14 billion	September 2007	Cyclical
ESA 2008: Jumbo Loan Limit	FNMA	+$41.57 billion	February 2008	Cyclical
ESA 2008: Jumbo Loan Limit	FHLMC	+$41.57 billion	February 2008	Cyclical
Removal of Portfolio Limit	FNMA	+$9.28 billion	February 2008	Non-Cyclical
Removal of Portfolio Limit	FHLMC	+$9.05 billion	February 2008	Non-Cyclical
Reduced Capital Surcharge	FNMA	+$53.33 billion	March 2008	Cyclical
Reduced Capital Surcharge	FHLMC	+$43.33 billion	March 2008	Cyclical

Description	Agency	Annualized Impact	Timing	Classification
Reduced Capital Surcharge	FNMA	+$17.75 billion	May 2008	Cyclical
HERA 2008: Jumbo Loan Limit	FNMA	-$13.34 billion	July 2008	Cyclical
HERA 2008: Jumbo Loan Limit	FHLMC	-$13.34 billion	July 2008	Cyclical
Conservatorship: Portfolio Limit Increase	FNMA	+$67.5 billion	September 2008	Cyclical
Conservatorship: Portfolio Limit Increase	FHLMC	+$66.75 billion	September 2008	Cyclical
Agency MBS Program Launch	Treasury	+$80.0 billion	September 2008	Cyclical
QE1 Launch	Federal Reserve	+$250.0 billion	November 2008	Cyclical
ARRA 2009: Jumbo Loan Limit	FNMA	+$13.34 billion	February 2009	Cyclical
ARRA 2009: Jumbo Loan Limit	FHLMC	+$13.34 billion	February 2009	Cyclical
HASP: Portfolio Limit Increase	FNMA	+$50.0 billion	February 2009	Cyclical
HASP: Portfolio Limit Increase	FHLMC	+$50.0 billion	February 2009	Cyclical
QE1 Expansion	Federal Reserve	+$750.0 billion	March 2009	Cyclical
Agency MBS Program Sales	Treasury	-$120.0 billion	March 2011	Cyclical
Agency MBS Reinvestment	Federal Reserve	+$262.0 billion	September 2011	Cyclical
Third SPSPA Amendment	FNMA	-$22.16 billion	August 2012	Non-Cyclical
Third SPSPA Amendment	FHLMC	-$22.16 billion	August 2012	Non-Cyclical
QE3 Launch	Federal Reserve	+$480.0 billion	September 2012	Cyclical
QE3 Taper	Federal Reserve	-$60.0 billion	December 2013	Cyclical

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

Historical Background

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

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. During this growth period, Freddie was turned into a publicly traded

company with the same profit incentives for balance sheet growth as Fannie, while the Federal Home Loan Banks were granted permission to invest in MBS. Prudential regulations were tightened for private banks, but remained light for the GSEs despite a 1992 reform. The agencies increasingly retained their own and acquired each other's MBS, as opposed to selling them to private investors. As part of an ambitious home-ownership strategy, the Clinton administration was supportive of the efforts by Fannie and Freddie to develop automated underwriting systems and ramped up affordable housing goals for their purchases.

The rapid rise in agency ownership of mortgage debt increasingly became a cause of concern with public officials, and in the wake of the Enron scandal Fannie and Freddie were required to start filing reports with the Security and Exchange Commission. Allegations of accounting fraud in 2003 prompted an investigation by regulators, leading to capital surcharges in the fall of 2004 and a settlement that included portfolio caps. 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 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 the their portfolios at an annual rate of 10%, increased to 15% in 2012, until they reach a $250 billion each. The day after the agreement, the Treasury announced its own MBS purchase program, while the Federal Reserve's MBS program was launched a few weeks later. As a result of the Fed and Treasury programs, the combined agency ownership share regained levels similar to the early 2000s despite a gradual decline in holdership by the traditional housing agencies. In contrast, Fannie and Freddie have been allowed to grow their MBS guarantee book essentially without limits. Since the financial crisis, the vast majority of conforming loans originated have been acquired, guaranteed and sold off in MBS by the agencies.

Data Sources and Construction

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

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

> Fannie Mae: Monthly data on Fannie's retained mortgage portfolio from 1950 to 2003 is from various issues of the Federal Reserve Bulletin, which stopped reporting GSE portfolio statistics in 2003. From then onwards, the data is from Fannie's monthly volume summary cross-checked with the annual reports from OFHEO/FHFA for consistency. Prior to 1950, the data is based on fiscal year data from a

Fannie publication titled "*FNMA Background and History*" (1969 and 1973 editions), as well as Series N-159 from the Historical Statistics of the United States (1960 edition).

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

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

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

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

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

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

The upper left panel of Figure 1 shows annual data up to 1952 and quarterly data afterwards. Missing quarterly data on FHLB holdings is obtained by linear interpolation of annual data.
Residential mortgage originations shown in the lower left panel of Figure 1 is the quarterly aggregate of the monthly series described below.
Agency Net Portfolio Purchases and Pool Issues is the sum of net portfolios purchases of both whole loans as well as mortgage pools, and of issues of mortgage pools respectively, by Fannie Mae, Freddie Mac, Ginnie Mae, the FHLBanks, the Treasury Department, the Federal Reserve, and a number of other government agencies:

Fannie Mae: Monthly data on Fannie's net portfolio purchases from 1953 to 1998 is from various issues of the Federal Reserve Bulletin (portfolio purchases less sales). More recent data is from Fannie's monthly volume summary cross-checked with the annual reports from OFHEO/FHFA for consistency. While data on purchases is available over the entire sample, data on portfolio sales is missing for 1986 and 1988-1997. We impute the missing observations using data on Fannie's commitments to purchase and sell, actual purchases, and the net change in the retained portfolio. The imputation is done by Kalman smoothing in a state space model estimated by maximum likelihood as in Shumway and Stoffer (1982) using monthly data from 1980 to 2014. The model used is a vector autoregressive process for the net portfolio purchase rate, retained mortgage portfolio growth, and the ratio of purchases and net commitments to the retained portfolio. Data on Fannie pool issues from 1993 is from Lehnert, Passmore and Sherlund (2008), extended to 2014 using Fannie's monthly volume summaries. Pre-1993 monthly data is obtained by subtracting Freddie and Ginnie pool issues from total net purchases

by agency mortgage pools from monthly releases by the Department of Housing and Urban Development from the Survey of Mortgage Lending Activity (obtained through the National Archives and Records Administration).

