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*Qianying Chen, Andrew Filardo, Dong He and Feng Zhu*

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# Financial Crisis, Unconventional Monetary Policy and International Spillovers*

**Qianying Chen**
International Monetary Fund

**Andrew Filardo**
Bank for International Settlements

**Dong He**
Hong Kong Monetary Authority
Hong Kong Institute for Monetary Research

**Feng Zhu**
Bank for International Settlements

September 2014

## Abstract

This paper studies the effects of unconventional monetary policies in the major advanced economies. We first examine the cross-border financial market impact of central bank announcements of asset purchase programmes based on event studies. We find marked effects, as expansionary balance sheet policies influence the prices of a broad range of emerging market assets, raising equity prices, lowering government and corporate bond yields and compressing CDS spreads.

We then study the economic impact of US quantitative easing on both emerging and advanced economies, based on an estimated global vector error-correcting macroeconomic (VECM) model, which takes into account trade and financial linkages. We focus on the effects of reductions in US term and corporate spreads, and in US market volatility. The estimated effects are sizeable and differ across economies. First, US QE measures which help to lower market volatility and reduce corporate spreads appear to have had far greater impact than lowering term spreads, as Blinder (2012) suggested.

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Qianying Chen, International Monetary Fund (IMF), qchen2@imf.org; Andrew Filardo, Bank for International Settlements (BIS), andrew.filardo@bis.org; Dong He, Hong Kong Monetary Authority (HKMA) and Hong Kong Institute for Monetary Research, dhe@hkma.gov.hk; Feng Zhu, BIS, feng.zhu@bis.org.

Second, such measures have prevented a prolonged recession and severe deflation in the advanced economies. Third, the impact on emerging economies has varied but is generally stronger than in the US and other advanced economies. US QE measures contributed to overheating in Brazil, China and other emerging economies in 2010 and 2011, but supported recovery in 2009 and 2012. The sign and size of QE effects differ across economies, implying that their costs and benefits are unevenly distributed.

Keywords: Announcement Effects, Emerging Economies, Financial Markets, Global VECM, International Spillovers, Quantitative Easing, Unconventional Monetary Policy

JEL Classifications: E43, E44, E52, E65, F42, F47

# 1. Introduction

The 2007-2009 US subprime mortgage crisis, the recent euro area sovereign debt crisis and the Great Recession have had a major impact on the design and implementation of monetary policy. Following the crises, central banks in the major advanced economies lowered policy rates rapidly to near zero, and the scope for further monetary easing through policy rate cuts became very limited. Notably, several central banks have taken measures which are considered "unconventional", departing from the standard procedure, which would react to changes in inflation and output by changing short-term interest rates. A natural question policymakers ask is whether such policies are effective, and if so, how effective they are and whether they bring benefits which outweigh possible costs and risks.

Pre-crisis research on the impact and effectiveness of central bank balance sheet policies is limited, as such policies rarely came into serious consideration. One exception was the research on the impact of Operation Twist implemented by the Kennedy Administration between 1961 and 1964, which relied on selling short-term but buying longer-term Treasury debt in order to modify the term structure of interest rates. Holland (1969) and Modigliani and Sutch (1966, 1967) show that the Operation had a relatively small impact on longer-term bond yields. This has been confirmed by event studies of Bernanke, Reinhart and Sack (2004), Swanson (2011) and Meaning and Zhu (2012). A second strand of literature focuses on the Bank of Japan's 2001–2006 quantitative easing (QE), and Ugai (2007) provides good survey of related empirical work.

The recent unconventional policy actions taken by central banks in a number of major economies have led to a burgeoning literature. Most work has focused on their domestic effects and analysed several channels of domestic transmission. This emphasis on the domestic impact can be justified on the grounds that a refined knowledge of the precise impact is essential in order to correctly calibrate changes in the size or composition of central bank balance sheet policies to achieve the desired effects on the economy. Much of the research has relied on event studies analysing the announcement effects of QE on asset markets, while a number of papers have employed regression analysis. Among others, D'Amico and King (2010), Doh (2010), Gagnon et al (2010, 2011), Joyce, Lasaosa, Stevens and Tong (2011), Krishnamurthy and Vissing-Jorgensen (2010, 2011) and Meaning and Zhu (2011, 2012) have provided estimates for the Federal Reserve and the Bank of England's large-scale asset purchase programmes.

Yet we know very little about the impact of central bank balance sheet policies on real activity. [1] On the one hand, monetary policy tends to have long and variable lags, and balance sheet policies may be no exception. Data availability is an issue as the sample following the implementation of

[1] Hofmann and Zhu (2013) study the effects on inflation expectations of Federal Reserve asset purchases and found these were well-anchored and such purchases had little impact. Gambacorta, Hofmann and Peersman (2012) estimate a panel VAR for eight advanced economies and find that an exogenous rise in central bank balance sheets at the ZLB leads to a temporary rise in output and prices, with the impact on output qualitatively similar to those of conventional monetary policy.

unconventional measures remains short, and their effects have yet to fully run their course. On the other hand, the usual monetary policy transmission channels may have been severely impaired following the recent global financial crisis and recession, and pre-crisis models could have simply become obsolete. Also unconventional policy can be transmitted in different ways from the traditional channels for interest rate policy in normal times.

There has been so far little research on the spillovers of central bank balance sheet policies, much less the impact on emerging markets. A better understanding of the international implications of QE measures helps policymakers in the emerging economies to better cope with the challenges implied by such policies. Relying on event studies on US asset purchases, Neely (2010) finds that besides reducing US Treasury yields by 100 basis points and corporate bond yields by 80 basis points, US QE lowered bond rates in the other advanced economies by 20–80 basis points and depreciated the US dollar by 4–11 percentage points. He suggests that portfolio rebalancing yielded greater effects than signalling. Glick and Leduc (2011) show that commodity prices on average fell on the days of US announcements of asset purchases, despite a decline in long-term interest rates and US dollar depreciation.

Fratzscher, Duca and Straub (2013) find that earlier US QE measures were highly effective in lowering sovereign yields and raising equity prices. But since 2010 such measures have had a muted impact on yields across countries. Chen, Filardo, He and Zhu (2014) apply shadow federal funds rates in a global VAR model to assess the domestic and global impact of US unconventional monetary policy. They find that US QE might have prevented two US recessions and also had substantial global spillovers. A review of recent work can be found in IMF (2013a, b).

There are two dominant views on the likely cross-border effects. The first view, typically held by economies which have implemented such policies, sees no major externalities. If anything, stronger domestic growth spurred by QE should promote a more stable global macro and financial environment and increase demand for exports from other economies. On the other hand, many emerging economies hold the view that such policies could depreciate domestic currencies and significantly inflate risk-adjusted interest rate differentials vis-à-vis other economies, leading to potentially large capital inflows, credit growth, and consumer and asset price inflation pressures in these economies.

Nevertheless, the cross-border effects of QE may be perceived as beneficial or harmful depending on the cyclical positions of the economies involved. Initially, QE may have contributed to alleviating acute global funding difficulties and stabilising credit markets at a time of raging financial crisis and severe global recession. But at a later stage when emerging economies returned to solid growth, further QE actions might have raised currency appreciation pressures and encouraged speculative capital inflows there, contributing to overheating and asset market excesses.

This paper first examines the immediate cross-border financial market impact of unconventional monetary policies in a more systematic way. We find that various QE programmes have generally led to easier financial conditions domestically and abroad, and to significant spillovers with higher asset prices in the emerging economies. Then we study the real effects of QE, both domestic and international, estimating a global VAR model. The longer-run cross-border spillovers differ across economies. We find that reducing US corporate spreads and market volatility, and to a less extent, US term spreads, has had sizeable effects on financial conditions and economic activity both domestically and globally. Counterfactual analyses indicate that US QE, especially LSAP1, has prevented US and other advanced economies from staying mired in the Great Recession and severe deflation.

The effects on emerging economies are generally stronger and more diverse than in the advanced economies, and in some cases greater that US domestic effects. The strength of the effects partly depend on how each economy reacted and adjusted to US policy shock, and partly on the existing economic and financial structure, policy framework, and exchange rate arrangements. US QE measures contributed to overheating in Brazil, China and other emerging economies in 2010 and 2011, and by reducing US corporate spreads, they supported recovery in these economies in 2009 and 2012. We find that the sign and size of the QE effects differs across economies, implying that the costs and benefits of US QE policies have been unevenly distributed between the advanced and emerging economies.

The paper is organised as follows. Section 2 describes unconventional monetary policy measures, namely the asset purchase programmes which have been implemented by central banks, and various cross-border channels of transmission. Section 3 presents empirical results of event studies on the cross-border impact of QE in the advanced economies, and provides impulse responses to a US QE shock estimated from a global VECM model. The domestic and cross-border effects of US asset purchases on output, inflation, credit, equity prices, and exchange rates are assessed based on counterfactual analyses. Section 4 concludes.

# 2. Unconventional Monetary Policy

Bernanke and Reinhart (2004) suggest three policy alternatives when central banks face the zero lower bound on nominal interest rates: first, shape public expectations about the future path of the policy rate; second, implement quantitative easing, i.e., increase the size of the central bank's balance sheet beyond the level needed to maintain a zero policy rate; third, change the composition of the central bank's balance sheet in order to affect the relative supply of securities held by the public.[2]

Central bank balance sheets change often as a passive response to policy actions such as open market operations. The active management of the size and composition of central bank balance sheets as the main policy instrument has been much less common (eg US Operation Twist in the

[2] See also Bernanke, Reinhart and Sack (2004).

early 1960s). The recent balance sheet measures have been associated with policy rates constrained at the zero lower bound (ZLB). One example was Japan, which, after a decade of anaemic growth and persistent deflation, implemented a QE programme from March 2001 to March 2006, expanding its balance sheet on the liability side by setting targets for current account balances held by financial institutions with the Bank. Eventually the Bank purchased almost JPY 30 trillion of Japanese government bonds (JGB).

Following the recent global crisis and prolonged economic weakness, several central banks implemented balance sheet policy measures. Besides the Bank of Japan, which already had a sizeable balance sheet at the onset of the global crisis, the balance sheets of the Federal Reserve, European Central Bank and Bank of England have expanded significantly since the second half of 2008. The various large-scale asset purchase programmes have not only changed the size of their balance sheets but also their composition.[3]

The use of balance sheet policies by the US Federal Reserve has evolved over time. In the first stage, many segments of US capital markets were dysfunctional as the global financial crisis raged. The Federal Reserve introduced the Term Auction Facility, the Term Securities Lending Facility and the Primary Dealer Credit Facility to support the market segments with severe liquidity shortages.[4] The second stage was marked by a sharp expansion of the Federal Reserve's balance sheet through its first large-scale asset purchase (LSAP) programme, announced in November 2008, extended in 2009 and completed in March 2010. The aim was to "support the functioning of credit markets through the purchase of longer-term securities". The announced total amount of asset purchases ($1.7 trillion) represented 22% of the combined outstanding Treasuries, long-term Agency debt, and fixed-rate agency mortgage-backed securities (MBS), worth around $7.7 trillion at the beginning of the operation. In November 2010, as recovery faltered, LSAP2 was launched to purchase an additional $600 billion in longer-term Treasury securities by mid-2011.

In late 2011, the Federal Reserve entered a new stage announcing a maturity extension programme (MEP), under which it would buy longer-term Treasury securities for $400 billion by the end of June 2012, financed with the proceeds from selling shorter-term securities. The programme was extended to the end of 2012. The MEP or "Operation Twist" aimed to extend the average maturity of the Federal Reserve's Treasury securities portfolio from five to roughly eight years, involving changes only in the composition of its balance sheet. To support recovery and help ensure price stability, in September 2012, the Federal Reserve announced LSAP3 which included additional open-ended purchases of agency MBS at $40 billion per month. In December, upon the completion of the MEP, the Federal Reserve decided to continue to buy longer-term Treasury securities at $45 billion per month. In late

[3] The asset-side approach became known as "credit easing", with the objectives of easing domestic financial conditions, restoring credit flows and repairing impaired monetary transmission. For ease of exposition, we use the terminologies "credit easing", "quantitative easing", "central bank balance sheet policy", "unconventional monetary policy" and "asset purchase programmes" interchangeably wherever the circumstances are clear.

[4] See Campbell et al (2011) and Wu (2010, 2011) for assessment of the effectiveness of the US Federal Reserve term facilities.

April 2013, the Federal Reserve started to discuss the tapering of asset purchases, which led to expectations of a deceleration of purchases as early as the third quarter of 2013.Beginning in January 2014, it successively moderated the pace of purchases of agency MBS and longer-term Treasury securities.

The Bank of England (BOE) established its Asset Purchase Facility (APF1) in January 2009 to "buy high-quality assets financed by the issuance of Treasury Bills", the aim being to "improve liquidity in credit markets". The announced GBP 200 billion in asset purchases was concentrated in gilts (GBP 198 billion). Buyable assets included UK gilts and "high-quality" private sector assets, including commercial paper and corporate bonds. In October 2011, the BOE initiated another round of asset purchases that culminated in a total asset purchase size (both APF1 and APF2) of GBP 375 by July 2012. In addition, the BOE launched its funding for lending scheme in July 2012, with the goal to incentivise banks and building societies to boost their lending; in April 2013, the scheme was extended until 2015 and became more focused on lending to small and medium-sized institutions.

The Bank of Japan's (BOJ) Asset Purchase Program (QE2), announced in October 2010 as part of its Comprehensive Monetary Easing (CME), was designed to encourage "a decline in longer-term market interest rates and a reduction in various risk premiums to further enhance monetary easing". Through the programme, "the Bank purchases various financial assets and conducts fixed-rate funds-supplying operations against pooled collateral". In late 2011, the BOJ increased its asset purchases by JPY 25 trillion, to a target of JPY 40 trillion. It also introduced a Growth Supporting Funding Facility (GSFF) in 2010, raising it to JPY 5.5 trillion in March 2012. In April 2013, the BOJ initiated the Quantitative and Qualitative Monetary Easing (QQME) programme which aimed at doubling the size of its monetary base and the average maturity of its government bond purchases.

