# Estimating the Effects of Macroprudential Policy Shocks*

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May 11, 2014

**Abstract**

In the aftermath of the financial crisis, macroprudential measures to calm overheating property markets such as maximum loan to value (LTV) ratios received considerable attention. Little is known, however, about the effectiveness of those measures. This is due to the fact that only very few tightening and easing episodes are observed, often associated with a large variety of instruments, making event studies the only viable empirical approach. This paper, in contrast, proposes a Qual VAR to uncover the latent propensity for macroprudential tightening from binary information on LTV tightening episodes. We provide impulse response functions for macroprudential policy shocks derived from a VAR. This allows us to, first, acknowledge the endogenous nature of macroprudential policy, second, derive the surprise component of policy in terms of macroprudential shocks, third, estimate the dynamic impact of macroprudential measures and, fourth, compare their impact with that of conventional monetary policy shocks. The results are derived for Asian economies, where macroprudential measures to avoid property bubbles haven been used before and during the global financial crisis.

**Keywords:** macroprudential policy, Qual VAR, monetary policy, property prices

**JEL classification:** E32, E44, E52

*This paper was supported by the Center for Economic Research of Korea (CERK) by Sungkyunkwan University (SKKU) and the Korea Economic Research Institute (KERI). Oliver Jungkurth provided excellent research assistance. The project was started while I was visiting the IMF's Asia-Pacific department. I am grateful for the IMF's generous hospitality.

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# 1 Introduction

Using macroprudential policy tools to avoid financial imbalances ranks high on the agenda of international financial diplomacy despite very limited knowledge about their effects. As conventional monetary and fiscal tools proved ill suited to prevent an overheating housing market and overly expansive credit growth, a new set of macroprudential tools received enormous attention. Among these tools are measures directly addressing the housing market such as caps on loan-to-value (LTV) or debt-to-income (DTI) ratios.[1] Although these are praised continuously in financial circles, little is known about their impact, if any, on house prices, credit growth and, very importantly, its side-effect on overall economic activity.

Quantifying the effectiveness of those measures is extremely difficult as macroprudential actions (1) involve a multitude of instruments, (2) are taken at infrequent intervals and (3) have been in use for a very short time span only making traditional regression analysis difficult. Changes in maximum LTV ratios, for example, are scattered through time and often address different segments of the property market. The literature typically either conducts event studies or distinguishes policy actions according to a tightening or easing stance and codes these episodes with a binary indicator. Many empirical studies then relate house prices or credit growth to standard macroeconomic control variables and this binary macroprudential policy indicator, either on its own or interacted with one of the controls.[2]

Here we propose a new alternative estimation approach: We start with the binary policy indicators used before but acknowledge they do not measure the overall macroprudential policy stance appropriately. Even in quarters where we do not observe a policy action, policy certainly leans towards tightening, easing or maintaining a neutral stance. This information is not incorporated if we use the binary indicator only. Therefore, we do not use them directly in a regression. Instead, we employ Dueker's (2005) Qual VAR (Qualitative Vector Autoregression) to uncover the latent, i.e. unobservable, propensity to macroprudential tightening from the observed binary policy data. This gives us a continuous series, not only zeros and ones, on policy's propensity to tighten the macroprudential stance. Most importantly, this series is endogenous and reflects the business cycle and the situation on the housing market. This is accomplished by assuming a systematic relationship, essentially one equation of the VAR system, between macroeconomic fundamentals and macroprudential policy actions. Once this latent series is uncovered, a standard VAR can be

[1] See IMF (2013), among others.

[2] See, among others, Lim et al. (2011) and Arregui et al. (2013) for surveys from a policy perspective.

estimated and impulse response functions can be studied.

Providing impulse response functions for macroprudential policy shocks derived in this way has four advantages crucial for policy evaluation: it allows us to, first, acknowledge the endogenous nature of macroprudential policy, second, we can analyze the surprise component of policy in terms of macroprudential shocks, third, we can pin down the dynamic impact of macroprudential measures and, fourth, their impact can be compared with that of conventional monetary policy shocks.

We apply the Qual VAR model to housing-related macroprudential policies in Korea, Hong Kong and Singapore. These countries have a substantial experience for more than a decade with using macroprudential measures to calm an overheating property market. This is because in Hong Kong and Singapore, both maintaining a fixed or managed, respectively, exchange rate, monetary policy directed towards addressing domestic financial imbalances is not feasible. Likewise, monetary policy in Korea was hesitant to apply the blunt tool of interest rate policy to prick the housing bubble. Instead, LTV and DTI measures have been applied extensively. In fact, advanced economies can learn a lot from the Asian experience with regard to non-monetary stabilization tools. As in most economies the monetary policy stance is highly expansionary to accelerate the weak economic recovery, asset prices sour globally. Since the nominal interest rate will not be raised from the level of essentially zero for the foreseeable future, non-monetary instruments are an attractive option to prevent bubbles, in particular in housing markets.

From the Qual VAR we obtain plausible series for the latent changes of the policy instrument, which track well the cycles in macroprudential policies over the past decade. The impulse response functions show that an unexpected macroprudential tightening leads to a significant drop in house price appreciation and credit growth in Korea. For Hong Kong and Singapore the evidence is considerably weaker.

The remainder of this paper is organized as follows. Section two relates this paper to the available literature in this field. The Qual VAR is introduced in section three. Section four provides information on the data used in this study and the identification scheme. Section five presents and discusses the main results. Some conclusions are drawn in section six.

# 2 Evaluating macroprudential policies

The knowledge about the effectiveness of macroprudential policy measures is still limited - for the reasons discussed in the introduction. When evaluating these policies, special attention has been paid to advanced emerging markets in Asia such as

Korea, Hong Kong and Singapore. In these economies, macroprudential policies, in particular those addressing the housing market, haven been actively over for several years in order to calm an overheating property market. As in some countries, notably Hong Kong and Singapore, the monetary authorities keep the exchanged rate pegged, an autonomous monetary policy used to address domestic financial imbalances has not been available. Making things worse, the series of unconventional monetary policies in the mature economies flooded these economies with liquidity exacerbating appreciating pressure on domestic asset prices.[3] Among all countries, Korea has used macroprudential measures most widely. Adjusting maximum LTV or DTI ratios gave the Bank of Korea, which is responsible for setting these housing-related macroprudential policies, the room to avoid or postpone a tightening of conventional monetary policy. Korea pioneered these measures in the early 2000s.

Not surprisingly, most studies of the effectiveness of macroprudential policies pay special attention to these Asian economies. The literature can be organized into two major strands. The first strand consists of calibrated Dynamic Stochastic General Equilibrium (DSGE) models featuring, besides the standard components such as firms, households and a central bank, a housing sector or a financial sector requiring collateral in terms housing. Christensen and Meh (2011), Gelain, Lansing and Mendicino (2013) or Walentin (2013) provide models in which a countercyclical LTV ratio is set according to some feedback rule. Funke and Paetz (2013) calibrate a DSGE model specifically to Hong Kong. These papers typically find that a countercyclical LTV ratio can moderate house price fluctuations and credit growth. Since these results are derived from a set of linearized equilibrium conditions, these models cannot address the build-up of housing bubbles. Furthermore, so far the models are calibrated only.

A second strand of the literature makes use of information on various policy actions as an independent variable to explain asset price movements and credit growth in a time-series or panel regression framework.[4] Gerlach and Peng (2005) estimate the reduced-form interaction between mortgage credit and house prices in Hong Kong. They show that the interaction changes since the early 1990s when an LTV cap was introduced in Hong Kong. In a study on the US housing market, Almeida, Campello and Liu (2006) show that maximum LTV ratios reduce the dependence of house prices to income. The studies of Craig and Hua (2011), Igan and Kang (2011), Wong et al. (2011), Choi (2013), Zhang and Zoli (2013), Kuttner and Shim (2012, 2013) and Claessens, Ghosh and Mihet (2013) all use the data set (or parts of it) we

[3] See Tillmann (2013) for an analysis of capital inflow shocks on asset prices in Asia.

[4] See Lim et al. (2011) for an excellent overview.

employ in this paper, e.g. binary data on macroprudential policy actions collected by the BIS and the IMF. We explain this data set below. In all of these contributions house prices or credit is related to a set of standard macroeconomic control variables and the binary macroprudential policy indicator. The results mostly show that macroprudential policies have some effect on house prices and credit. The case of Korea is highlighted in Bruno and Shin (2013), who estimate a large panel including a dummy for Korea interacted with a dummy for the macroprudential policy package Korea adopted in 2010. They find that capital inflows to Korea were significantly decoupled from global conditions after the introduction of macroprudential measures.

Here we extend this line of research and reconcile it with the standard approach to evaluate monetary policy shocks, which relies on VAR estimates and impulse response analysis. The problems with the singe-equation or panel regressions available in the literature are the following: First, the binary policy indicators are not exogenous treatments. Instead, they are most likely endogenous. A strong house price appreciation makes a tightening of LTV ratios more likely. Treating them as independent variables misses this endogeneity.[5] Second, some of these policy indicators represent information that has been expected and, hence, is already incorporated in asset prices. Put differently, it is the surprise component of these policies that should matter. Elliott, Feldberg and Lehnert (2013) survey the history of macroprudential policies in the US and test for their effect on the evolution of credit aggregates. They argue that: "As has long been recognized in the monetary policy literature, in principle we should be examining innovations to policymakers' reaction functions rather than raw policy variables. Typically, analysts examine the reaction of variables of interest to the shocks to the monetary policy equation in a vector autoregression (VAR). However, as the previous section made abundantly clear, macroprudential policy instruments are inherently multidimensional and, moreover, the set of commonly used instruments shifts over time." (p. 42). Third, monetary policy studies use impulse response functions to trace out the dynamic adjustment of the endogenous variables following a policy shock. The standard panel regression, however, shows only the impact response to, say, a macroprudential tightening. These three concerns are addressed by our Qual VAR approach to macroprudential policy presented in the following section.

[5] A recent paper that explicitly takes the endogenous nature of policies into account is Forbes, Fratzscher and Straub (2013). They present a propensity score matching model that controls for macroprudential policy systematically responding to macroeconomic variables.

# 3 A Qual VAR Approach

In this section we propose using a Qual VAR introduced by Dueker (2005) to study macroprudential policy shocks. While the conventional VAR model is the dominant tool to analyze monetary policy, it cannot be used to address macroprudential policy as there is no continuous indicator of macroprudential policy actions. What we do have at hand, however, are a few selected tightening or easing episodes of macroprudential policy. A Qual VAR bridges the gap between the standard VAR literature of policy shocks and the very small number of macroprudential policy actions.

The idea of the Qual VAR is to uncover the latent, i.e. unobservable, propensity for macroprudential tightening from the binary information on actual macroprudential actions and the dynamic interaction with other business cycle variables.[6] The approach can best be introduced by stressing the analogy with a dynamic probit model. Suppose we observe a binary dependent variable $y_t \in \{0, 1\}$, which is driven by a continuous latent variable $y^*$

$$y_t = \begin{cases} 0 & \text{if } y_t^* \leq 0 \\ 1 & \text{if } y_t^* > 0 \end{cases} \tag{1}$$

with

$$y_t^* = \rho y_{t-1}^* + \mathbf{X}_{t-1}\beta + \epsilon_t, \quad \epsilon_t \sim N(0, 1), \tag{2}$$

where $\mathbf{X}_{t-1}$ is a set of explanatory variables. The latter equation is dynamic in the sense that the latent variable exhibits some autoregressive properties. A Qual VAR includes this equation in a VAR system of the $\mathbf{X}_t$ vector.

A Qual VAR model with $k$ endogenous variables and $p$ lags can be written as

$$\mathbf{\Phi}(L)\mathbf{Y}_t = \mu + \epsilon_t \tag{3}$$

where

$$\mathbf{Y}_t = \begin{pmatrix} \mathbf{X}_t \\ y_t^* \end{pmatrix} \tag{4}$$

consists of macroeconomic data, $\mathbf{X}_t$, and the latent variable, $y_t^*$.

In order to use a Markov Chain Monte Carlo (MCMC) estimation, we have to make the following distributional assumptions: First, the VAR coefficients, $\mathbf{\Phi}$, are normally distributed with the mean and the variance given by the OLS estimates. Second, for the covariance matrix, $\mathbf{\Sigma}$, an inverted Wishart distribution is assumed.

[6] El-Shagi and von Schweinitz (2012) point to identification problems of a Qual VAR. While acknowledging the drawbacks, we still consider a Qual VAR superior to, say, event studies as a tool for macroprudential policy evaluation.

Third, the latent variable, $y^*$, that is required to be positive whenever $y_t$ is equal to one, is said to follow a truncated normal distribution. With the knowledge of the VAR coefficients, the conditional distribution of the latent variable could be derived. Given the latent variable, the conditional distribution of the VAR coefficients is given by the OLS estimates. Since neither of the previous two conditioning assumptions holds, we resort to MCMC estimation. After a sufficient number of iterations, a draw from either conditional distribution can be seen as a draw from the joint posterior distribution. As in Dueker (2005), we run 10,000 iterations from which the first 5,000 are discarded to allow for convergence towards the posterior distribution.[7]

Dueker (2005) also provides applications of the Qual VAR to including binary NBER recession dates or, alternatively, "Romer dates" in a monetary policy VAR. Bordo, Dueker and Wheelock (2007) present a VAR model which incorporates information of a binary indicator of stock market conditions. The forecasting performance of the Qual VAR are studies in one of Dueker's (2005) applications and in Assenmacher-Wesche and Dueker (2010).

# 4 Data and Identification

To estimate the Qual VAR system, we chose the following variables: the vector $\mathbf{X}_t$ consists of the growth rate of real GDP, the change in the short-term interest rate, the growth rate of real credit and the change of real house prices. All growth rates are defined as annual percentage changes. The Consumer Price Index (CPI) is used to deflate nominal variables. The rate of GDP growth is supposed to capture the state of the business cycle.[8] The stance of monetary policy is reflected by the short term interest rate. We estimate one version of the model including the growth rate of overall credit and one with the growth rate of credit to households only. Besides house prices, the main objective of many macroprudential policy measures, credit is included to study one of the main transmission channels of macroprudential policies. All data comes from the IMF's International Financial Statistics (GDP, CPI, interest rate) and the BIS (credit, house prices). The model is estimated for Korea (KOR), Hong Kong (HKG) and Singapore (SGP).