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

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

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

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

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

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

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

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

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

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

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

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

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

Monthly mortgage market data: The *conventional mortgage rate* is the 30 year fixed-rate conventional conforming mortgage rate. From 1971 onwards, the conventional rate is the monthly average commitment rate from the Freddie Mac primary mortgage market survey. Pre-1971 data is from the Federal Housing Adminstration (FHA)/Departement of Housing and Urban Development (HUD) series for the primary conventional market rate, available from the Federal Reserve Bulletin (various issues).
The *FHA mortgage rate* is the 30-year fixed-rate FHA-guaranteed mortgage rate. Rate data for FHA-mortgages offered in the secondary market from 1963 is provided by FHA/HUD and is available from various issues of the Federal Reserve Bulletin. Earlier data is from the NBER's macrohistory database (series m13045). The series has a handful of missing observations and was discontinued in 2000. We impute data by Kalman smoothing in a VAR/state space model estimated by maximum likelihood as in Shumway and Stoffer (1982) using several closely related interest rate series over the 1976-2014 period: the conventional 30-year rate (FHA/HUD as well as the Freddie Mac series), the 3-month and 10-year Treasury rates, and yields on Ginnie Mae securities (from the Federal Reserve Bulletin as well as the MTGEGNSF Index from Bloomberg). A couple of missing observations prior to 1976 were imputed in a similar fashion using data on the 3-month and 10-year Treasury rates, on interest rate data provided by Saul B. Klaman's 1961 NBER publication "The Postwar Residential Mortgage Market", and on interest rate ceilings on FHA loans applicable at the time. The 10y and 3m 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 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. 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 Federal Home Loan Bank Sourcebooks. 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 final series is seasonally adjusted using the X-13 program from the Census Bureau.
The monthly series for *mortgage debt* is based on interpolation of the quarterly mortgage debt series from the Financial Accounts of the United States (see Figure 1) using the series on monthly originations. The series is constructed by linear interpolation of the implied quarterly repayment rates. The final series is seasonally adjusted using the X-13 program from the Census Bureau.

Other Monthly Variables The series on (seasonally adjusted) *housing starts* is from the Census Bureau and obtained through the FRED database at the Federal Reserve Bank of St. Louis (series HOUST). *House prices* post-1975 are measured by the Freddie Mac house price index (FMHPI) available at `http://www.freddiemac.com/finance/house_price_index.html`. The data are extended before 1975 by splicing with the home purchase component of the BLS Consumer Price Index (PHCPI), 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). 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 Treasure rates are series TB3MS and GS10 from FRED. The *GSE stock price index* post 1988 is the geometric average of stock price indices for Fannie Mae and Freddie Mac (from Bloomberg), and the Fannie stock price index from 1970 through 1988. The *S&P 500 index* is the nominal index from Shiller (2015) deflated by the nominal price level. The *BAA and AAA corporate bond rates* are the Moody's seasoned BAA and AAA yields (series BAA and AAA from FRED).

A Appendix for Online Publication: Additional Results and Robustness Checks

A.1 Cumulative Credit Multipliers

This section discusses a number of robustness checks of the results presented in Section 4.2 regarding the cumulate effects of agency purchases.

Scaling by Trend Originations The baseline specification in (2) uses a trend in personal income as the scaling variable. Figure A.1 reports the results when we instead use a long run trend in annualized mortgage originations. The latter is obtained by fitting a third degree polynomial of time to the log of real mortgage originations obtained using the core PCE price index as the deflator. This is potentially consequential for the results because of trend growth of the mortgage market relative to the economy. However, the figure shows that the results remain generally similar to the baseline. 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.

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

pattern is more similar to agency behavior before the growth of mortgage securitization in the mid 1980s.