The European Central Bank (ECB) announced its covered bond purchase programme (CBPP) in May 2009, which was implemented between July 2009 and June 2010 for a nominal value of EUR 60 billion. It was intended to support "a specific financial market segment that is important for the funding of banks and that had been particularly affected by the financial crisis". A total of 422 different bonds, mainly with maturities of three to seven years, were bought, with 73% in the secondary market. Despite its relatively small size, empirical evidence suggests that CBPP helped lower banks' financing costs, stimulating a revival of the covered bond market and dampening euro area covered bonds by about 12 basis points.[5]

From May 2010 to June 2012, the ECB made bond purchases of over EUR 200 billion via its Securities Markets Programme (SMP) to address the malfunctioning of securities markets and restore monetary transmission. In September 2012, the ECB terminated the SMP and announced details of an Outright Monetary Transactions (OMT) programme, which has yet to be activated, to address euro area redenomination risks and to repair monetary transmission. Focusing on purchases of

[5] Cour-Thimann and Winkler (2013) provide an interesting account of the ECB's non-standard measures and compare these to actions of other central banks, stressing the usefulness of the flow-of-funds perspective on QE policies.

government bonds with maturities of one to three years, the OMT had no ex-ante time or size limit. Like the SMP, the OMT purchases would be fully sterilised. In addition, the ECB carried out Long-Term Refinancing Operations (LTRO), offering three-year LTROs in December 2011 and February 2012 in order to support bank lending and counteract risks of a disorderly deleveraging process.

In sum, the role, objectives, instruments and corresponding operating procedures of central banks' balance sheet policies have differed over time and across economies, as these economies have gone through different phases of the financial and economic cycle. Initially, such policies focused on providing ample liquidity to stabilise financial markets and shore up confidence, e.g. with various term facilities set up by the Federal Reserve, and also currency swaps. As the crisis subsided, balance sheet policies placed a greater emphasis on lowering borrowing costs and easing credit conditions for the private sector, so as to promote growth and employment. Such policies have taken the form of liquidity support, large-scale asset purchases, commitment to very low interest rates for an extended period of time, or even foreign exchange market interventions.

Given the elevated degree of financial integration and trade openness, economies have become highly interdependent. Even though central bank balance sheet policies may have been designed primarily to tackle domestic economic issues, they are bound to have wider cross-border effects. Indeed, as economic recovery gained traction or lost momentum in the emerging economies, such spillovers became a major concern, eg during the Federal Reserve's LSAP2 implementation and then its discussions of tapering during 2013. The paper focuses on whether quantitative easing in the advanced economies, through its immediate impact on financial stability, have had a significant impact on the emerging economies.

### 2.1 Cross-Border Transmission of Unconventional Monetary Policy

In a global economy, leakage from domestic monetary policy is unavoidable, and the size of such leakage may differ across countries depending on the strength of the cross-border transmission channels. There are a number of cross-border transmission channels through which unconventional policy may operate. The first is the portfolio rebalancing channel. US Treasury securities play a special role in the global economy, as the US dollar is the main reserve currency and no other sovereign or private debt instruments are seen as perfect substitutes. If US asset purchases lower US long-term bond yields, investors could turn to emerging market assets of similar maturities for higher risk-adjusted returns. This boosts asset prices, lowers interest rates and eases financial conditions in the emerging economies.

A second channel operates through global financial markets and is a combination of liquidity, asset price and risk-taking channels. With a well-integrated global market, a sizeable quantitative easing in a major economy boosts global liquidity. When interest rates are expected to stay very low in the foreseeable future in the major advanced economies, large interest rate differentials are expected to persist, relative to the emerging economies with supposedly sounder macro fundamentals and more

solid growth prospects. Quantitative easing could spur carry trades and capital flows into emerging economies with higher risk-adjusted rates of return, which in turn would push up consumer and asset prices. In addition, persistently low interest rates and abundant liquidity would create incentives for financial institutions in both advanced and emerging economies to search for yields, taking on greater risk for contractual or institutional reasons.[6] An extended period of suppressed interest rates could lead banks to miscalculate risks.

While these channels are similar in nature to domestic channels, others are distinctly international. Through a third exchange rate channel, QE may depreciate the domestic currency vis-à-vis other currencies, and the impact on emerging economies can be particularly large if the depreciation is to a major international reserve currency. Currency speculation can play a role by increasing the size and volatility of capital flows. An extended period of extraordinary monetary easing by the Federal Reserve could put persistent appreciation pressure on emerging market currencies. In some emerging economies where currencies are pegged to the USD, currency interventions may lead to large foreign reserve accumulation, which, if not fully sterilised, could increase domestic money and credit.

Fourth, real effects of quantitative easing in the advanced economies could spread directly through an external demand or trade channel. QE can boost demand for emerging economy goods and services through easier trade credit and increased spending in the advanced economies. But such effects depend on the degree of import elasticity in the advanced economies, and must be balanced against the likely impact of an appreciation of emerging market currencies caused by the QE.

Fifth, QE may solicit endogenous monetary policy responses in the other economies. For instance, many central banks in the emerging economies have kept their monetary conditions accommodative despite recovery, rising inflation and asset prices. This may have in part reflected fears that widening interest rate differentials would drive up exchange rates and create disruptive capital inflows.

# 3. Effects of Unconventional Monetary Policy

Have unconventional monetary policies in the advanced economies brought significant international spillovers? If so, have such effects been beneficial or detrimental? There are two conventional views. The first view considers that such policies are designed for domestic contingencies and should be evaluated on the basis of their domestic impact alone. Any spillovers beyond borders are unintended and should be primarily an issue for other policymakers to address. The second view sees a major cross-border impact of such policies that may lead to unbalanced global outturns. As these policies are being conducted by the major advanced economies, and given the dominant role of advanced-economy currencies and their financial markets in the global economy, big shifts in monetary accommodation are bound to significantly impact emerging economies.

[6] See Borio and Zhu (2008) and Gambacorta (2009) for further details.

Moreover, the range of central bank balance sheet policies in the advanced economies could have a rather different impact across emerging economies and over time, depending on the state of economic and financial conditions. During the global financial crisis and the ensuing recession, these balance sheet policies helped to stabilise global financial markets, support trade credit and prevent a collapse of demand and real activity in both the advanced and emerging economies. In a second phase, as the recovery gathered pace in the emerging economies but languished in major advanced economies, growth prospects have since diverged. Large interest rate differentials and cheap and abundant liquidity has led to volatile, partly speculative, capital flows into emerging economies.[7]

We study the cross-border spillovers of unconventional monetary policies in the advanced economies in two steps. First, we study the more immediate impact of these policies on global financial markets based on event studies. The methodology can be justified as financial market responses tend to be swift in a highly integrated global market. However, monetary policy has long and variable lags in affecting real activity, and QE is no exception. Therefore, in the second step, we assess the longer-term impact using a formal econometric model in order to capture relevant cross-country macro-financial linkages.

### 3.1 Cross-Border Announcement Effects of Quantitative Easing

This section examines the global financial market responses to significant announcements of QE programmes by the US Federal Reserve, the Bank of England, the Bank of Japan and the European Central Bank. We find significant but varied spillover effects of monetary policy announcements on a wide range of emerging financial markets. On average, US LSAP1 had a much larger cumulative effect than LSAP2. By comparison, Japan's quantitative easing programme earlier in the decade had a somewhat greater impact on the region than US LSAP2 did.

We measure financial market responses to significant announcements about QE programmes, extending the event study methodology used in Gagnon et al (2010, 2011) and Meaning and Zhu (2011) to focus on the international impact. One important finding of their research is that US and UK QE announcements compressed the term spreads of Treasury securities, and the 10-year Treasury yields fell much more than the two-year Treasury yields around the announcement dates. With the very short end of the term structure pinned down by the zero lower bound, the yield curve pivoted down. Other US fixed income securities were also affected.

#### 3.1.1 Effects of Earlier QE Measures on Emerging Asia

We focus on the relevant announcement dates associated with LSAP1 and LSAP2, making adjustments according to the opening and closing times of regional financial markets. Then, we estimate the average cumulative 2-day changes in a number of major financial indicators across the

[7] See BIS (2012) and De Nicolò et al (2010).

global financial market. These include the 2- and 10-year sovereign bond yields, corporate bond yields, sovereign CDS spreads and the US dollar exchange rate. Table 3.1 reports our findings.

The cumulative impact of US QE lowered emerging Asian bond yields, boosted equity prices and exerted upward pressures on bilateral exchange rates against the USD. During LSAP1, 2-year yields fell on average across emerging Asia by about 15 basis points, and 10-year yields declined by 85 basis points, implying a downward twist at longer maturities. During LSAP2, 2- and 10-year yields edged down, and there was a smaller shift and twist of the yield curve. Yields on corporate bonds fell significantly, indicating that the programmes impacted risk premia in Asia.

In terms of perceived sovereign credit risk, US LSAP1 announcements significantly reduced emerging Asian sovereign CDS spreads, especially when compared to responses during LSAP2. One explanation for the bigger impact could be the surprise element carried by LSAP1 announcements. The LSAP1 can be seen as a credible Federal Reserve commitment backed up with a demonstrated readiness to act. As a follow up to this commitment, the surprise element was largely lost with the LSAP2, when the market developed a better understanding of asset purchases over time.

These differences may reflect disparate economic conditions at the time. Asian economies were in a much more precarious state at the time of LSAP1 than during LSAP2. In the immediate aftermath of the Lehman bankruptcy, the financial meltdown in the advanced economies spread rapidly to emerging Asia, quickly casting a pall on the economy.[8] In this context, LSAP1 played an important role in countering the forces behind an emerging self-reinforcing macro-financial downward spiral. At the time of LSAP2, however, emerging Asia had by and large been experiencing a strong recovery. Unsurprisingly, LSAP2 impact on credit default spreads was more muted.[9]

Other asset markets have been equally affected by QE announcements. Equity prices rallied during LSAP1, and Asian currencies experienced some appreciation. The extent of the actual appreciation has to be interpreted carefully. Some of the exchange rate pressure in Asia was addressed by foreign exchange intervention to resist appreciation, especially during the LSAP2 period. Notwithstanding initial concerns in the region regarding disruptive currency appreciation pressures, significant currency appreciation did not materialise following LSAP2 announcements.[10]

The effects of central bank asset purchase programmes can be better understood in terms of their per-dollar impact (Table 3.2). The cumulative effects corresponding to $1 billion (x 100) asset purchases confirm that, for long-term yields, LSAP2 announcements had a smaller per-dollar impact than those during LSAP1. Early on in the two programmes, LSAP1 had a bigger per-dollar impact on

[8] The chronology of the international financial crisis in Asia can be found in Filardo (2011).

[9] We focus on the impact of changes in the size of a central bank's balance sheet, rather than the impact that might be due to changes in the asset composition.

[10] The impact on commodity prices (not reported) remains a puzzle and hard to reconcile with the equity price movements. More research is needed.

bond yields and equity returns than LSAP2. When comparing the entire period, the effects were not too dissimilar.

It is illustrative to compare the impact of the Federal Reserve's QE programmes on emerging Asian financial markets with those of the Bank of Japan. The results indicate that announcements of Japan's 2001–2006 QE generally had greater total and per-dollar effects. This is consistent with the understanding that the Bank's QE was important in preventing the economy from falling deep into a self-reinforcing deflationary cycle.[11]

Event studies are subject to a number of limitations and some caveats need to be heeded. First, however refined the event windows are, one would inevitably include effects from other potentially important economic or policy news releases around the announcement dates. Although one- or two-day windows may not completely eliminate the contamination risk, they do help, and the windows are long enough to account for reactions from geographically dispersed financial markets to announcements of a set of very unfamiliar tools. In fact, the results using 1-day or 2-day event windows are consistent and largely similar.

Second, to the extent that some of the impact of QE programmes occurs outside the windows around the identified announcement dates, and as QE policies could have non-negligible lags, our study may actually underestimate their effects. Inevitably and certainly, we missed some less dramatic announcements. Also markets may have learned to better anticipate policy announcements and move accordingly well in advance.

Third, the event study methodology does not consider co-movements in different financial markets and therefore cannot properly account for contagion that may run across non-source markets. Despite these caveats, the results of the event study clearly suggest that the Federal Reserve's QE programmes had important cross-border spillover effects on emerging Asia.

### 3.1.2 Effects of Recent QE Measures on Regions

The implementation of unconventional monetary policies in recent years has reinforced the idea that they have a significant cross-border impact. This underscores the fact that globalisation is altering the policy trade-offs faced by central banks around the world.

On completion of LSAP2, US Federal Reserve launched MEP in late 2011 and then LSAP3 in September 2012. Subsequently, the Federal Reserve started to discuss the tapering of its asset purchases in late April 2013, which caused significant market reactions. Figure 3.1.1 presents the spillover effects of these recent policy changes alongside the earlier programmes.

[11] For example, see Ugai (2007).

In emerging Asia and Latin America, LSAP3 impacts are to a first approximation similar to the impact of LSAP2, in terms of direction and size. LSAP3 had a modest negative impact on yields. The LSAP3 impact on equity prices was positive in emerging Asia but smaller than that of LSAP2.

One "puzzle" relates to the impact of MEP (see Figure 3.1.1). While it loosened US policy, the spillover effects in emerging Asia, Latin America and other advanced economies look similar to the tightening impact of the earlier tapering episode. Equity prices fell in the other advanced economies upon MEP announcements, and currencies depreciated against US dollar. In the emerging economies, the impact of MEP on sovereign yields was very small but the tightening effects on corporate bond yields and equity prices were sizeable. The MEP, unlike LSAP programmes, involved no change in the overall size of the Federal Reserve's asset holdings. While a moderation in the pace of balance sheet expansion implied by tapering may be interpreted as a tightening, MEP without any size change could be perceived by markets as "contractionary" compared to outright asset purchases expanding asset holdings.

In the case of the Bank of England, its APF2 programme has had an impact similar to other expansionary central bank balance sheet policies on emerging Asia and Latin America with yields down and equities prices up (Figure 3.1.2). The FLS programme also has an impact in the same direction as APF2 but it is smaller in size, especially considering the small size of FLS. The Bank of Japan's QQME has had a sizeable increase on emerging Asia and Latin America (Figure 3.1.3), in contrast to the pattern seen in the United States (the more recent LSAPs programmes having had a smaller impact that LSAP1). With respect to the exchange rate impact, the Bank of Japan's QQME has led to a similarly sized depreciation of the yen exchange rate compared to the Bank of Japan's QE2; in the other advanced economies, the depreciation was much larger for this programme than for the previous programmes covered in the figure. The impact on yields was small in emerging Asia; in Latin America government and corporate yields fell.