We include the variables as percentage changes for two reasons: firstly, estimating the Qual VAR requires all variables to be strictly stationary. While in the monetary policy literature variables are often included in log levels which are clearly non-stationary, uncovering the latent variable in our case forces us to take that is-

[7] For details we refer to Dueker's (2005) original contribution.

[8] We do not include the inflation rate in order to keep the model as parsimonious as possible.

sue seriously. Secondly, and most importantly, the data on macroprudential policy measures to be described below reflect macroprudential policy *actions*, i.e. *changes* of the macroprudential policy stance. Since macroprudential policies are fairly new policy tools, there is no agreement yet on how to measure the overall stance of policy, e.g. when policy is considered tight or loose. We only observe tightening or easing steps, respectively.

Besides the observable macroeconomic variables, the Qual VAR comprises the latent macroprudential measure $y_t^*$. The binary variable $y_t$, which is observable, is an indicator of macroprudential tightening actions. Consistently, we interpret $y_t^*$ as the unobservable propensity to tighten macroprudential policy. As there is a multitude of macroprudential policy instruments which are, in addition, adjusted only infrequently, identifying tightening actions is not straightforward. To construct a binary variable we use the qualitative information collected in Shim et al. (2013) and, alternatively, in Lim et al. (2013). According to the affiliations of these authors, we refer to the first source as BIS data and the latter as IMF data. Both data sets include measures ranging from reserve requirements over foreign exchange-related measures to tax instruments. We use only use those instruments that directly address the indebtedness of households, e.g. a reduction of loan-to-value (LTV) ratios or debt-to-income (DTI) caps as these are typically adjusted to calm an overheating property market. However, we use other indicators as robustness checks. For each data set we assign a value of $y_t = 1$ whenever we observe a tightening action in quarter $t$. A value of $y_t = 0$ is assigned otherwise. Table (1) reports the resulting incidents of macroprudential tightening.[9]

For the computation of impulse response functions, macroprudential and monetary policy shocks, respectively, must be identified. In the monetary VAR literature this is the decisive step to which an enormous amount of work was dedicated over the past three decades. By using a Cholesky factorization, we chose the simplest approach to identification. This amounts to imposing a triangular ordering onto the variables such that a variable's innovation has a contemporary impact only on those variables ordered below. The problem of this approach is to specify a direction of causality among macroeconomic variables, monetary policy and macroprudential policy within on quarter. Beyond a given quarter, the ordering should not matter. We choose to include the variables in the following order: GDP growth, interest rate change, propensity to macroprudential tightening,credit growth, house price change.

[9] As the Qual VAR deals with zero-one variables only, we chose to feed data on macroprudential tightening episodes -coded as ones- into the model as opposed to easing episodes. The latter, however, would generate more unreliable results as there are much more tightening than easing episodes in the sample period.

As in Gerlach and Assenmacher-Wesche (2008) or, more recently, Gali and Gambetti (2013), we order house prices after the policy variables, followed only by credit growth.[10] Asset prices most likely reflect both monetary and macroprudential policy actions within one quarter, while monetary and macroprudential policies do not respond to asset price movements in a given quarter. We also assume that within a quarter monetary actions affect macroprudential policy actions but not vice versa. This latter ordering reflects two considerations. First, as conventional monetary policy hit the zero lower bound on nominal interest rates, authorities might have used unconventional instruments such as macroprudential tools subsequently. Second, in HKG and SGP monetary policy targets the exchange rate with very little room to actively use the short-term interest rate as a policy instrument. It is more likely that macroprudential policies within a given quarter adjust to changes in monetary policy rates, which in the case of HKG and SGP is mostly determined abroad.
We chose the Cholesky factorization mainly for comparability of the results with existing evidence on monetary policy shocks, which is also very often derived under such a triangular identification scheme. The sign restrictions approach of Uhlig (2005), which recently became a popular alternative, is not straightforward to apply as there are no commonly agreed upon sign restrictions which could by utilized to identify a macroprudential shock.
Since the sample is rather short, we estimate each VAR model with $p = 2$ lags.[11]

# 5 Results

The results are depicted in a large set of figures in the appendix. We consider each country in turn. In each country we study the results based on the BIS data set on policy actions first. After that, we discuss the results based on the IMF data set. Given the number of impulse response functions, we only sketch the broad tendencies and won't go into every detail.

## 5.1 Korea

The latent propensity to tighten derived from using total credit and household credit are depicted in figures (1) and (2), respectively. In each of these figures (also for the other countries), the shaded areas indicate episodes for which the binary policy indicator signals a macroprudential tightening. The solid line is the latent propensity

[10] Assenmacher-Wesche and Gerlach (2008) and Goodhart and Hofmann (2008) estimate panel VARs to show that monetary policy shocks have a significant effect on asset prices.
[11] The Qual VAR is estimated using the RATS codes available on `www.estima.com`.

to tighten uncovered by the Qual VAR. By construction, the propensity is positive in each shaded area. This is all the algorithm imposes on the latent variable. The swings reflect tightening and easing phases while the scale of the latent variable bears no direct interpretation. In both figures we clearly see a plausible tightening cycle. Policy tightened in 2006/07 when house prices reached a peak. We also see the easing of policy following the Lehman collapse and the repatriation of foreign funds directly thereafter.

Based on these series, the VAR can be estimated to generate impulse response functions. Figures (3) and (4) show the responses to a macroprudential shock and a conventional monetary shock, respectively.[12] In all figures we also provide bootstrapped 90% confidence bands. After an unexpected macroprudential tightening, house price appreciation falls significantly. Likewise, credit growth slows significantly in the first four quarters after the shock. A monetary shock, in contrast, only leads to a credit contraction on impact without a signfiicant fall in house prices. When estimated on household credit data rather than total credit, see figures (5) and (6), macroprudential shocks significantly reduce credit growth, but have a non-significant effect on house prices. In this case the monetary shock leads to significantly negative credit and house price responses. We can conclude that a macroprudential policy shock is effective in dampening credit growth and moderately effective in reducing the appreciation of house prices.

Raising interest rates to prevent housing bubbles is often considered too blunt an instrument because higher rates also contract the rest of the economy. Assenmacher-Wesche and Gerlach (2008) show that an interest rate increase large enough to avoid a housing bubble would lead to a severe recession. We find that using a macroprudential policy instrument sidesteps this problem. Tightening macroprudential policy reduces house prices without having a significantly negative effect on overall GDP.

The size of the house price response, seems to be considerably smaller than that following a monetary policy shock. This impression is probably misleading as we study here the response to a "typical" shock of one standard deviation. In most cases, however, the typical macroprudential shock at the policy dates was much larger than one standard deviation in size. In fact, several standard deviations are needed to give rise to a tightening episode. The sign and the shape of the responses are therefore more reliably estimated.[13]

As in conventional VAR models, we can also use a historical decomposition to extract

[12] We do not present the response of the latent variable itself and the interest rate. These results are available upon request.

[13] This issue is also stressed in the empirical application in Dueker (2005) to the Romer dates.

the realizations of the macroprudential policy shock. We plot the shock derived from total credit and household credit in figures (7) and (8), respectively. Again, the unexpected easing in 2008/09 is followed by some tightening in early 2010 as foreign capital started to return to emerging market economies. Note that it is misleading to cross-check these bars with the latent series derived before. The shock reflects unexpected tightenings. A negative shock must not necessarily mean a policy easing. Rather, a negative shock reflects that the policy tightening is weaker than expected based on the macroprudential history incorporated in the VAR model. For the IMF data set, see figures (9) to (16), the overall picture is very similar. The latent series is a bit more volatile reflecting the fact that the IMF data provides less information on tightening action compared to the BIS data set. The impulse responses, however, remain roughly unchanged.

## 5.2 Hong Kong

For Hong Kong, the latent macroprudential policy stance uncovered by the Qual VAR, see figures (17) and (18) is again plausible and reflects financial conditions in Asian emerging markets economies in light of swings in capital inflows due to unconventional monetary policies in advanced economies. Since there are fewer binary tightening episodes than in Korea used as input for the Qual VAR, it is more demanding for the algorithm to uncover the latent variable. As a result, the latent series is more volatile than in the case of Korea. Nevertheless, we clearly see the swings in the tightening stance, in particular so when using narrow data on household credit only.

A surprise macroprudential tightening, however leads to counterintuitive or insignificant responses of house prices and credit for all definitions of credit aggregates and for both data sets. The responses to a monetary policy shock are mostly in line with our prior. It is however doubtful whether one can interpret a monetary policy shock in Hong Kong in much the same way as, say, in Hong Kong. The reason is that due to the currency board maintained vis-a-vis the USD monetary impulses are in fact originating in the US and cannot be derived from a VAR with domestic variables only.

## 5.3 Singapore

The latent propensity to tighten housing-related policy instruments in Singapore is equally volatile as in Hong Kong. This is again due to very few tightening episodes entering the Qual VAR system. As a result, uncovering the latent series cannot be

as robust as in the case of Korea. The responses to macroprudential shocks, see (43) and (45), lead to a significantly negative response of house price growth and credit growth. Again, the responses of credit growth occur fast while the maximum response of house price appreciation can be observed two or three quarters after the macroprudential policy shock. The size and the timing of the macroprudential shocks themselves, see figures (39), (40), (47) and (48), vary across the different combinations of data sets, but are overall plausible. We see the relaxation of macroprudential policy instruments following the meltdown in late 2008/early 2009 and the subsequent tightening towards late 2009/early 2010 in light of massive capital inflows to emerging market economies.

# 6 Conclusions

Quantifying the effectiveness of macroprudential policies is needed in order to design policy appropriately. Despite the growing consensus that macroprudential policy measures could be useful, the empirical effectiveness is still not very well established.

Often the information on macroprudential policy actions is available in qualitative form only. Researchers then typically code this information into a binary tightening/easing indicator and include it into standard regressions of house prices and credit growth on various fundamentals. This paper goes a step further and aims at uncovering the latent propensity for policy to tighten from this binary information set. This can be achieved by exploiting the assumption that macroprudential policy responds systematically to macroeconomic fundamentals. The resulting Qual VAR allows us to estimate impulse response functions for macroprudential shocks - very much like the standard VAR model generates impulse response functions for monetary policy shocks. The results suggest that an unexpected macroprudential tightening has a significant effect on house prices and credit growth with the effect being strongest in Korea and mostly absent in Hong Kong.

There are numerous ways to extend this line of research. While this paper focuses on the housing market, other areas of macroprudential policy could ve evaluated using the Qual VAR together with the qualitative information on policy actions. Given the uncovered, latent information we are also able to estimate reactions functions for macroprudential policy similar to those for monetary policy. Given the current boom in global asset prices and the reluctance to raise interest rates, the need for a macroprudential tightening grows. This should also raise the interest in measuring the effectiveness of macroprudential policies even more.

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Table 1: Tightening dates of housing-related macroprudential policies

| KOR | | HKG | | SGP | |
|---|---|---|---|---|---|
| BIS data | IMF data | BIS data | IMF data | BIS data | IMF data |
| 2002Q3 | 2002Q3 | 2009Q4 | 2009Q4 | 2010Q1 | 2009Q3 |
| 2002Q4 | 2003Q2 | 2010Q3 | 2010Q3 | 2010Q3 | 2010Q1 |
| 2003Q2 | 2003Q4 | 2010Q4 | 2010Q4 | 2011Q1 | 2011Q1 |
| 2003Q4 | 2005Q2 | 2011Q2 | 2011Q2 | | 2012Q4 |
| 2005Q2 | 2005Q3 | | 2012Q3 | | |
| 2006Q2 | 2006Q1 | | | | |
| 2006Q4 | 2007Q1 | | | | |
| 2007Q1 | 2007Q3 | | | | |
| 2007Q3 | 2009Q3 | | | | |
| 2009Q3 | 2009Q4 | | | | |
| 2009Q4 | | | | | |
| 2011Q2 | | | | | |

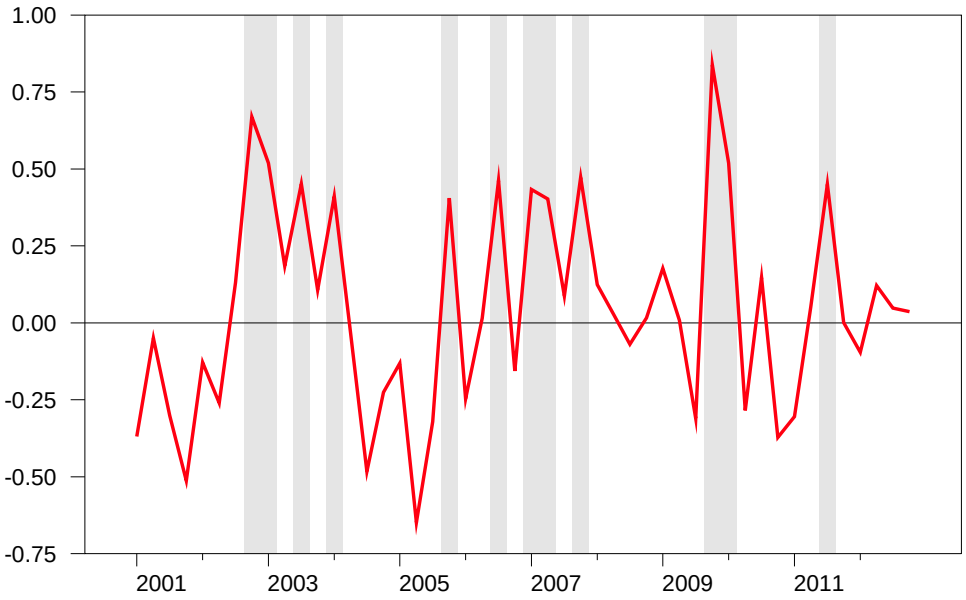


Figure 1: Latent propensity to macroprudential tightening in Korea (BIS data, total credit)