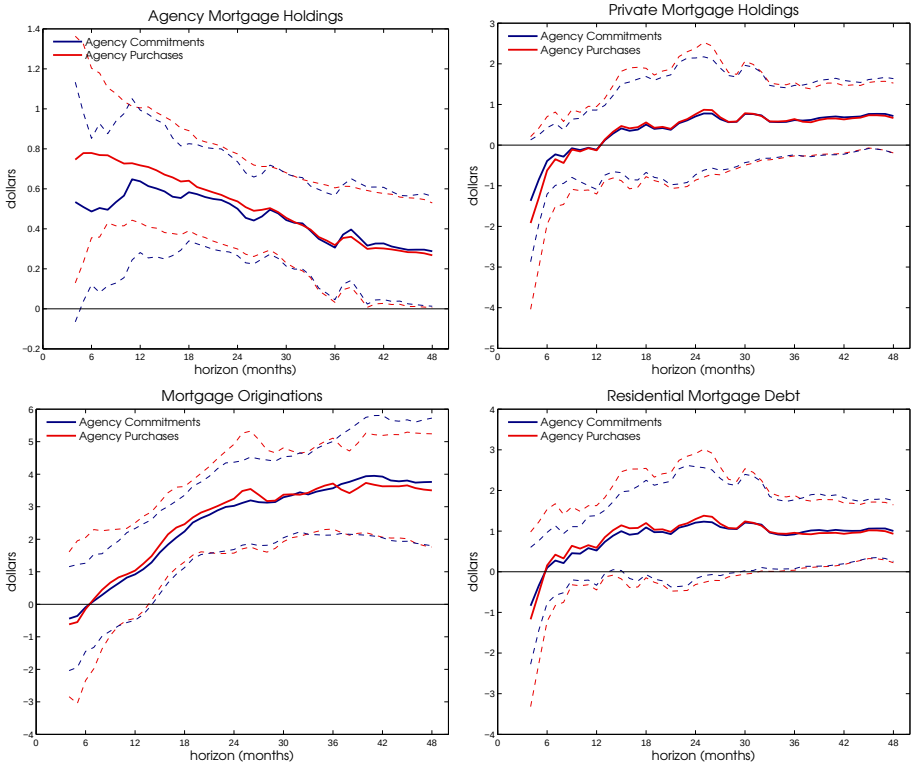

Figure A.1 Cumulative Estimates Using Trend Originations as the Scaling Variable

Notes: The figure shows dollar changes per dollar increase in agency net portfolio purchases or commitments to purchase cumulated over the reported horizon in months. Estimates are from Local Projections-IV regressions, see equation (2). Broken lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

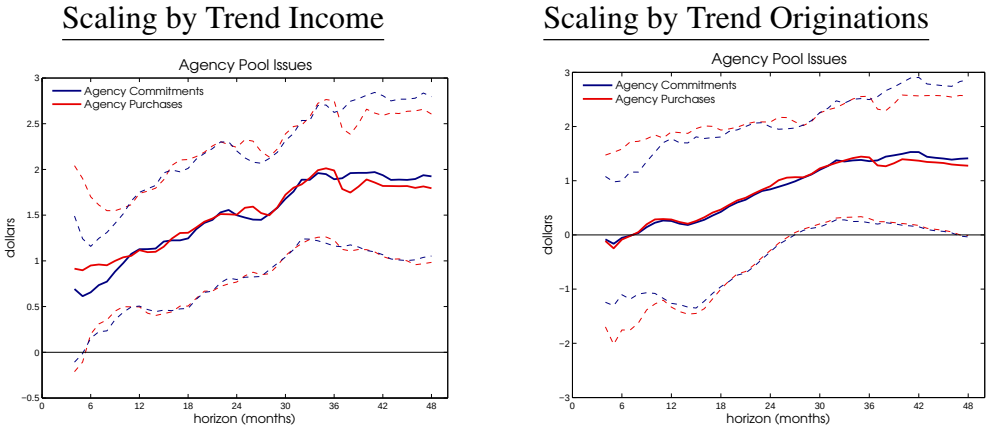

Figure A.2 Total Mortgage Pool Issuance associated with Agency Mortgage Purchases.

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

Other Robustness Checks Table A.1 clarifies how the results depend on instrumentation and the choice of controls. Estimates from the benchmark specifications of Section 4.2 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.

We highlight the following patterns. First, the point estimates across the IV regressions are all quite similar. Controlling for interest rates is the most consequential. When leaving out interest rates in [2], we find somewhat smaller increases in mortgage originations and debt. The results are essentially unchanged by including the cyclical controls (unemployment and income growth). Interestingly, and conditional on including the richest control set as in our benchmark specification, the results remain similar when we also include the cyclically motivated policy events in the instrument, see column [8]. This is in our view not too surprising. Based on our reading of the various historical policy actions, see Fieldhouse and Mertens (2016), recognition and decision lags likely exceed one month in practice. With a sufficiently rich set of lagged controls, including the cyclical actions may therefore not lead to any meaningful violation of the exogeneity requirements. Instrumentation with policy events, however, is important for the results. The OLS estimates in columns [1], [3] and [5] differ substantially in size and display very different time patterns from the IV counterparts in columns [2], [4] and [6]: agency holdings rise immediately and more or less independently of the horizon, private holdings do not fall significantly over shorter horizons, and originations are higher by an amount that is much less dependent on the horizon. The OLS estimates are likely contaminated by reverse causality, as this pattern is more consistent with private lenders simply passing on newly originated loans to the agencies rather than selling existing loans off their balance sheets. The fact that the OLS origination multipliers vary less with the horizon indicates a stronger contemporaneous relation with agency purchases. Given 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.

Table A.2 verifies the robustness of the results to variations in the sample and to the inclusion of additional indicators of agency activity. For comparison, column [1] repeats the benchmark estimates based on net commitments. For brevity, all other columns are based on using commitments as the measure of agency purchasing activity. Column [2] extends the end point of the sample from December 2006 to December 2014. Note that in this case the h-th regression in (2) drops the last h observations. Column [3] restricts the sample by setting September 1982 as the starting point, marking the end of the period of non-borrowed reserves targeting by the Federal Reserve. This shorter sample selects a period of more stable monetary policy. Because of the smaller sample, we omit in this case the cyclical controls to reduce the number parameters to be estimated. Columns [4], [5] and [6] show results when we omit in turn each of the three largest policy interventions from the non-cyclical narrative instrument: the October 1977 conforming loan limit increase and expansion of the Brooke-Cranston Tandem program, the December 1982 increase in Fannie Mae's debt-to-capital limit, and the September 2004 tightening of capital requirements. In each case we add the omitted event as a separate dummy variable, including both the contemporaneous value and twelve lags to the control variables. The final two columns include lagged values of two indicators of agency activity as additional controls: the volume of mortgage pool issues (in ratio of X_t) and log ratio of GSE stock prices to the S&P 500 index. In the latter case, the sample starts in September 1971 instead of December 1967, reflecting the fact that Fannie Mae stock started trading on August 31, 1970.

