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Testing the global banking glut hypothesis

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PERFORMANCE: EXPECTATIONS, CONSTRAINTS AND
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ABSTRACT

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JEL classification: F32, F33, F34

Keywords: Global Banking Glut, Global Savings Glut, Cross-Border Banking Transactions, House Prices, Mortgage Loans, VAR model.

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Testing the Global Banking Glut Hypothesis[☆]

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Abstract

This paper presents VAR results on the recent economic history of the U.S and focuses on the dependence of U.S. macrofinancial variables on international capital flows. Both gross and net flows are included in the analysis. The results indicate that cross-border funding has affected the build-up in the U.S. housing market irrespective of how these flows are defined and measured. Both the savings glut hypothesis and the banking glut hypothesis are supported by these findings. However, net banking flows appear to explain the higher volatility in the increase in house prices as well as the mortgage loan boom.

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1. Introduction

In this paper, we focus on the recent boom in U.S. house prices and mortgage loans. Many authors have argued that the surging capital flows into the U.S. contributed to the run-up in house prices and mortgage loans.¹ We focus on different types of capital flows, distinguishing between acquisitions of government and corporate assets. The recent literature has highlighted the different role played by gross and net inflows in explaining the credit boom. In particular, Shin (2012) suggests that the easy credit conditions in the U.S. were due to gross cross-border positions rather than net capital flows. Following this line, we also distinguish between gross and net flows in explaining the U.S. housing and credit boom.

Since Ben Bernanke’s (2005) speech addressing global imbalances, it has been argued that current-account imbalances were a key factor leading to the permissive financial conditions in the U.S. during the “great moderation”. Bernanke (2005, 2007) presented the global savings glut hypothesis by stating that the excess supply of savings relative to investments in surplus countries was channeled into deficit countries, such as the U.S., which fundamentally affected credit conditions. Caballero and Krishnamurthy (2009) presented a model to explain how foreign demand for safe USD-denominated assets moved the U.S. financial system into advanced financial engineering in respect of mortgage processing, in order to create the low-risk assets demanded by foreigners and to keep a levered claim on domestic debt. This financial engineering made it possible to use loans of dubious quality as raw material for highly rated securities. This in turn had substantial macroeconomic effects: capital flows from emerging markets made credit cheap and fuelled the asset price boom (see e.g. Bernanke (2010), Bertaut et al. (2012)).

Figure 1, first row, plots HP-filtered data for real house prices, mortgage loans and the current account deficit of the United States. Mere “eyeball econometrics” suggests that these three variables are strongly linked and consistent with the savings glut hypothesis. Sá et al. (2014) and Sá and Wieladek (2014) found that capital inflow shocks have a significant effect on house prices, which corroborates the savings glut hypothesis.² Spain and Ireland are other

¹See Bernanke (2005), Towbin et al (2012), Ferrero (2012), Mendicino and Punzi (2014).

²Punzi (2013) shows a different causality by studying the link between house price increases and current account deficits through the lens of a dynamic stochastic general equilibrium model. Her model shows that increasing housing demand pushes the U.S. economy to borrow from abroad.

excellent examples of countries where the inflow of foreign funding occurred simultaneously with a house price bubble.³

However, an alternative hypothesis shows that different sources of international financial flows have affected credit conditions in the U.S. economy, particularly emphasizing the role of gross flows relative to net flows. Acharya and Schnabl (2010) and Shin (2012) argue that banks outside the U.S. were investing large amounts of funds in long-term U.S. assets before the 2007 financial crisis, suggesting that the global saving glut hypothesis is meaningless relative to the role of foreign banks. As pointed out by Borio and Disyatat (2011), substantial gross inflows of investments came from Europe, rather than China or oil exporting Arab countries.⁴ Bertaut et al. (2012) found that countries running current account surpluses affect credit conditions by lowering long-term yields on US Treasury securities. As a result, European investors substitute Treasury assets with private securities, as they seek higher yields. The role of European banks is not evident in the current account statistics because the net difference between debts and receivables is small; financing was acquired in the very same market where the loans were granted.⁵ Figure 2 compares data for 2003 and 2007, revealing that while surplus countries have been accumulating U.S. assets, these purchases have consisted almost exclusively of Treasury and Agency bonds. Europeans have shown a preference for holding larger shares in AAA-rated asset-backed securities (including private-label MBS), equities and lower-rated debt.⁶

Shin (2012) introduced the Global Banking Glut hypothesis, which emphasizes the global excess supply of banks' financial intermediation capacity. He presented both statistical evi-

³Most of the countries with massive net inflows of foreign funding were hit particularly hard by the international financial crisis (Aizenman and Pasricha (2012), Kauko (2012)), consistent with the "capital bonanza" hypothesis of Reinhart and Reinhart (2008).

⁴Benhima (2013) shows that some countries, including China, suffer from a misallocation of capital and invest only in short-term projects. As financial markets integrate, emerging countries gain more access to cheaper short-term assets abroad, leaving them with more resources to invest in long-term projects at home.

⁵European banks raised wholesale funds from their affiliates in the United States. Via their head offices and/or financial centres, they lent those funds back to non-banks in the United States or in other countries, either directly or by funding local banks.

⁶Because of the depreciation in the U.S. dollar against the euro and because the U.S. supply of new financial assets (i.e. mortgage backed securities), European banks have intensively expanded their balance sheets in the U.S. and elsewhere through their foreign branches.

dence on the growing role of European banks in the U.S. and a formal model on how excess financial intermediation capacity could affect credit conditions. As pointed out by Shin (2012), the introduction of the Basel II capital adequacy system in the EU enabled European banks to expand their balance sheets overseas by freeing up bank capital by reducing the average risk weight of the different balance sheet items in the capital adequacy calculations.⁷ Although the original intention of the Basel II regulatory reform was not to loosen solvency requirements, the reform may have boosted the supply of bank loans in the United States. Cetorelli and Goldberg (2012b) found that foreign banks pushed significant funding to their U.S. branches by transferring funds across branches. Such internal balance sheet movements of foreign branches in the U.S. had sizable effects on their lending.

In this paper, we estimate a Structural Vector Autoregressive (SVAR) model to study the macrofinancial interlinkages behind the housing market. We extend the econometric analysis of Lambertini et al. (2013), Goodhart and Hofmann (2008), Musso et al. (2011) and Sá and Wieladek (2014) by considering different sources of net and gross foreign funding, and estimating their contributions to house prices and the household debt boom.⁸ We find evidence in support of both the savings glut hypothesis and the banking glut hypothesis. Funding shocks from abroad generate increases in consumption, residential investment, dwelling prices and the stock of mortgage loans. We find that net banking inflows can explain the volatility of house prices and mortgage loans better than gross securities or gross banking flows. Like Kollmann (2013), we find that banking shocks matter for U.S. real activity.⁹ Our results raise many questions about the need for macroprudential policies. Effective regulations of cross-border banking are important for domestic and global financial stability in a deep financially integrated world economy.

In our estimation, we make use of two specific datasets: the Treasury International Capital (TIC) surveys of foreign portfolio holdings of U.S. securities and the banking statistics

⁷See also Cetorelli and Goldberg (2012a) and Correa et al. (2012).

⁸We identify funding shocks as Cetorelli and Goldberg (2012a), Bruno and Shin (2014) and Devereux and Yetman (2010) by assuming that international flows are driven mainly by head office balance sheet management considerations, and therefore fund dynamics can be considered exogenous from the perspective of U.S. global banks foreign locations.

⁹Kollmann (2013), using a Bayesian method, estimates a two-country DSGE model with global banks to assess the role of banks as a source of shocks and as a transmission channel in the global economy.

of the Bank for International Settlements (BIS). TIC data covers all cross-border portfolio investment flows whereas BIS data covers all flows that pass through the banking system. In practice, the majority of investment flows covered by TIC data consist of transactions in securities issued by the Treasury and US agencies.

Our analysis finds further evidence of the short-term connection between the supply of foreign funding and banking sector problems. Cross-border transactions have always been seen as having beneficial long-term effects because they enable diversification of borrowing and lending internationally, thereby reducing the volatility of domestic lending.¹⁰ However, such international banking transactions may jeopardise financial stability because domestic banks are exposed to external shocks. Indeed, the 2007-2009 crisis showed that cross-border lending has greatly contributed to the vulnerability of the financial and banking sector. We find that from the point of view of banking stability, growing banking inflows may prove destabilizing, irrespective of whether we measure them on gross or net basis. Instead, growing inflows in the securities market do not seem a problem. As pointed out by Shin (2012), the expansion of foreign banks U.S. assets is partly due to the introduction of the Basel II capital adequacy system in many countries, and the resulting expansion of global bank intermediation capacity. As to the securities market, there was no regulatory change that would have had equally strong consequences.

Shin (2012) and Bertaut et al. (2012) concluded that the banking glut has contributed to the easing of credit conditions in the United States. We contribute to their findings by showing the quantitative importance of net flows relative to gross flows in fuelling the housing boom. Justiniano et al. (2014) found that the savings glut was a major driving force of the the U.S. housing boom, but signs of the banking glut were also detected. Justiniano et al. (2014) did not particularly focus on portfolio allocation by foreign investors, as they assume that economic agents have perfect foresight in terms of risk and thus are indifferent to portfolio composition. Therefore, they do not consider the preference of saving glut countries for safe U.S. dollar assets relative to the preference of global banking glut countries for non-government securities. Igan et al. (2011) analysed the leads and lags of different macroeconomic and housing market related variables in a large number of countries but paid little attention to cross-border funding flows.

¹⁰See Allen et al. (2011).

The rest of the paper is organized as follows. Section two presents the data and the econometric method. Section three presents some preliminary results. Section four tests whether the econometric framework is able to explain the 2008 crisis. Section seven concludes and discusses the findings.

2. Data and Methodology

In this section, we describe the data and methodology used to construct Impulse-Response Functions (IRFs). We implement a simple VAR model as a useful statistical model to address the issue.¹¹

In our estimation, we make use of two specific datasets: the Treasury International Capital (TIC) surveys of foreign portfolio holdings of U.S. securities and the banking statistics of the Bank for International Settlements (BIS).

The TIC system reports U.S. holdings of different kinds of foreign securities and foreign holdings of U.S. securities. Following previous contributions, such as Borio and Disyatat (2011) and Bertaut et al. (2012), we focus on long-term securities. Table 1 shows the increasing accumulation of flows from and to the U.S. The ratio between the two flows is less than one, implying that the U.S. is selling larger amounts of long-term securities than it is buying from abroad. Table 2 shows that the U.S. has been selling debt securities rather than equities, and that this debt has been sold to current account surplus countries. However, Figure 2 reveals that while surplus countries have been accumulating U.S. assets in net terms, these purchases have consisted almost exclusively of Treasuries and Agencies. On the other hand, Europeans have preferred AAA-rated asset-backed securities (including private-label MBS), equities and lower-rated debt.

BIS banking statistics report banking assets and liabilities denominated in foreign currencies. Shin (2012) shows that European banks played an important role in influencing credit conditions in the United States by providing U.S. dollar intermediation capacity, even though net flows between Europe and the U.S. were small. Effectively, European global banks sustained the “shadow banking system” in the U.S. by utilizing USD-denominated funding in

¹¹See Christiano (2012) which points to the important role that vector autoregressions (VARs) continues to play.

the wholesale market to purchase securitized claims on U.S. borrowers.¹² Figure 3 shows a sharp increase in the gross cross-border assets and liabilities of foreign affiliates in the U.S. held by the rest of their banking groups outside the U.S. between 1978 and 2012. These gross positions were very large, peaking at some \$10 trillion and were mainly denominated in U.S. dollars. European banks held most of these assets and liabilities, as shown in their external balance sheets, with counterparties in the United States (see Figure 4).¹³ In net terms, European banks have been lending to non-banks and borrowing from banks in the United States. There has been a significant maturity mismatch; McGuire and von Peter (2009) show that European banks were borrowing short and lending long. If European banks' cross-border operations eased credit conditions in the U.S., they have helped to tighten the credit conditions since the crisis.

Even though the main contribution came from Europe, we use the overall US dollar assets and liabilities reported by all (44 BIS-reporting) countries in the locational BIS statistics on banks' international gross assets and liabilities.¹⁴ These data are based on residence of reporting institution and measure the activities of all banking offices residing in each reporting country, including both domestic institutions and branches or subsidiaries of foreign banks. Every office reports exclusively on its own operations at the unconsolidated level, which includes international transactions with entities of the same banking group. On the claims side, banks report all loans granted, working capital to branches/subsidiaries and deposits with other banks, including those with their own affiliates (inter-office positions). On the liabilities side, banks report all claims on the reporting bank including deposits and borrowing from others. This includes borrowing from own affiliates, including head office or controlling parent institution, and working capital received from the head office or controlling parent institution.

We compare the impact of the composition of capital inflows on the housing and mortgage loan booms by using the TIC data, i.e. Treasury bond market, and BIS data, i.e. cross-

¹²Bruno and Shin (2014) point out that the run-up in cross-border lending closely mirrors an increase in wholesale funding raised by global banks, primarily from U.S. money markets, around the same time.

¹³See Hills and Hogarth (2013), Chart 7.

¹⁴BIS reporting banks include banks residing in the G10 countries, plus Australia, Austria, the Bahamas, Bahrain, Bermuda, Brazil, the Cayman Islands, Chile, Chinese Taipei, Curacao, Cyprus, Denmark, Finland, Greece, Guernsey, Hong Kong SAR, India, Indonesia, Ireland, Isle of Man, Jersey, Korea, Luxembourg, Macao SAR, Malaysia, Mexico, the Netherlands Antilles (till Q3 2010), Norway, Panama, Portugal, Singapore, South Africa, Spain and Turkey.

border banking lending. The savings glut hypothesis refers to current account imbalances (see Bernanke (2005), Sá et al. (2014), Sá and Wieladek (2014)), while the banking glut hypothesis refers to banks' willingness and ability to accumulate gross international claims denominated in U.S. dollars (see Shin (2012)). We emphasize our results by highlighting the difference between net and gross flows in the international transmission of shocks.

Table 3 gives standard deviations of current account, housing prices, mortgage loans, and gross and net sources of capital inflows. Those variables have shown increasing volatility even during the Great Moderation. Therefore, we focus on these variables to highlight their relationship. Therefore, we find it important to highlight the relationship of those variables that are characterized by increased volatility with real macro-variables that have showed lower volatility, such as real consumption and real residential investment.

Methodology

Like Uhlig (2005), we estimate a structural vector auto-regression (SVAR) model using a limited set of variables. Consider the following VAR:

$$A_0 Z_t = c + A(L)Z_{t-1} + \varepsilon_t \quad (1)$$

where Z_t is the vector of endogenous variables, A_0 is the matrix of contemporaneous interaction, $A(L)$ is a matrix polynomial in the lag operator L and ε_t is the vector of structural shocks with covariance matrix Σ .