The ECB's unconventional monetary policy programmes have differed considerably from those of the other major central banks (Figure 3.1.4). The LTRO and OMT programmes were designed partly to address impediments in euro area monetary transmission, their announcements had non-negligible spillovers. The effect of OMT is interesting as the programme has yet to be actually used, this suggests that signalling could be important. It has led to lower corporate yields in emerging Asia and Latin America and an increase in equity prices. The euro appreciated at the time of the announcements, as confidence was bolstered against a scenario of euro breakup.[12]

### 3.1.3 Effects of QE Measures on Individual Emerging Economies

Averaging QE effects across regions can mask important differences in the economy-specific impacts. In the section, we examine the impact on emerging Asian and Latin American economies of US LSAP1,

[12] We have also examined the announcement effects of CBPP1, CBPP2, SMP, and different stages of LTROs separately, the message turns out to be similar to what we present in Figure 3.1.4.

LSAP2, MEP and LSAP3 programmes, and of Japan's recent QQEP, owing to the size of these QE programmes and the strength of likely transmission to emerging economies. The results reveal a rather diverse set of QE effects.

Figures 3.1.5 - 3.1.8 report the cross-economy cumulative 2-day changes in various asset prices by economy. The programmes have had a differential impact across economies in Asia but a more similar impact on Latin America economies. It is clear that the Asian economies most affected – both on the high side and the low side – differ across the US QE programmes. In other words, LSAPs and MEP did not affect the region in a uniform way. Some economies that responded strongly in LSAP1 were not the ones that responded strongly in LSAP2 or LSAP3. This strongly suggests that the spillovers are context dependent – both in terms of the state of the recoveries and the policy actions that were taken (or were expected to be taken) in response to the news about US monetary policy.

The general pattern of the impact reveals that MEP affected the regions in a very different way from the LSAPs. This suggests that expanding the size of central bank balance sheets can have different cross-border spillovers than policies that simply alter the composition of the balance sheet, even if both sets of policies are largely stimulatory in the home country.

To further understand these disparate patterns, we examine the cross-sectional impact of each programme with a focus on emerging Asia. For US LSAP1, Hong Kong SAR and Indonesia were most positively affected in terms of yields and equity returns (Figure 3.1.5); the latter saw big moves in CDS spreads and USD exchange rates. The general picture from these data reflects the fact that these economies were heavily hit by the initial phase of the global financial crisis. For Hong Kong SAR and Korea, the impact reflects strong trade ties and the importance of cross-border financing with the United States. In the case of Indonesia, the credit rating and general vulnerabilities to the global economy via commodity exports appear to account for the sensitivity. The Philippines and Singapore, on the other hand, were much less affected than the rest of emerging Asia, at least in terms of financial market reactions to announcements during the LSAP1 period.

For US LSAP2 announcements, the results are rather mixed (Figure 3.1.6). Sovereign CDS spreads declined in almost all the emerging economies under analysis, while Hong Kong SAR saw its yields drop much more than the others. Equity markets in China, Hong Kong SAR, India and Thailand experienced a significant rally. One factor behind this might be the pace of foreign reserve accumulation which was rapid in some economies. Markets may have interpreted further LSAP as an indication that domestic policy rates would stay low. In contrast, the economies that found themselves in the bottom of the ordering were diverse.

For the MEP programme, the cross-sectional evidence reveals a diverse set of responses (Figure 3.1.7). Overall, the MEP spillover is associated with a tightening of financial conditions in emerging markets. Corporate yields and CDS spreads rose considerably in the Philippines, China and Indonesia; in Latin America, the CDS and exchange rate responses were larger. The negative impact

on equity prices in Latin America was smaller than the average for Asia and with a much smaller dispersion. The details support the view that size changes of central bank balance sheets lead to different spillovers from policies that alter the composition of balance sheets.

For LSAP3, emerging Asia had a similar pattern regarding the impact (Figure 3.1.8). Across the board, corporate yields and CDS spreads declined and stock markets rose on the news. The appreciation of local currencies was small but nearly all in a positive direction. The impact on short and long sovereign yields was mixed in both emerging Asia and Latin America.

It is still too early to draw conclusions about the spillover effects of the tapering, a process that started in late April in 2013 but could last for some time. But the early evidence suggests that cross-border spillovers are substantial. This illustrates the challenging policy environment that emerging economies face as QE policies in the advanced economies are exited.

Overall, the event study provides clear evidence of spillovers from unconventional monetary policies in the advanced economies to emerging economies, despite possible diminishing returns with decreasing effects of announcements for successive programmes.[13] It is hard to pin down the exact transmission channels with the event study methodology, but the results suggest various cross-border channels could be at work. There also seems to be evidence that merely changing the composition of a central bank's balance sheet can have a very different impact from measures that also involve a size expansion in the balance sheet. In addition, the signalling channel may be strong, with spillovers present even when the expected balance sheet changes occur at some unspecified time in the future (ie OMT and tapering).

### 3.2 Global VECM Model Analysis: Impulse Responses

To assess the longer-term effects of US unconventional policies on both real and financial activities, domestic and foreign, we estimate a global vector error-correction macroeconomic (GVECM) model, developed by Pesaran, Schuermann and Weiner (2004), in two steps. First, we estimate country-specific vector error-correcting models, where domestic variables are related to foreign variables. Then, we combine the country models to generate impulse responses for all variables in the GVECM model simultaneously.

The model is structured as follows.[14] For each economy we include six domestic endogenous variables: real GDP growth, CPI inflation rate, a monetary policy indicator, credit growth, equity price inflation and a foreign exchange pressure index. We then bring in a reduced set of exogenous variables which include, eg foreign real GDP growth and the CBOE Volatility Index (VIX). For any economy, the foreign variables are constructed as weighted averages of the corresponding variables

[13] See Meaning and Zhu (2011) and Goodhart and Ashworth (2013).

[14] We provide technical details on the structure of the GVECM in Appendix 5.1.

in all other economies. The country-specific foreign variables are treated as weakly exogenous when $N$ is sufficiently large and the idiosyncratic shocks are weakly correlated; with the exception of the US economy, where these are treated as endogenous.

Following the crisis, the Federal Reserve rapidly cut the federal funds rate to near zero and implemented a range of unconventional measures. These included liquidity support and credit facilities, large-scale asset purchases and forward guidance. We focus on three variables as monetary policy "indicators" which ideally would reflect such measures: 1) US term spread between 10-year and 3-month Treasury yields; 2) BofA Merrill Lynch US corporate spread (BBB minus AAA bond yields); and 3) CBOE Volatility Index (VIX), a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Kapetanios et al (2012) and Pesaran and Smith (2012) evaluate the effects of UK QE approximating it with a 100-basis-point reduction in UK term spreads or in the medium to long-term government bond yields. We consider US corporate spreads and VIX as US QE also involved rescue and lending operations in the early stage and later on, large-scale purchases of private assets with, eg the Commercial Paper Funding Facility, agency MBS purchases and the Term Asset-Backed Securities Loan Facility.

Blinder (2012) suggests six unconventional policy options, among which are: the purchases of "long-term Treasuries", considered a "weak policy tool unless used in huge volume" as "US Treasury markets are the broadest, deepest, and most active fixed-income markets in the world"; and the purchases of "private securities", as with the "massive purchases of MBS, and before that, with its purchases of commercial paper in the fall of 2008". He further points out that "unlike purchasing Treasury securities, the goal of this sort of QE is not to flatten the yield curve but rather to shrink risk premiums between private-sector debt instruments and Treasuries".

Admittedly, the three variables reflect information beyond US monetary policy, as they are also standard barometers of financial sector health. But even in normal times, the term spread is considered a useful monetary policy indicator, as central banks act to shape public expectations of a specific interest rate path well into the future. At the ZLB, when the funds rate lost its information content, these variables reflect the immediate objectives (and impact) of US QE measures, namely, to stabilise financial markets, reduce longer-term Treasury yields, lower borrowing costs for corporates and households and restore credit flows.[15] While purchasing US Treasuries and agency debt would directly lower US long-term Treasury yields and via portfolio rebalancing reduce corporate bond yields, credit support and purchases of agency debt and agency mortgage-backed securities would help stabilise markets and reduce VIX.

[15] Blinder (2010) suggests central banks can use unconventional tools to "reduce interest rate spreads" such as "term premiums and/or risk premiums". This means the Federal Reserve can use open market operations to buy long-term Treasuries, or use QE to target "risk or liquidity spreads". Indeed "since private borrowing, lending, and spending decisions presumably depend on (risky) non-Treasury rates, reducing their spreads over (riskless) Treasuries reduces the interest rates that matter for actual transactions *even if riskless rates are unchanged*."

We also use term and corporate spreads for euro area, Japan and UK, as they have also faced the ZLB on interest rates and implemented non-standard measures. For all emerging economies, we describe monetary policy with growth rates in a broad monetary aggregate. This is because central banks in emerging economies tend to use a wider range of policy tools and a broad monetary aggregate may remain the best indicator for monetary policy.

We measure any stress on an economy's currency by computing an exchange rate pressure index as a weighted average of changes in the nominal effective exchange rates (NEER) and in foreign exchange reserves. The index is a variant of the index proposed by Eichengreen, Ross and Wyplosz (1995) and it takes into account different exchange rate regimes as well policy interventions by the respective governments.

Notably, besides trade linkages, we also use financial linkages, approximated using consolidated bank lending statistics from the Bank for International Settlements (BIS), to gauge the strength of time-varying interdependence across economies. The data are representative and of quarterly frequency, contrary to many existing capital flows data. We weight trade and financial linkages equally, as changing the relative weights seems to make little difference for model estimates.

In addition, we use a new set of BIS total credit to the non-financial private sector series.[16] The BIS series on average has a span of 45 years and is available for 40 advanced and emerging economies.[17] The database accounts for credit from all sources, not only that extended by domestic banks. There is a degree of international comparability and consistency across time, as uniform statistical criteria have been applied as much as possible. In terms of financial instruments, credit covers loans and debt securities.

To identify the shocks, we use the recursive Choleski scheme, with the following ordering of the endogenous variables: output growth, inflation, monetary policy, VIX index of market volatility, equity price inflation, credit growth, and foreign exchange pressure. The ordering is consistent with the existing VAR literature. We have tried a number of different orderings and the results are largely robust to these. We estimate two different GVECM models, one with term spreads as the monetary policy indicator for the US, the euro area, Japan and the UK, the other with corporate spreads instead, while VIX is included in both models. Correspondingly, we present two set of results, one for "monetary policy" shocks in terms of term spreads and VIX, and the other in terms of corporate spreads and VIX. The same method can be actually used to analyse unconventional measures carried out by central banks other than the Federal Reserve.

[16] The "private non-financial sector" includes non-financial corporations (both private- and public-owned), households and non-profit institutions serving households as defined in the System of National Accounts 2008.

[17] Details of the new BIS credit series can be found at: www.bis.org/statistics/credtopriv.htm. Also see Dembiermont et al (2013).

The GVECM model is estimated for two distinct sample periods: the pre-crisis period from February 1995 to June 2007, just before the outbreak of the US subprime mortgage crisis in July 2007; and the crisis period from July 2007 to February 2013. We analyse the impulse responses to a one-standard-deviation reduction in the US VIX index of implied market volatility and in US term and corporate spreads from several key real and financial variables in both advanced and emerging economies, paying attention to the relative strength of different channels of domestic and international transmission. We then assess the overall US QE impact on the global economy, and the impact of LSAP1, LSAP2 and MEP with counterfactual analyses comparing actual data to those projected on the assumption that these QE measure were absent.

### 3.2.1 Domestic Effects of US Term Spread, Corporate Spread and VIX Shocks

We present in Figure 3.2.1 two sets of estimated impulse responses to a negative one-standard-deviation US term spread shock of 14.6 basis points over 36 months, one for the pre-crisis sample (February 1995 to June 2007) and the other for the crisis sample (July 2007 to February 2013).

Notably, as in most cases with global VAR estimates, our confidence bands tend to be wide and many impulse response estimates for both the pre-crisis and crisis samples are statistically insignificant.[18] This is largely due to the fact that GVAR models are very large with too many parameters to estimate, while macro time series tend to be short, so there are insufficient degrees of freedom and model estimates do not have enough accuracy. Moreover, as one may expect, the crisis-sample confidence bands turn out to be generally much wider, reflecting smaller sample sizes for the period, as well as heightened economic and policy uncertainties. To improve accuracy, in estimating each country model we exclude those foreign variables considered less likely to affect and be affected by the country's economic activity. Unlike in the earlier literature (eg Pesaran et al 2004), we compute bootstrap confidence intervals with a large number (5000) of iterations, and we provide the 90% bootstrap error bands around the mean estimates of the impulse responses to a one-standard-error shock.

Several interesting points stand out. First, while pre-crisis responses to a negative term-spread shock were all insignificant except for equity prices in the first three months, US credit growth began to have a significantly positive response four months after the shock (Figure 3.2.1). In fact, a 146-basis-point stimulus would sustain credit growth almost 3 percentage points higher thereafter. Also the shock increased VIX in the crisis period and slowed equity price inflation in the pre-crisis period, with statistically significant effects in the first four months following the shock. This suggests that a decline in US term spreads may be perceived negatively by markets as a harbinger of less encouraging prospects and, as a consequence, markets agitate. Nevertheless, term spread changes typically had small and insignificant effects on the US domestic economy.

[18] Examples include Pesaran and Smith (2006) and Dees et al (2007), where the 90% bootstrap error bands around the mean estimates of generalised impulse responses are mostly large and include zero. To make estimates more significant, Chudik and Fratzscher (2011) use 50% bootstrap error bands instead.

Second, unlike in the pre-crisis period, actions which reduce the VIX level by 8.7% would directly have a significant and positive impact on output growth in the crisis period, suggesting financial stability matters for US growth (Figure 3.2.2). But while an expansionary VIX shock had a large and significant impact on CPI and equity price inflation in the pre-crisis period, the impact is small and insignificant in the crisis period, suggesting a possible change in the transmission mechanism. Stabilising financial market also had a significant positive impact on credit growth in the first couple of months in the crisis period, and from the second to sixth month in the pre-crisis period. Interestingly, while reducing VIX would depreciate the US dollar in the pre-crisis period, it seems to promote USD appreciation in the crisis period.