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

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

	Months	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Agency Holdings	12	0.35***	0.61***	0.33***	0.67***	0.35***	0.65***	0.67***	0.55***
		(0.19, 0.50)	(0.34, 0.88)	(0.18, 0.48)	(0.42, 0.92)	(0.21, 0.49)	(0.39, 0.91)	(0.43, 0.90)	(0.25, 0.86)
	18	0.37***	0.55***	0.33***	0.57***	0.35***	0.53***	0.56***	0.42***
		(0.25, 0.48)	(0.31, 0.78)	(0.22, 0.44)	(0.34, 0.80)	(0.25, 0.45)	(0.29, 0.76)	(0.33, 0.79)	(0.15, 0.69)
	24	0.37***	0.49***	0.31***	0.50***	0.33***	0.46***	0.48***	0.37***
		(0.26, 0.47)	(0.28, 0.71)	(0.20, 0.42)	(0.28, 0.73)	(0.23, 0.43)	(0.25, 0.68)	(0.27, 0.69)	(0.12, 0.63)
	36	0.36***	0.25*	0.28***	0.24*	0.29***	0.22*	0.23*	0.14
		(0.27, 0.46)	(−0.02, 0.51)	(0.18, 0.38)	(−0.01, 0.50)	(0.20, 0.38)	(−0.03, 0.47)	(−0.03, 0.49)	(−0.16, 0.44)
	48	0.35***	0.24*	0.27***	0.21	0.27***	0.20	0.19	0.18
		(0.26, 0.44)	(−0.03, 0.50)	(0.17, 0.37)	(−0.06, 0.49)	(0.18, 0.37)	(−0.07, 0.47)	(−0.06, 0.45)	(−0.10, 0.47)
Private Holdings	12	−0.15	−0.75**	−0.12	−0.80**	−0.10	−0.74**	−0.75**	−0.65
		(−0.46, 0.16)	(−1.39, −0.11)	(−0.40, 0.17)	(−1.45, −0.16)	(−0.38, 0.18)	(−1.40, −0.07)	(−1.40, −0.11)	(−1.48, 0.17)
	18	−0.16	−0.43	−0.07	−0.32	−0.06	−0.23	−0.25	0.00
		(−0.40, 0.07)	(−1.03, 0.18)	(−0.29, 0.15)	(−0.96, 0.33)	(−0.28, 0.15)	(−0.83, 0.36)	(−0.88, 0.38)	(−0.71, 0.72)
	24	−0.12	−0.25	0.06	−0.12	0.06	−0.07	−0.08	0.18
		(−0.34, 0.11)	(−0.87, 0.36)	(−0.14, 0.27)	(−0.74, 0.51)	(−0.14, 0.26)	(−0.64, 0.49)	(−0.65, 0.50)	(−0.53, 0.90)
	36	−0.04	0.16	0.26***	0.35	0.29***	0.32	0.33	0.54
		(−0.30, 0.22)	(−0.73, 1.06)	(0.08, 0.45)	(−0.35, 1.05)	(0.09, 0.49)	(−0.31, 0.94)	(−0.31, 0.97)	(−0.20, 1.28)
	48	0.17	0.71	0.52***	0.94	0.54***	0.86	0.82	0.86
		(−0.14, 0.49)	(−0.67, 2.09)	(0.28, 0.76)	(−0.20, 2.09)	(0.29, 0.78)	(−0.18, 1.90)	(−0.17, 1.81)	(−0.23, 1.96)
Mortgage Debt	12	0.19**	−0.14	0.21***	−0.13	0.25***	−0.09	−0.09	−0.10
		(0.03, 0.36)	(−0.57, 0.28)	(0.06, 0.37)	(−0.58, 0.31)	(0.09, 0.41)	(−0.54, 0.37)	(−0.55, 0.37)	(−0.69, 0.49)
	18	0.20***	0.12	0.26***	0.25	0.29***	0.29	0.31	0.42
		(0.06, 0.34)	(−0.33, 0.56)	(0.12, 0.41)	(−0.24, 0.74)	(0.14, 0.44)	(−0.13, 0.72)	(−0.15, 0.77)	(−0.11, 0.95)
	24	0.25***	0.24	0.37***	0.39	0.39***	0.39*	0.40*	0.56**
		(0.11, 0.40)	(−0.23, 0.71)	(0.23, 0.51)	(−0.09, 0.87)	(0.25, 0.53)	(−0.03, 0.81)	(−0.04, 0.84)	(0.01, 1.10)
	36	0.33***	0.41	0.54***	0.59**	0.58***	0.54**	0.56**	0.68**
		(0.14, 0.51)	(−0.27, 1.10)	(0.42, 0.67)	(0.08, 1.10)	(0.44, 0.72)	(0.10, 0.98)	(0.11, 1.01)	(0.15, 1.20)
	48	0.52***	0.95	0.79***	1.16**	0.81***	1.07***	1.01***	1.04**
		(0.28, 0.76)	(−0.19, 2.08)	(0.62, 0.95)	(0.25, 2.07)	(0.63, 0.99)	(0.26, 1.87)	(0.25, 1.78)	(0.19, 1.89)
Originations	12	2.25***	1.32**	2.41***	1.22***	2.37***	1.32***	1.36***	1.53***
		(1.68, 2.82)	(0.30, 2.34)	(1.95, 2.87)	(0.30, 2.13)	(1.91, 2.84)	(0.37, 2.27)	(0.33, 2.38)	(0.42, 2.64)
	18	2.46***	1.85***	2.79***	1.97***	2.72***	2.12***	2.26***	2.51***
		(1.98, 2.95)	(0.88, 2.81)	(2.44, 3.14)	(1.04, 2.90)	(2.36, 3.08)	(1.23, 3.00)	(1.27, 3.26)	(1.47, 3.54)
	24	2.47***	2.01***	2.91***	2.35***	2.82***	2.49***	2.56***	2.92***
		(2.05, 2.89)	(1.09, 2.93)	(2.55, 3.27)	(1.40, 3.29)	(2.46, 3.17)	(1.60, 3.37)	(1.59, 3.52)	(1.85, 3.99)
	36	2.44***	2.86***	3.10***	3.39***	3.08***	3.41***	3.55***	3.64***
		(1.96, 2.93)	(1.41, 4.31)	(2.63, 3.58)	(1.95, 4.82)	(2.59, 3.58)	(2.07, 4.76)	(2.22, 4.88)	(2.13, 5.15)
	48	2.55***	3.41***	3.20***	4.03***	3.18***	3.99***	3.79***	3.94***
		(2.04, 3.06)	(1.36, 5.46)	(2.61, 3.79)	(2.07, 5.99)	(2.60, 3.77)	(2.16, 5.81)	(2.06, 5.52)	(2.01, 5.87)
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 LP-IV regressions, see equation (2). OLS: no instrument used; 2SLS-NC, instrument based on non-cyclical policy events; 2SLS-ALL: instrument based on all policy events. 95% Newey and West (1987) confidence bands in parentheses. Asterisks denote 10%, 5% or 1% significance. Sample: Jan 1967 to Dec 2006.