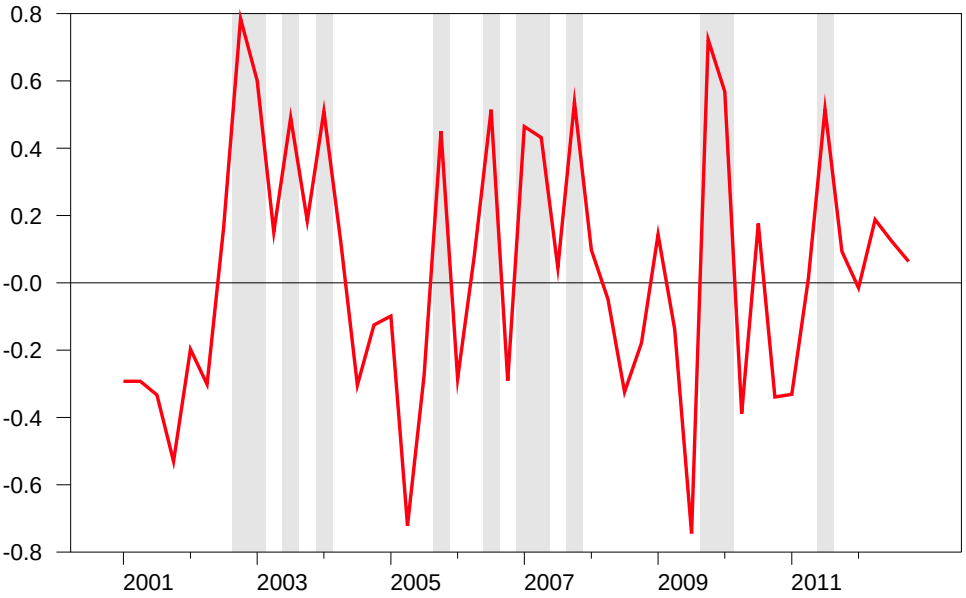


Figure 2: Latent propensity to macroprudential tightening in Korea (BIS data, household credit)

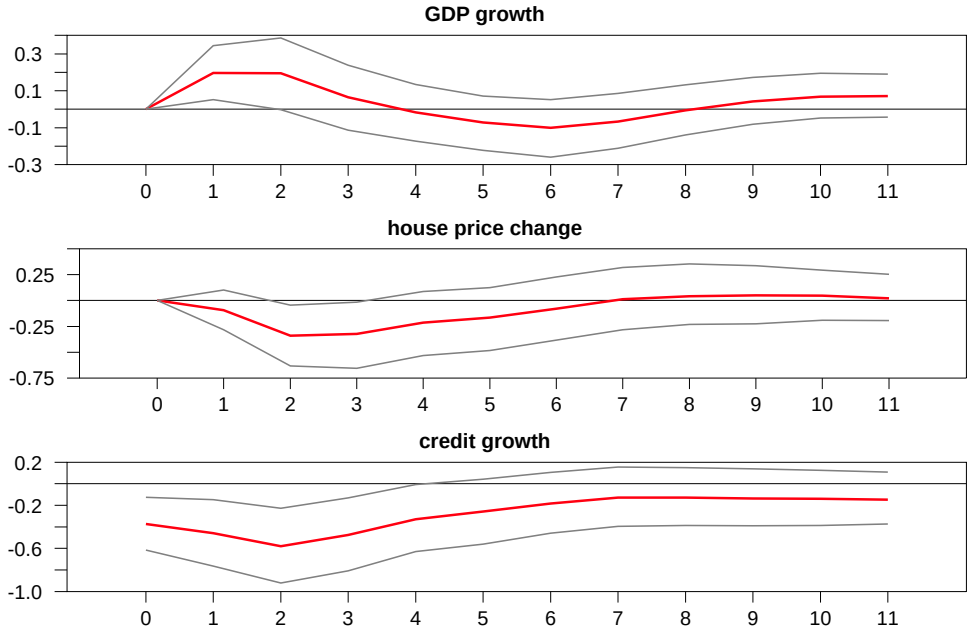


Figure 3: Macroprudential policy shock in Korea (BIS data, total credit)

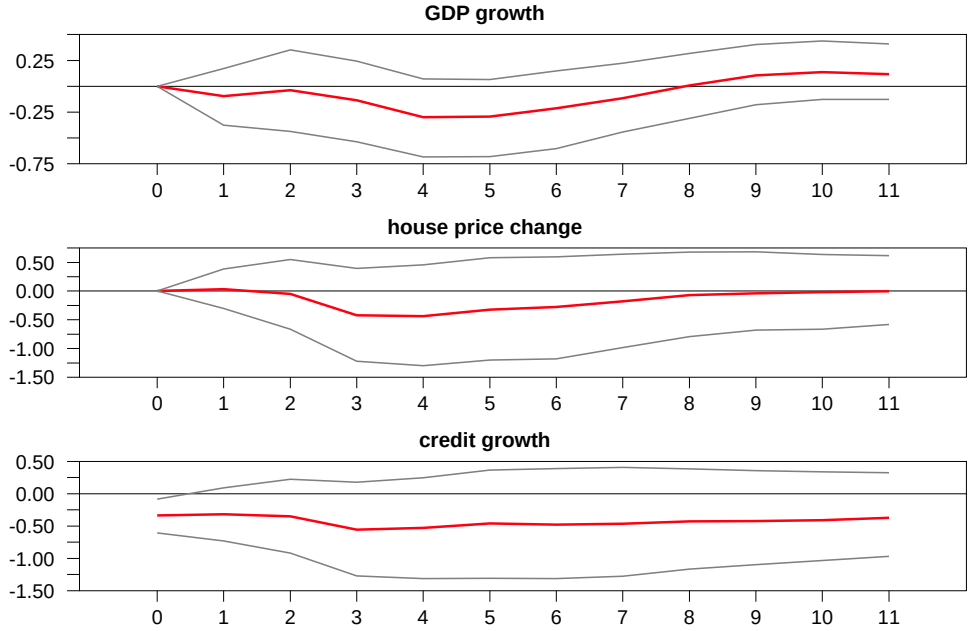


Figure 4: Monetary policy shock in Korea (BIS data, total credit)

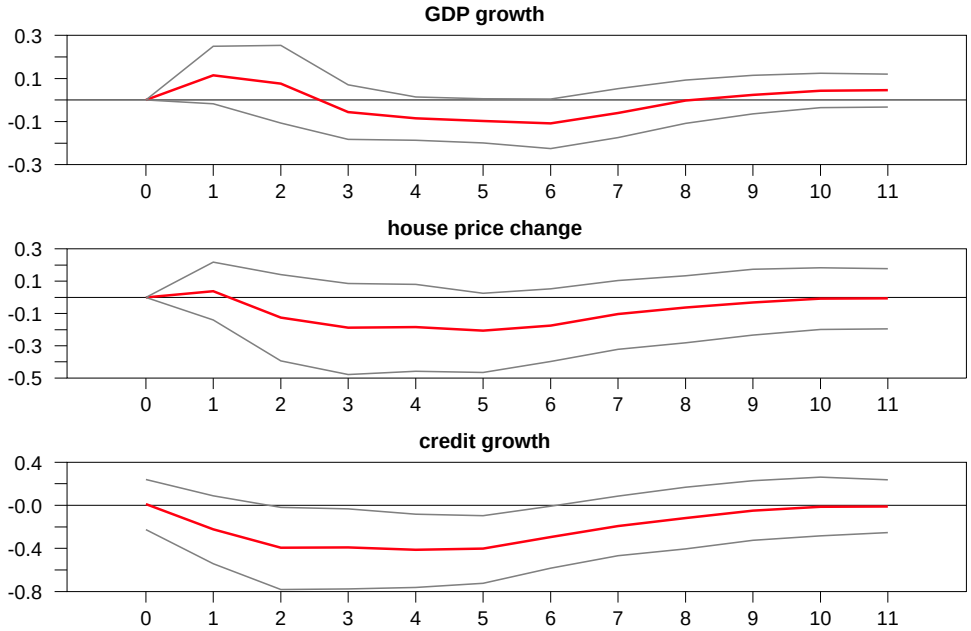


Figure 5: Macroprudential policy shock in Korea (BIS data, household credit)

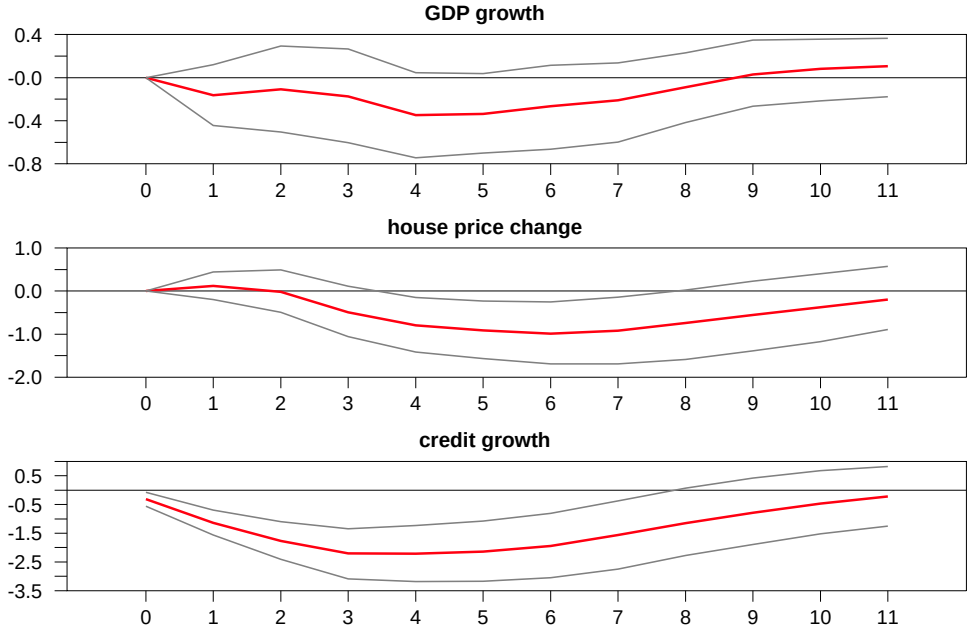


Figure 6: Monetary policy shock in Korea (BIS data, household credit)

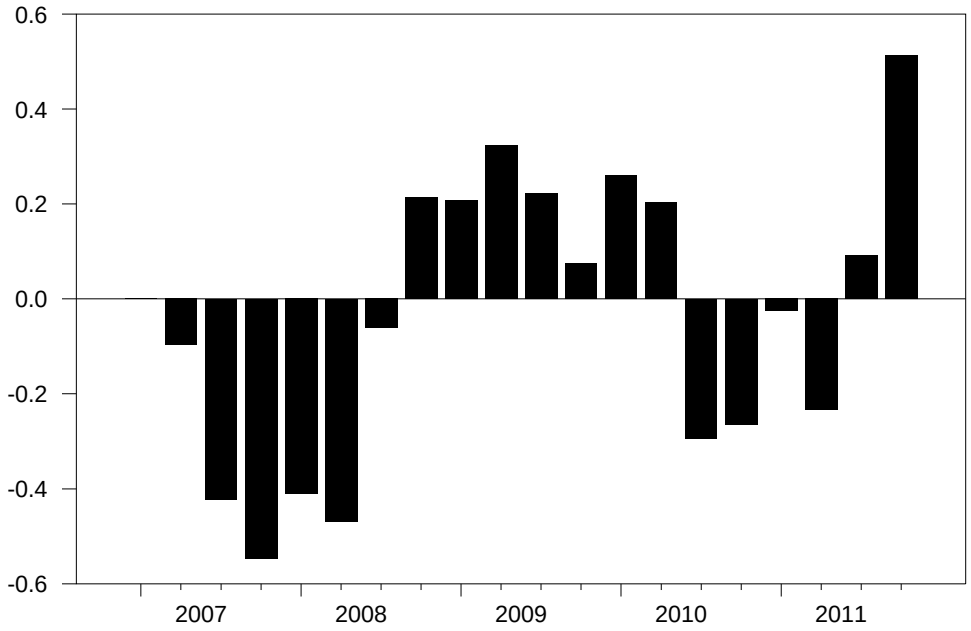


Figure 7: Macroprudential policy shocks in Korea (BIS data, total credit)

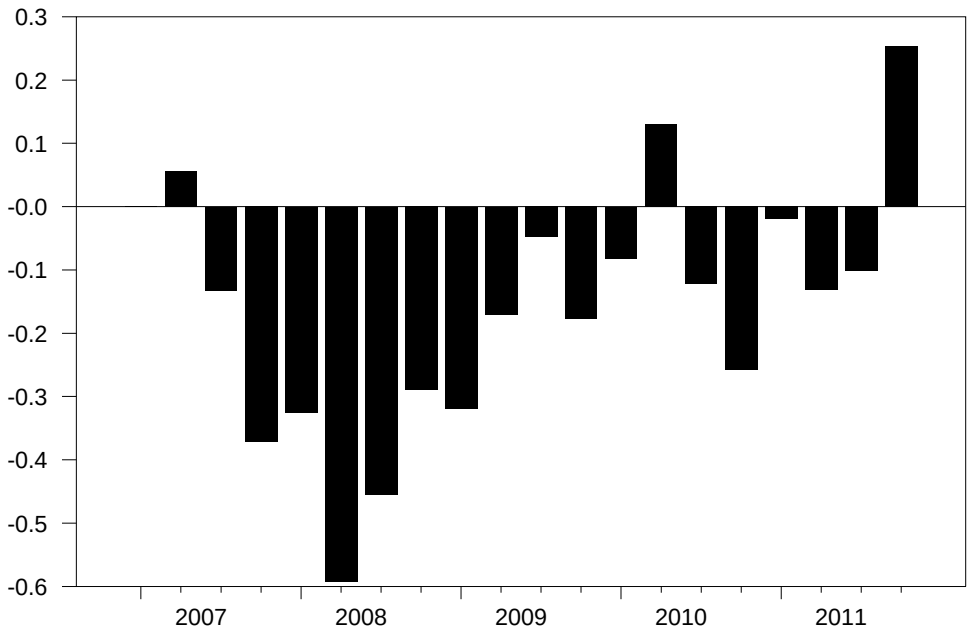


Figure 8: Macroprudential policy shocks in Korea (BIS data, household credit)