Third, estimates based on the corporate spread model suggest that actions to lowerUS corporate spreads have a strong positive impact in both the pre-crisis and crisis periods, but the impact becomes twice as large after the crisis, pointing to a useful role for QE policies (Figure 3.2.3). Indeed reducing US corporate spreads by 229 basis points would push US real GDP growth 3 to 4 percentage points higher. Lowering US corporate spread would also raise credit growth and CPI and equity price inflation, lower market volatility and depreciate the US dollar. Apparently, it may pay off more for the US Federal Reserve to act directly on reducing the costs of corporate borrowing rather than purchasing Treasury securities and indirectly driving down corporate borrowing costs.

On the other hand, impulse responses to a 10% reduction in the VIX level in the model with corporate spreads are qualitatively similar to those based on the term-spread model. Stabilising markets has a significant positive impact on CPI inflation, credit growth and also depreciates the US dollar in the pre-crisis period, but effects in the crisis period appear to be largely insignificant (Figure 3.2.4).

### 3.2.2 Spillovers of US Term Spread, Corporate Spread and VIX Shocks

This section investigates the impact of US QE efforts in stabilising financial markets and improving the economic prospects in the other major advanced economies, emerging Asia and Latin America. We focus on the crisis-period impulse responses to US term and corporate spread shocks for the euro area, Brazil and China (Figure 3.2.5-3.2.10). The impulse responses to a US VIX shock for these economies, and to all three US shocks in the other advanced and emerging economies are grouped in Appendices 5.5.1 and 5.5.2.

We first notice that while the impulse responses tend to be large in many cases, they remain largely insignificant due to estimation difficulties with large-scale Global VECM models. Second, in some cases there are substantial differences in pre-crisis and crisis period impulse responses to US term and corporate spread shocks in the economies under analysis, this implies a possible change in cross-border transmissions of US monetary and financial shocks. An alternative explanation can be that the crisis sample is still too small for us to obtain more accurate estimates that are comparable to the pre-crisis period estimates. Third, there are substantial cross-country differences in impulse responses to US shocks, notably in terms of monetary and exchange rate policy responses.

Figure 3.2.5 and 3.2.6 present results on the euro area impulse responses to a one-standard-deviation shock to US term (14.6 basis points) and corporate (22.9 basis points) spreads, respectively. We observe that a US term spread shock drives a significant decline in euro area term spreads in both the pre-crisis and crisis periods, and the effect is twice as big in the crisis period, reaching 13 basis points and staying above 10 basis points during most of the 3-year horizon. The almost one-to-one response shows a strong relationship between the US and euro area economies: when the US eases policy, apparently the euro area follows closely. On the other hand, a US term spread shock has a greater positive impact on CPI and equity price inflation in the crisis period but less impact on credit and output growth. Notably, the crisis-period euro appreciation provoked by a US term spread shock is much greater than in the pre-crisis period: a 146-basis-point drop in US term spread tends to push the euro up by almost 5 percentage points in 6 months and by 3 percentage points thereafter. Strong and sustained euro appreciation and weak credit growth may have reduced the likely large positive impact on euro area growth from US easing.

A negative US corporate spread shock also significantly reduces euro area corporate spreads in both the pre-crisis and crisis periods. It drives up euro area credit and output (significantly) growth by about 0.17 and 0.24 percentage points, respectively. Equity prices are up by over 2 percentage points in 3 months. US easing raises euro area inflation and it depreciates the euro by about 0.5 percentage point. Therefore reducing US term and corporate spreads may act in opposing directions on euro exchange rates.

We turn to Brazil and China, two major emerging economies from Latin American and Asia. Figure 3.2.7 and 3.2.8 show Brazil's impulse responses to a one-standard-deviation negative shock to US term and corporate spreads. First, while monetary policy responds little to a US term spread shock, money growth rises significantly to a US corporate spread shock. Interestingly, and probably as a consequence, Brazilian inflation, credit and output growth all come down following a US term spread shock, while credit and output growth quicken after a corporate spread shock. For both types of shocks, equity prices accelerate, and currency appreciation pressure rises by 0.8 percentage point in 6 months and 0.9 in one month following a term and corporate spread shock, respectively. Strong appreciation pressure on the Brazilian Real as a consequence of US easing and the generally anaemic output and inflation reactions caused concerns in Brazil of a "currency war".

China's policy responses to US stimulus clearly differentiate depending on the nature of the US shock (Figure 3.2.9 and 3.2.10). For a 146-basis-point negative US term spread shock, China raises money and credit growth which peak at about 2.5 and 3 percentage points in 3 and 6 months, respectively. But in response to a 229-basis-point negative shock to US corporate spread, China tightened by reducing money and credit growth by about 3 and 5 percentage points within one year. Different policy reactions may be due to the fact that, while seen as US policy efforts to ease financial conditions, a reduction in term spreads may also be interpreted as a sign of worsening US growth prospects, while a cut in corporate spreads may be understood as improving corporate access to credit and better business outlook.

Nevertheless, reducing US corporate spreads is far more accommodative for the Chinese economy despite China's policy tightening. Real GDP growth increases significantly and rapidly by 1.7 percentage points in response to a 229-basis-point negative US corporate spread shock, and inflation rises by over 2.5 percentage points. Against a US term spread shock, the impact on output growth is small and insignificant, and the inflation response is negative. For both shocks, equity prices accelerate as expected, and the RMB Yuan faces depreciation pressures due to its close association with the USD.

Therefore the major advanced and emerging economies respond with different monetary, credit and exchange rate policies to different types of US stimulus, and naturally the economic outcomes differ. We now examine the maximum crisis-sample impulse responses in 17 economies to a negative US VIX, term and corporate spread shock over a five-year horizon (Figures 3.2.11-14). The cumulative impulse responses and impulse responses for other economies not presented in this section can be found in the figures contained in Appendices 5.5.1-4.

Figures 3.2.11-14 clearly indicate diversity in the impulse responses to US QE measures, across advanced and emerging economies and within each region. But there are also commonalities. First, equity prices tend to rise faster following a US term or corporate spread or VIX shock. This suggests that QE measures which stabilise financial markets and reduce private-sector borrowing costs have unequivocal beneficial effects on global markets.

Second, except for exchange rate pressures, the maximum impulse responses tend to be smaller in the advanced economies. In particular, US QE measures turn out to have a greater impact on economic and financial variables in many emerging economies than on the domestic economy. This is consistent with previous work. In particular, Mackowiak (2007) finds that US monetary policy shocks quickly and strongly affect interest and exchange rates in a typical emerging economy, and price and real output there respond more than the US counterparts.[19] Therefore, cross-border spillovers of US stimulus measures cannot be dismissed as insignificant by-products of little consequence for the global economy.

Third, while China tends to be less affected by US monetary and financial shocks, this is not the case for other smaller emerging economies. For different reasons, Hong Kong and Singapore in Asia and Chile in Latin America seem to show the greatest impact. All are small open economies, and while Hong Kong and Singapore are important regional financial centres bound to be heavily influenced

[19] Frankel, Schmukler and Serven (2004) cannot reject full transmission of international interest rates in the long run. Also interest rates in countries with more flexible exchange rate regimes adjust more slowly. Edwards (2010) find that "there is a strong and fairly rapid transmission of changes in the Federal Funds rate into interest rates in the Latin American countries in the sample. This effect is equally large in the Asian nations in the long run". But the adjustment path differs and it is very fast and cyclical in Latin America, but gradual and slower in East Asia.

by US monetary and financial conditions, Chile has a high exposure to commodity trade. With a currency board linked to the US dollar, the HK dollar faces strongest depreciation pressures following a US term or corporate spread shock, while the Indonesian rupiah faces the greatest depreciation pressures from a US VIX shock. Indeed, a US term spread shock has the greatest maximum impact on the HK economy, while credit and output growth and inflation in Hong Kong and Singapore are most affected by a US corporate spread shock.

On balance, an expansionary US term or corporate spread shock raises credit and output growth in more than half of the economies in the sample. The response of inflation is generally negative for a US term-spread shock but positive for a US corporate-spread shock. Based on maximum impulse responses, following a US term spread shock, monetary policy loosens in Hong Kong, China, India, Thailand, Malaysia and all advanced economies, while it tightens in the other eight emerging economies, most strongly in Chile and the Philippines. In response to a US corporate-spread shock, monetary policy loosens again in all advanced economies, plus Argentina, Brazil, Thailand, Singapore and Korea. Indeed besides the advanced economies, most emerging economies respond in different ways to US stimulus depending on the nature of the shock. Distinct responses in term of monetary, exchange rate and credit policies may have led to different economic outcomes in the economies we include in the sample.

The impact of US QE measures have clearly differed significantly both across economies and across variables, implying that different transmission and adjustment mechanisms may dominate in the rather distinct economies. Moreover, the impact on the US economy and on some emerging economies actually have opposite signs and are generally of quite different sizes, suggesting that benefits and costs have not been distributed evenly. The burden of exchange rate adjustment could have been especially large for Brazil, Mexico, Korea and India, which tend to face greater currency appreciation pressures following a negative US VIX, term or corporate spread shock.

#### 3.2.3 Robustness Check

The results of impulse response analyses are robust to different model specifications and different variable definitions, including using base money growth instead of broad money growth, and using the federal funds rate in the term spread instead of the 3-month US Treasury bill rate. They are also robust to different ordering of the variables in the identification schemes for the shocks to US term spread, corporate spread and VIX, which we use to proxy unconventional monetary policy. For instance, the results change little if we assume that term spreads also react contemporaneously to equity prices in addition to real GDP and CPI inflation.

### 3.3 Global VECM Model Analysis: Counterfactual Analysis

Given the rather short period of time that has passed since the introduction of a wide range of unconventional monetary policy measures, including large-scale asset purchases, the empirical

results we derive from the global VECM model estimates should be seen as work in progress and the conclusions are tentative. Uncertainties remain large surrounding both the strength and pace of transmission of US QE measures to domestic and global financial and real activities. In fact, the pre-crisis norm of domestic and cross-border monetary policy transmissions may have been severely impaired following the global financial crisis, and our analysis already provides evidence of possible changes in the transmission. Neither the practicing central banks nor the private sector are familiar with the ongoing practices with balance sheet policies, or their tapering and eventual exit, and it takes time for economic agents to learn how such policies are transmitted and adjust their behaviour accordingly. All this adds difficulty to our work.

In this section, we try to gain a better understanding of the impact of US QE efforts in stabilising financial markets and easing financial conditions by constructing different counterfactual scenarios about US VIX, term and corporate spreads, based on the crisis-sample impulse response estimates derived from the global VECM models. We then compare the actual data with the counterfactual scenarios in order to gauge possible effects of the US QE measures which are supposedly reflected in the actual data. However, we need to bear in mind that the actual data would also reflect many other important factors affecting the global economy after the global financial crisis; these may include supply-side shocks such as euro area sovereign debt crisis, large fiscal stimulus in China, and commodity price fluctuations.

Ideally, we would like to construct counterfactual scenarios in which the US QE measures are assumed not to have been implemented at all, eg the Federal Reserve's asset purchases are zero and no liquidity facilities are provided. In practice, we do not know how US VIX, term and corporate spreads would behave and at what levels they would arrive in the absence of US QE.

We design three different scenarios which represent our best guess: in the first "constant" scenario, we assume US VIX and either the term or corporate spread remain constant within each period of the QE programme, at the levels recorded immediately before the implementation of each US asset purchase programme, namely LSAP1, LSAP2 and MEP;[20] In the second "increasing" scenario, the natural logarithm of VIX is assumed to increase by 0.1, and either the US term or corporate spread is assumed to increase by 10 basis points, in each and every month during each period of QE programme (LSAP1, LSAP2 and MEP); the third "jump" scenario describe a situation where the natural logarithm of VIX is assumed to jump by 0.5, and either US term or corporate spread is assumed to jump by 200 basis points at the start of each period. Thereafter they stay above the actual values during the entire period of QE programme.

For presentation purposes, we only include results on the "constant" and "jump" scenarios on US term or corporate spreads here. The panels on US term or corporate spreads in Figures 3.3.1-2 show both the actual and the two counterfactual "policy" paths.

[20] LSAP1, from December 2009 to March 2010; LSAP2, from November 2010 to June 2010; MEP, from October 2011 to December 2012; and LSAP3, from October 2012 onwards.

### 3.3.1 Domestic Effects of Reductions in US Term & Corporate Spreads

Counterfactual analyses suggest that the US QE measures have had sizeable domestic effects, and such effects differ substantially depending on whether such measures involve a substantial fall in US term or corporate spreads. Assuming that the different phases of asset purchases have managed to keep US VIX, term and corporate spreads at levels lower than otherwise, such actions indeed seem to have facilitated US credit growth and economic recovery.

Notice that during LSAP1, US term and corporate spreads actually drifted back up midway through the programme to levels higher than when the asset purchases began, and they kept climbing up during LSAP2 (see the black and blue lines in Figure 3.3.1-2). This means that LSAP1 and LSAP2 asset purchases failed to cut US interest rate spreads below the levels just before each programme began, and the "constant" scenarios are not true stress scenarios in contrast with the "jump" scenarios. There are two possibilities: first, factors such as adverse supply shocks or further financial sector strains could have counteracted the effects of asset purchases and pushed US interest rate spreads higher; second, the effect of US asset purchases on interest rate spreads could have been short-lived and they died out well before each phase of the programme was completed.

In Figures 3.3.1 and 3.3.2 we compare the dynamics of US economic and financial variables in the "constant" and "jump" scenarios for term and corporate spreads with their actual path. First, QE measures which reduce US term spread appear to have had a relatively small impact on output growth and equity prices, but a sizeable impact on inflation, credit growth and the USD exchange rate. Reducing US term spread lowers US inflation by about 2 percentage points and appreciates the US dollar by over 5 percentage points in different phases of US QE. On the other hand, it stimulates credit growth by about 3 percentage points. Also output growth and equity price inflation would be lower without the asset purchase programmes.