Table A.2 Credit Multipliers, Sample and Robustness Checks

	Months	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Agency Holdings	12	0.65***	0.87*	0.42***	0.88	0.63***	0.66***	0.70***	0.62***
		(0.39, 0.91)	(−0.05, 1.79)	(0.23, 0.61)	(−0.27, 2.03)	(0.37, 0.89)	(0.36, 0.95)	(0.37, 1.03)	(0.31, 0.93)
	18	0.53***	0.64*	0.31***	0.78*	0.51***	0.52***	0.59***	0.47***
		(0.29, 0.76)	(−0.02, 1.29)	(0.16, 0.45)	(−0.14, 1.70)	(0.28, 0.74)	(0.26, 0.77)	(0.27, 0.91)	(0.12, 0.82)
	24	0.46***	0.47**	0.26***	0.60	0.45***	0.46***	0.52***	0.42**
		(0.25, 0.68)	(0.09, 0.85)	(0.12, 0.41)	(−0.13, 1.32)	(0.23, 0.66)	(0.23, 0.68)	(0.22, 0.83)	(0.04, 0.80)
	36	0.22*	0.29**	0.07	0.30	0.19	0.14	0.20	0.26
		(−0.03, 0.47)	(0.07, 0.51)	(−0.10, 0.25)	(−0.23, 0.83)	(−0.06, 0.45)	(−0.14, 0.42)	(−0.13, 0.52)	(−0.14, 0.65)
	48	0.20	0.18	0.08	0.07	0.18	0.13	0.19	0.29
		(−0.07, 0.47)	(−0.12, 0.49)	(−0.13, 0.29)	(−1.21, 1.36)	(−0.10, 0.47)	(−0.19, 0.45)	(−0.19, 0.56)	(−0.10, 0.67)
Private Holdings	12	−0.74**	−1.53	−0.44*	−0.84	−0.70**	−0.80**	−0.91**	−0.92**
		(−1.40, −0.07)	(−3.59, 0.53)	(−0.93, 0.05)	(−3.34, 1.67)	(−1.38, −0.03)	(−1.56, −0.03)	(−1.72, −0.10)	(−1.67, −0.17)
	18	−0.23	−0.86	0.02	0.21	−0.22	−0.31	−0.28	−0.30
		(−0.83, 0.36)	(−2.41, 0.68)	(−0.28, 0.32)	(−2.28, 2.69)	(−0.83, 0.40)	(−0.94, 0.32)	(−1.06, 0.49)	(−1.29, 0.69)
	24	−0.07	−0.37	0.19	0.56	−0.05	−0.16	−0.09	−0.25
		(−0.64, 0.49)	(−1.27, 0.52)	(−0.10, 0.48)	(−1.75, 2.88)	(−0.63, 0.54)	(−0.72, 0.41)	(−0.84, 0.66)	(−1.30, 0.80)
	36	0.32	−0.14	0.56***	0.78	0.37	0.45	0.35	−0.24
		(−0.31, 0.94)	(−0.98, 0.70)	(0.25, 0.87)	(−0.53, 2.10)	(−0.28, 1.02)	(−0.29, 1.19)	(−0.45, 1.15)	(−1.07, 0.59)
	48	0.86	0.45	1.13***	2.14	0.91	1.15*	0.93	0.17
		(−0.18, 1.90)	(−0.84, 1.74)	(0.45, 1.81)	(−4.05, 8.32)	(−0.18, 2.01)	(−0.14, 2.45)	(−0.59, 2.46)	(−0.88, 1.22)
Mortgage Debt	12	−0.09	−0.66	−0.02	0.04	−0.07	−0.14	−0.21	−0.30
		(−0.54, 0.37)	(−1.90, 0.59)	(−0.37, 0.33)	(−1.70, 1.78)	(−0.53, 0.39)	(−0.66, 0.38)	(−0.75, 0.34)	(−0.81, 0.21)
	18	0.29	−0.22	0.32**	0.99	0.30	0.21	0.30	0.17
		(−0.13, 0.72)	(−1.23, 0.78)	(0.07, 0.57)	(−1.31, 3.28)	(−0.15, 0.74)	(−0.22, 0.64)	(−0.25, 0.86)	(−0.57, 0.91)
	24	0.39*	0.10	0.45***	1.16	0.40*	0.30	0.44	0.16
		(−0.03, 0.81)	(−0.54, 0.74)	(0.22, 0.68)	(−0.98, 3.30)	(−0.03, 0.83)	(−0.09, 0.69)	(−0.13, 1.00)	(−0.60, 0.92)
	36	0.54**	0.15	0.63***	1.08**	0.57**	0.59**	0.54*	0.02
		(0.10, 0.98)	(−0.56, 0.86)	(0.41, 0.85)	(0.01, 2.16)	(0.11, 1.02)	(0.07, 1.11)	(−0.04, 1.12)	(−0.59, 0.62)
	48	1.07***	0.63	1.21***	2.21	1.10**	1.28**	1.12*	0.46
		(0.26, 1.87)	(−0.50, 1.76)	(0.68, 1.74)	(−2.80, 7.22)	(0.26, 1.94)	(0.28, 2.29)	(−0.09, 2.33)	(−0.31, 1.22)
Originations	12	1.32***	0.43	2.07***	−0.18	1.38***	1.31**	1.16*	1.53***
		(0.37, 2.27)	(−3.30, 4.16)	(1.39, 2.75)	(−4.83, 4.47)	(0.43, 2.32)	(0.30, 2.32)	(−0.09, 2.41)	(0.52, 2.54)
	18	2.12***	1.48	2.91***	1.41	2.17***	1.99***	2.03***	2.40***
		(1.23, 3.00)	(−1.41, 4.38)	(2.38, 3.44)	(−2.19, 5.02)	(1.27, 3.08)	(1.03, 2.94)	(0.73, 3.33)	(1.15, 3.65)
	24	2.49***	2.17***	3.21***	2.60	2.55***	2.34***	2.53***	2.63***
		(1.60, 3.37)	(0.60, 3.74)	(2.66, 3.77)	(−0.56, 5.75)	(1.64, 3.46)	(1.42, 3.26)	(1.26, 3.80)	(0.99, 4.26)
	36	3.41***	2.54***	3.82***	4.51***	3.53***	3.59***	3.72***	2.71***
		(2.07, 4.76)	(1.30, 3.79)	(3.00, 4.63)	(1.28, 7.74)	(2.14, 4.93)	(1.99, 5.18)	(1.88, 5.56)	(0.90, 4.53)
	48	3.99***	3.37***	4.33***	6.28	4.10***	4.33***	4.37***	3.07***
		(2.16, 5.81)	(1.39, 5.35)	(3.03, 5.63)	(−3.82, 16.38)	(2.18, 6.02)	(2.08, 6.58)	(1.61, 7.12)	(1.27, 4.87)
Sample:		67M1-06M12	67M1-14M12	82M10-06M12	67M1-06M12	67M1-06M12	67M1-06M12	67M1-06M12	71M09-06M12
Modification:		Benchmark	Full Sample	Post 1982 Sample	Omitting Sept 2004	Omitting Dec 1982	Omitting Oct 1977	Controls incl. Pool Issues	Controls incl. GSE excess return