To identify the shocks, we use the Cholesky decomposition of the covariance matrix, which assumes a recursive exogeneity structure.¹⁵ Therefore, the first variable in the VAR is only affected contemporaneously by the shock to itself. The second variable in the VAR is affected contemporaneously by the shock to the first variable and the shock to itself, and so on.¹⁶

The sample covers the period between the first quarter of 1978 until the fourth quarter of 2009. The vector Z_t contains the federal funds rate (FFR), the log of real private consumption (C), the log of the GDP deflator (P), the log of home mortgage loans deflated by the GDP deflator (Loans), the log of the real house price index deflated by the GDP deflator (HPI)

¹⁵See Giuliadori (2005), Adalid and Detken (2007), Goodhart and Hofmann (2008), Assenmacher-Wesche and Gerlach (2010), Abildgren (2012) and Musso et al. (2011).

¹⁶The orthogonalized shocks should not be interpreted as structural shocks, but rather as orthogonalized reduced-form shocks. Identification of structural shocks is possible under a different shock identification scheme, such as a combination of long-run and short-run restrictions or sign restrictions.

and a proxy for capital inflows to GDP, which we generally refer to as “funding flow”. This “funding flow” variable can be defined in several alternative ways: the current account balance (a proxy for the global saving glut as defined in Bernanke (2005)), gross banking inflows (gross US dollar claims, as a proxy for global banking glut as defined in Shin (2012)), net banking inflows (net US dollar cross-border lending), gross securities inflows (foreign gross acquisitions of government assets) and net securities inflows (net foreign acquisitions of government assets). We look at how shocks to these types of funding flows affect the rest of the economy.

Based on the Schwarz information criterion and Hannan-Quinn information criterion, we choose the lag length of one quarter. Further, as in Lambertini et al (2013) and Leduc and Sill (2013), we also controlled for changes in the conduct of monetary policy using a shift dummy from 1979Q4 and another to capture issues related to the zero-lower bound and the use of unconventional monetary policy measures, such as large scale asset purchases, starting from the fall 2007. Moreover, we use the Shadow Federal Funds Rate proposed by Wu and Xia (2014) for the same purpose.¹⁷

We order the variables as follows: funding flows, inflation, private consumption, interest rate, mortgage loans, house price index.

For the interest rate, we consider the fed fund rate and mortgage spread. We assume that the mortgage spread affects house prices, housing wealth and collateral values. Taking into account the collateral channel, the mortgage spread, i.e. a proxy for the external risk premium, can affect spending decisions if collateral constraints are binding. For mortgage spread, we follow Walentin (2014) who uses the 30-year Conventional Mortgage Rate relative to the average of the 5-year and the 10-year Treasury bond rate, in order to isolate the term premia given the longer maturity of mortgage loans. Walentin (2014) finds that this measure of mortgage spread captures movements in credit supply.¹⁸ However, the standard literature has measured the spread in terms of the long-term mortgage rate and the deposit rate.¹⁹ Figure 5 plots both measures. Mortgage spreads are countercyclical. They decrease before the house price peaks in the U.S. (vertical lines) and increase just after the drop in housing

¹⁷The Wu-Xia shadow rate is constructed as a linear function of three latent variables called factors; see Wu and Xia (2014) and Figures 20 and 21 in the Appendix.

¹⁸Walentin (2014) identifies mortgage spread shocks and isolates the mortgage-specific variable from the short-term risk-free rate, term spread and a mortgage spread.

¹⁹Musso et al. (2011).

prices.

We extend Christiano et al. (1997) by including cross-border funding and, at a later stage, the two variables directly related to banking distress, residential investment, real exchange rate and VIX index. Thus, we estimate the following equations:

$$Z_t = [Funding\ Flows, P, C, FFR, Loans, HPI]' \quad (2)$$

and

$$Z_t = [Funding\ Flows, P, C, FFR, Spread, Loans, HPI]' \quad (3)$$

The ordering of economic activity, inflation and interest rates is standard in the monetary transmission literature. We follow Den Haan and Sterk (2011) and Musso et al. (2011) by ordering inflation before economic activity. We chose private consumption as an economic indicator of economic activity because we are interested in capturing the wealth effects of asset prices. As house prices increase, more collateral is available for mortgages, which eases the borrowing constraint of households (see Aoki et al. (2004) and Muellbauer and Murphy (2008)). This housing wealth or collateral effect may be stronger in countries with more sophisticated mortgage markets because its existence is largely due to the availability of products that allow housing equity withdrawal.

Mortgage loans and house prices are placed lower in the ordering. Assenmacher-Wesche and Gerlach (2010) argue that they should follow interest rates because monetary policy only reacts to asset price movements if these are prolonged, while asset prices react immediately to changes in monetary policy. The ordering of mortgage loans and house prices is arbitrary. Goodhart and Hofmann (2008) suggest that house prices should appear before financial variables because prices are probably stickier. Similarly, Musso et al. (2011) order house prices before credit because they interpret credit as a mortgage loan demand function. Christiano et al. (1997) and Assenmacher-Wesche and Gerlach (2010), instead, order credit before housing prices, arguing that a shock to credit affects output and the price level with a lag, while house prices can react within one quarter to a shock. We order housing prices after mortgage loans, allowing housing prices to react contemporaneously to credit shocks, thereby allowing credit standards to affect asset prices immediately. Our results appear robust to inverting the order of house prices versus mortgage loans. We order the funding flows as the first variable, assum-

ing that structural shocks to all the other variables are constructed by their own residuals, which are orthogonal to cross-border shocks. In any case, the order of the funding flows is trivial, and it is difficult to say whether funding flows should come first or last. We use a Granger Causality test to help to determine the ordering. Table 5 presents the estimated causalities between net banking flows and the house price index. Up to four lags, we find that net banking flows Granger cause house prices, and not the contrary. We also test the causality ordering in the VAR model (see Table 6). When the dependent variable is net banking flows, all variables included in the VAR have immediate explanatory power, except for the interest rate. Hence, past values of the variables included in the VAR do not help to predict the net cross-border banking inflows; therefore this variable should be the first. Our choice of ordering funding flows first finds support from Cetorelli and Goldberg (2012a), Bruno and Shin (2014) and Devereux and Yetman (2010). They find that international flows are driven mainly by head office balance sheet management considerations and, therefore, fund dynamics can be considered exogenous from the perspective of U.S. global banks' foreign locations. However, it can also be argued that foreign banks increase the supply of funds by responding to a U.S. variable, in the sense they are attracted by a booming housing market or have high expectations about economic growth. We checked for robustness by ordering this variable lower in the VAR; changes in the ordering of the variables had no substantial effect on the results (see Appendix, Figure 15).

3. Econometric results

3.1. Evidence from Reduced Form VAR

The following section shows our main empirical findings through the orthogonalized impulse-response functions (IRFs). Following Uhlig (2005), we show the median as well as the 16% and the 84% quintile of the estimated impulse responses in all the plots. All the variables are logarithmic, with the exception of interest rates and funding flows, the latter of which are expressed as a ratio of GDP. Each box of the figures gives the impulse responses over 20 quarters of one standard deviation of the innovations. We are interested in showing the dynamics of the macroeconomy following liquidity-providing funding flow shocks. Each row reports impulse-response functions given different sources of funding flows, both gross and net (see Figure 6).

The first row reports IRFs due to a total capital inflow shock, i.e. a current account shock. Rows 2 to 5 report IRFs due to shocks of some particular components of the current account, i.e. securities and corporate assets.

An increase of one standard deviation in any of these variables generates an economically significant positive response in consumption, mortgage debt and housing prices. With respect to the current account, higher foreign preference for U.S. assets leads to an expansionary monetary policy, which in turn generates an increase in mortgage loans. Lower interest rates boost the demand for loans, and therefore raise the demand for houses, thereby increase house prices. Due to the wealth effect coupled with lower interest rates, consumption increases as well. Net securities and banking inflows generate similar dynamics, but the net banking inflows shock leads to more amplified effects on mortgage loans and house prices. Gross banking funds instead do not affect the policy rate, and gross securities inflows have only a one-period impact on the policy rate. Therefore, the hypothesis that funding supply itself has macroeconomic effects is confirmed. The large increase in funding supply from foreign countries influences credit conditions in the U.S, thereby amplifying credit booms and lowering interest rates and inflation. Moreover, mortgage loans and house prices show strong persistence over the 16 quarters (4 years).

In order to quantify the importance of particular funding flows, we present the forecast error variance decomposition to highlight the proportion of unanticipated changes in a variable that can be attributed to innovations in the variable itself or to other variables in the system. Table 7 reports the 20-step ahead forecast error variance for mortgage loans and housing prices due to each funding flow shock. As can be seen, the current account deficit overall is able to explain about 34% and 32% of the variance of house prices and mortgage debt, respectively. This finding corroborates the savings glut hypothesis. Moreover, net banking inflows are also capable of explaining a fairly substantial part of the total variance in house prices and mortgage loans, relative to other types of inflows.

Figure 7 reports impulse-response functions for a VAR which also includes the rate spread between the 30-year Conventional Mortgage Rate and the average of the 5-year and the 10-year Treasury bond rate. The results are invariant relative to the first VAR. The mortgage spread decreases due to a funding shock, which increases bank leverage in the case of banking flows. The results are consistent with Borio and Disyatat (2011) and Rey (2013) who find that there is a positive feedback loop between greater credit supply, asset price inflation, and

a compression of spreads. The results hardly change if one uses the Wu-Xia shadow rate instead of the actual Federal Funds Rate. (See Figure 21 in comparison with Figure 7). As to the impact of funding shocks on mortgage loans and house prices, the choice between the two alternative ways to measure the monetary policy stance seems irrelevant.

The variance decomposition holds as in the previous case (see Table 8). Net banking inflow shocks can explain 19 % and 38 % of the volatility of house prices and mortgage debt, respectively. As pointed by Shin (2012), gross flows are important in understanding the easing of credit conditions in the U.S., but we find that net inflows are more important.

3.2. Robustness via Sign Restrictions Methodology: Push-Pull Factors

In the previous section, we proposed orthogonalized reduced-form shocks to determine the order of foreign banking flows. We have also confirmed that inverting the order does not affect the results (see Figure 15 in the Appendix). However, it is not trivial to identify funding flow shocks as structural shocks. Therefore, in this section, we propose a sign restriction method in order to support the Cholesky identification scheme.²⁰

We also investigate whether such fund inflows were determined by country-specific factors (pull effect) or global factors (push effect). In particular, we compare increasing liquidity into the U.S. (push effect) with the U.S. monetary policy shock (pull effect).²¹

To identify funding shocks, we follow Sá and Wieladek (2014). They derive the sign restrictions from a two-country dynamic stochastic general equilibrium (DSGE) model, similar to the one in Ferrero (2012).²² Sá and Wieladek (2014) identify savings glut shocks as risk premium shocks. In particular they find that the perceived safety of US assets encourages foreign investors to move their savings into U.S. assets, leading to an increase in consumption in the U.S. and a widening current account deficit. They also interpret the saving glut shock as an increase in the degree of patience of foreign households who reduce consumption and increase savings. Those extra savings are partly allocated to US assets, which generate an

²⁰For a similar example, see Walentin (2014).

²¹Bertaut et al. (2012) show that capital from current account surplus countries has gone into the United States, but some regulatory and financial factors encouraged Europeans to buy U.S. corporate assets by pulling capital from Europe in response to attractive returns.

²²Their model has tradable consumption goods and housing, and introduces an endogenous borrowing constraint for households, as in Kiyotaki and Moore (1997).

increase in consumption in the U.S., a current account deficit and dollar appreciation. Long-term interest rates decline in both the U.S. and the rest of the world in response to the increase in global savings.²³

We assume that banking glut shocks have the same sign as they moved liquidity into the U.S. via the international banking system and increased the banking capacity there. We also follow Kollmann (2013) in identifying funding flow shocks. Kollmann (2013) estimates a two-country DSGE model to show that banking shocks matter for the dynamics of macro and banking variables.²⁴ We can extend Kollmann's (2013) intuition by allowing for an expansion of the balance sheet via increases in foreign claims and liabilities, with banks violating the target capital ratio. Therefore, we assume that if there is a push effect because of, for example, extra bank capital, the amounts of foreigners' USD assets and liabilities increase. This causes a supply shock, which induces the U.S. economy to borrow more from abroad. Cetorelli and Goldberg (2012b) found that foreign banks have pulled significant funding from their U.S. branches during the Great Recession, with about 12 percent net internal fund withdrawal. Analogously, during the Great Moderation, foreign banks pushed funding via internal shocks to the balance sheets with sizable effects on lending supply.

We define a funding flow shock impulse vector as one in which the sign restrictions hold. In other words, in a funding flow shock impulse vector, the response of real activity is non-negative. Therefore, the impact on consumption must be positive, and the impact on the interest rate spread must be negative. No sign restrictions apply to the other variables (see Table 10, column (1) - (2)).²⁵

Figure 8 shows that increases in foreign funding causes increases in consumption, mortgage loans and house prices, while price levels and short interest rates decline. Funding shocks represent a push-effect of liquidity into the United States. The results are similar to those obtained when the Cholesky decomposition was used to identify shocks. They are also consistent with Cetorelli and Goldberg (2012b), Sá and Wieladek (2014) and Mendicino and Punzi (2014).

Some authors have argued that the run-up in house prices in the U.S. was mainly due

²³In contrast, Bracke and Fidora (2012) interpret a saving glut as a negative shock to savings, which leads to an increase in consumption and price, while crowding out investment and raising short-term interest rate.

²⁴Kollmann (2013) defines a banking shock as an exogenous fluctuation in the required bank capital ratio.

²⁵Table 10, columns (1) - (2) applies equally to both gross and net inflows.

to loose monetary policy (e.g. Taylor (2007), Bracke and Fidora (2012), Borio and Disyatat (2011)), whereas Igan et al. (2013) conclude that in an overheating economy, monetary policy becomes an inefficient tool for preventing housing market bubbles. Now, we identify pull effect factors related to monetary policy shock. As in Sá and Wieladek (2014), we assume that a reduction in nominal short-term interest rates in the US raises consumption and prices, leading to a deterioration of the current account (See Table 10, column (3)). Such an identification scheme is similar to Bracke and Fidora (2012). We interpret the expansionary U.S. monetary policy as a pull-effect that attracts funding flows.

Figure 9 shows that expansionary monetary policy causes an increase in consumption, mortgage loans and house prices if the VAR includes the current account deficit or net securities inflows, but has no impact on house prices when the VAR includes gross flows. House prices show a negative response for a few quarters, which becomes positive for quarters 10 to 13, when net banking flows is included in the VAR. This result is in line with Sá and Wieladek (2014) who conclude that monetary policy played a role in the mortgage and housing boom but the impact of the global savings glut has been even stronger. Igan et al. (2013) also concluded that during the pre-crisis era, house prices were little affected by U.S. monetary policy.