On the other hand, QE measures which lower US credit spreads have had substantial effects on the US economy, in part due to the fact that successive programmes have reduced US credit spreads by over 400 basis points since late 2008, compared to a reduction of over 140 basis points in US term spread. Without QE programmes, and especially purchases of agency MBS which helped lower US corporate spreads, the US economy would have remained mired in the Great Recession with severe deflation. Judged by the "jump" scenario, each asset purchase programme could have kept real GDP growth at least 5 percentage points higher, and inflation 4-5 percentage points higher. Credit growth was raised by 2-3 percentage points on average in each programme. The greatest impact has been on equity prices, which could be up to 30 (jump) or 60 (constant) percentage points lower without QE programmes; and on USD nominal effective exchange rate, which could have been between 10 (jump) and 25 (constant) percentage points lower without QE.

To summarise, the domestic effects of US QE measures have differed substantially depending on their impact on credit and corporate spreads. Actions which have successfully reduced US corporate

spread have delivered a sizeable stimulus to credit growth and equity markets and provided sizeable USD depreciations, which have eventually prevented the US economy from sliding into a major sustained recession and severe deflation. In contrast, QE measures lowering US term spreads have had far smaller impact, and some effects have been of the wrong sign. If policymakers aim to lower private sector borrowing cost, restore credit flows and stimulate growth, then it would pay to act directly on reducing corporate spreads.

### 3.3.2 Spillovers of Reductions in US Term and Corporate Spreads

In similarity to the domestic effects of US QE programmes, cross-border spillover effects have been far more significant for measures which reduce US term spread for the economies under analysis. This section focuses on the impact of US QE measures on three major economies: the euro area, Brazil and China. In Appendices 5.5.5-6, we present figures on the counterfactual analyses of spillovers of US QE measures to the other sample economies. The spillovers to euro area economies of US unconventional policies have been first manifested on corresponding euro area policy easing: indeed the region's term spread could be 50 basis points higher, and corporate spreads 100 to 200 basis points higher (depending on the scenarios) were it not for euro area responses to US policy initiatives (Figure 3.3.3-4).

However, although measures reducing US term spreads appear to have supported euro area credit and output growth and raised both CPI and equity price inflation, such effects pale in comparison to the spillovers from measures reducing US corporate spreads. Such measures have stimulated euro area credit and output growth by 2.5 and 5 percentage points compared to the jump scenario, and by 5.5 and 10 percentage points in the constant scenario. Besides helping euro area avoid a severe recession in 2012, these measures also help the region shake off deflationary concerns and support euro area equity markets, without which equity price inflation could be 50 percentage points lower. QE measures reducing US corporate spreads also have depreciated the euro NEER by 10 to 20 percentage points, probably through a significant decline in euro area corporate spreads in response to US QE measures.

Counterfactual analyses reveal that US QE measures have had powerful spillover effects on the emerging economies, mainly through reductions in US corporate and (to a much lesser extent) term spreads. The impact tends to be diverse both across economies and across variables, reflecting equally diverse policy responses, exchange rate regimes and economic structures.

In Brazil, US QE measures to lower US term spreads have encouraged stronger money growth (up to 4 percentage points higher), boosted equity prices (15 percentage points higher) and put strong appreciation pressures on the Real (up to 5.5 percentage points higher), but the measures have reduced credit growth by 2 to 3 percentage points which may have driven down output growth (Figure 3.3.5).

In contrast, QE measures to lower US corporate spreads have had far greater expansionary effects on the Brazilian economy (Figure 3.3.6). First, policy eased and money growth cumulatively reached 2-4 percentage points higher as in the case with measures lowering US term spreads. In terms of individual US QE programmes, Brazil's monetary policy eased most in LSAP1 but the expanding US QE size dictated sizeable overall easing in Brazil.

Second, US QE measures on US corporate spreads have had strong positive spillovers to Brazilian financial markets, elevating equity returns and credit growth by up to 45-50 and over 15 percentage points higher depending on the scenario and on the specific US QE programme. Interestingly, US stimulus appears to have supported Brazilian growth most in LSAP1 and MEP plus LSAP3, with a small impact during LSAP2 when Brazil was most outspoken about the likelihood of overheating due to US QE. This might be attributed to tighter Brazilian monetary policy in the period. Yet the overall impact on Brazilian credit growth of US QE measures from ever-expanding asset holdings is very large, reaching almost 30 percentage points towards the end of 2012.

Third, Brazil has indeed been confronted with difficult policy challenges associated with strong currency appreciation pressures arising from US QE stimulus which lowers US corporate spreads. Specifically, the Brazilian real has faced appreciation pressures of as much as 18 percentage points during each QE programme (LSAP1, LSAP2 and MEP plus LSAP3), with the overall US QE impact reaching above 15 (jump) and 30 (constant) percentage points at the end of 2012. From Brazil's perspective, a "currency war" is probably no exaggeration.

Nevertheless, US QE measures on US corporate spreads have stimulated Brazilian output growth and raised inflation. Effectively, US LSAP1 helped the Brazilian economy to rapidly recover from the 2009 recession and MEP plus LSAP3 helped to avoid a major recession during much of 2012. But US LSAP2 started when Brazilian output growth reached a peak of almost 8%, and was perceived to have contributed to Brazil's overheating. Clearly, the same type of US policy measures can be seen as beneficial or harmful depending on the economic circumstances, especially the cyclical conditions in the affected country.

US QE measures apparently have affected the Chinese economy far less. US stimulus reducing US term spreads has been met with looser monetary, credit and exchange rate policies in China, as money and credit growth rose and the Chinese Yuan fell, though by a relatively small margin (Figure 3.3.7). Equity returns also increased but by 10 percentage points at most. Finally, such measures almost had no effects on China's output growth and slightly lowered China's inflation.

On the other hand, as is the case for all other economies, US QE measures which reduce US corporate spread has had a far more substantial impact on the Chinese economy (Figure 3.3.8). First and interestingly, China significantly tightened its monetary and credit policy and also appreciated the Chinese Yuan to contain the strong accommodative effects of US stimulus, in stark comparison to Brazil's policy responses. In fact, money and credit growth were lowered by up to 5 and 8 percentage

points, respectively, in LSAP1 and MEP plus LSAP3, but changed little in LSAP2. By the end of 2012, money and credit growth were 5 and 9 (jump) and 12 and 19 (constant) percentage points lower, and appreciation pressure on Chinese Yuan was 2 (jump) and 4 (constant) percentage points higher.

Second, despite China's endogenous policy tightening, US QE measures reducing US corporate spreads have provided a sizeable stimulus to the Chinese economy. Real GDP growth has been supported by US QE throughout and was boosted by 2.5 (jump) to 5.5 (constant) percentage points by the end of 2012. In the absence of US QE, China might have faced significant deflation especially in 2009 and 2012. Yet when China's output growth went well above 9% in 2010 and 2011, and inflation was over 5% in 2011, US QE was seen to have contributed to China's overheating. Equity returns were also boosted during LSAP1, LSAP2 and MEP plus LSAP3, and were over 25 percentage points higher in mid-2012.

In comparison to Brazil, US QE measures seem to have had much smaller impact on the Chinese economy. This could be due to two reasons: first, the Chinese economy is of a far bigger size and is also more diversified to absorb external shocks; China clearly responded to US stimulus with tighter monetary and credit policies and also made efforts to minimise the impact of such stimulus on China's Yuan exchange rates as the RMB has moved closely with US dollar and therefore appreciated less than Brazilian real.

Other emerging economies have also been affected by US QE measures to different degrees, depending on each economy's characteristics, institutional frameworks and policy responses. In general, US QE measures have provided a significant boost to emerging equity markets. Yet stimulus measures reducing US term spreads have had small spillover effects except in the case of Hong Kong, a small, open but key regional financial centre which is in a currency board arrangement with the HK dollar pegged to US dollar (Figures 5.5.5.1-6). On the other hand, QE measures reducing US corporate spreads have had sizeable and diverse spillover effects on all economies under study (Figures 5.5.5.7-12). As India tightened its monetary policy and kept the Indian rupee higher in response to US stimulus on corporate spreads, the stimulus had a limited impact on India's output growth and inflation. In contract, Thailand has kept its monetary policy and the Thai baht exchange rate little changed in response to US stimulus, and such stimulus has had significant spillovers in the country boosting credit and output growth and inflation.

# 4. Conclusion

This paper examines the domestic and cross-border consequences of the recent central bank balance sheet policies on both advanced and emerging economies. We study the global financial market impact of QE policies using event study techniques, and the domestic and spillover effects of US unconventional monetary policies on both real and financial activities using an estimated global VAR model. The work suggests that QE policies have important domestic and spillover effects, and such effects vary significantly across regions and individual economies.

Event studies reveal a sizeable expansionary global impact from QE measures in the advanced economies, and the global portfolio rebalancing and signalling or confidence channels may have played a major role. The announcement effects tend to be larger in the emerging economies than in US domestic markets. Furthermore, such effects differ across economies, and the impact of successive programmes, eg US LSAP1 and LSAP2, and UK APF1 and APF2, also differ. QE announcements lowered emerging market bond yields, boosted equity prices and exerted upward pressures on bilateral exchange rates against the dollar. We also find that the effects of US MEP were more in line with US tapering in 2013. This indicates that expanding the size of asset holdings is more effective, and merely changing the composition of asset holdings can be perceived as policy tightening in the absence of a commensurate increase in overall asset purchases.

Analyses based on an estimated global VECM model suggest that US QE, especially reductions in US corporate spreads and market volatility due to, eg large-scale purchases of agency MBS and other private assets, has had a sizeable impact domestically and internationally. This confirms Blinder's (2012) view that purchasing treasuries to lower term spreads is a weak tool, and reducing risk premia by acquiring private-sector assets is much more potent.[21] The impulse responses reveal significant differences across economies in how each endogenous variable evolves following a reduction in the US VIX, term or corporate spreads. Second, monetary policy and exchange rates respond with a greater diversity in the emerging economies, which may partly explain important cross-economy difference in the responses of output, inflation and credit. Third, US QE measures have had sizeable and widespread impact on global equity prices, and the global confidence channel is important. In addition, the impact of US stimulus on the US economy and on some emerging economies actually have opposite signs, suggesting that benefits and costs have not been distributed evenly. And compared to its domestic impact, US QE turns out to have a far greater impact on most emerging economies.

Counterfactual analysis confirms that US QE measures are more effective if these involved a reduction in US corporate spreads instead of US term spreads, and that stabilising financial market pays off. We draw three conclusions. First, US QE measures have lent strong support to US and other advanced economies, without which they may still be mired in the Great Recession and severe deflation. Second, US QE spillovers were seen in more positive light in the emerging economies in 2009 and 2012, when the economies faced significant economic difficulties; and they were perceived as harmful by contributing to overheating in 2010 and 2011, when many emerging economies already enjoyed solid growth and rapidly rising inflation. Third, policy responses made a difference. While China and India tightened monetary policy and appreciated their currencies in response to US QE measures reducing US corporate spreads, the impact on output growth and inflation was more limited. As Brazil loosened monetary policy and Thailand kept its monetary policy and exchange rate

[21] Blinder (2012) suggests that "this particular brand of unconventional monetary policy (purchases of private-sector securities to reduce risk premiums) appeared to work very well in the cases of CP and MBS. But, of course, the risk spreads were then at crisis levels. One cannot expect such strong effects under more normal market conditions. That said, every private debt market is less deep and less liquid than the Treasury markets. So it is reasonable to expect more interest rate "bang" for each "buck" of asset purchases."

unchanged, the effects tended to be large. Indeed Brazil has been among the economies most affected by US unconventional policies.

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**Table 3.1 Cumulative Two–Day Change around Announcement Days of QE for Asia[1]**

| | Announce-ment period | Total amounts (billions) | Gov't 2-year yields (bps) | Gov't 10-year yields (bps) | Corp bond yields[2] (bps) | Sov'gn CDS premia[3] (bps) | Equity prices (%) | FX against USD[5] (%) |
|---|---|---|---|---|---|---|---|---|
| **US** LSAP1 | Nov 08 to Aug 10 | $1,725 | –15.01 | –84.97 | –54.49 | –12.07 | 9.18 | 3.72 |
| LSAP2 | Aug 10 to Nov 11 | $600 | –4.12 | –8.37 | –26.46 | –6.65 | 4.15 | –0.04 |
| **JP** QE1[6] | Mar 01 to Mar 06 | ¥30,000 | –39.91 | –49.07 | … | … | 7.42 | 0.86 |

[1] Simple averages of China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. [2] Excluding Indonesia. [3] Excluding India and Singapore. [4] A positive change indicates an appreciation against the US dollar. [5] As a function of data availability, 2– and 10–year yields exclude China, Indonesia and Malaysia; for corporate bond yields and sovereign CDS premia, data are unavailable.

Sources: Bloomberg; Datastream; Markit; national data; Authors' calculations.

**Table 3.2 Per-Billion Dollar (x 100) Impact of QE for Asia[1]**

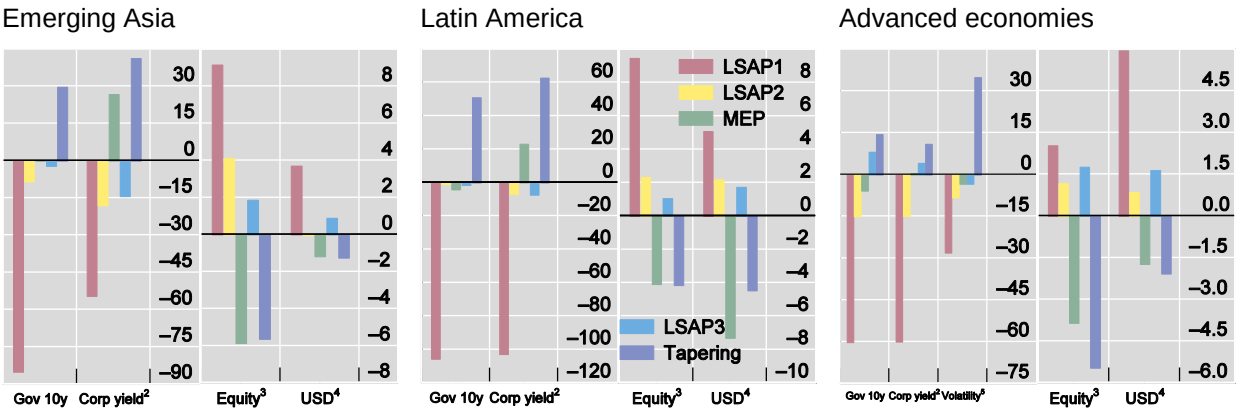
| | Announce-ment period | Total amounts (billions) | Gov't 2-year yields (bps) | Gov't 10-year yields (bps) | Corp bond yields[2] (bps) | Sov'gn CDS premia[3] (bps) | Equity prices (%) | FX against USD[4] (%) |
|---|---|---|---|---|---|---|---|---|
| **US** LSAP1 | Nov 08 to Aug 10 | $1,725 | –0.9 | –4.9 | –3.2 | –0.7 | 0.5 | 0.2 |
| LSAP2 | Aug 10 to Jun 11 | $600 | –0.7 | –1.4 | –4.4 | –1.1 | 0.7 | –0.01 |
| **JP** QE1[5] | Mar 01 to Mar 06 | $258 | –15.4 | –19.0 | … | … | 2.9 | 0.3 |

[1] Simple averages of China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand of the cumulative 2-day changes around announcement days of QE, divided by the total dollar amount of QE x 100. [2] Excluding Indonesia. [3] Excluding India and Singapore. [4] A positive change indicates an appreciation against the US dollar. [5] As a function of data availability, 2– and 10–year yields exclude China, Indonesia and Malaysia; for corporate yields and sovereign CDS premia, data are unavailable.