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

A.2 Additional Results on Interest Rates and Credit Spreads

This section discusses a number of additional results regarding the effects of news shocks to agency purchases on interest rates and credit spreads. Figure A.3 shows point estimates for the first 24 months after an increase in anticipated purchases by one percentage point of trend originations, together with 95% Newey and West (1987) confidence bands. The responses in blue are based on the regressions in (3) and the narrative instrument. The responses in red are based on the regressions in (4) and the GSE excess returns instrument.

The first two panels in Figure A.3 show the responses of the AAA-rated and BAA-rated long term corporate bond yields. Taken together, the results suggest that agency purchases exert a downward pressure on corporate yields with a timing that coincides with the actual purchasing of mortgage assets by the agencies. The response of the corporate yields is qualitatively similar to those of mortgage and Treasury rates, showing initially no effect, and subsequently a gradual decline. The 95% confidence bands around the responses are relatively wide, and the responses are only marginally significant in the case of the narrative instrument. The declines in corporate bond yields are also quantitatively smaller than mortgage and Treasury rates, in particular for the narrative instrument. The third panel in Figure A.3 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 realtively short-lived, with the effects dissappearing after 7 or 8 months in the case of the narrative instrument, and only after a few months in the case of the GSE excess returns instrument. The next panel shows evidence for a drop in the spread between BAA and AAA-rated corporate bonds after 7 or 8 months, suggesting also some positive spill over effects on the demand for riskier long term bonds.