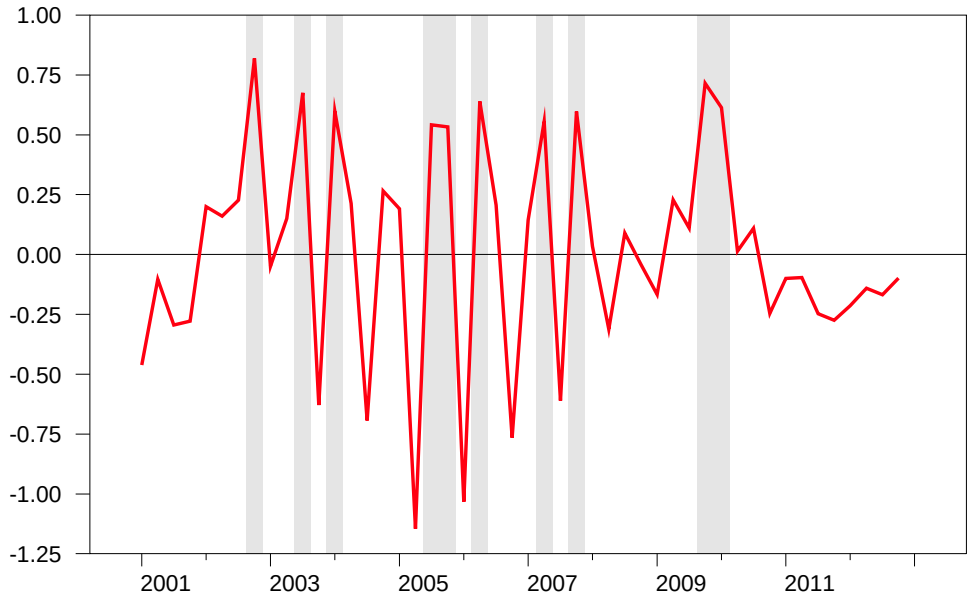


Figure 9: Latent propensity to macroprudential tightening in Korea (IMF data, total credit)

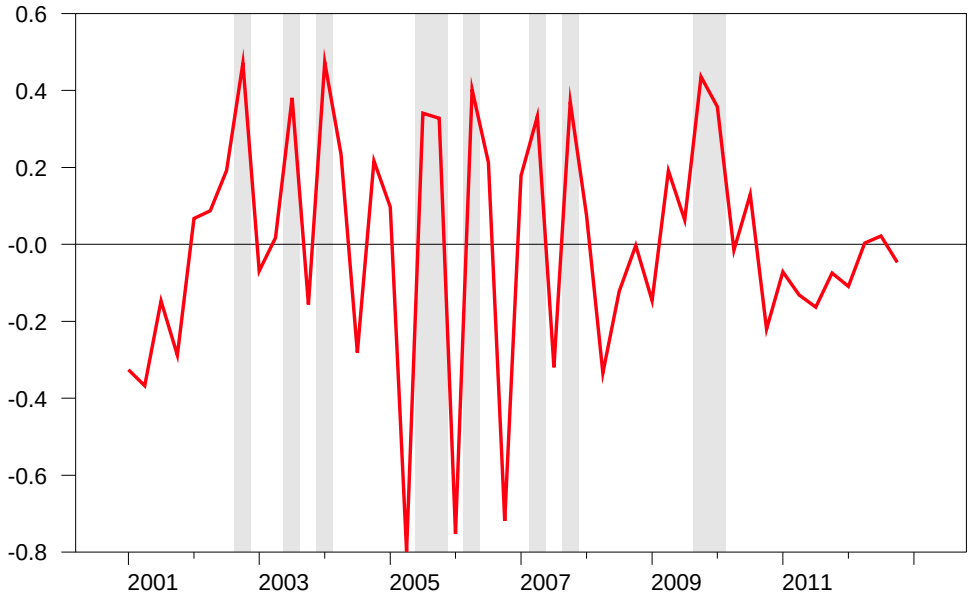


Figure 10: Latent propensity to macroprudential tightening in Korea (IMF data, household credit)

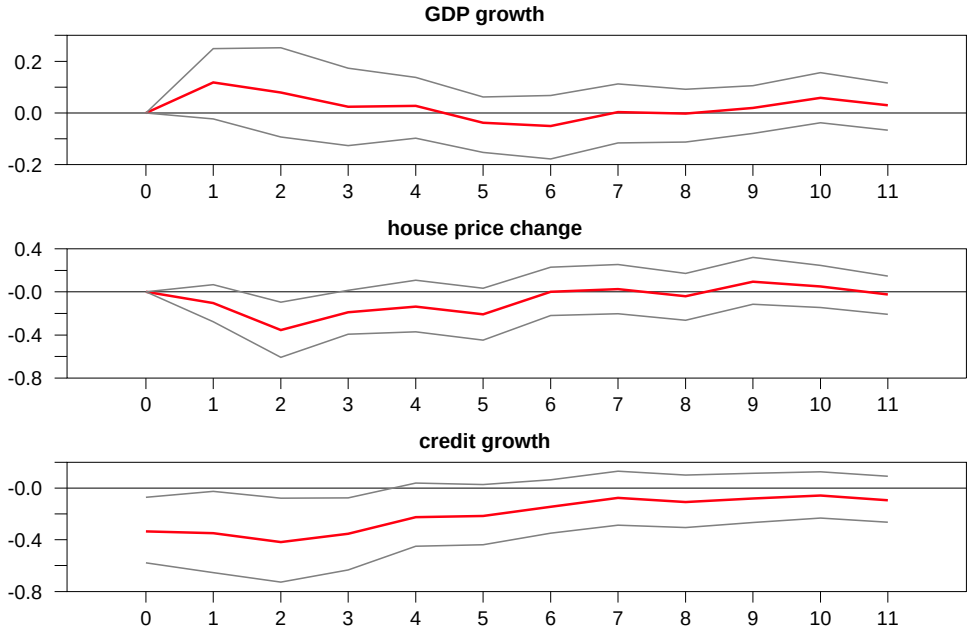


Figure 11: Macroprudential policy shock in Korea (IMF data, total credit)

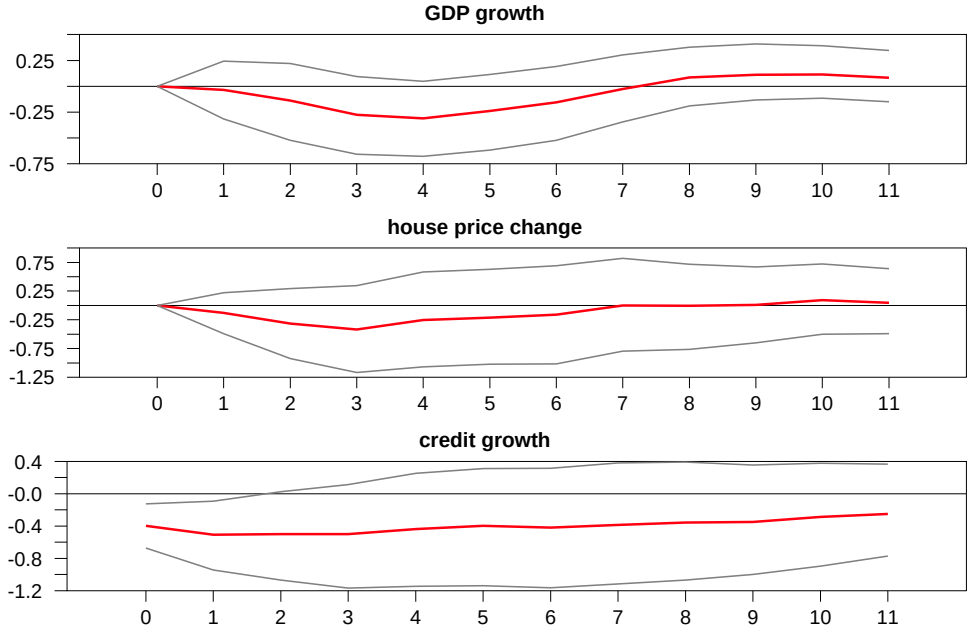


Figure 12: Monetary policy shock in Korea (IMF data, total credit)

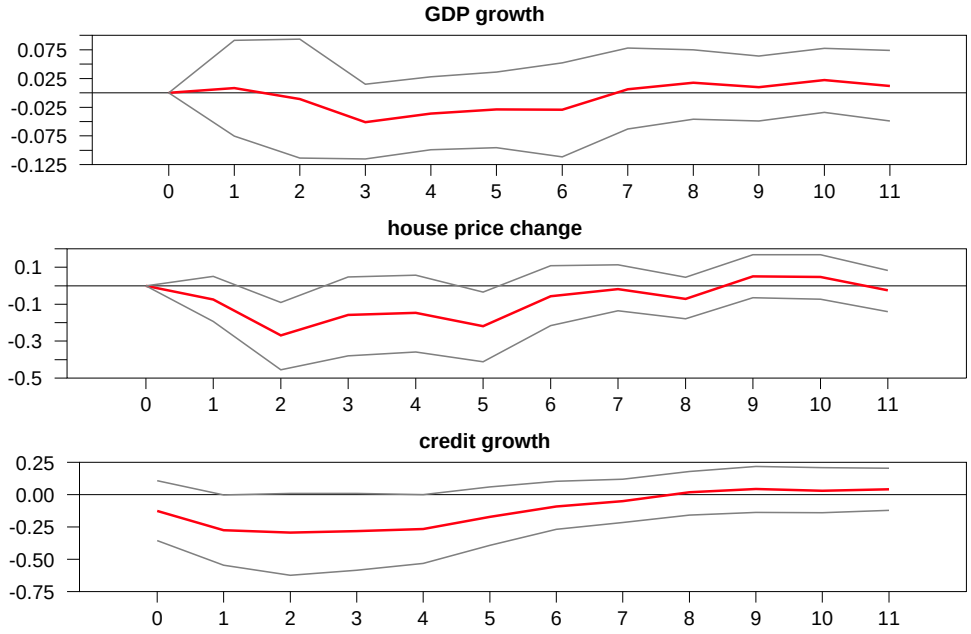


Figure 13: Macroprudential policy shock in Korea (IMF data, household credit)

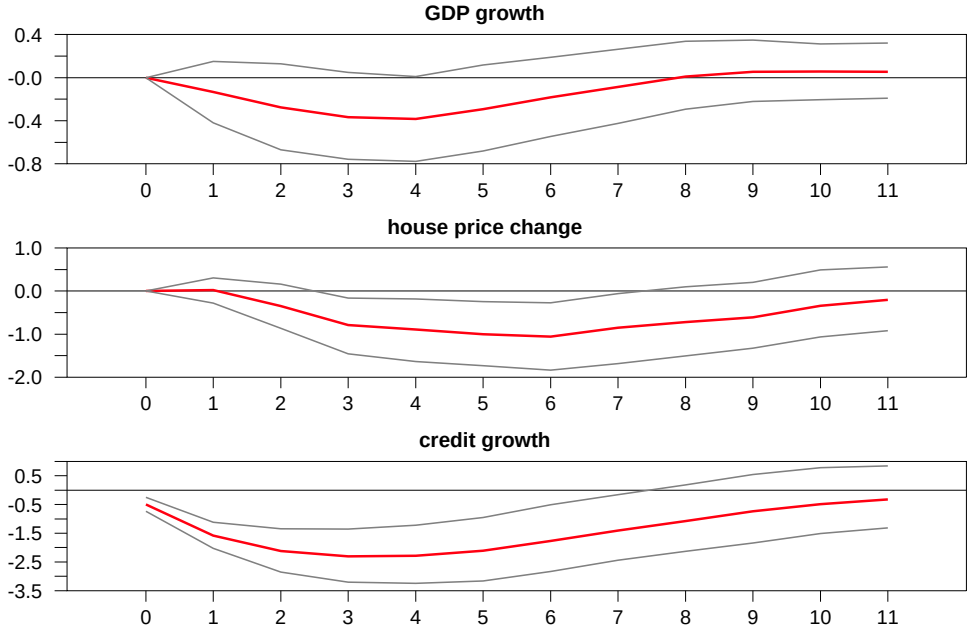


Figure 14: Monetary policy shock in Korea (IMF data, household credit)

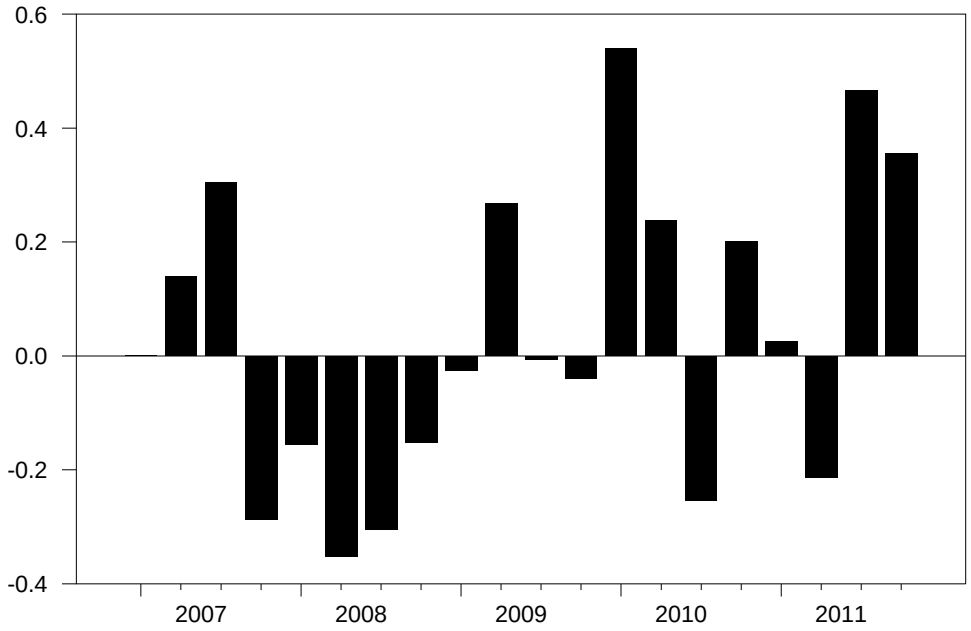


Figure 15: Macroprudential policy shocks in Korea (IMF data, total credit)