Sources: Bloomberg; Datastream; Markit; national data; Authors' calculations.

**Figure 3.1.1 Financial Market Spillover Effects of US Federal Reserve's Policy Measures[1]**

In basis points unless otherwise indicated

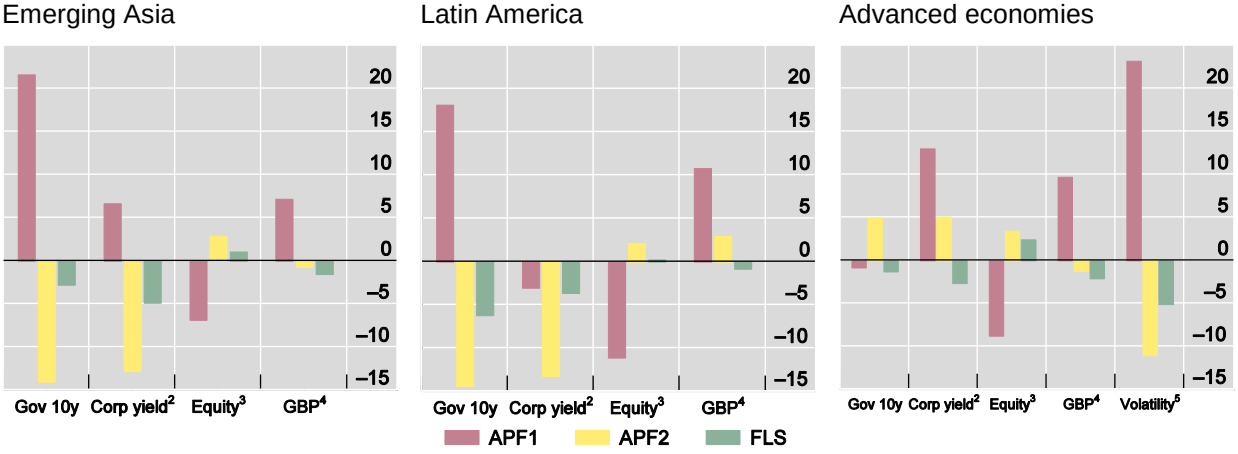



[1] Two-day event window. Simple averages based on a sample of countries. For emerging Asia: China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand; for Latin America: Brazil, Chile and Mexico; for the advanced economies: the euro area, Japan and the United Kingdom. [2] CEMBI Broad yields for emerging Asia and Latin America. [3] In per cent. [4] In per cent; US dollar bilateral exchange rates: a positive change indicates depreciation. [5] In per cent, stock market volatility indices.

Sources: Bloomberg; Datastream; JPMorgan; national data; Authors' calculations.

**Figure 3.1.2 Financial Market Spillover Effects of the Bank of England's Policy Measures[1]**

In basis points unless otherwise indicated

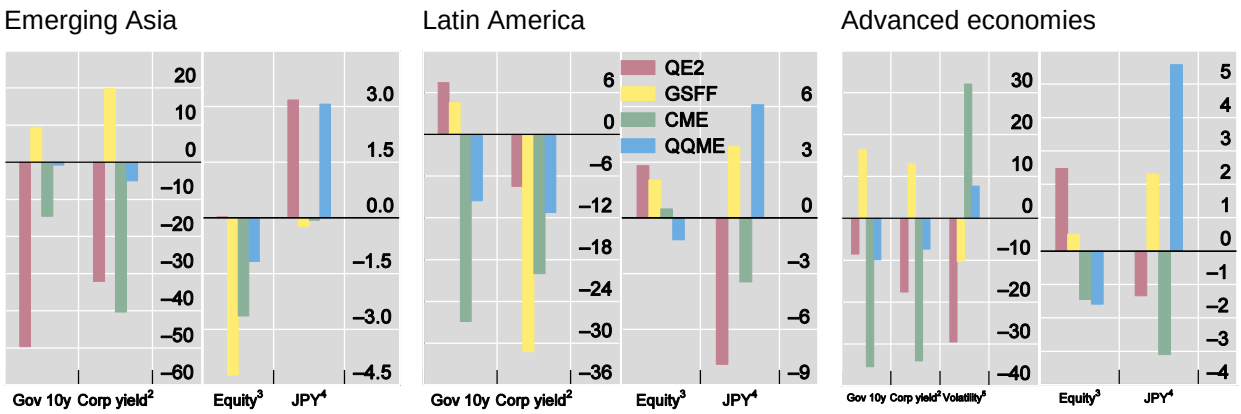



[1] Two-day event window. Simple averages based on a sample of countries. For emerging Asia: China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand; for Latin America: Brazil, Chile and Mexico; for the advanced economies: the euro area, Japan and the United States. [2] CEMBI Broad yields for emerging Asia and Latin America. [3] In per cent. [4] In per cent; Pound sterling bilateral exchange rates: a positive change indicates depreciation. [5] In per cent, stock market volatility indices.

Sources: Bloomberg; Datastream; JPMorgan; national data; Authors' calculations.

**Figure 3.1.3 Financial Market Spillover Effects of the Bank of Japan's Policy Measures[1]**

In basis points unless otherwise indicated

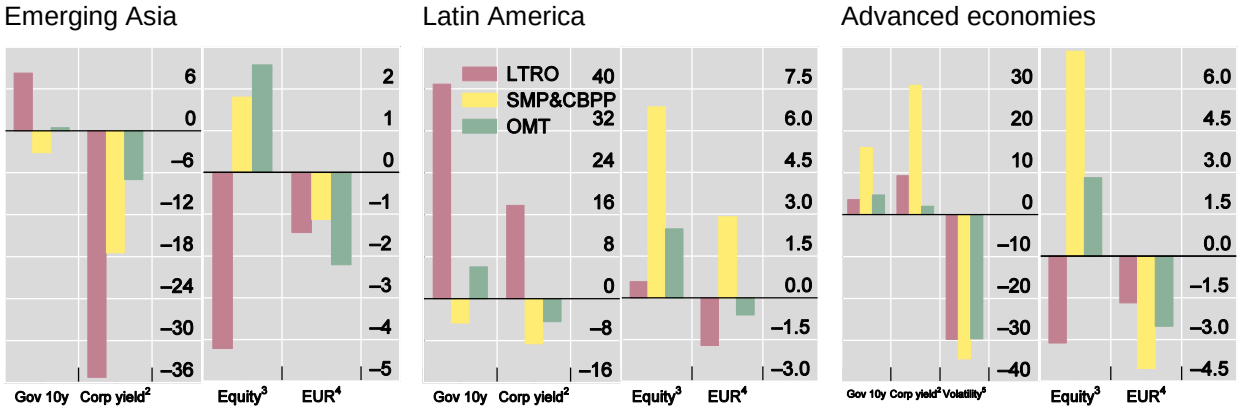



[1] Two-day event window. Simple averages based on a sample of countries. For emerging Asia: China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand; for Latin America: Brazil, Chile and Mexico; for the advanced economies: the euro area, the United Kingdom and the United States. [2] CEMBI Broad yields for emerging Asia and Latin America. [3] In per cent. [4] In per cent; yen bilateral exchange rates: a positive change indicates depreciation. [5] In per cent, stock market volatility indices.

Sources: Bloomberg; Datastream; JPMorgan; national data; Authors' calculations.

**Figure 3.1.4 Financial Market Spillover Effects of the Eurosystem's Non-Standard Measures[1]**

In basis points unless otherwise indicated



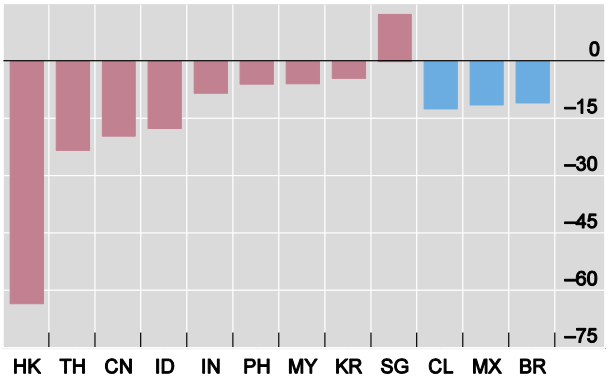

[1] Two-day event window. Simple averages based on a sample of countries. For emerging Asia: China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand; for Latin America: Brazil, Chile and Mexico; for the advanced economies: Japan, the United Kingdom and the United States. [2] CEMBI Broad yields for emerging Asia and Latin America. [3] In per cent. [4] In per cent; euro bilateral exchange rates: a positive change indicates depreciation. [5] In per cent, stock market volatility indices.

Sources: Bloomberg; Datastream; JPMorgan; national data; Authors' calculations.

**Figure 3.1.5. Cumulative Two-Day Changes around Announcement Days of LSAP1**

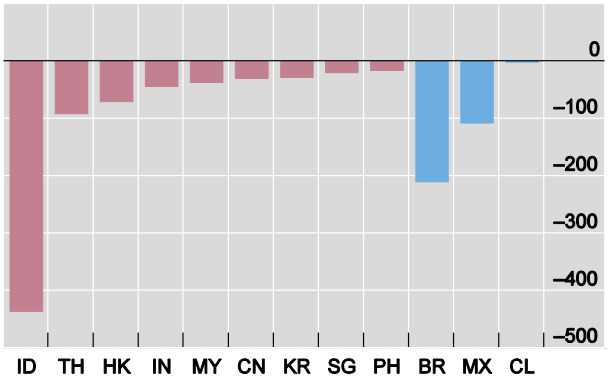
Two-year sovereign bond yield

Basis points



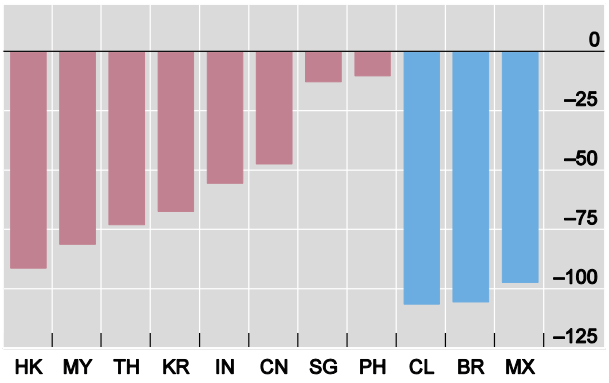

Ten-year sovereign bond yield

Basis points



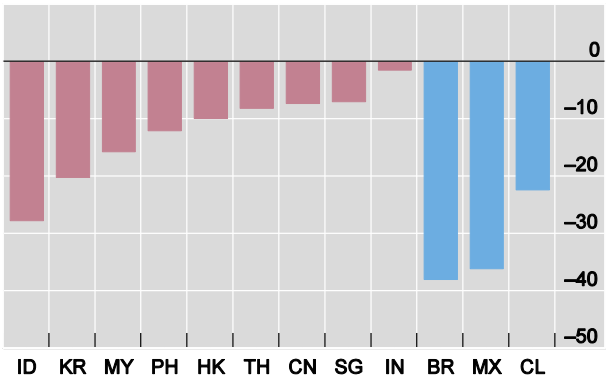

Corporate bond yield[1]

Basis points



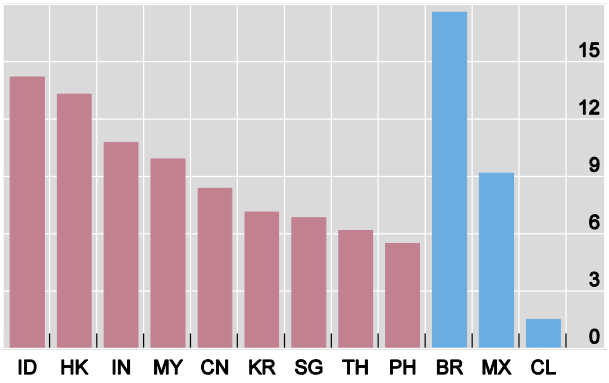

Sovereign CDS spread[2]

Basis points



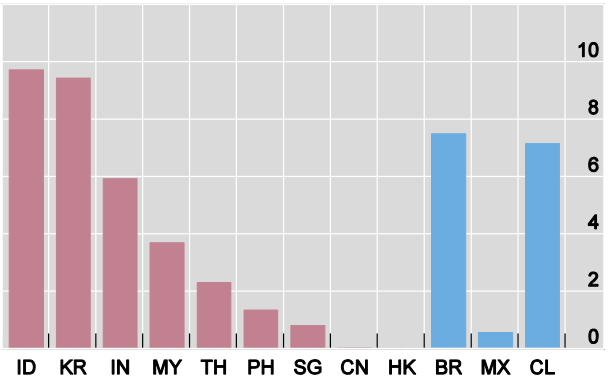

Equity price

Per cent




USD per local currency[3]

Per cent



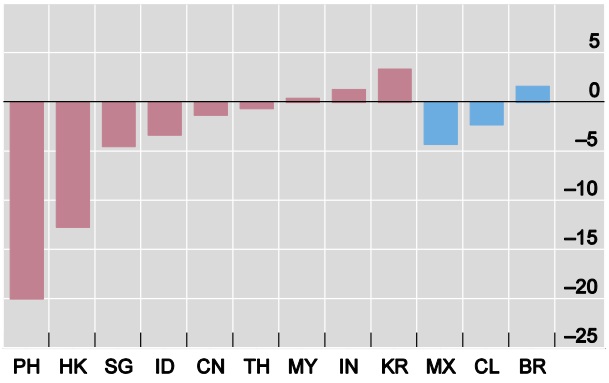

[1] JPMorgan Corporate Emerging Markets Bond Index (Broad) yield. [2] Senior five-year CDS spreads. [3] A positive change indicates appreciation against the US dollar.