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

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

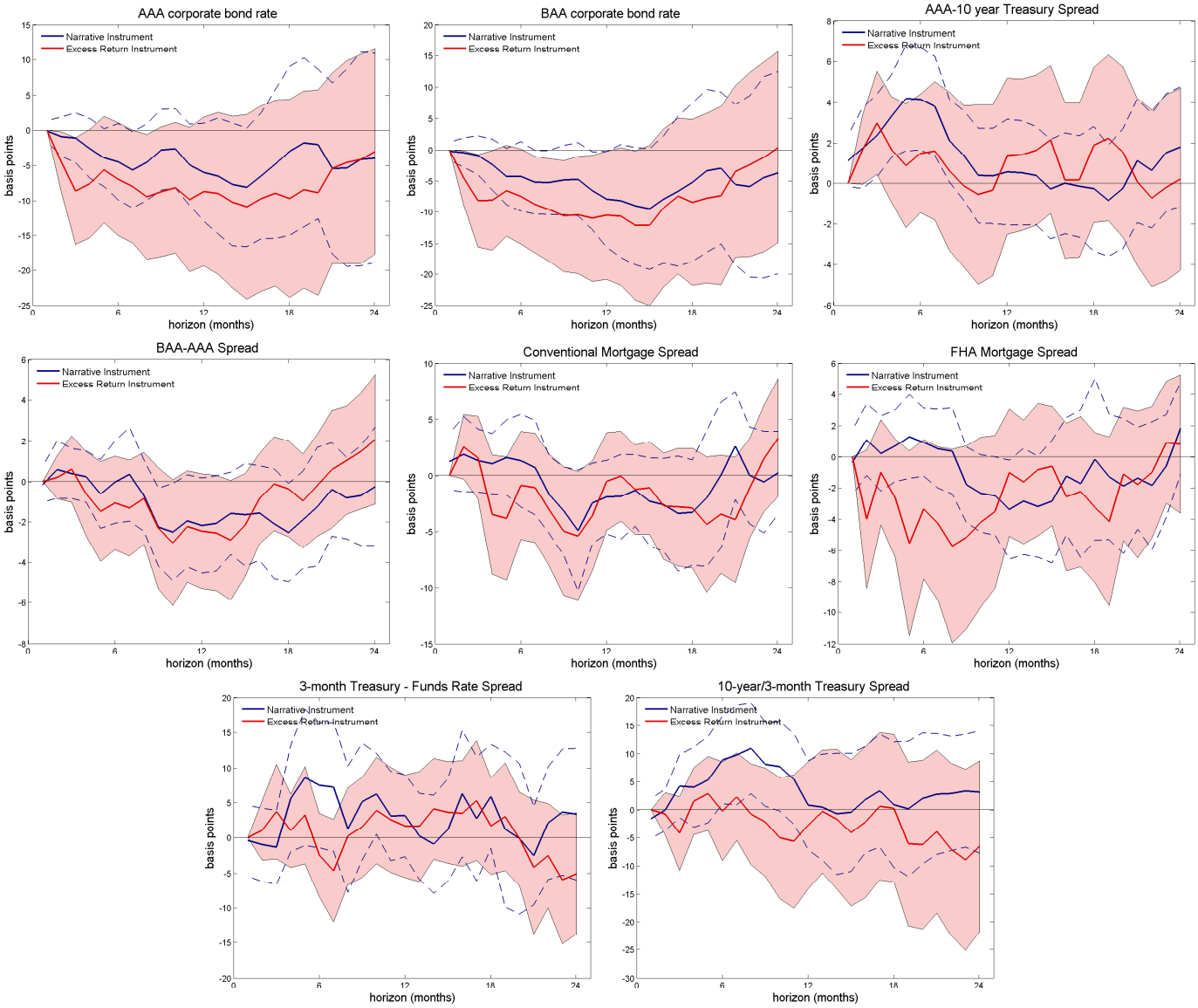

Figure A.3 Impulses Responses to A Shock to Anticipated Agency Purchases.

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with the (1) narrative policy indicator, see equation (3), or orthogonalized GSE excess stock returns innovations, see equation (4). Broken lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006.

A.3 Impulse Response Analysis: Robustness checks

Post 1982 sample Figure A.4 shows the response to an shock to anticipated agency purchases by one percentage point of trend originations, together with 95% Newey and West (1987) confidence bands. The estimates are based on a shorter sample that starts in October 1982 instead of December 1967 as in Figure 7. This starting period marks the end of the period of non-borrowed reserves targeting by the Federal Reserve and selects a period of more stable monetary policy using an interest rate target. 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 are qualitatively very similar to those of the full sample, including a rise in originations and declines in short and long term interest rates. Compared to the full sample, the rise in the of stock mortgage debt is smaller and no longer statistically significant in the case of the GSE excess returns instrument.

Omitting Policy Events from the Narrative Instrument Figure A.5 shows the response to an shock to anticipated agency purchases for the benchmark specification together with those when we omit in turn each of the three largest policy interventions from the narrative instrument: the October 1977 conforming loan limit increase and expansion of the Brooke-Cranston Tandem program, the December 1982 increase in Fannie Mae's debt-to-capital limit, and the September 2004 tightening of capital requirements. In each case we add the omitted event as a separate dummy variable, including both the contemporaneous value and twelve lags to the control variables. While there is some variation in the size of the responses, the results remain qualitatively similar to the benchmark narrative estimates. In all cases, there is a rise in originations and a decline in short and long term interest rates.