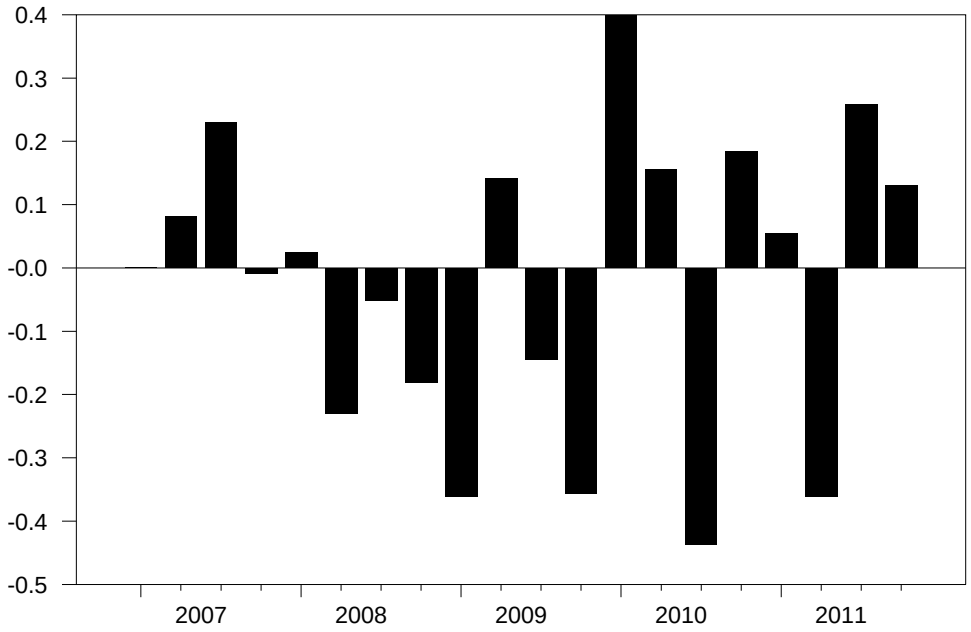


Figure 16: Macroprudential policy shocks in Korea (IMF data, household credit)

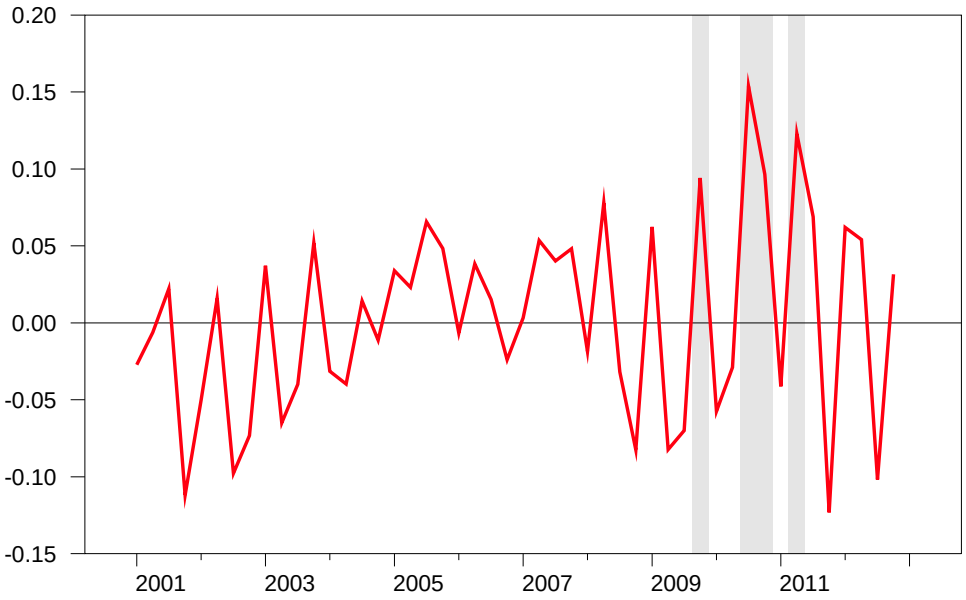


Figure 17: Latent propensity to macroprudential tightening in Hong Kong (BIS data, total credit)

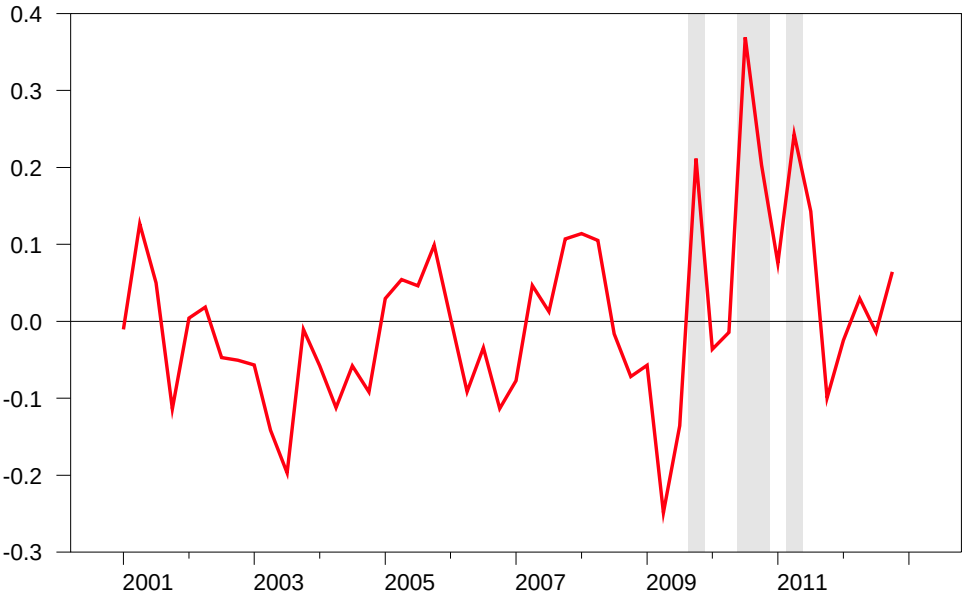


Figure 18: Latent propensity to macroprudential tightening in Hong Kong (BIS data, household credit)


Figure 19: Macroprudential policy shock in Hong Kong (BIS data, total credit)

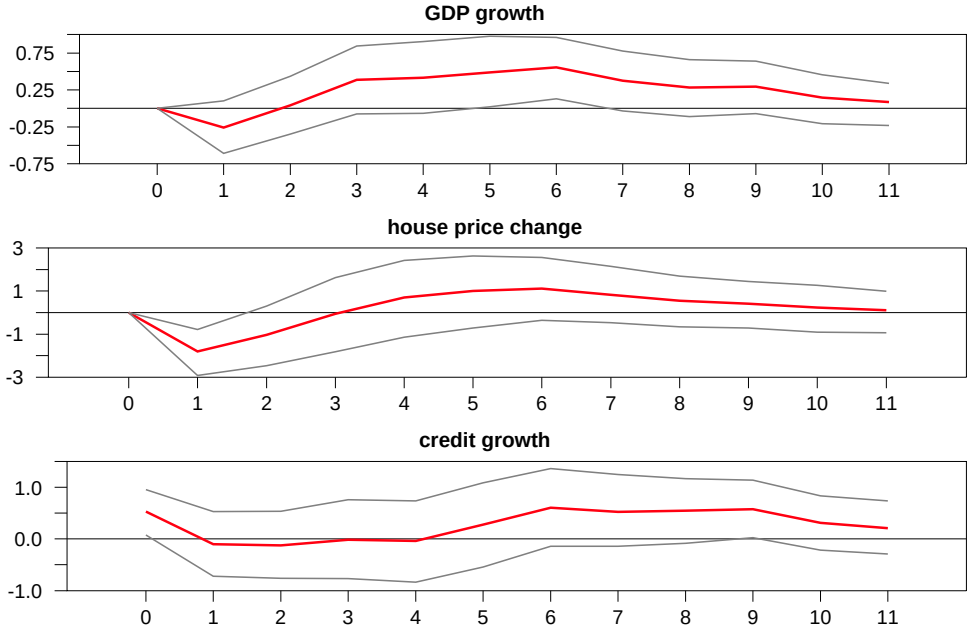


Figure 20: Monetary policy shock in Hong Kong (BIS data, total credit)

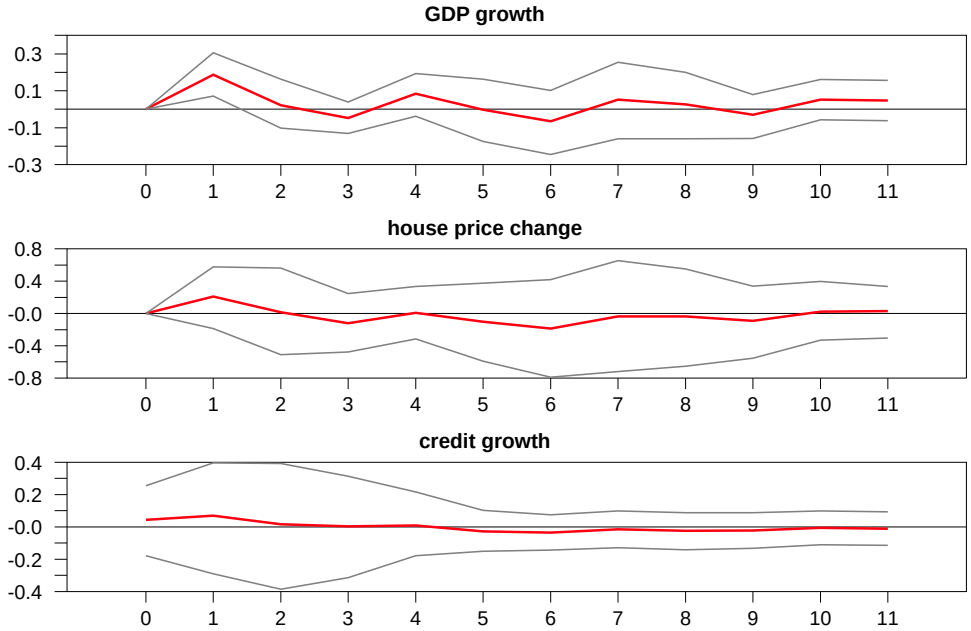


Figure 21: Macroprudential policy shock in Hong Kong (BIS data, household credit)

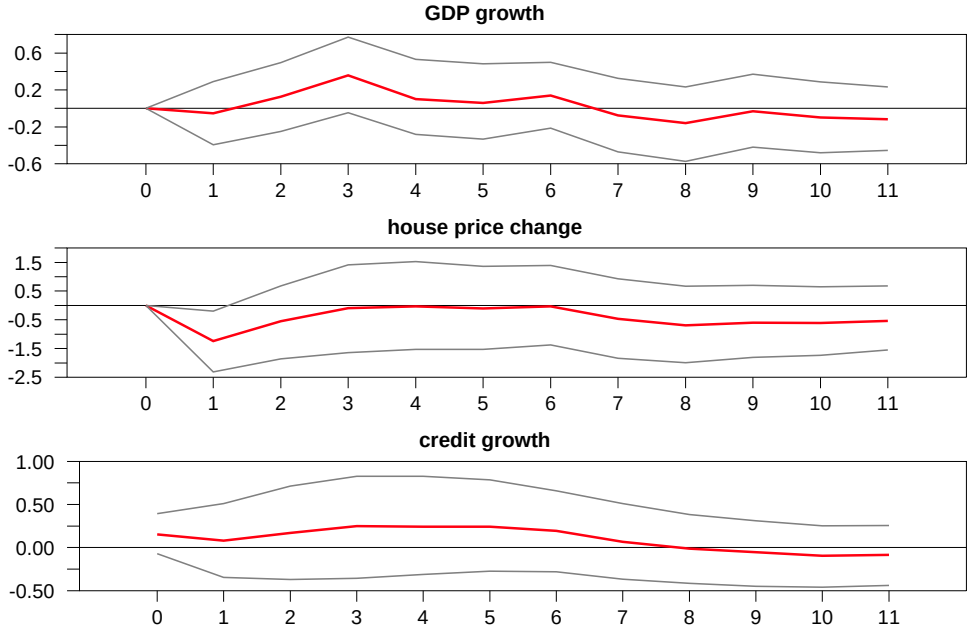


Figure 22: Monetary policy shock in Hong Kong (BIS data, household credit)

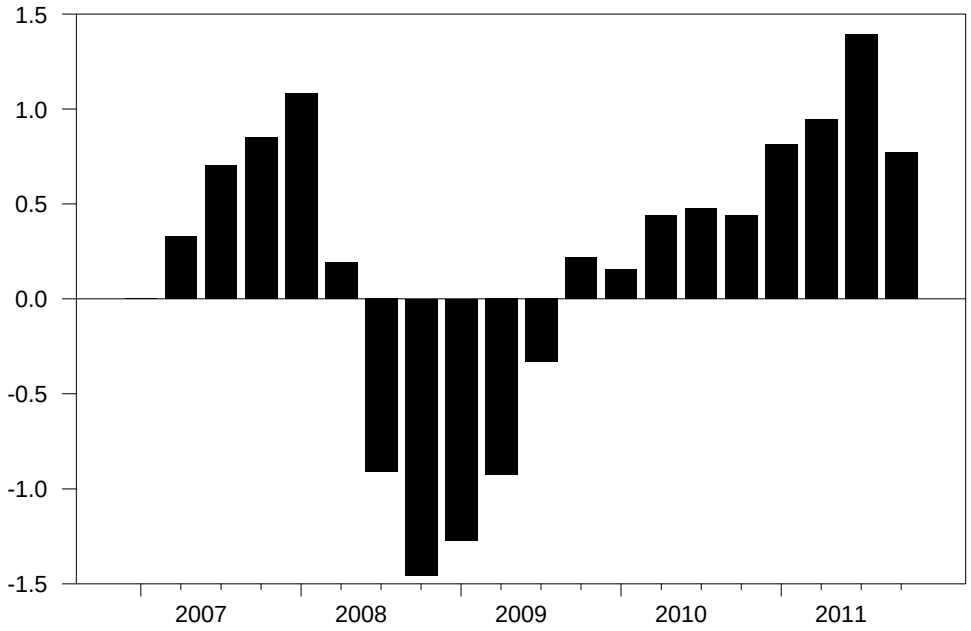


Figure 23: Macroprudential policy shocks in Hong Kong (BIS data, total credit)