Table 9 shows how monetary policy has affected house prices and mortgage loans. In general, monetary policy has a moderate impact on house prices, and the estimated effect may be as weak as 7% of total house price volatility. Monetary policy seems more relevant for mortgage loans, especially if the VAR includes net securities inflows. This result is consistent with Shin (2012), Bruno and Shin (2014) and Rey (2013) who show that monetary policy loosening has affected global bank leverage, capital flows and credit growth in the international financial system.

Fry and Pagan (2011) show that sign restrictions do not pin down models uniquely since more than one model is consistent with the restrictions. To avoid this violation, we apply the Median Target method proposed by Fry and Pagan (2011). As a robustness check, the Appendix reports the median and the 16th and 84th percentiles of the impulse responses due to net banking inflows (see Figure 18).

3.3. Extended Baseline Model

In this section, we test the robustness of our findings by extending the baseline model described above to include residential investments (IH), the real exchange rate (REER) and the VIX index. A large body of literature has investigated macro-financial interlinkages among credit variables, asset prices and economic activity, and the amplification of shocks through credit market imperfections (see Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1999)). The level of residential investment as a share of GDP was around 5% and has been strongly pro-cyclical (the maximum correlation in the U.S. was 0.68). Therefore, we include residential investment in order to analyze whether funding flow shocks have an impact on the overall housing market, including the supply side. We order residential investment after consumption and before house prices, assuming that the supply affects fluctuations in prices (see Lambertini et al. (2013)). Figure 10 shows that gross flows have no impact on residential investment, while net flows in both banking and securities generate a boom in residential investment, consumption, house prices and mortgage loans, as experienced by the U.S. economy.

We also consider the real exchange rate as an important variable for consideration in analyzing international capital flows. We order the real exchange rate as the last variable in the system, assuming that the exchange rate reacts to changes in capital flows and changes in short and long term interest rates. The impact on the real exchange rate is significant only for current account deficit shocks and net banking inflow shocks, and it is significant only for a few quarters after a year following the shock. These two funding flows generate a short appreciation of the dollar, as predicted in Sá and Wieladek (2014) (see Figure 11). The result is also consistent with Shin (2012) who highlights the important role played by the U.S. dollar in underpinning the global banking system.

As a robustness check and in order to take risk aversion into account, we also include in our estimation the VIX index from the Chicago Board Options Exchange Market as a measure of the implied volatility of S&P 500 index options. Recent studies have shown that the surge in capital flows is associated with a lower VIX (see Forbes and Warnock (2012) and Bruno and Shin (2014)). In particular, Rey (2013) shows that low values of the VIX during boom periods are associated with more capital inflows and outflows, more credit creation, more leverage and higher asset price inflation. We order the VIX index after policy rate as in Bruno and Shin (2014) who assumes that the VIX index adjust instantaneously after monetary policy news.

Net banking inflow shocks affect mortgage loans positively, which in turn push up house prices and reduce risk. Consumption is also boosted (see Figure 17 in the Appendix.)

3.4. Combining the Two Funding Flows

In this section, we analyze the impacts of different funding flows in the same VAR.

Bertaut et al. (2012) show that global savings glut countries have concentrated their U.S. purchases in Treasury securities, agency debt and low-risk investments. Given this surge in capital inflows, yields on safe assets were pushed down, thus raising the appetite for riskier assets of European banks into the United States. To investigate this idea, we include both net banking flows and net securities flows in the same VAR. We order net security flows as the first variable in accord with Bertaut et al. (2012). It represents a push effect, while we order net banking flows after interest rates, as a pull effect. Figure 12 shows that net securities flows generate an economic boom with a limited impact on net banking flows, mortgage loans and house prices. However, banking inflows are more important than security flows.²⁶ Net securities flows affect gross banking flows, i.e. they increase foreign claims, as suggested by the banking glut hypothesis. Moreover, including net securities inflows and gross banking inflows in the same VAR, a net securities inflow shock generates a boom in mortgage loans, house prices, consumption and residential investment (see Figure 13). This result confirms the findings by Bertaut et al. (2012) that securities inflows have been a push-effect and gross banking inflows a pull-effect.

4. Did the Banking Glut Lead to the Banking Crisis?

In this section, we consider the importance of funding flow shocks for the banking crisis. Cross-border transactions have always been seen to have beneficial long-term effects because they provide possibilities to diversify borrowing and lending internationally, thereby reducing the volatility of domestic lending.²⁷ However, such international banking transactions can jeopardise financial stability since domestic banks can be affected by external shocks.

²⁶Over long period, net banking inflows explain 17 % and 36 % of the volatility of house prices and mortgage debt, respectively. While net securities inflows explain only 0.2 % and 0.4 % of the volatility of house prices and mortgage debt, respectively. Results can be made available under request.

²⁷See Allen et al. (2011).

Indeed, the 2007-2009 crisis showed that cross-border lending has deeply contributed to the vulnerability of both the financial and banking sector.

We include the FED delinquency index as a proxy for banking distress in the VAR analysis; this index measures charge-offs and delinquency rates on loans and leases at commercial banks as a percentage of total receivables. Figure 14 shows impulse responses to a funding shock when our VAR includes this banking distress index. Funding shocks supply liquidity to the U.S. market, generating an economic boom. In the short term, only gross and net banking inflows affect banking distress, whereas for securities inflows, no impact on banking distress is detected.

Unfortunately, the delinquency index for the U.S. is available only from 1985 onwards. Hence, for robustness we also use the ratio of financial sector profits (excluding the FED system) to GDP as an alternative indicator of the state of the financial system. These data are available from 1978 onwards, and we can run the estimation with the full sample. Figure 19 in the Appendix shows that only net banking inflow shocks generate positive responses in financial profits in the short term. Results are consistent with Figure 14.

5. Conclusions and Discussion

Various countries have been running high current account surpluses which have financed the U.S. current account deficit. The world savings glut lowered world real interest rates and borrowing became cheaper and more readily available, fuelling both consumption and residential investment. Those facts were presented by Bernanke (2005), who introduced the global saving glut hypothesis to explain the need for the Federal Reserve to maintain the initial employment and inflation rate at desirable levels. However, Shin (2012) introduced the global banking glut hypothesis to show the importance of gross banking flows in explaining the economic boom in the U.S., as they led to easier credit conditions.

This paper has presented some VAR results on the dependence of U.S. macrofinancial variables on international capital flows. Both gross and net flows were included in the analysis. The results indicate that cross-border funding has affected the situation in the U.S. housing market irrespective of how these flows are defined and measured. Both the savings glut hypothesis and the banking glut hypothesis are supported by these findings. However, net banking inflows appear to be more important in explaining the run-up in house prices, mortgage loans and residential investments in the U.S., relative to gross banking inflows.

Our results raise several questions about the need for macroprudential policies. Effective regulations of cross-border banking are important for domestic and global financial stability in a deep financially integrated world economy.

Like any analysis, this one can be criticized. In the real world, almost nothing is purely exogenous. Both the U.S. current account deficit and the liquidity of the market for USD-denominated financial contracts can be affected by other variables. Future research could try to include new variables to explain the supply of funding in surplus countries, such as variables that affect the leverage or profitability of foreign banking systems (i.e. regulations on banks' capital adequacy) or domestic financial developments in some of the major surplus countries, such as China.

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Table 1: U.S. holdings of foreign long-term securities and foreign holdings of U.S. long-term securities.

Year	U.S. holdings of foreign long-term securities	Foreign holdings of U.S. long-term securities	Ratio of U.S. holdings to foreign holdings	Net positions in long-term of U.S. residents
1994	870	1,244	0.7	-374
2000	2,678	3,558	0.75	-880
2002	2,129	3,926	0.54	-1,797
2003	2,367	4,503	0.53	-2,136
2004	3,027	5,431	0.56	-2,404
2005	3,728	6,262	0.6	-2,534
2006	4,799	7,162	0.67	-2,363
2007	6,429	9,136	0.7	-2,707
2008	6,324	9,463	0.67	-3,139
2009	4,566	8,492	0.54	-3,926

Billions of dollars. Reports on the annual Survey of U.S. Holdings of Foreign Securities.

Table 2: Value of foreign holdings of U.S. long- and short-term securities, by major investing country, as of June 30, 2008, and June 30, 2009

Country	2008			2009			Balance on Current Account (% of GDP)
	Total	Equity	Debt	Total	Equity	Debt	
China	1,205	100	1,106	1,464	78	1,386	10.3
Japan	1,250	199	1,052	1,269	182	1,088	1.5
United Kingdom	864	376	488	788	279	509	-2.0
Luxembourg	656	191	466	578	137	441	7.6
Belgium	456	20	436	415	17	399	-2.4
Middle east oil-exporter	391	141	251	353	110	243	19.6
Ireland	400	75	325	348	60	288	-2.7
Canada	441	321	120	337	242	95	-0.9
Switzerland	314	162	152	328	130	198	7.6
Netherlands	312	188	123	233	128	105	2.4
Rest of world	3,016	878	2,134	2,768	660	2,105	
Total	10,322	2,969	7,352	9,641	2,252	7,388	

Billions of dollars.

Table 3: Standard Deviations (%)

	1978q1-2009q4	1978q1-1994q4	1995q1-2009q64
Current Account	1.894182	0.764659	1.689559
Mortgage Loans	0.591384	0.312381	0.343965
Gross Banking Inflows	0.182295	0.07606	0.163486
Net Banking Inflows	0.011272	0.009341	0.010528
Gross Securities Inflows	0.892634	0.267202	0.851644
Net Securities Inflows	0.391478	0.176757	0.286091
House Prices	0.113718	0.0266	0.100925

Table 4: Lag length of a VAR (AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.)

Lag	AIC	SC	HQ
0	-10.64794	-10.50551	-10.59012
1	-33.0614	-32.06441*	-32.65668*
2	-33.38343	-31.53188	-32.63181
3	-33.37016	-30.66404	-32.27163
4	-33.5562	-29.99552	-32.11076
5	-33.62793	-29.21269	-31.83559
6	-33.84447	-28.57466	-31.70523
7	-33.84199	-27.71763	-31.35585
8	-34.10551	-27.12658	-31.27246
9	-34.03549	-26.202	-30.85554
10	-34.33175	-25.6437	-30.8049
11	-34.68695	-25.14433	-30.81319
12	-35.03900*	-24.64182	-30.81834

* indicates lag order selected by the criterion.

Table 5: Individual Granger Causality Test

Lags	Null Hypothesis	F-statistic	Prob
1	House Prices does not Granger Cause Fund	0.0019	[0.9648]
	Fund does not Granger Cause House Prices	3.8097*	[0.0532]
2	House Prices does not Granger Cause Fund	0.3025	[0.7395]
	Fund does not Granger Cause House Prices	2.4466***	[0.0910]
3	House Prices does not Granger Cause Fund	0.9755	[0.4068]
	Fund does not Granger Cause House Prices	2.8821**	[0.0388]
4	House Prices does not Granger Cause Fund	1.3998	[0.2385]
	Fund does not Granger Cause House Prices	2.0195**	[0.0963]

*** 1%, ** 5%, * 10% significance; sample: 1978:1 to 2009:4.

Table 6: VAR - Granger Causality Test

Dependent Variable: Funding Flows	P	C	FFR	Loans	HPI
F-Statistic	1.7738	1.5306	6.4126	0.0647	0.1878
Signif	0.1855	0.2185	0.0126	0.7996	0.6655

Table 7: Variance Decomposition of Funding Inflow Shocks (20-step ahead forecast error variance)

VAR includes ⇒	Current Account	Gross Banking Inflows	Net Banking Inflows	Gross Securities Inflows	Net Securities Inflows
Impact on:					
House Prices	34%	12%	19%	11%	13.9%
Mortgage Debt	32%	9%	39%	5%	18.9%

VAR includes: Inflows, CPI, Real Consumption, Fed Fund Rate, Real Mortgage Loans, Real House Prices.

Table 8: Variance Decomposition of Funding Inflow Shocks (20-step ahead forecast error variance)

VAR includes ⇒	Current Account	Gross Banking Inflows	Net Banking Inflows	Gross Securities Inflows	Net Securities Inflows
Impact on:					
House Prices	38%	10%	19%	9%	12%
Mortgage Debt	35%	8%	38%	4%	16%

VAR includes: Inflows, CPI, Real Consumption, Fed Fund Rate, Spread, Real Mortgage Loans, Real House I

Table 9: Variance Decomposition of Monetary Policy Shocks (20-step ahead forecast error variance)

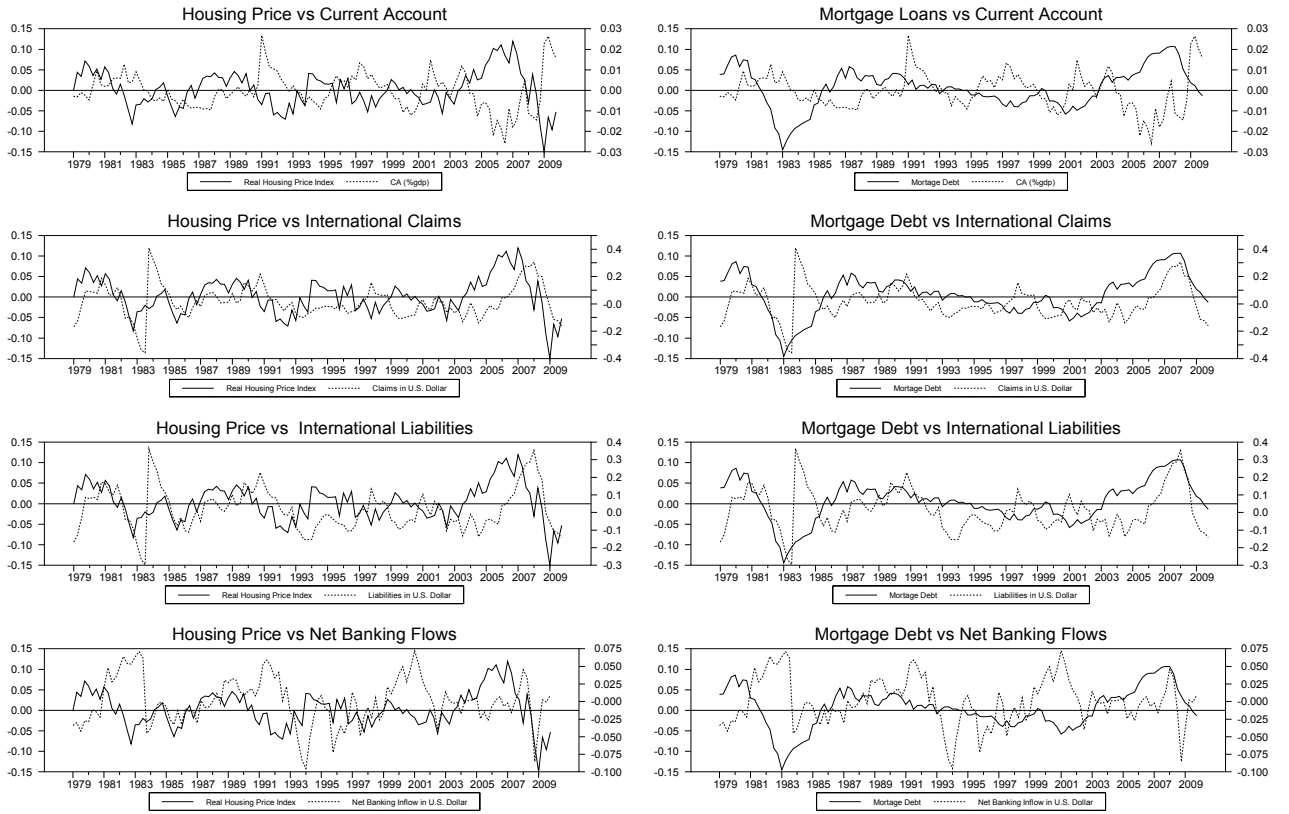
VAR includes ⇒	Current Account	Gross Banking Inflows	Net Banking Inflows	Gross Securities Inflows	Net Securities Inflows
Impact on:					
House Prices	10%	6%	7%	7%	10%
Mortgage Debt	30%	30%	29%	32%	39%