Sources: Bloomberg; CEIC; Datastream; JPMorgan; Markit; national data; Authors' calculations.

**Figure 3.1.6 Cumulative Two-Day Changes around Announcement Days of LSAP2**

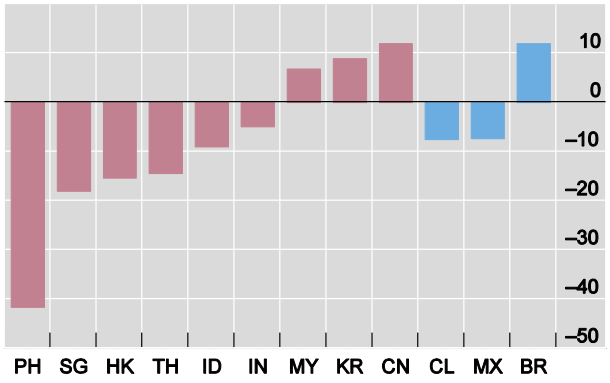
Two-year sovereign bond yield

Basis points



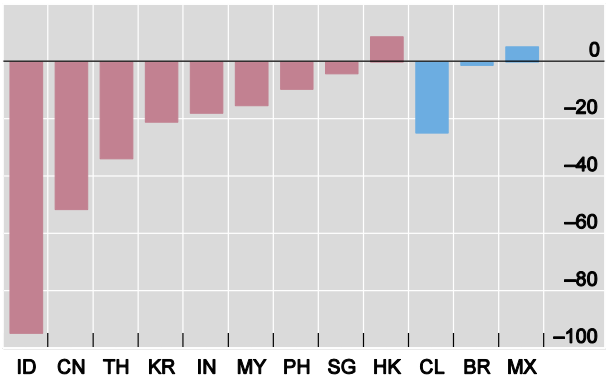

Ten-year sovereign bond yield

Basis points



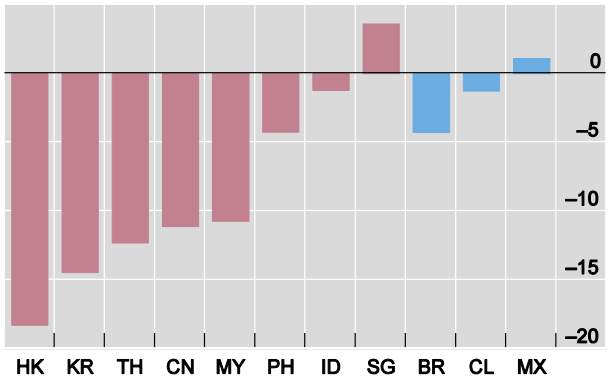

Corporate bond yield[1]

Basis points



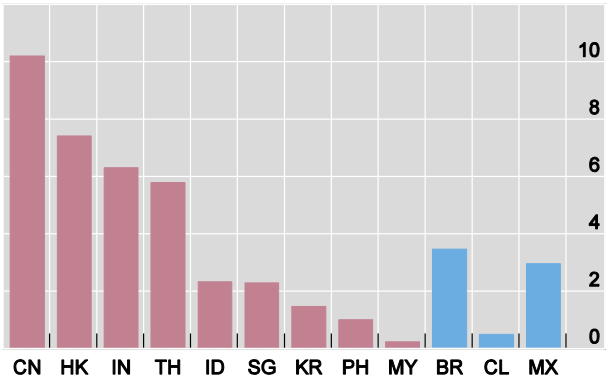

Sovereign CDS spread[2]

Basis points



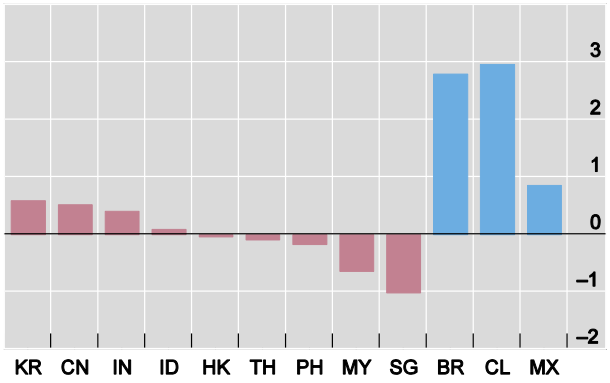

Equity price

Per cent




USD per local currency[3]

Per cent



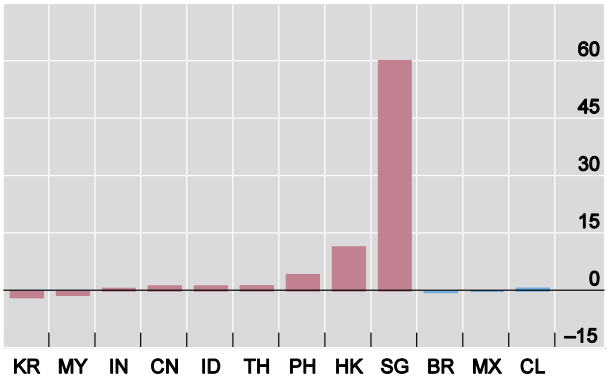

[1] JPMorgan Corporate Emerging Markets Bond Index (Broad) yield. [2] Senior five-year CDS spreads. [3] A positive change indicates appreciation against the US dollar.

Sources: Bloomberg; CEIC; Datastream; JPMorgan; Markit; national data; Authors' calculations.

**Figure 3.1.7 Cumulative Two-Day Changes around Announcement Days of MEP**

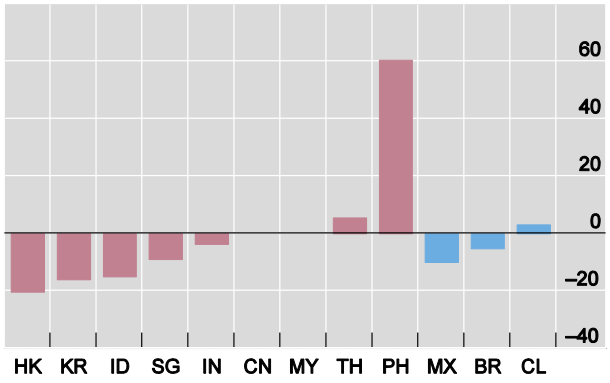
Two-year sovereign bond yield

Basis points



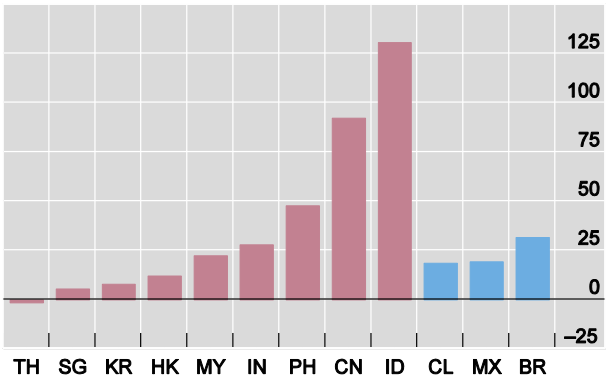

Ten-year sovereign bond yield

Basis points



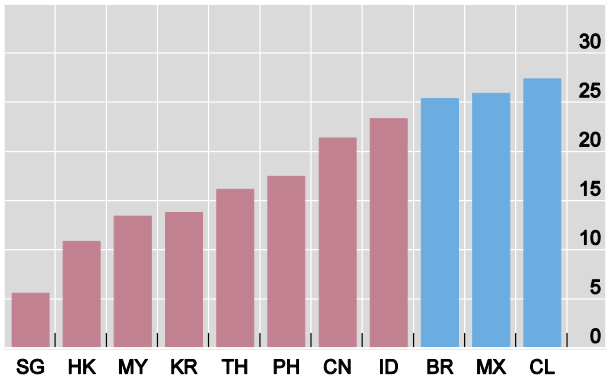

Corporate bond yield[1]

Basis points



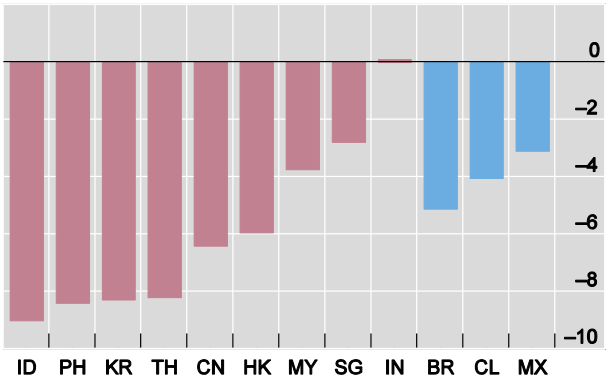

Sovereign CDS spread[2]

Basis points



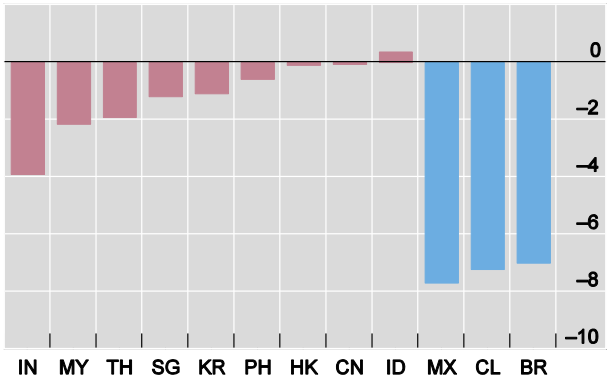

Equity price

Per cent




USD per local currency[3]

Per cent



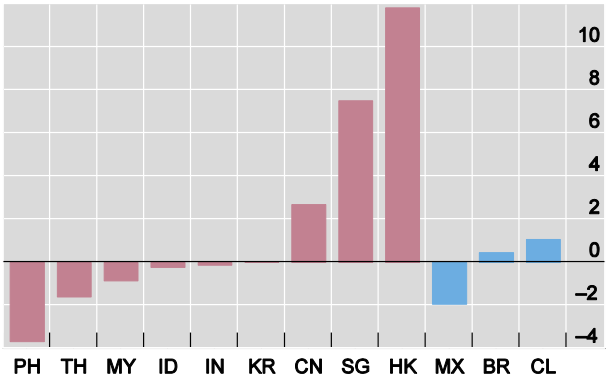

[1] JPMorgan Corporate Emerging Markets Bond Index (Broad) yield. [2] Senior five-year CDS spreads. [3] A positive change indicates appreciation against the US dollar.

Sources: Bloomberg; CEIC; Datastream; JPMorgan; Markit; national data; Authors' calculations.

**Figure 3.1.8 Cumulative Two-Day Changes around Announcement Days of LSAP3**

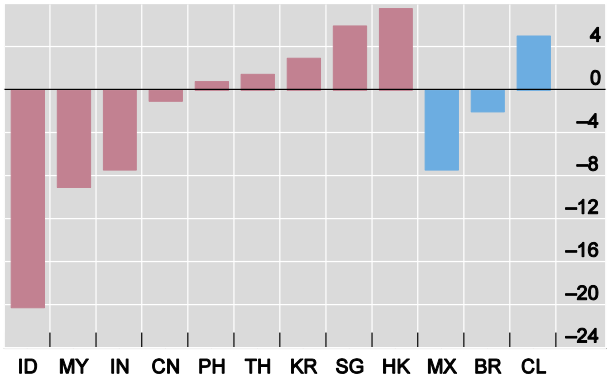
Two-year sovereign bond yield

Basis points



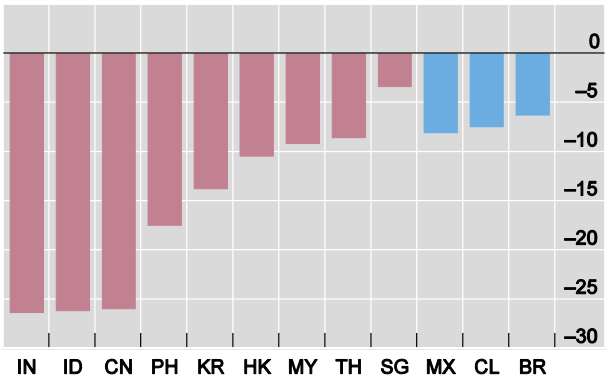

Ten-year sovereign bond yield

Basis points



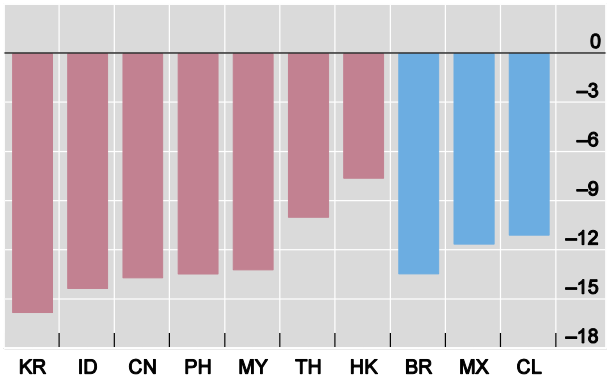

Corporate bond yield[1]

Basis points



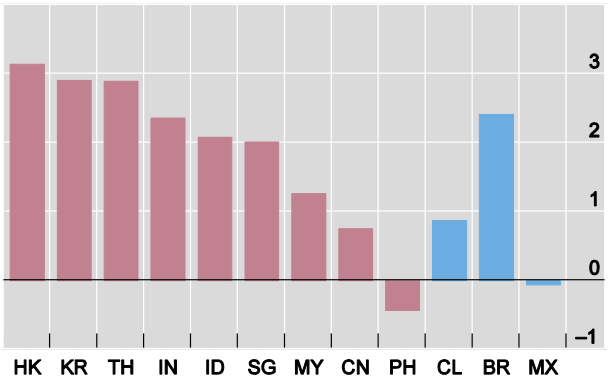

Sovereign CDS spread[2]

Basis points



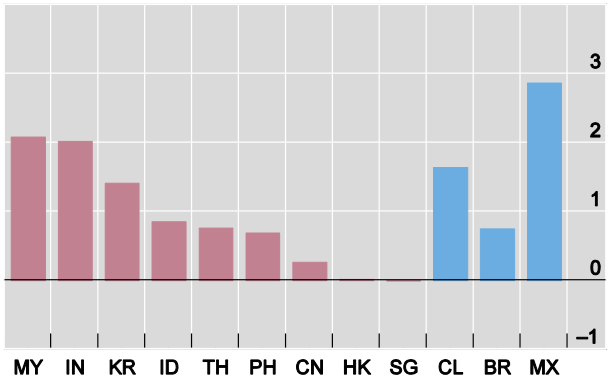

Equity price

Per cent




USD per local currency[3]

Per cent



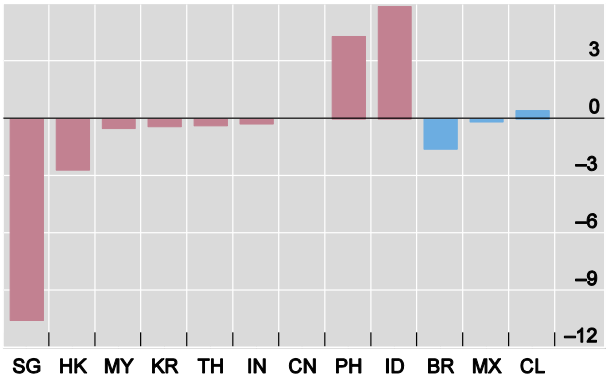

[1] JPMorgan Corporate Emerging Markets Bond Index (Broad) yield. [2] Senior five-year CDS spreads. [3] A positive change indicates appreciation against the US dollar.