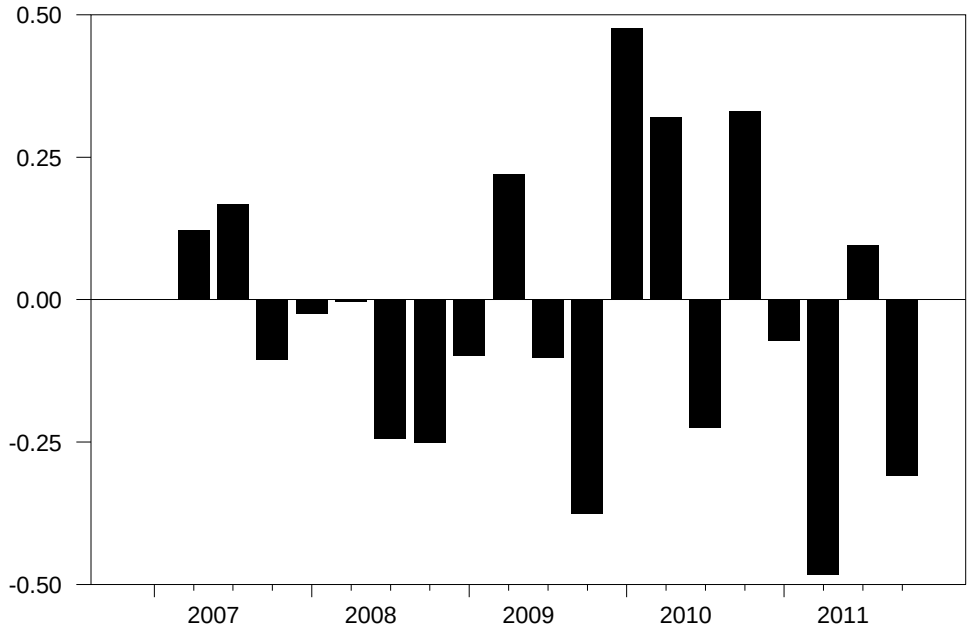


Figure 24: Macroprudential policy shocks in Hong Kong (BIS data, household credit)

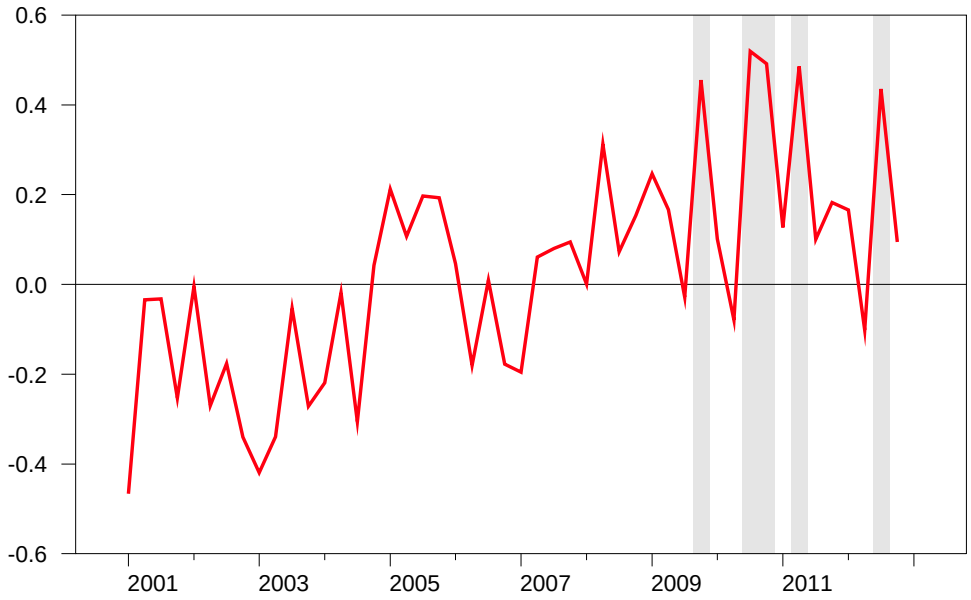


Figure 25: Latent propensity to macroprudential tightening in Hong Kong (IMF data, total credit)

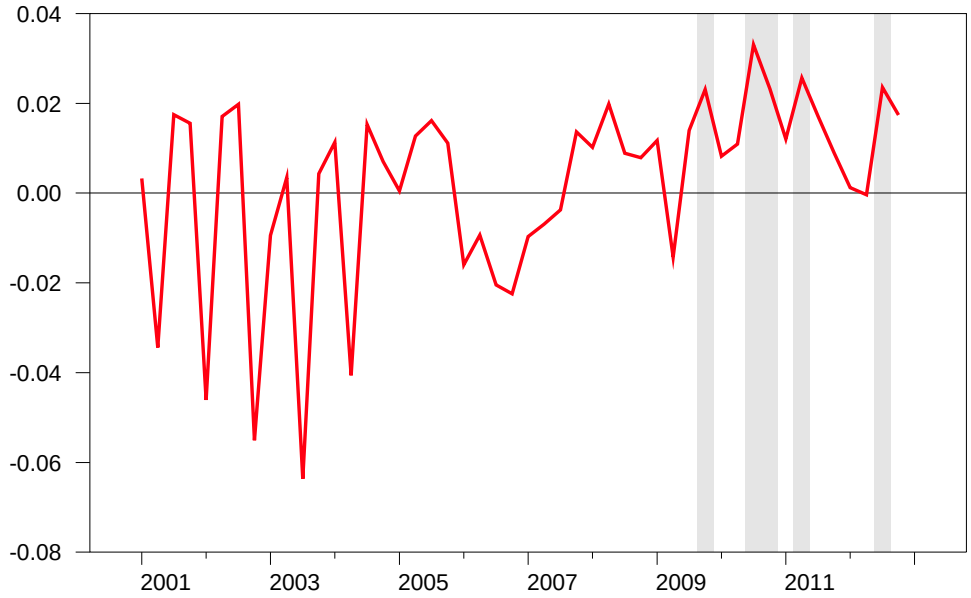


Figure 26: Latent propensity to macroprudential tightening in Hong Kong (IMF data, household credit)


Figure 27: Macroprudential policy shock in Hong Kong (IMF data, total credit)

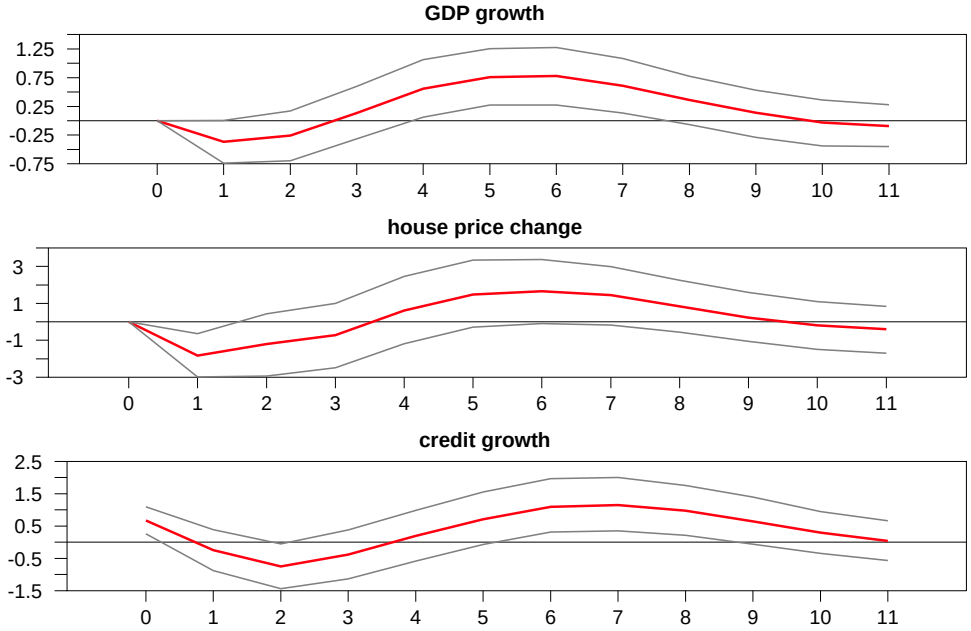


Figure 28: Monetary policy shock in Hong Kong (IMF data, total credit)

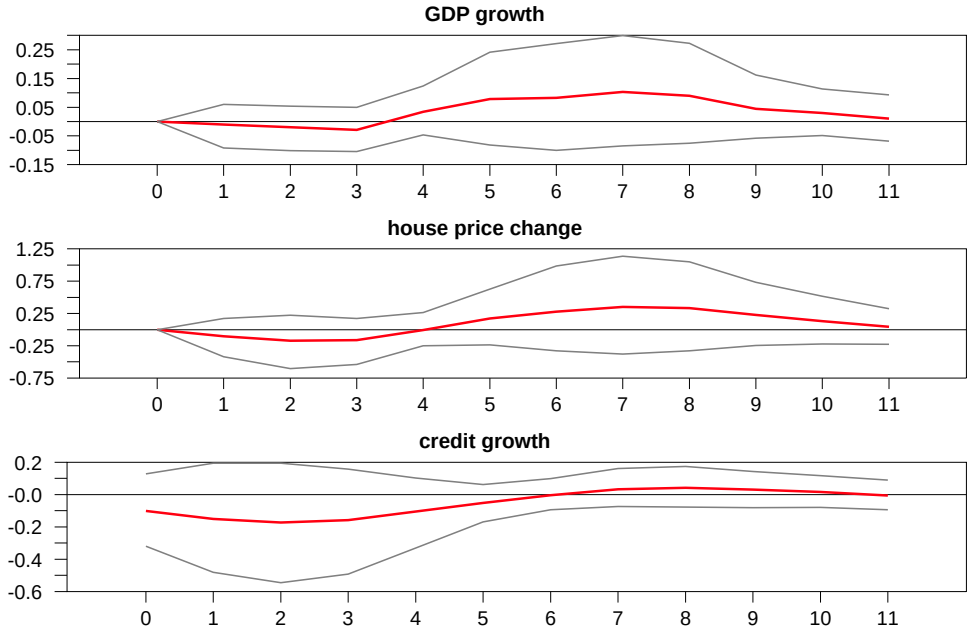


Figure 29: Macroprudential policy shock in Hong Kong (IMF data, household credit)

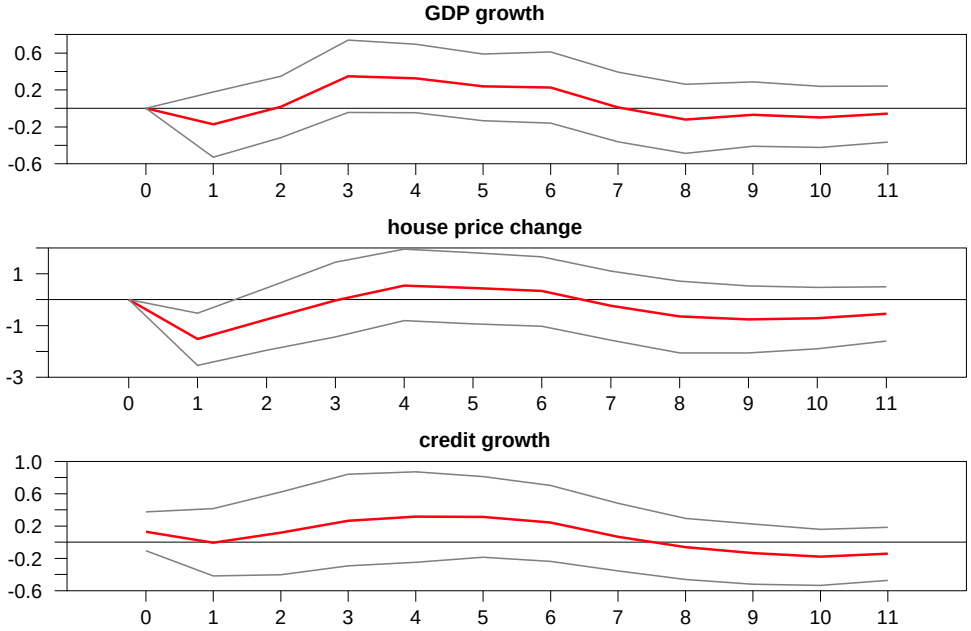


Figure 30: Monetary policy shock in Hong Kong (IMF data, household credit)