VAR includes: Inflows, CPI, Real Consumption, Fed Fund Rate, Spread, Real Mortgage Loans, Real House I

Table 10: Sign Restrictions Identification

Variable	Saving Glut Shocks (1)	Banking Glut Shocks (2)	Monetary Policy Shock (3)
Funding Flows	+	+	+
Price			+
Consumption	+	+	+
Fed Fund			-
Spread	-	-	-
Mortgage Loans			
House Price			

Figure 1: Data



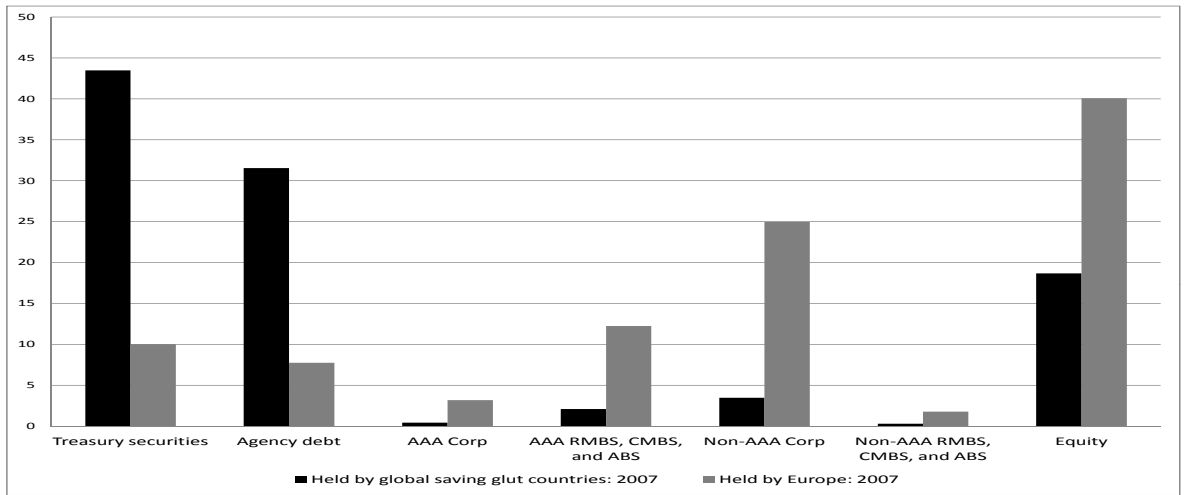
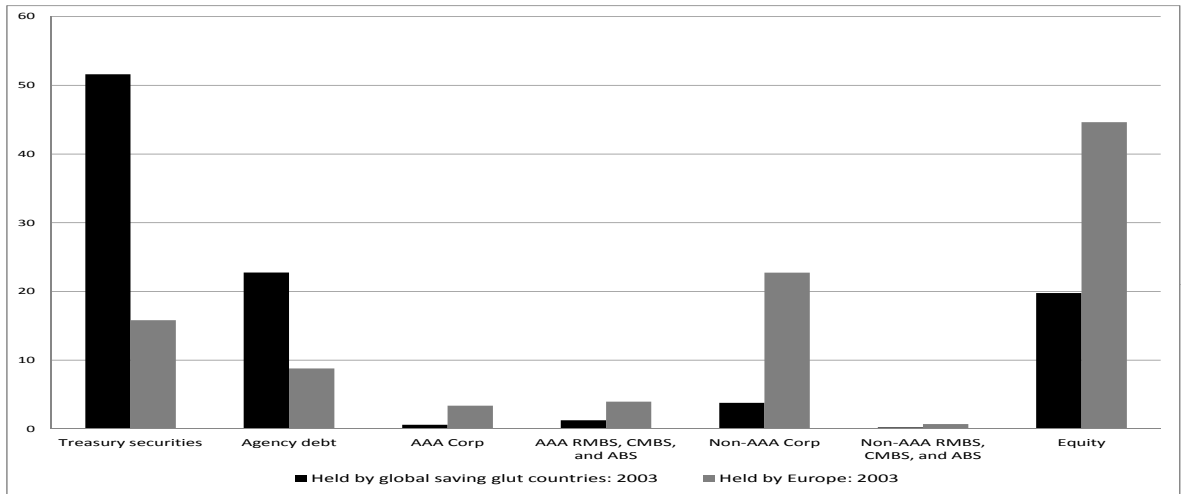


Figure 2: % Portfolio Holdings of U.S. Assets by European countries (grey area) and saving glut countries (black area) in 2003 (top panel) and 2007 (bottom panel).

Figure 3: Foreign Currency Assets and Liabilities of Banks outside the U.S.

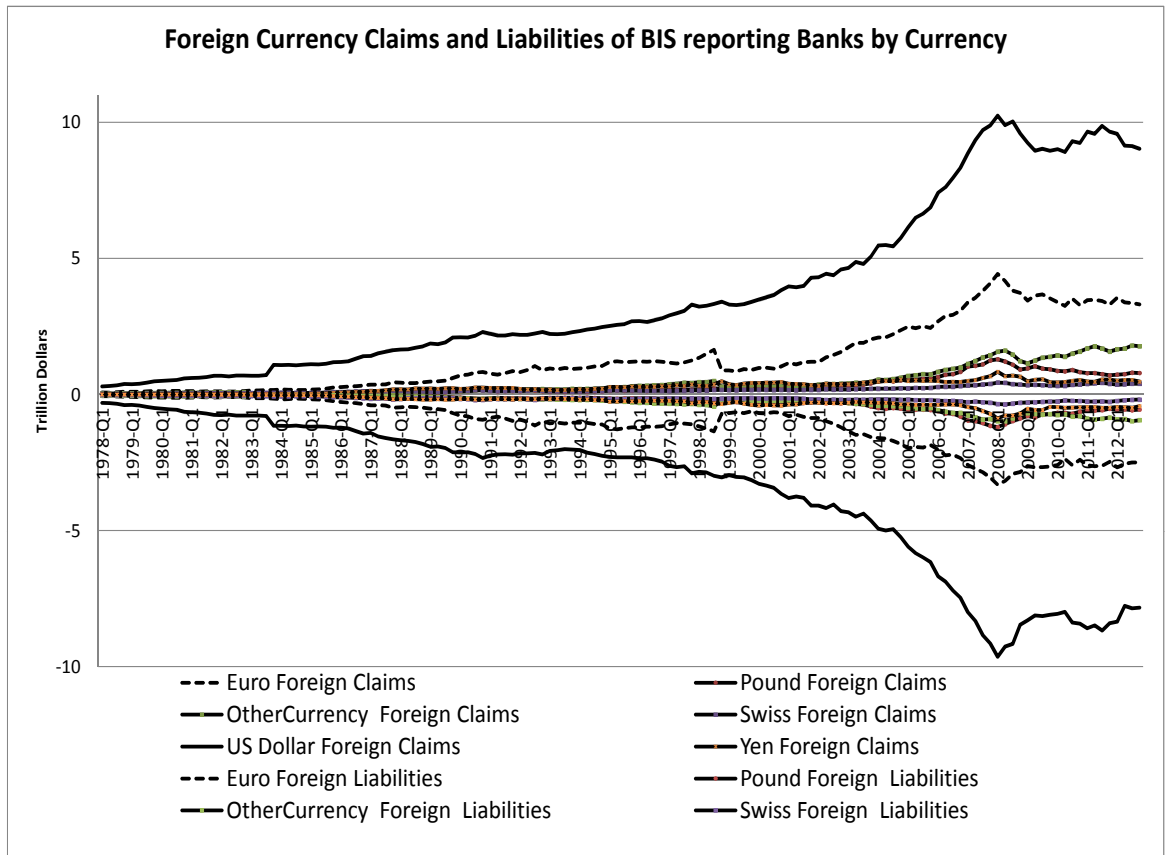


Figure 4: European-resident banks' gross and net cross-border claims on the United States. Hills and Hoggarth (2013): Chart7.

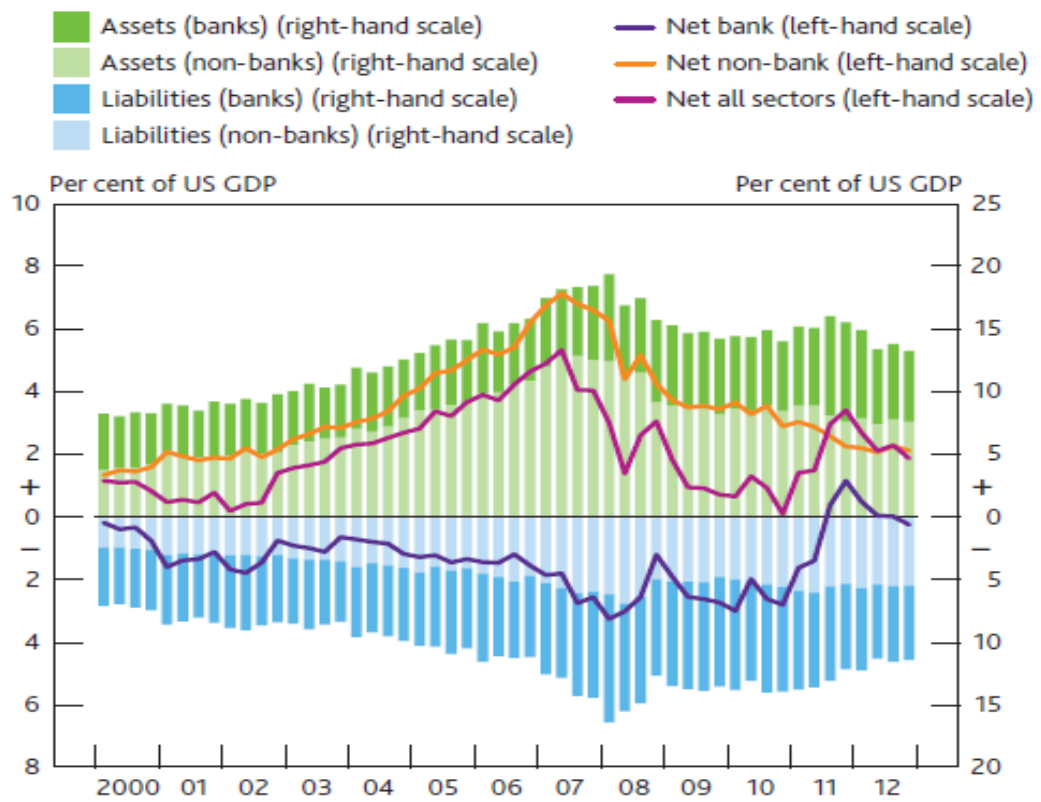
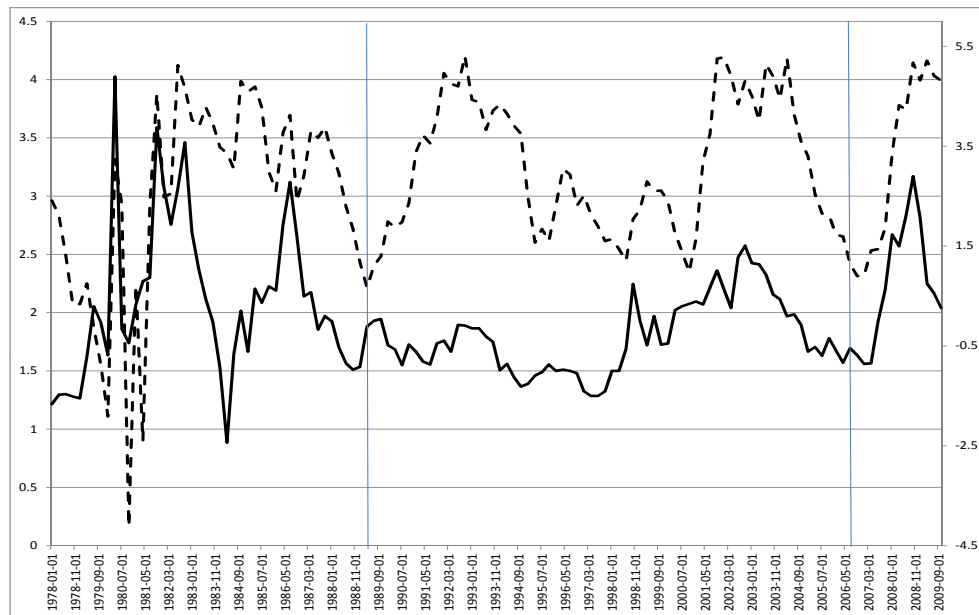


Figure 5: U.S. spread: 30-year fixed rate mortgage rate minus the average of the 5-year and the 10-year Treasury bond rate (solid line, LHS), 30-year fixed rate mortgage rate minus the Fed Fund rate (dashed line, RHS). Vertical lines represent House Price peaks.