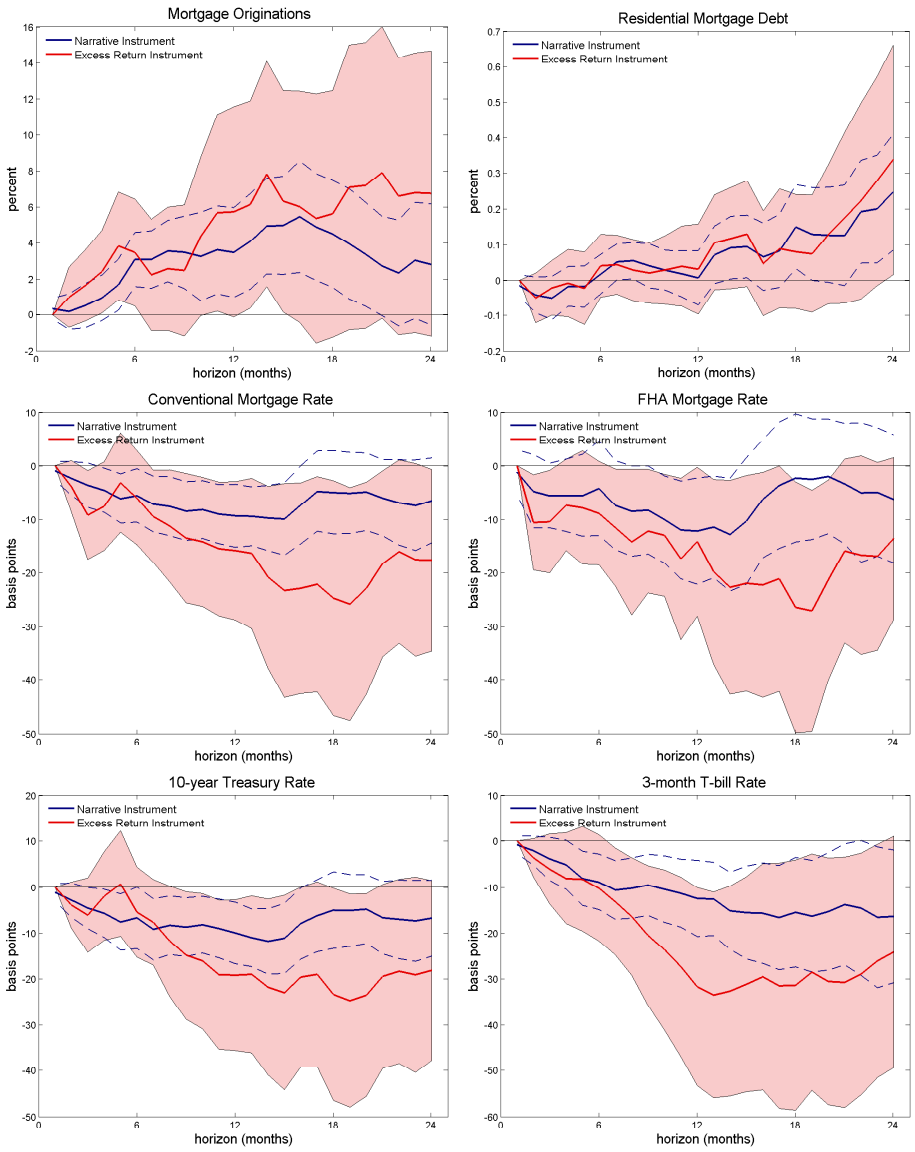

Figure A.4 Impulses Responses in the Post-1982 Sample.

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with the (1) narrative policy indicator, see equation (3), or orthogonalized GSE excess stock returns innovations, see equation (4). Broken lines and shaded areas are 95% Newey and West (1987) confidence bands. Sample: Oct 1982 to Dec 2006.

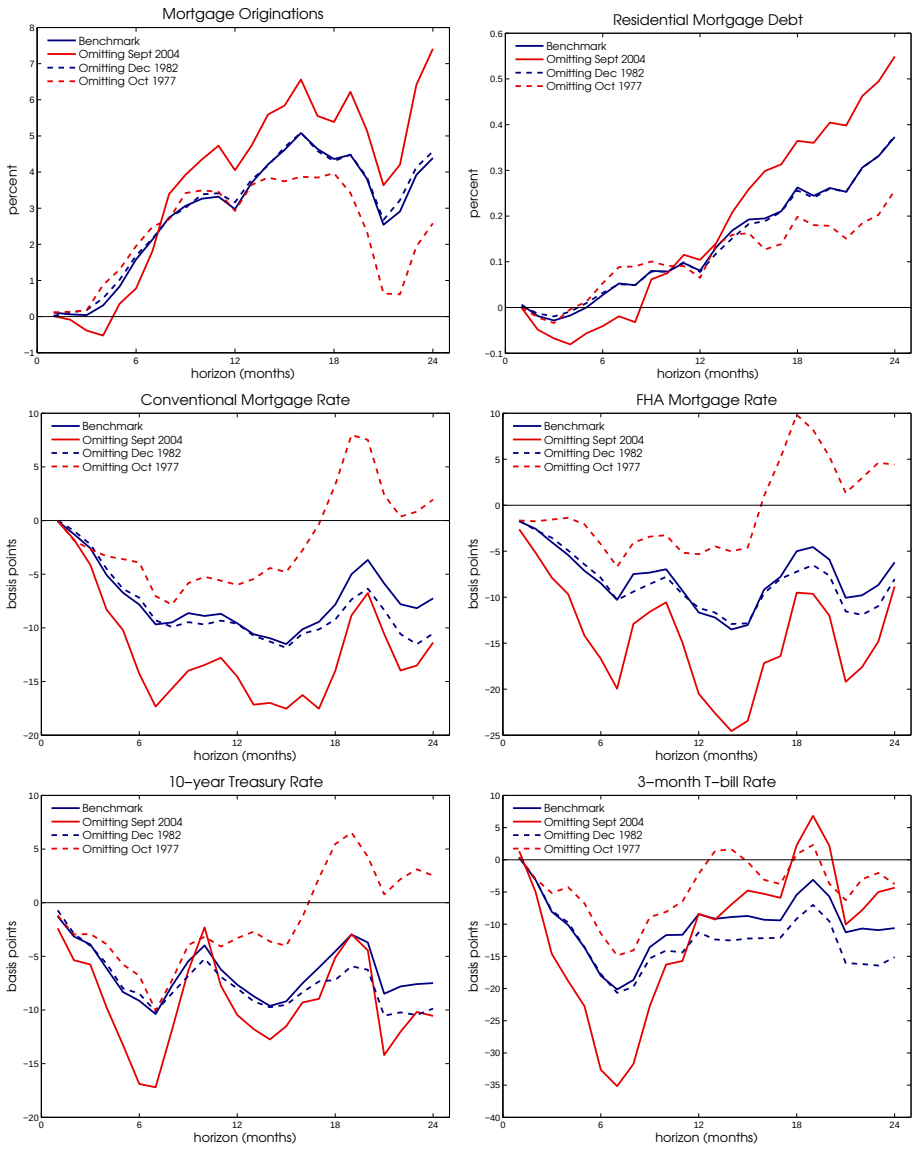

Figure A.5 Impulses Responses when Omitting Largest Policy Events.

Notes: The figure shows responses to a one pp. increase in the expected future agency market share measured by agency commitments as a ratio of trend originations. Estimates are from Local Projections-IV regressions instrumented with different versions of narrative policy indicator, see equation (3). Broken lines are 95% Newey and West (1987) confidence bands. Sample: Jan 1967 to Dec 2006