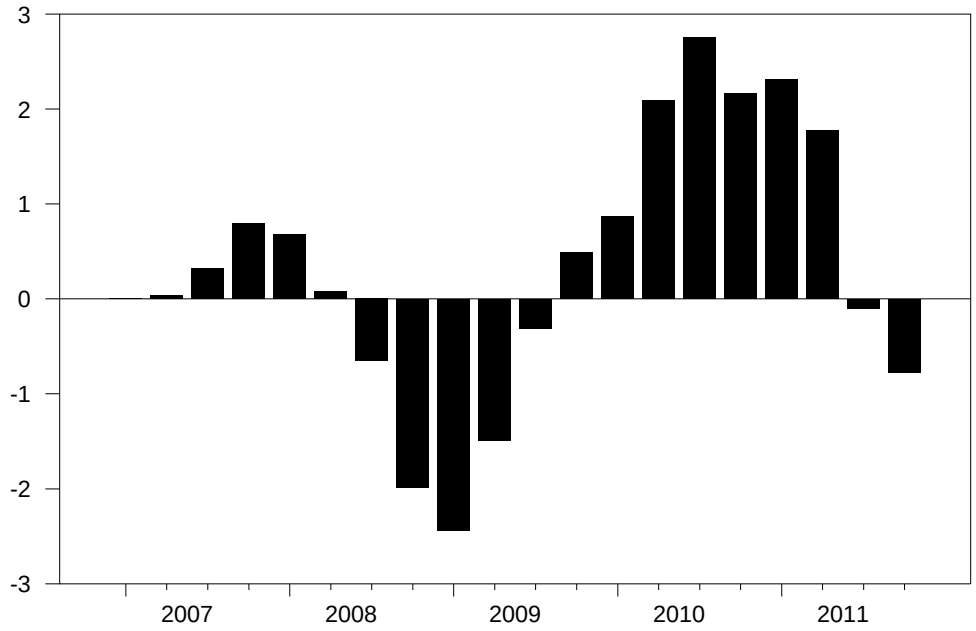


Figure 31: Macroprudential policy shocks in Hong Kong (IMF data, total credit)

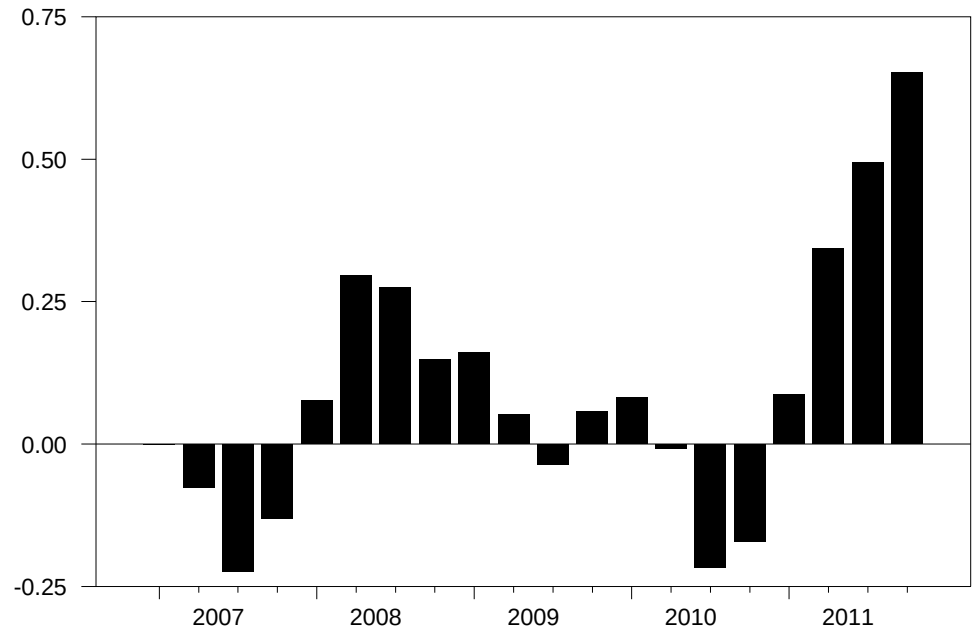


Figure 32: Macroprudential policy shocks in Hong Kong (IMF data, household credit)

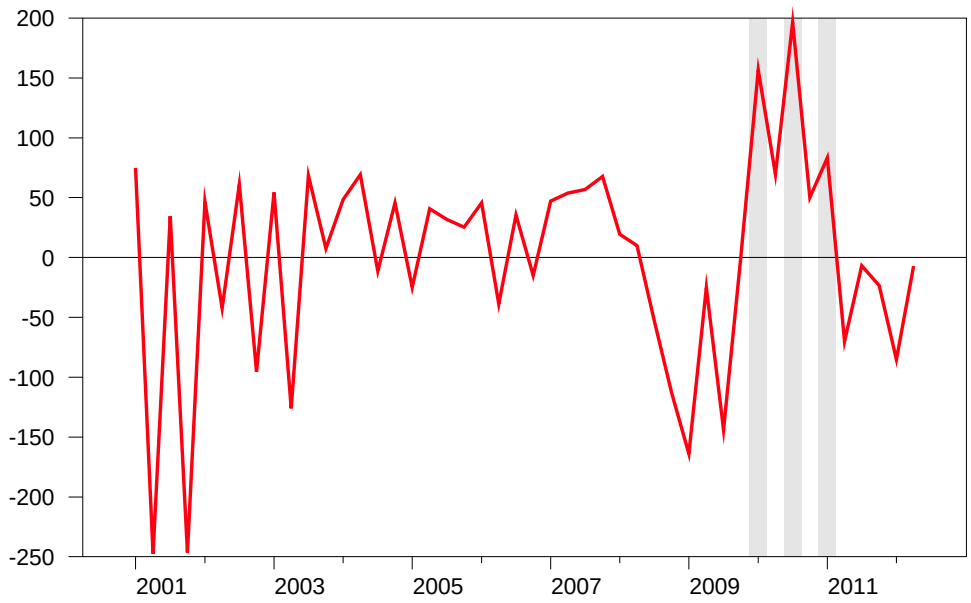


Figure 33: Latent propensity to macroprudential tightening in Singapore (BIS data, total credit)

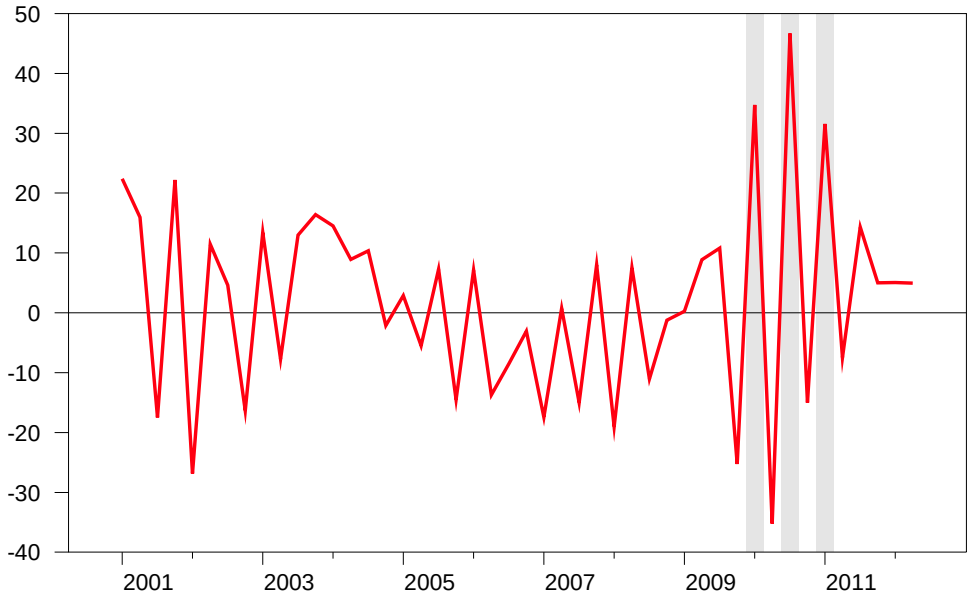


Figure 34: Latent propensity to macroprudential tightening in Singapore (BIS data, household credit)

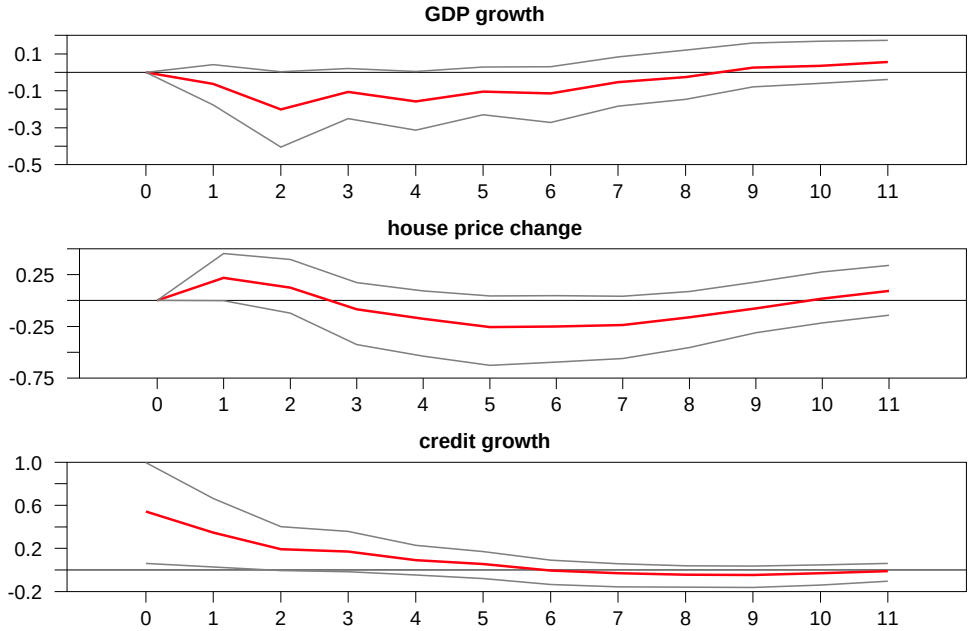


Figure 35: Macroprudential policy shock in Singapore (BIS data, total credit)


Figure 36: Monetary policy shock in Singapore (BIS data, total credit)

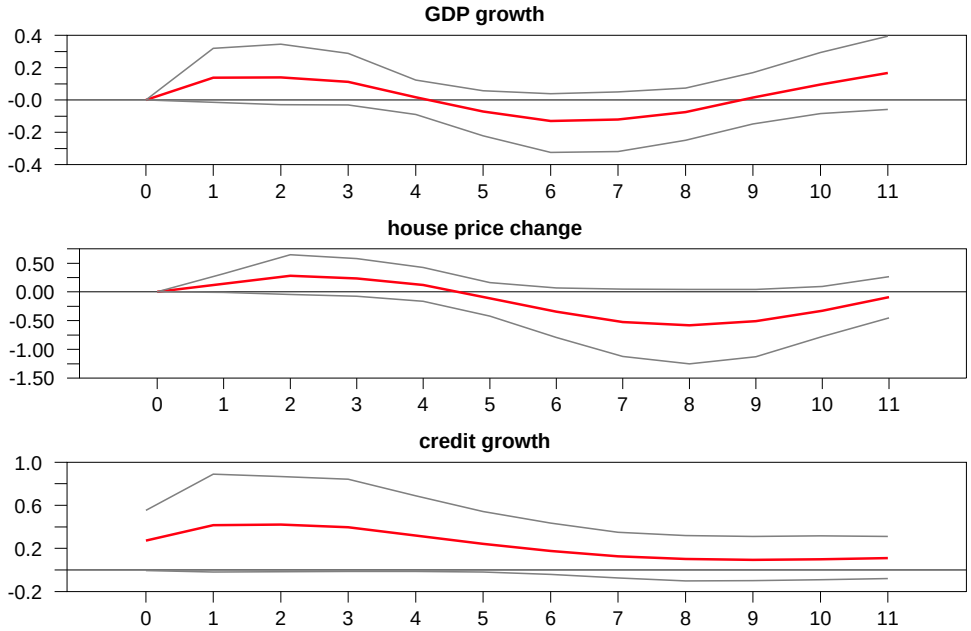


Figure 37: Macroprudential policy shock in Singapore (BIS data, household credit)


Figure 38: Monetary policy shock in Singapore (BIS data, household credit)

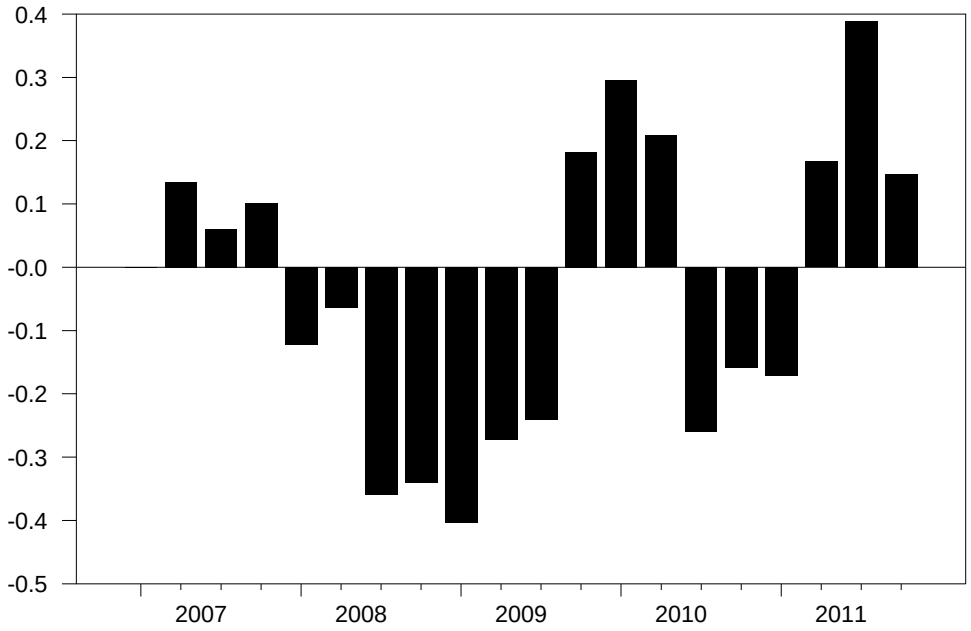


Figure 39: Macroprudential policy shocks in Singapore (BIS data, total credit)