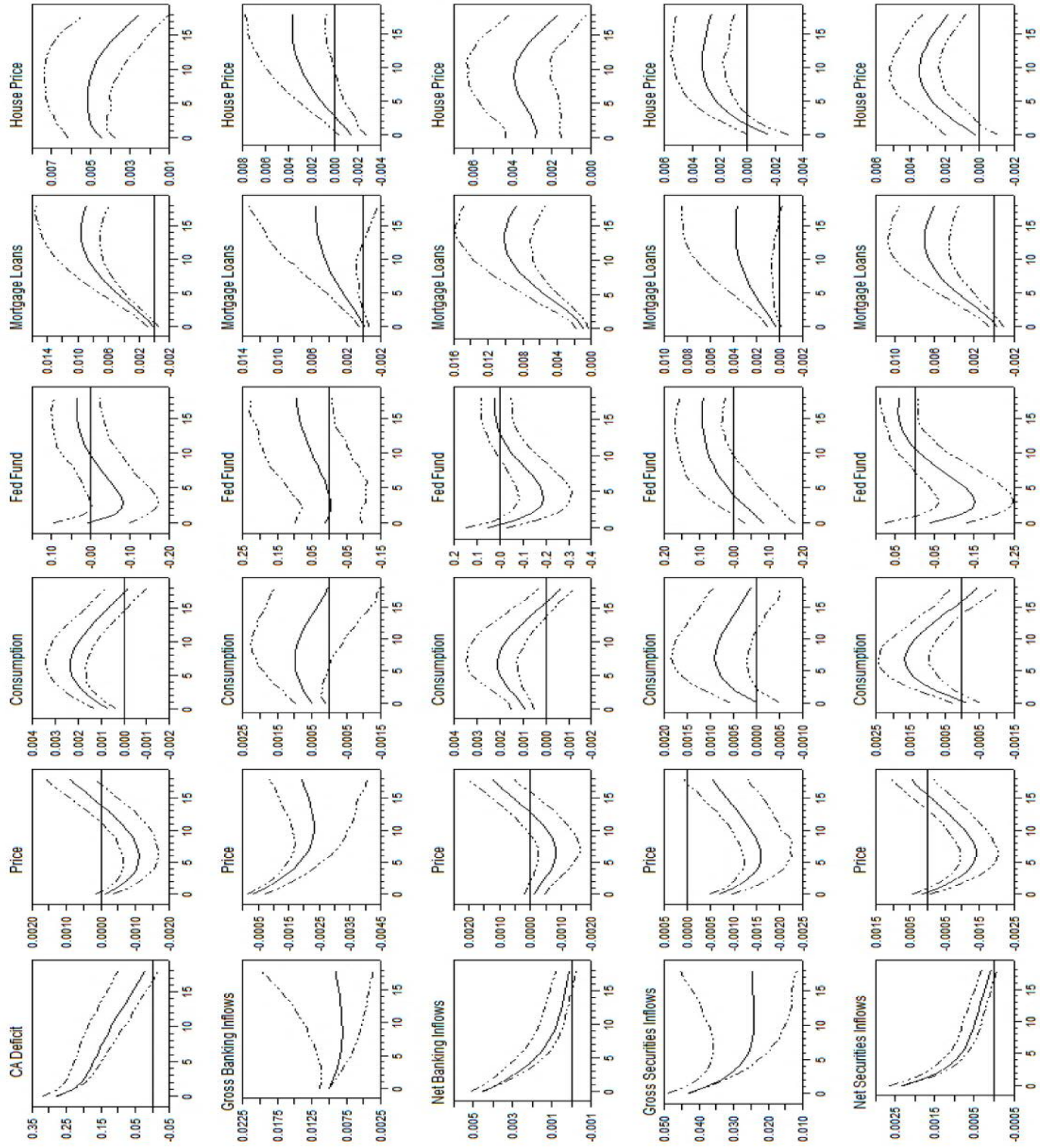


Figure 6: Response to Funding Inflows Shock (Cholesky Ordering).

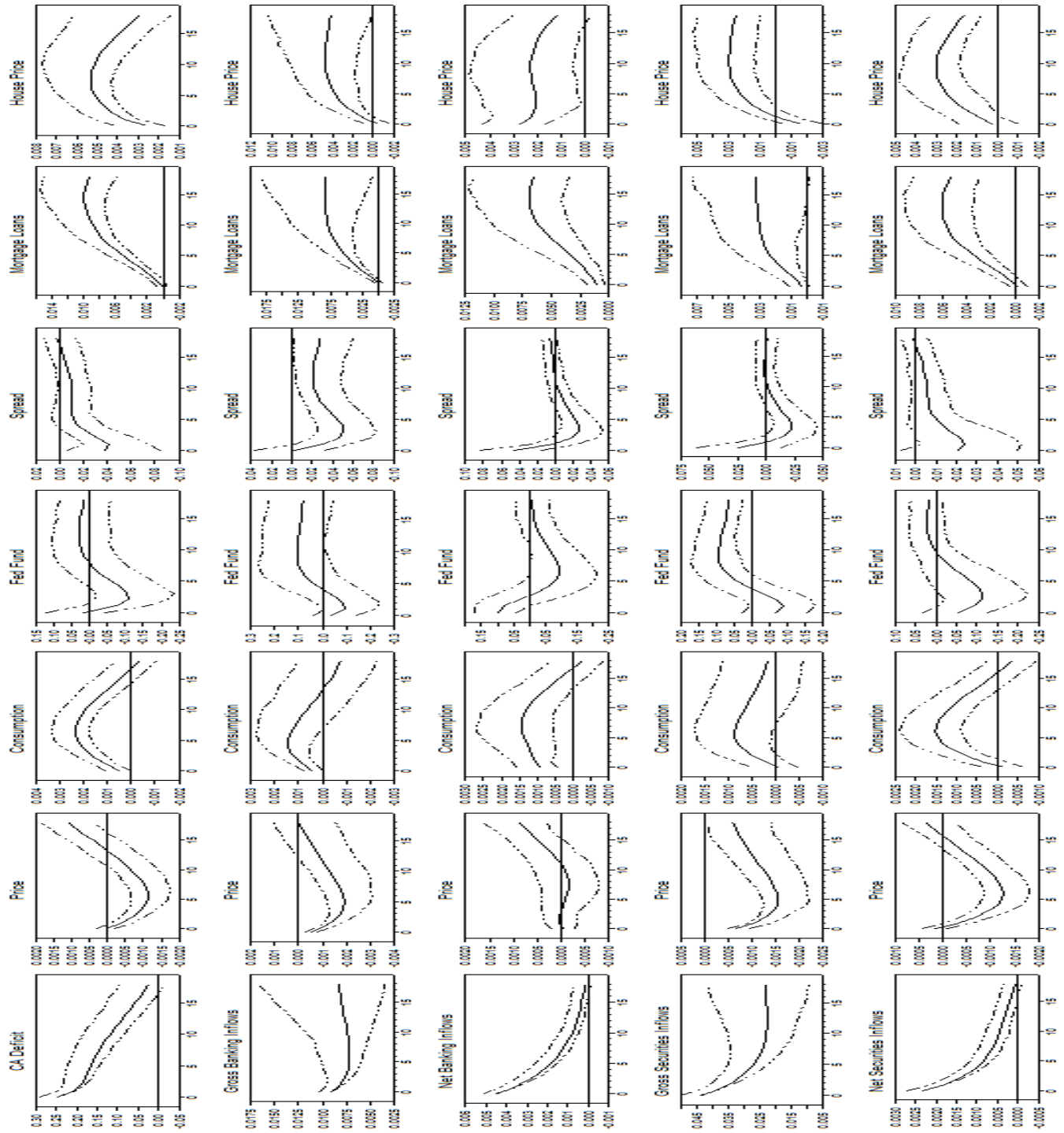


Figure 7: Response to Funding Inflows Shock (Cholesky Ordering).

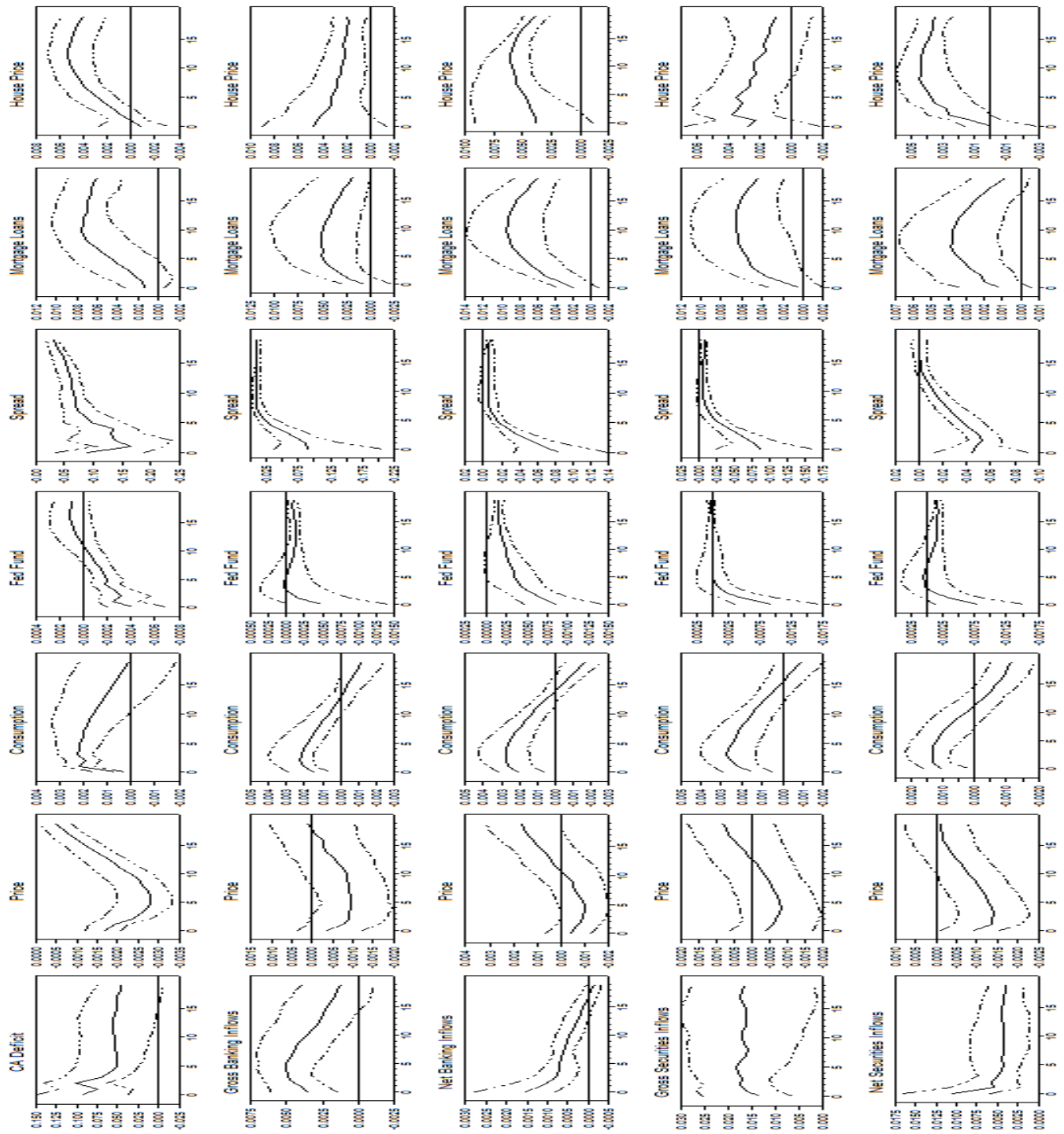


Figure 8: Response to Funding Inflows Shock (Sign Restrictions).

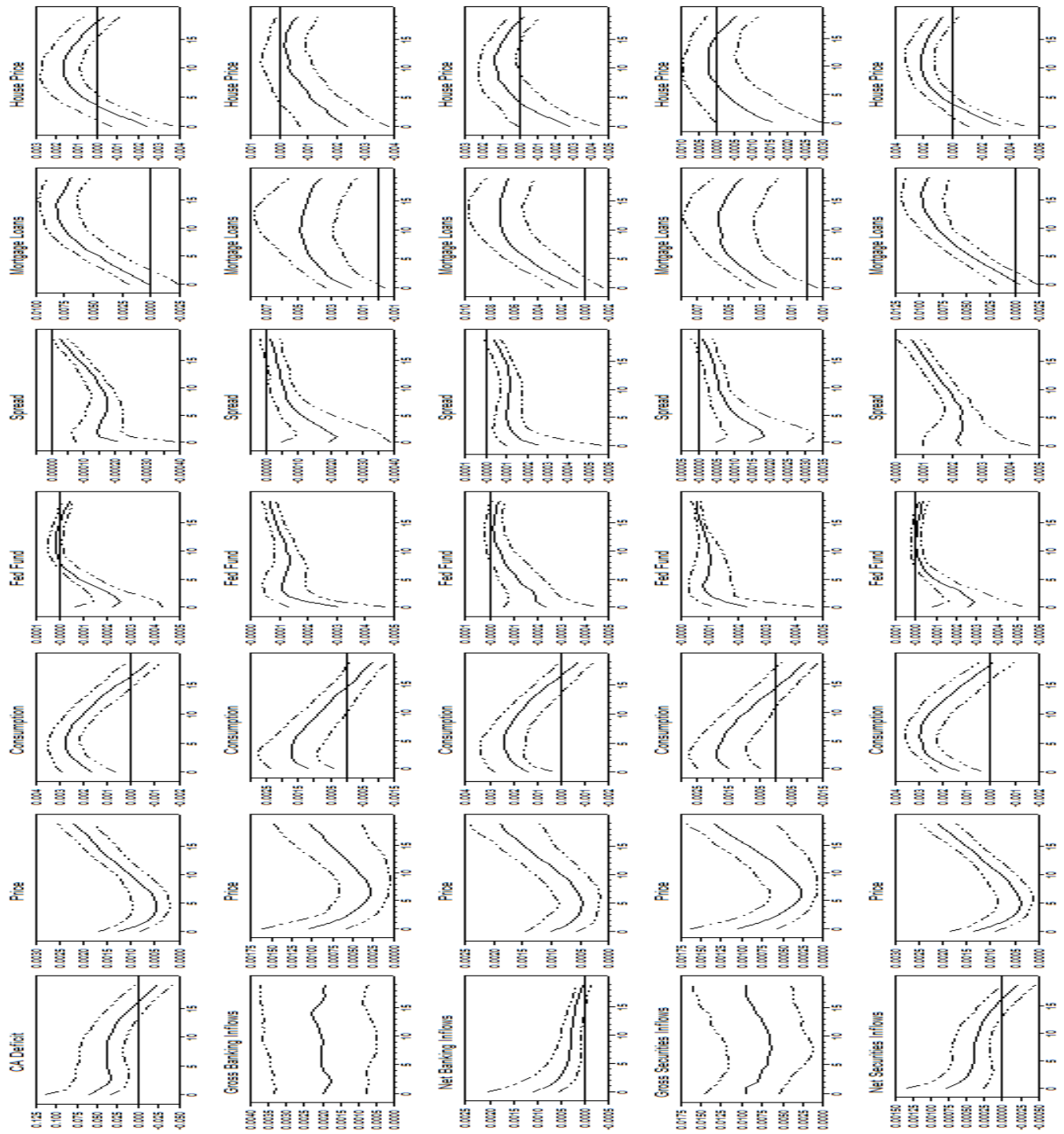


Figure 9: Response to Monetary Policy Shock (Sign Restrictions).