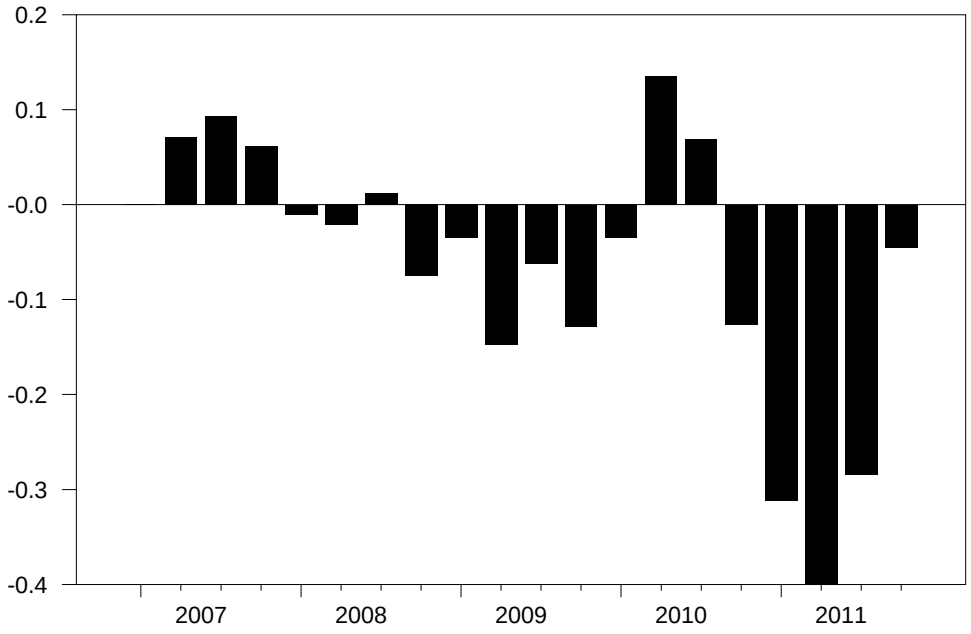


Figure 40: Macroprudential policy shocks in Singapore (BIS data, household credit)

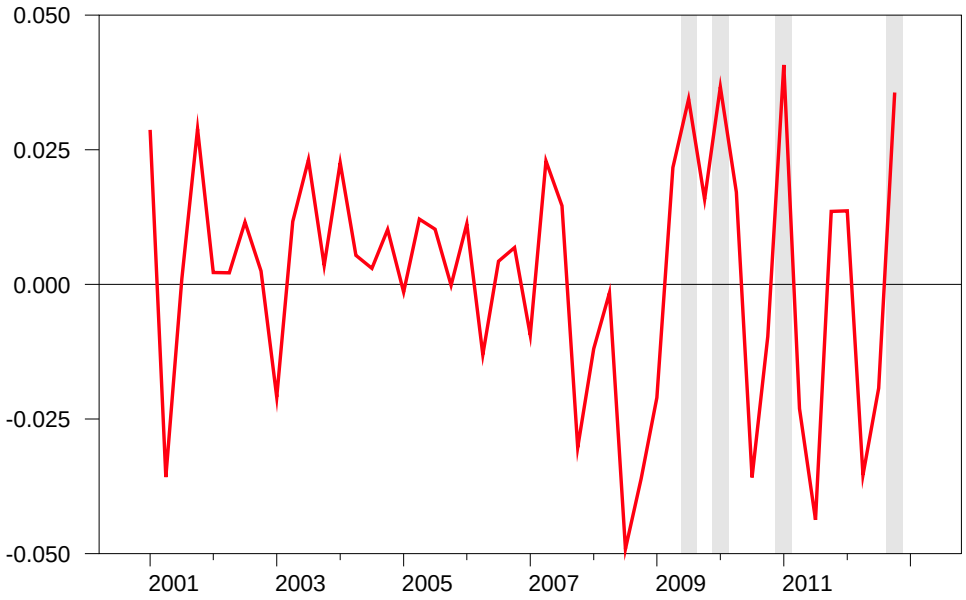


Figure 41: Latent propensity to macroprudential tightening in Singapore (IMF data, total credit)

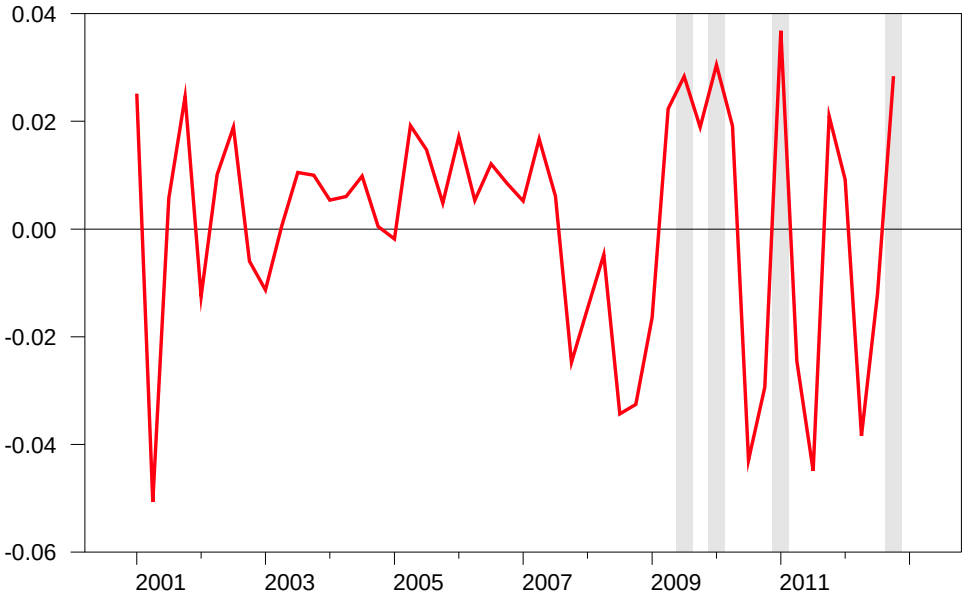


Figure 42: Latent propensity to macroprudential tightening in Singapore (IMF data, household credit)

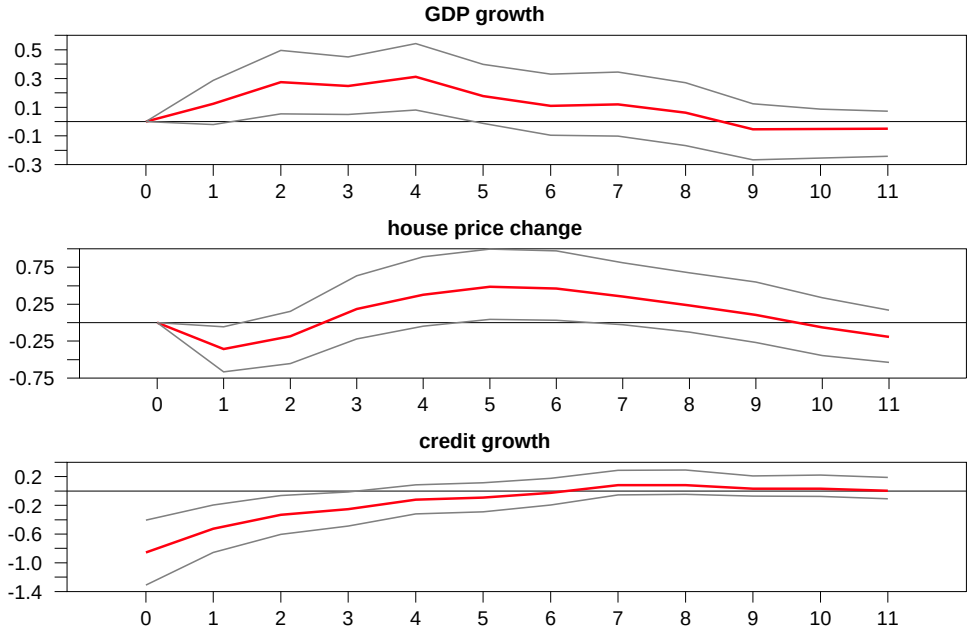


Figure 43: Macroprudential policy shock in Singapore (IMF data, total credit)

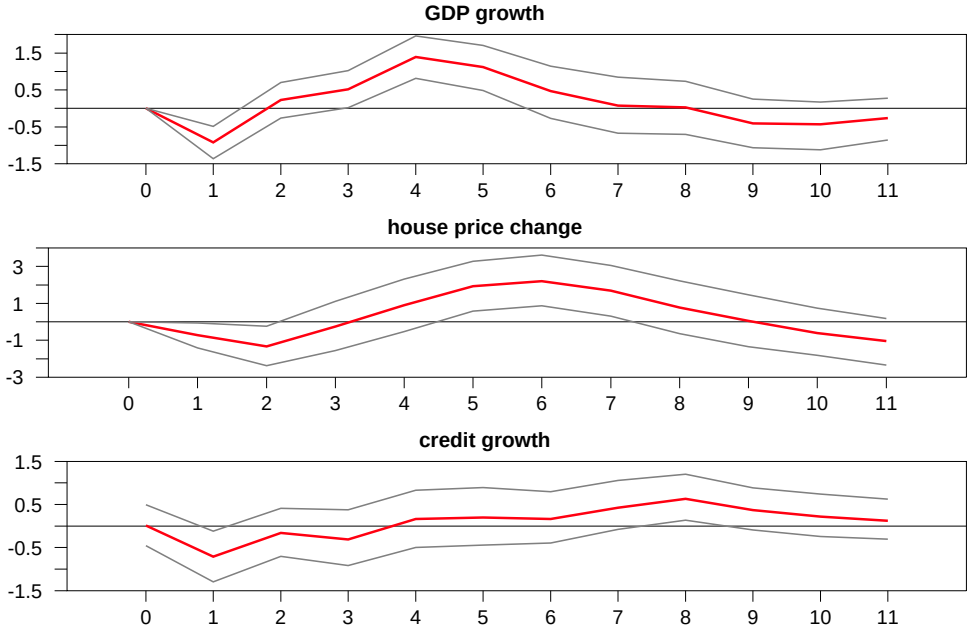


Figure 44: Monetary policy shock in Singapore (IMF data, total credit)


Figure 45: Macroprudential policy shock in Singapore (IMF data, household credit)


Figure 46: Monetary policy shock in Singapore (IMF data, household credit)

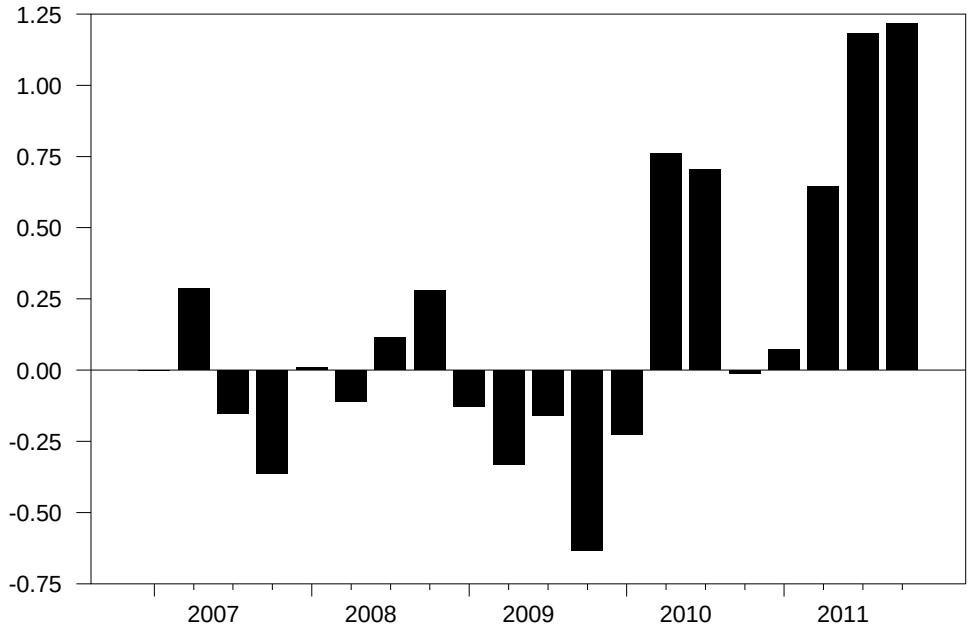


Figure 47: Macroprudential policy shocks in Singapore (IMF data, total credit)

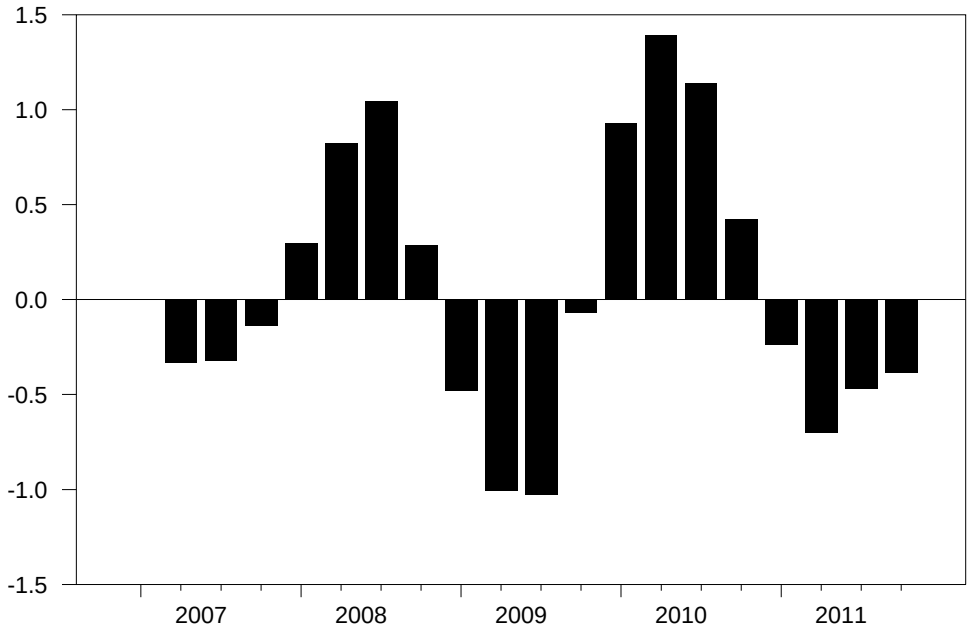


Figure 48: Macroprudential policy shocks in Singapore (IMF data, household credit)