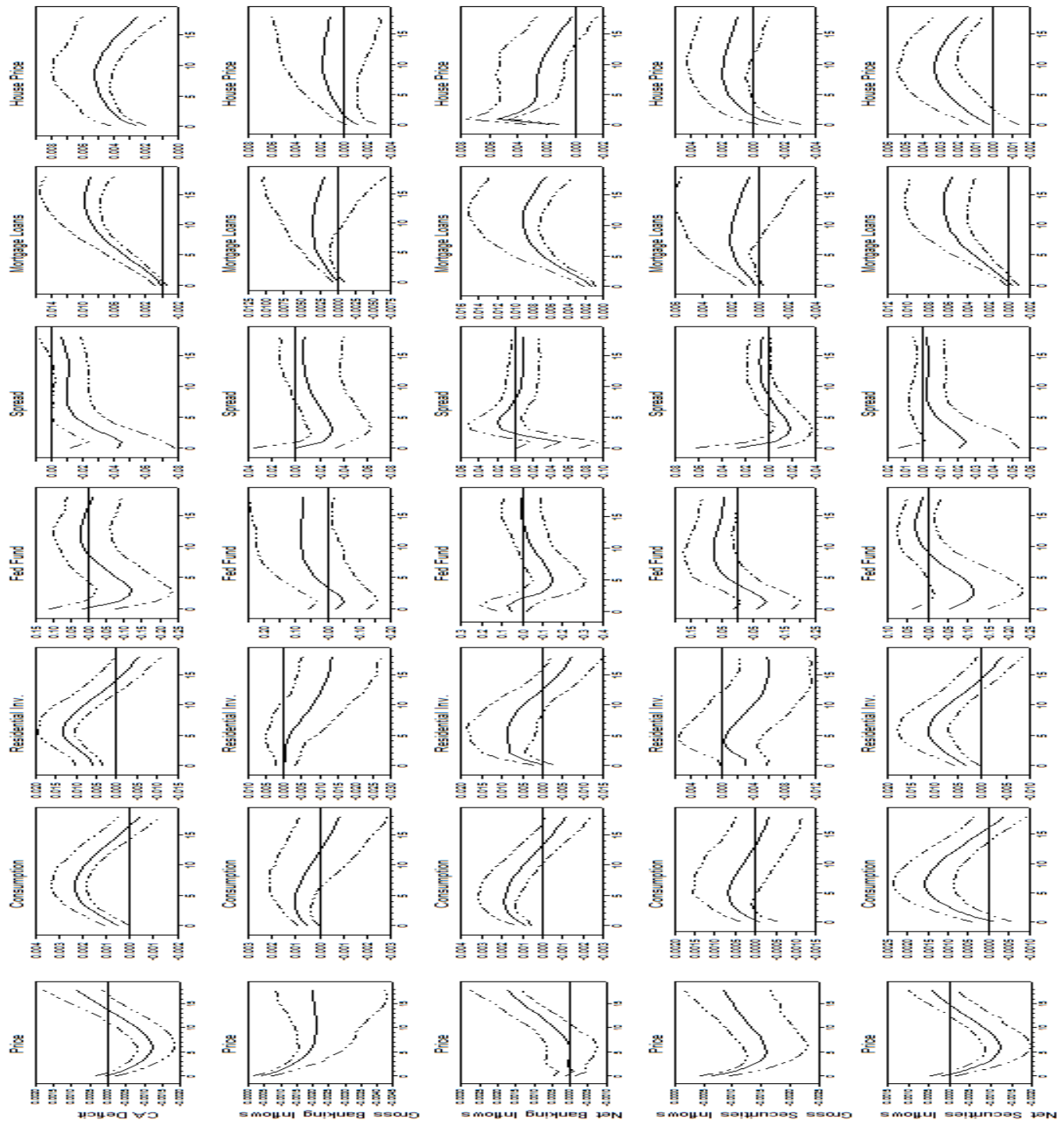


Figure 10: Response to Funding Inflows Shock (Cholesky Ordering) - VAR includes Residential Investments.

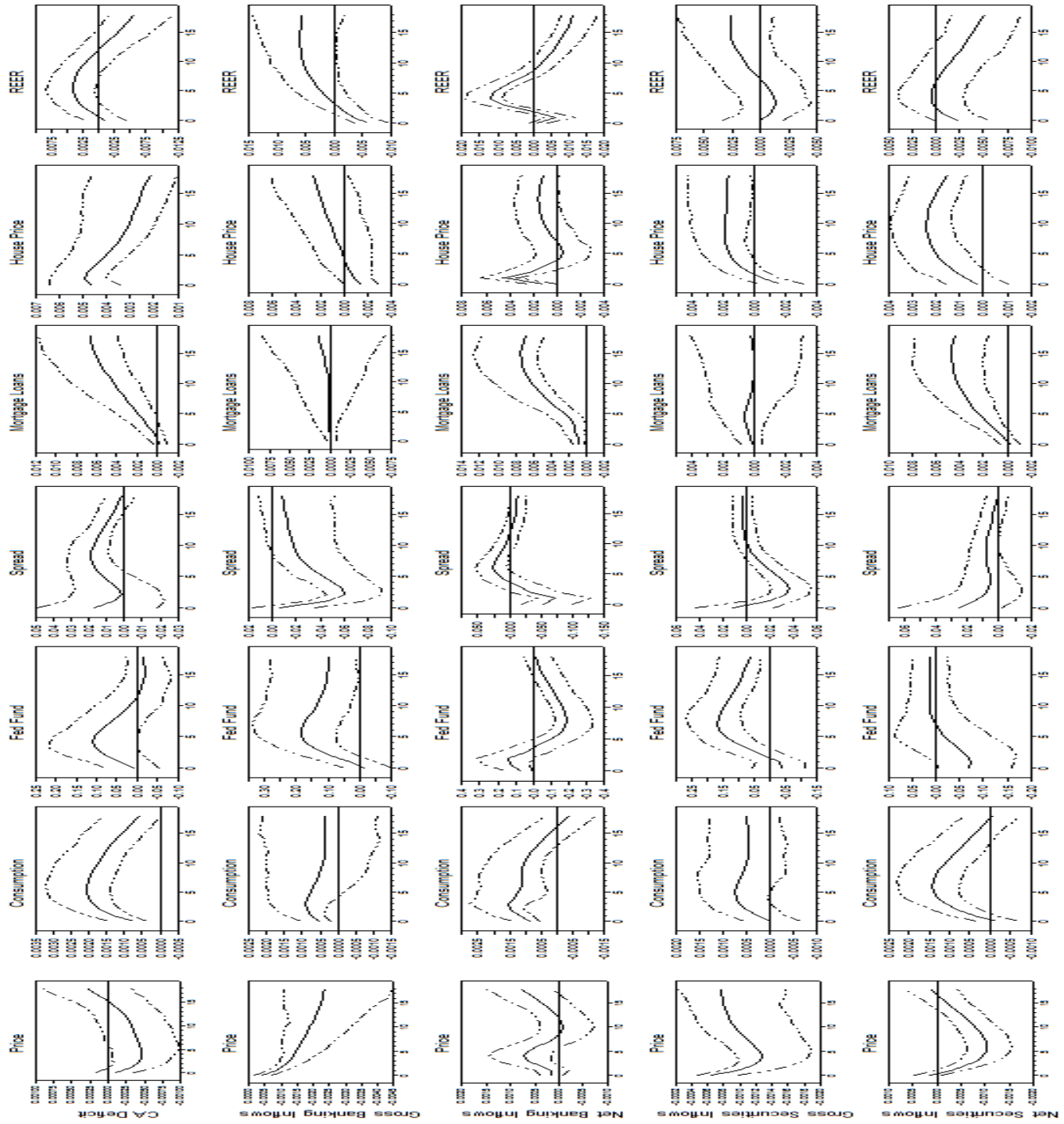


Figure 11: Response to Funding Inflows Shock (Cholesky Ordering) - VAR includes Real Exchange Rate.

Figure 12: Response to Net Securities Inflows shock on Net Banking Inflows.

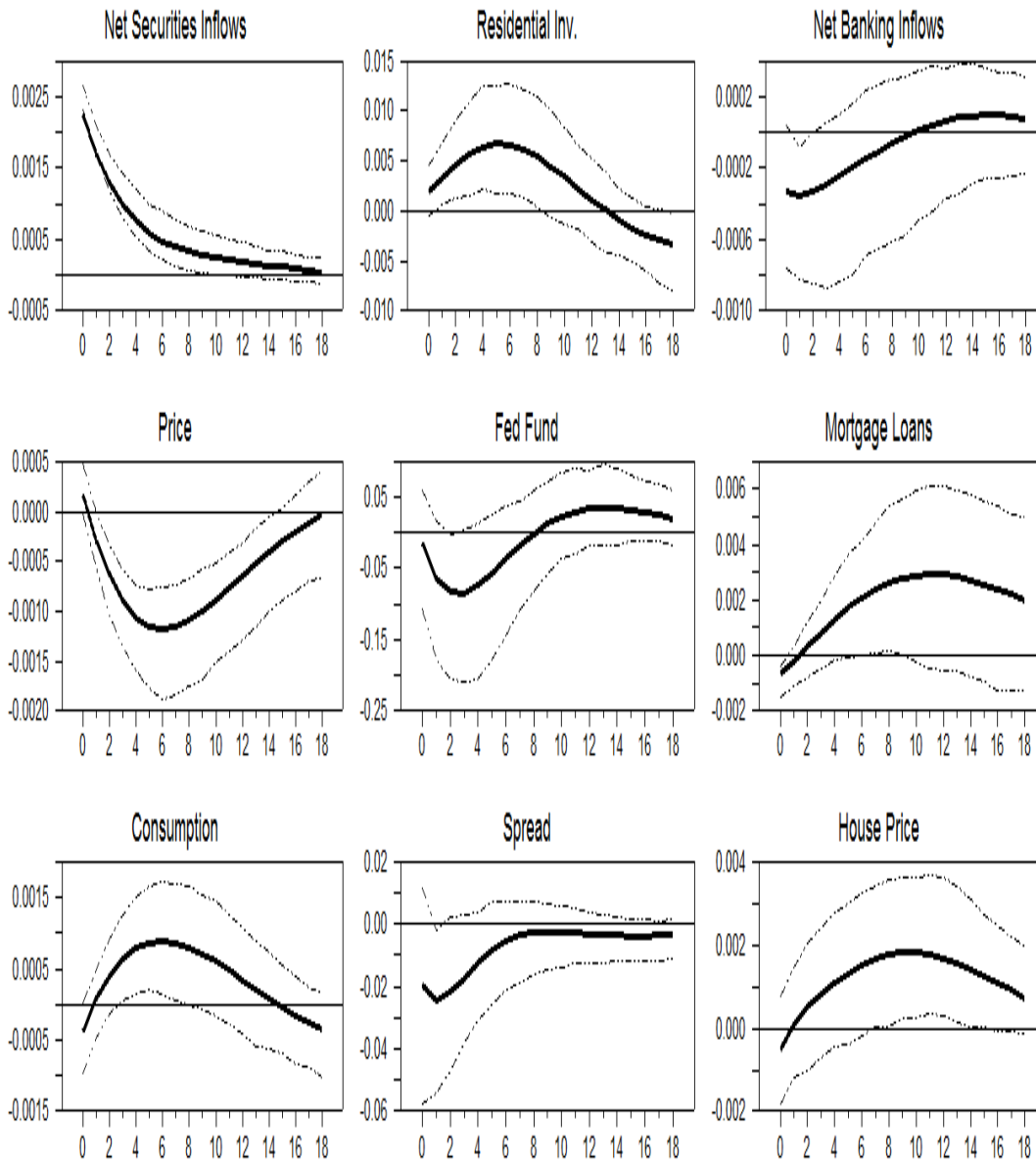
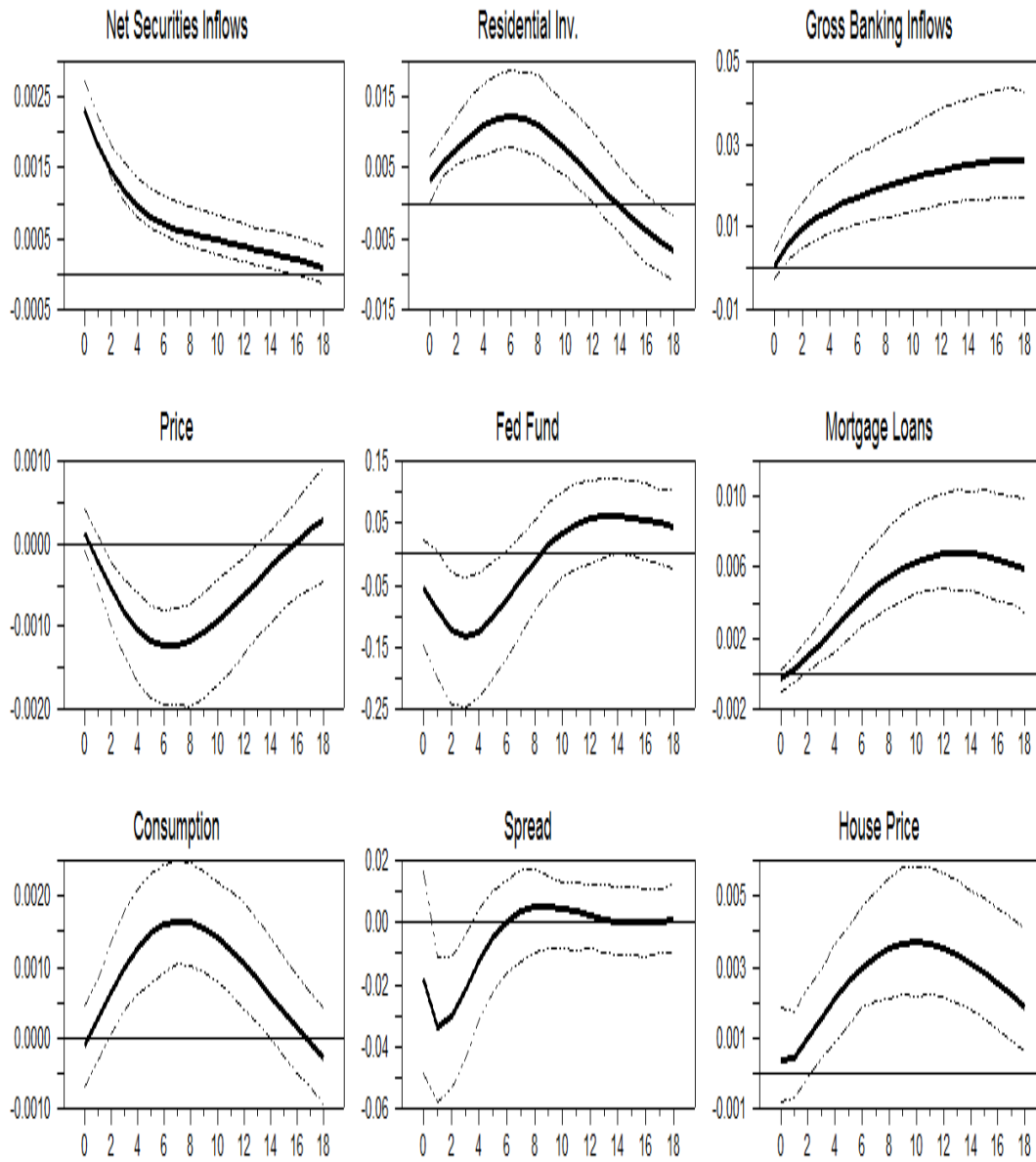


Figure 13: Response to Net Securities Inflows shock on Gross Banking Inflows.



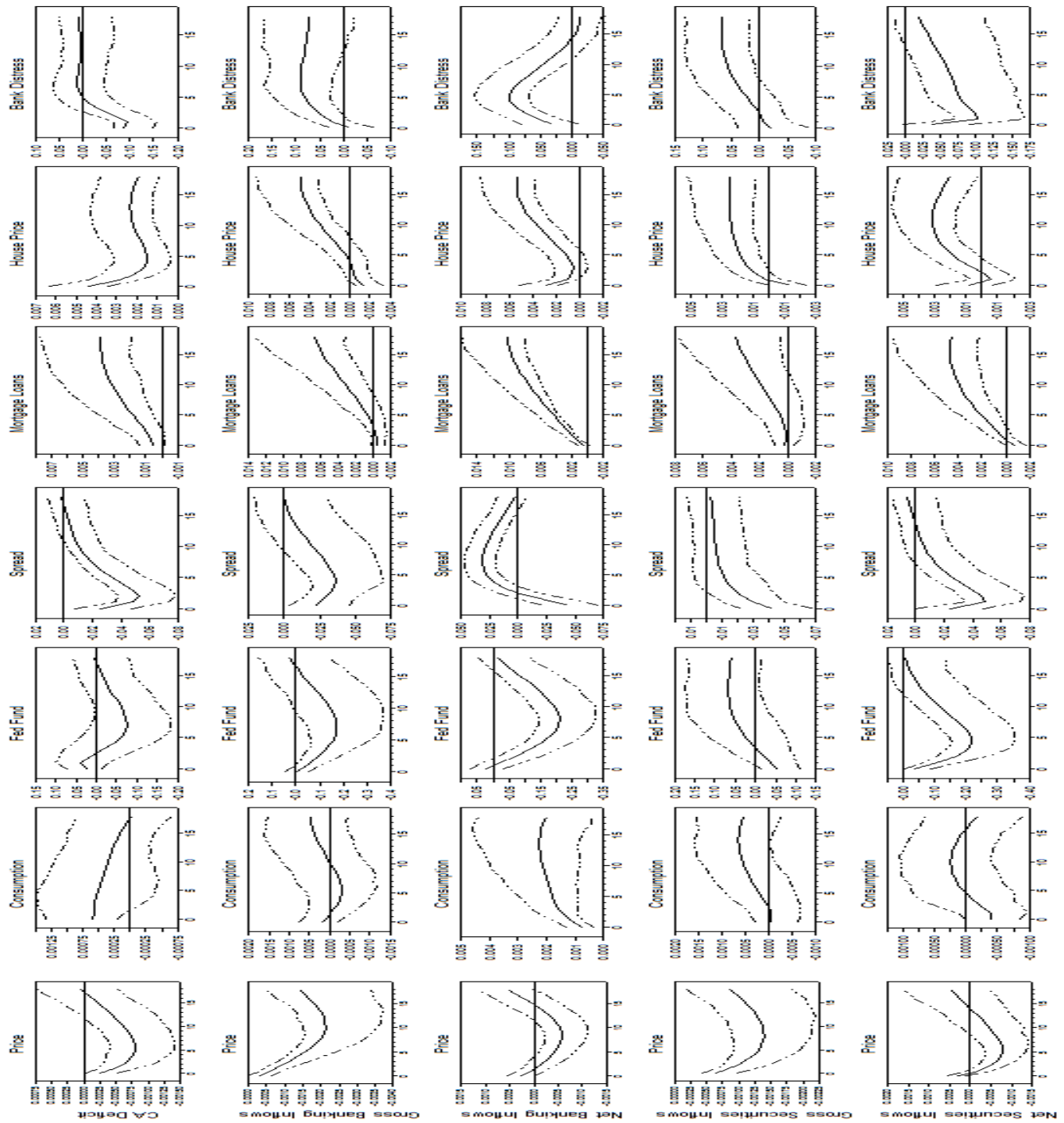
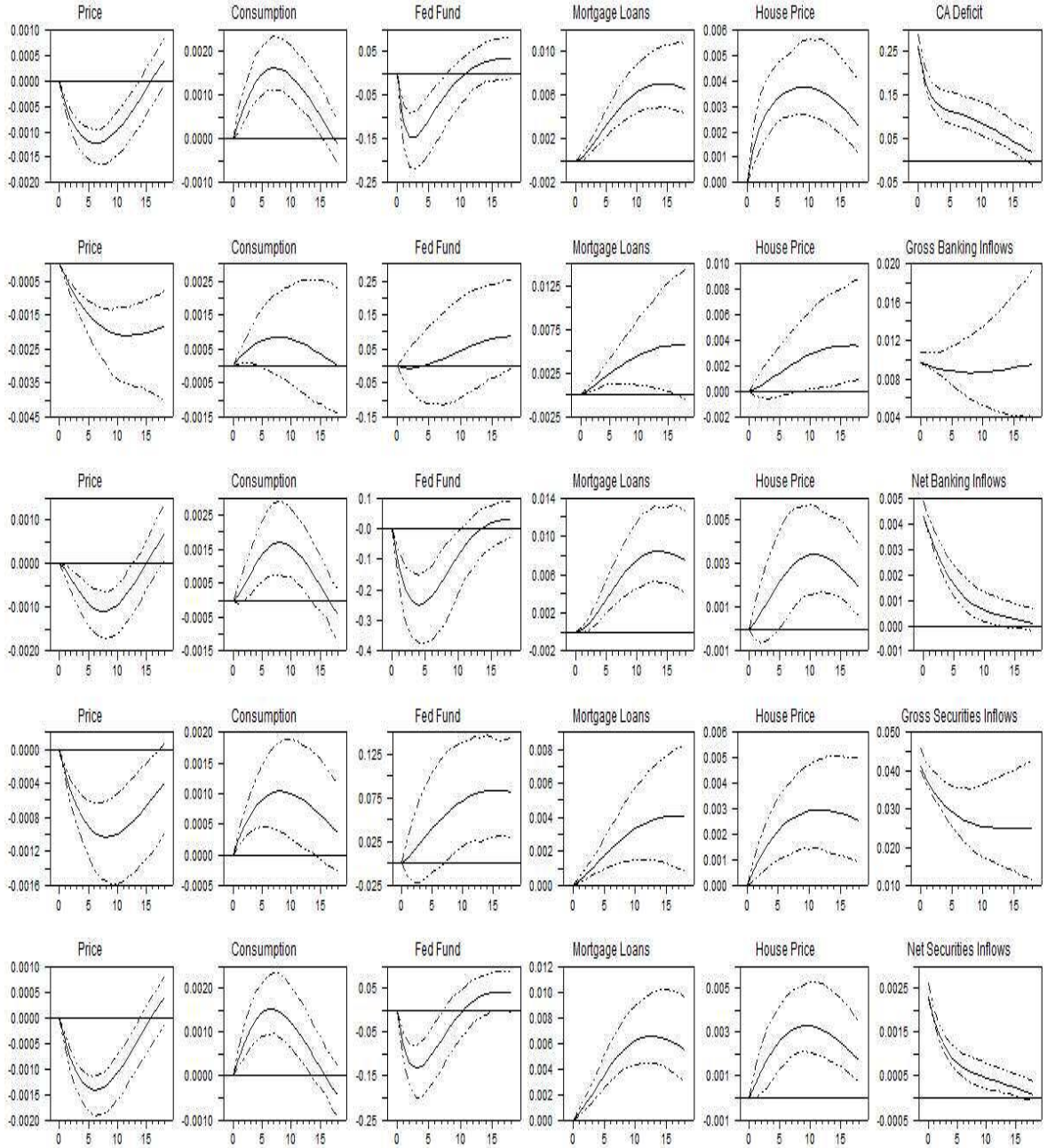


Figure 14: Response to Funding Inflows Shock (Cholesky Ordering) - VAR includes Bank Distress. Data since 1985.

Testing the Global Banking Glut Hypothesis

Appendix

Figure 15: Response to funding shock.



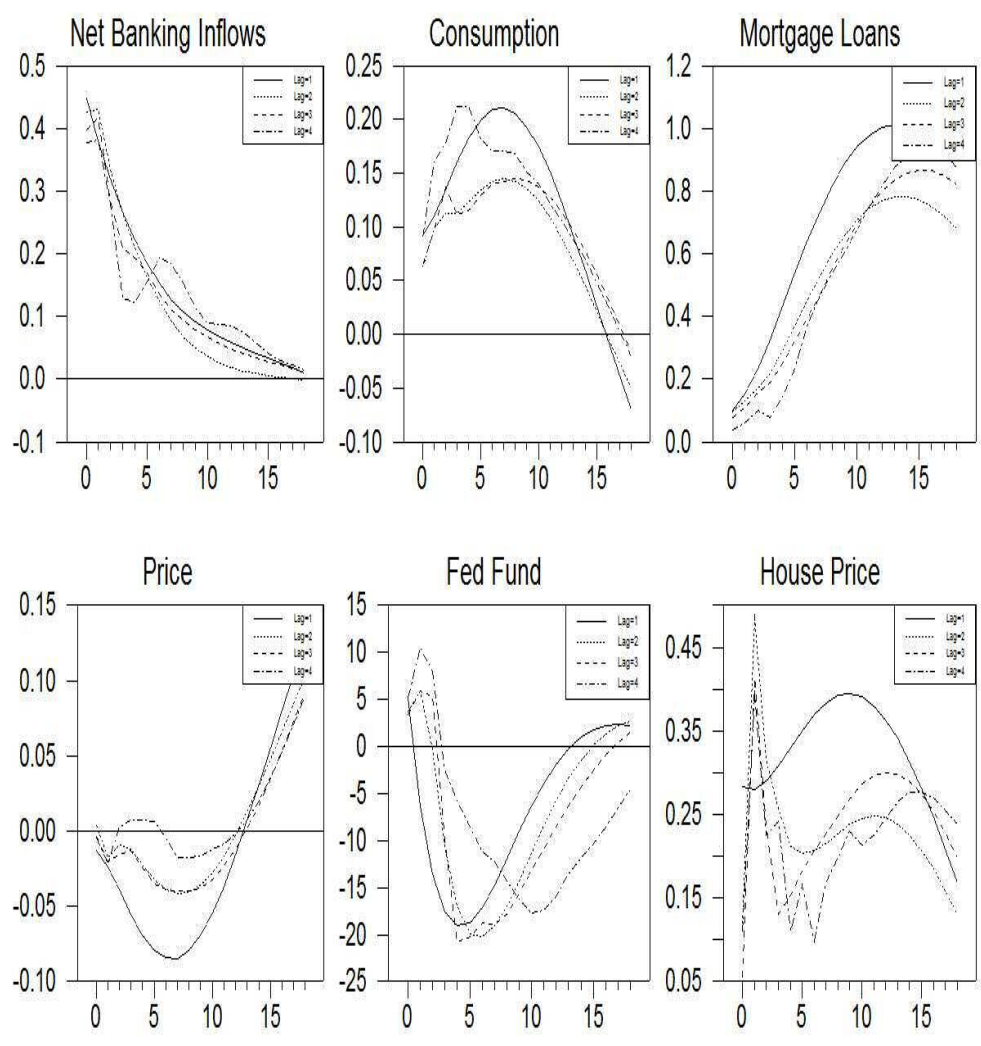


Figure 16: Response to Funding Inflows Shock at different Lags (Cholesky Ordering).

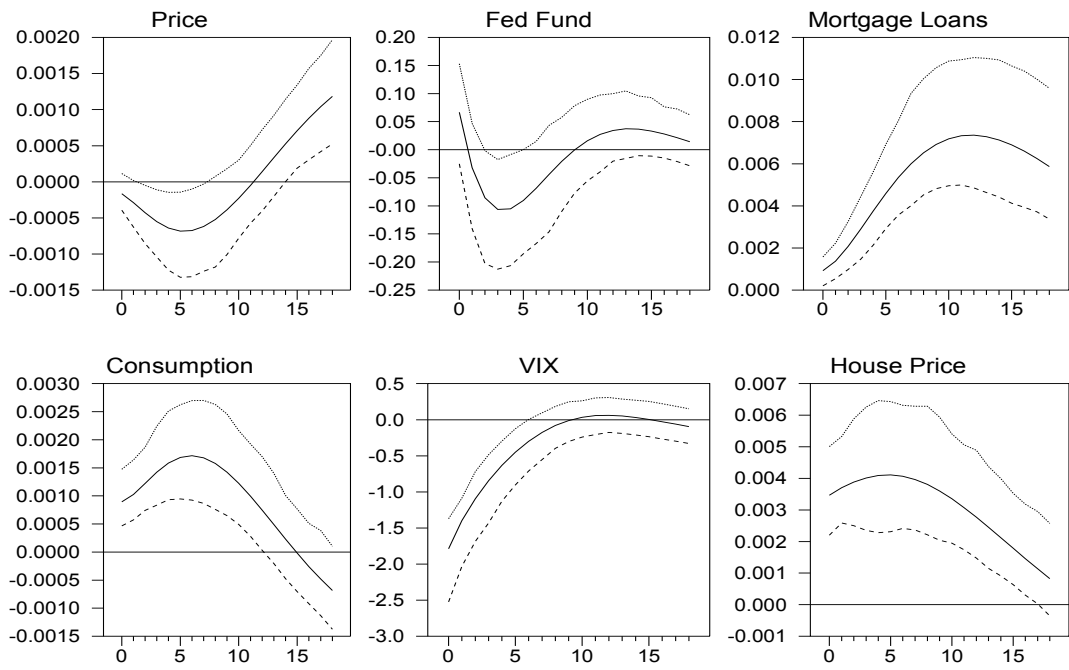


Figure 17: Response to Net Banking Inflows Inflows Shock - VAR controls for VIX index (Data: 1986-2009).

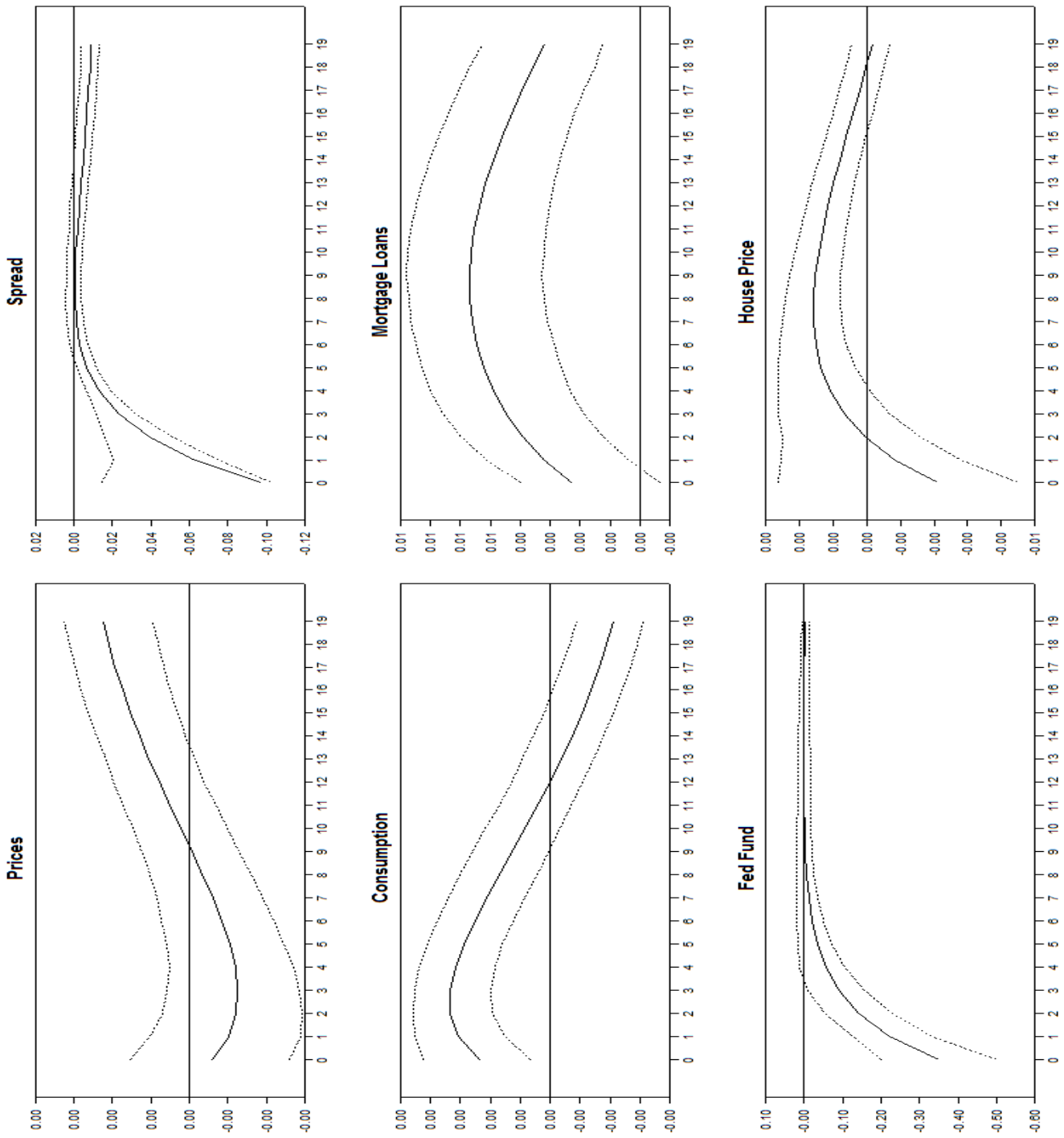


Figure 18: Median Sign-Restricted Response (Fry-Pagan Critique).

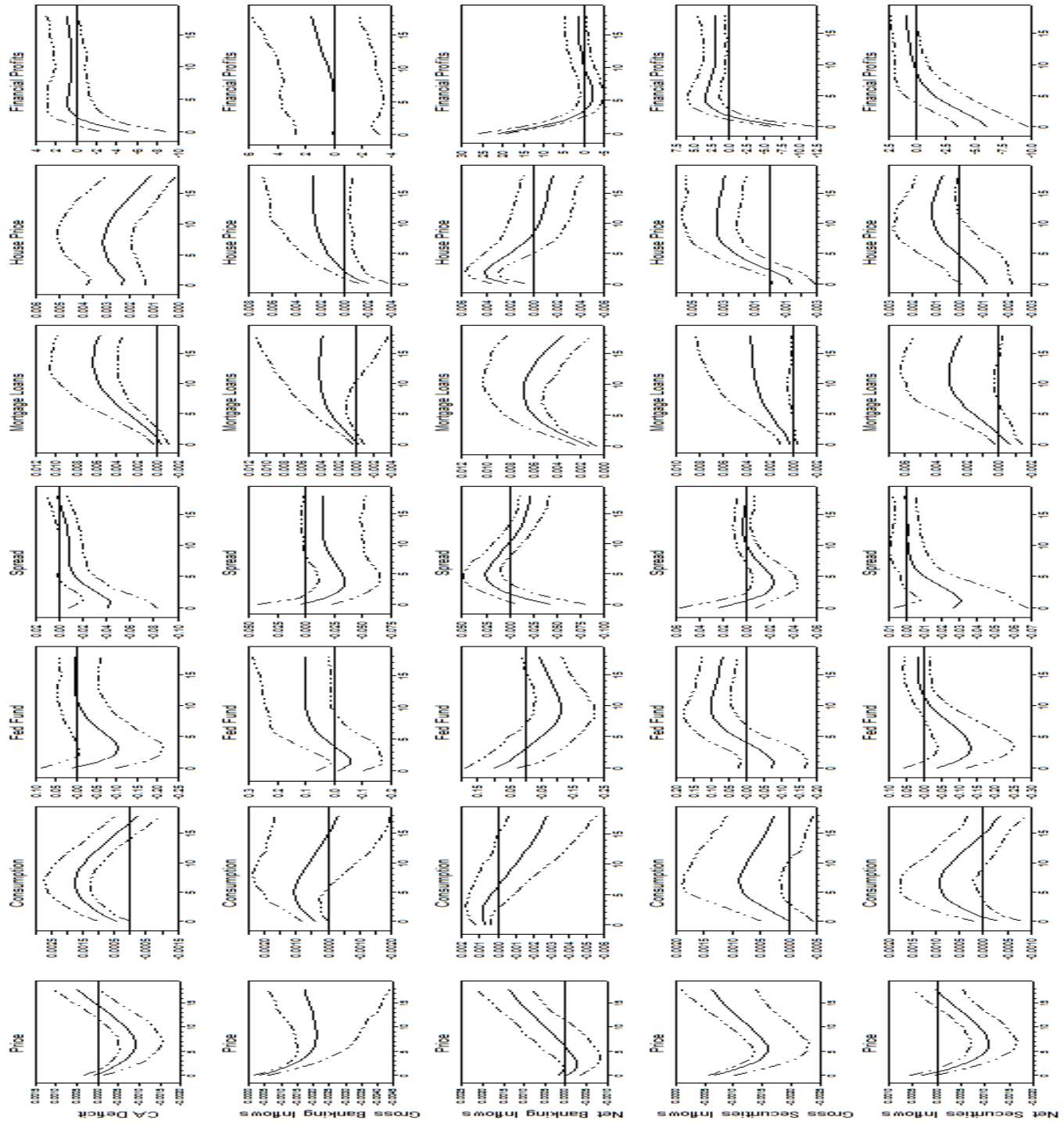


Figure 19: Response to Funding Inflows Shock (Cholesky Ordering) - VAR includes Banks' Financial Profits.

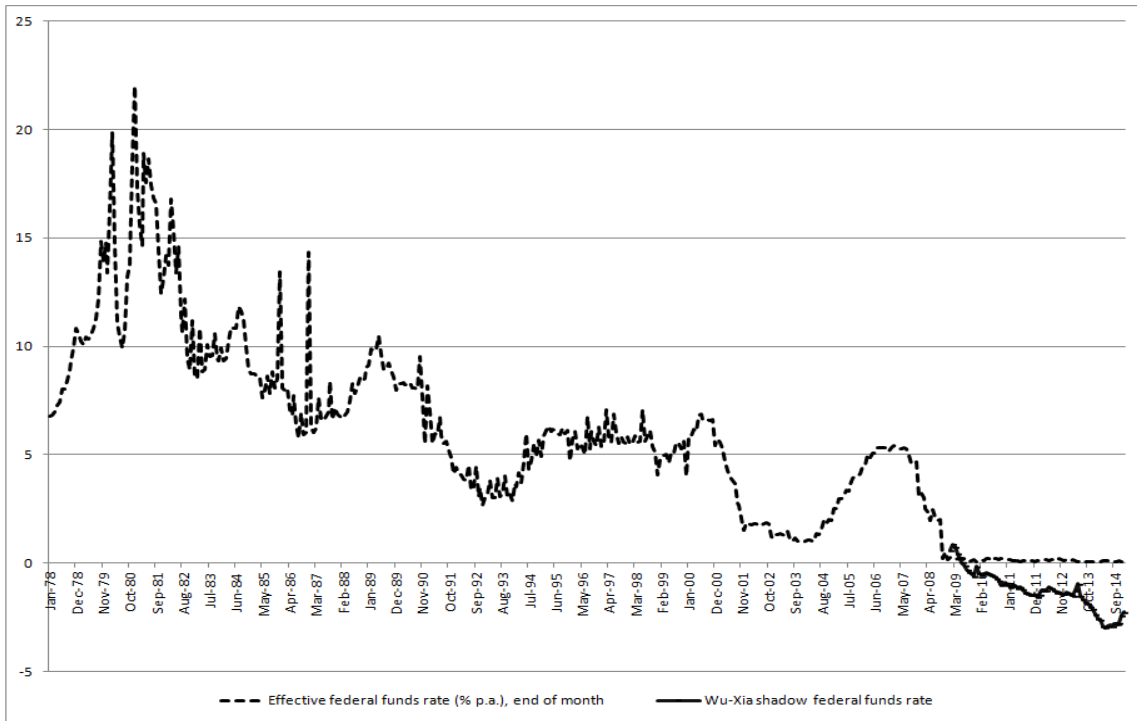


Figure 20: Effective Federal Fund Rate and Wu-Xia Shadow Federal Funds Rate data provided by the Federal Reserve Bank of Atlanta.

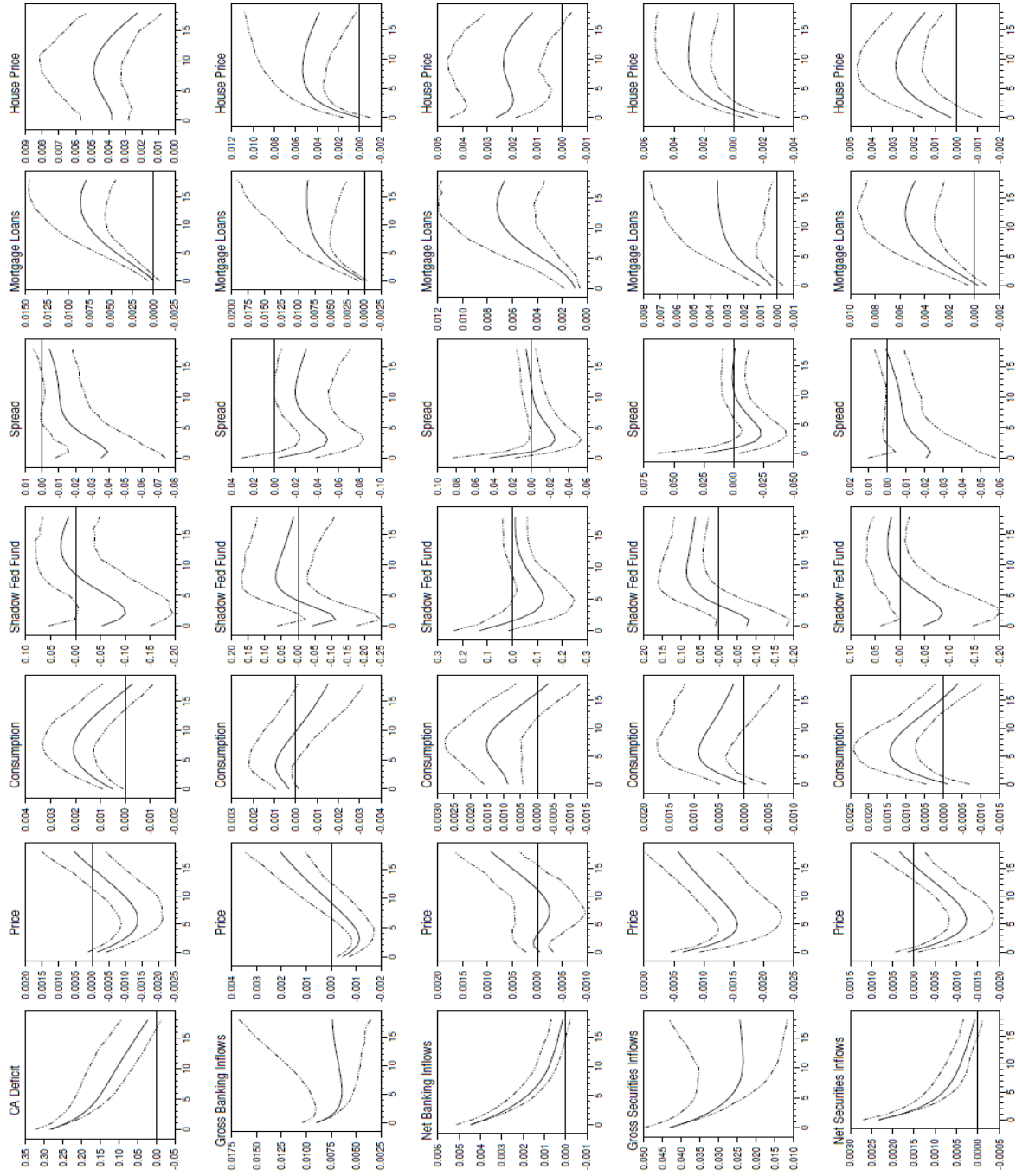


Figure 21: Response to Funding Inflows Shock (Cholesky Ordering) - VAR includes the Wu-Xia Shadow Federal Funds rate for the period January 2009 onwards.