Sources: Bloomberg; CEIC; Datastream; JPMorgan; Markit; national data; Authors' calculations.

**Figure 3.1.9 Cumulative Two-Day Changes around Announcement Days of BoJ's QQME**

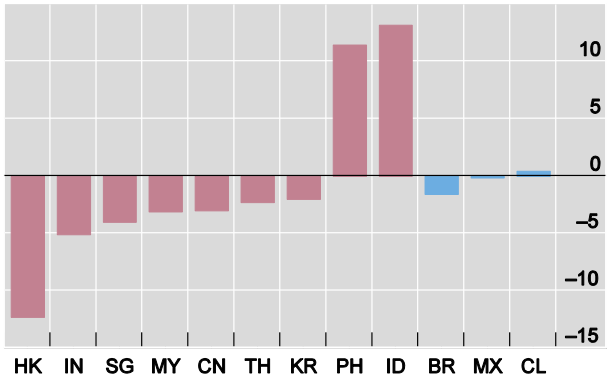
Two-year sovereign bond yield

Basis points



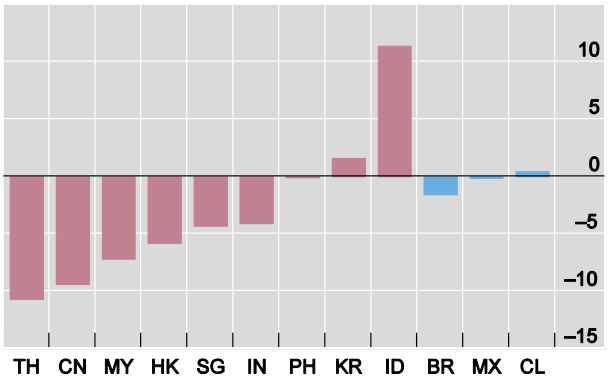

Ten-year sovereign bond yield

Basis points



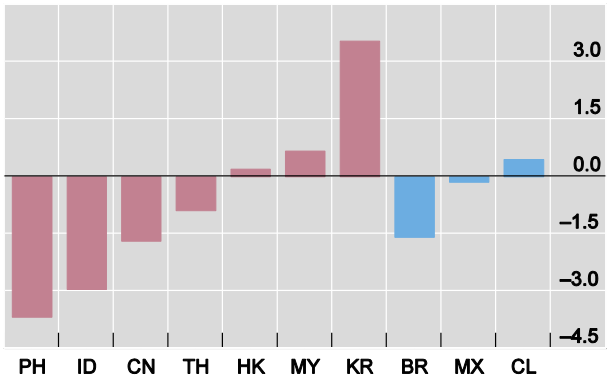

Corporate bond yield[1]

Basis points



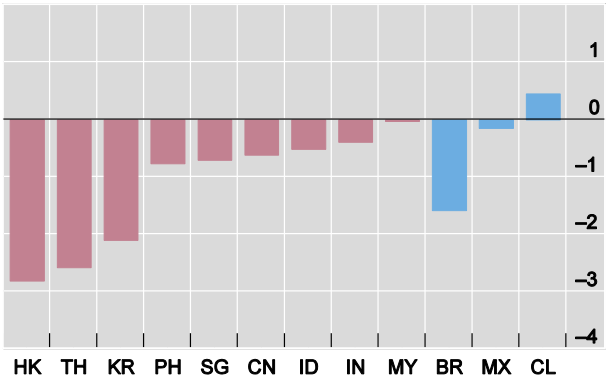

Sovereign CDS spread[2]

Basis points



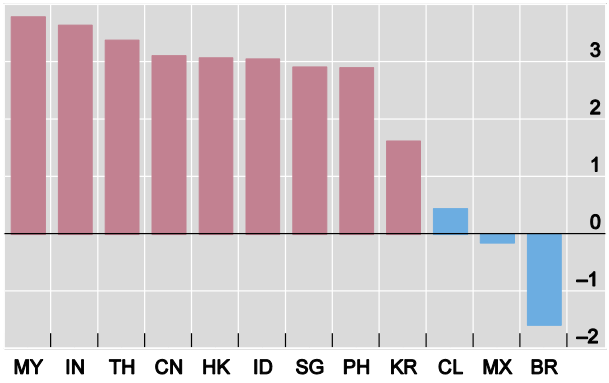

Equity price

Per cent




JPY per local currency[3]

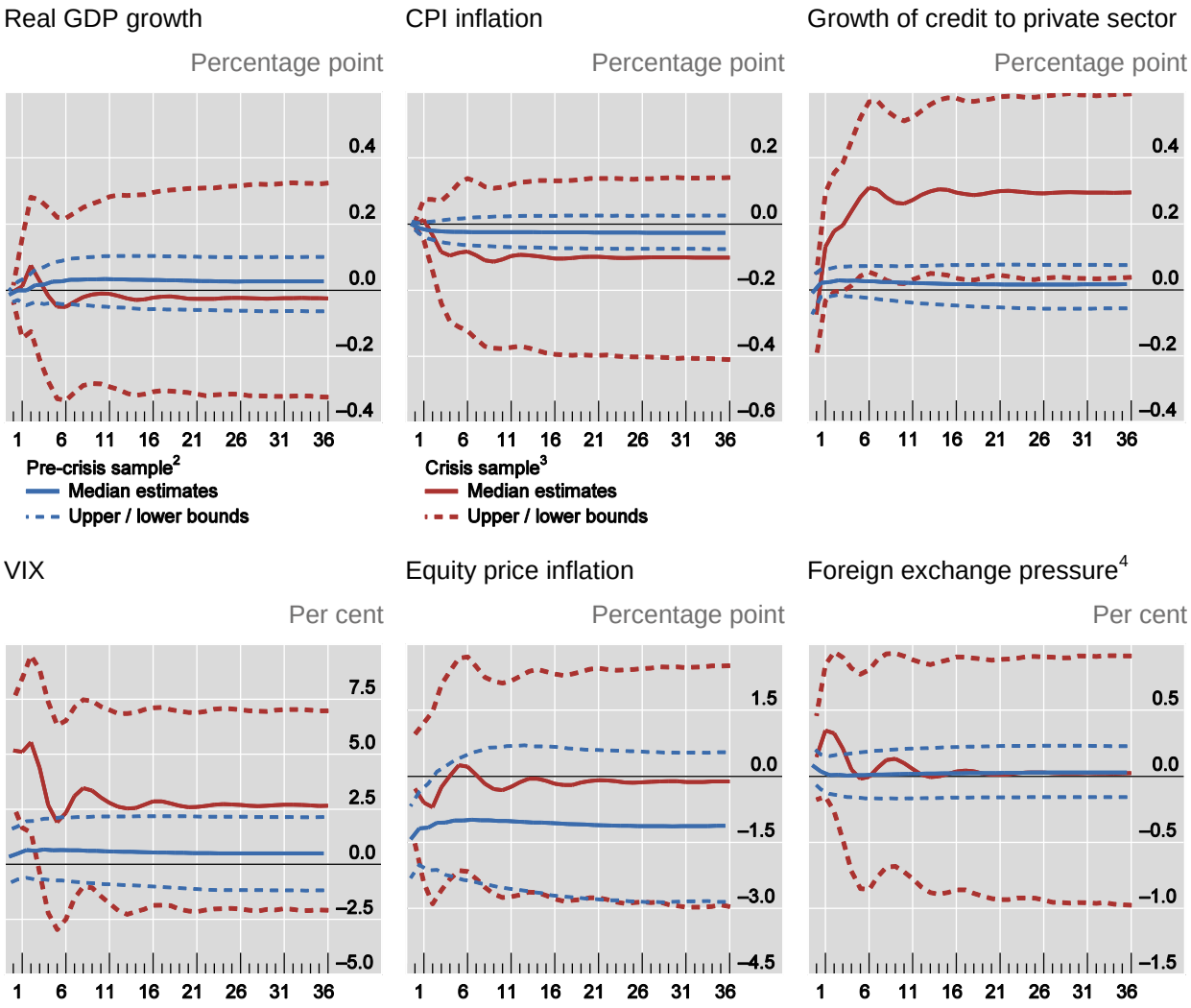
Per cent




[1] JPMorgan Corporate Emerging Markets Bond Index (Broad) yield. [2] Senior five-year CDS spreads. [3] A positive change indicates appreciation against the yen.

Sources: Bloomberg; CEIC; Datastream; JPMorgan; Markit; national data; Authors' calculations.

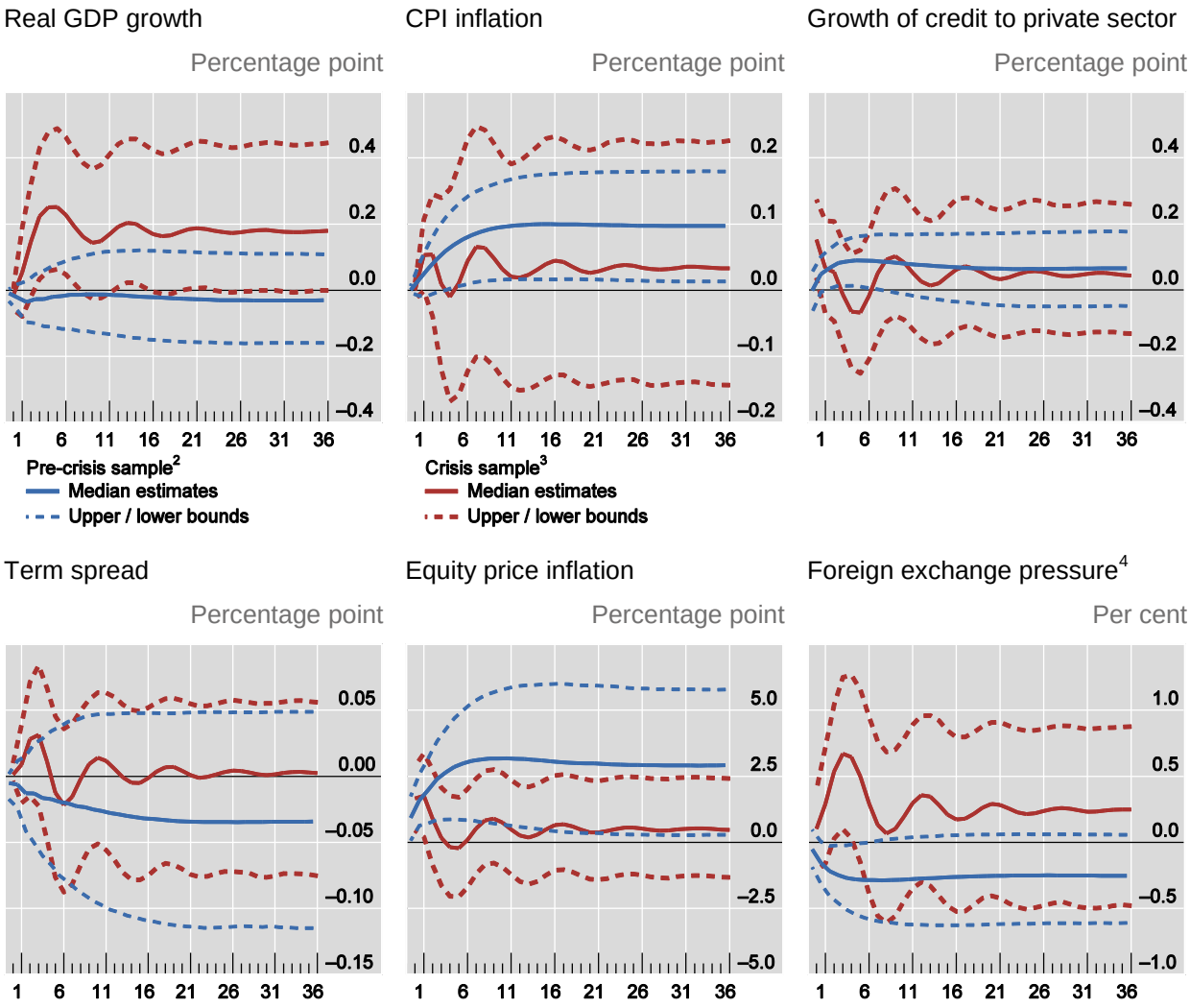
**Figure 3.2.1 Impulse Responses to a US Term Spread Shock: United States[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

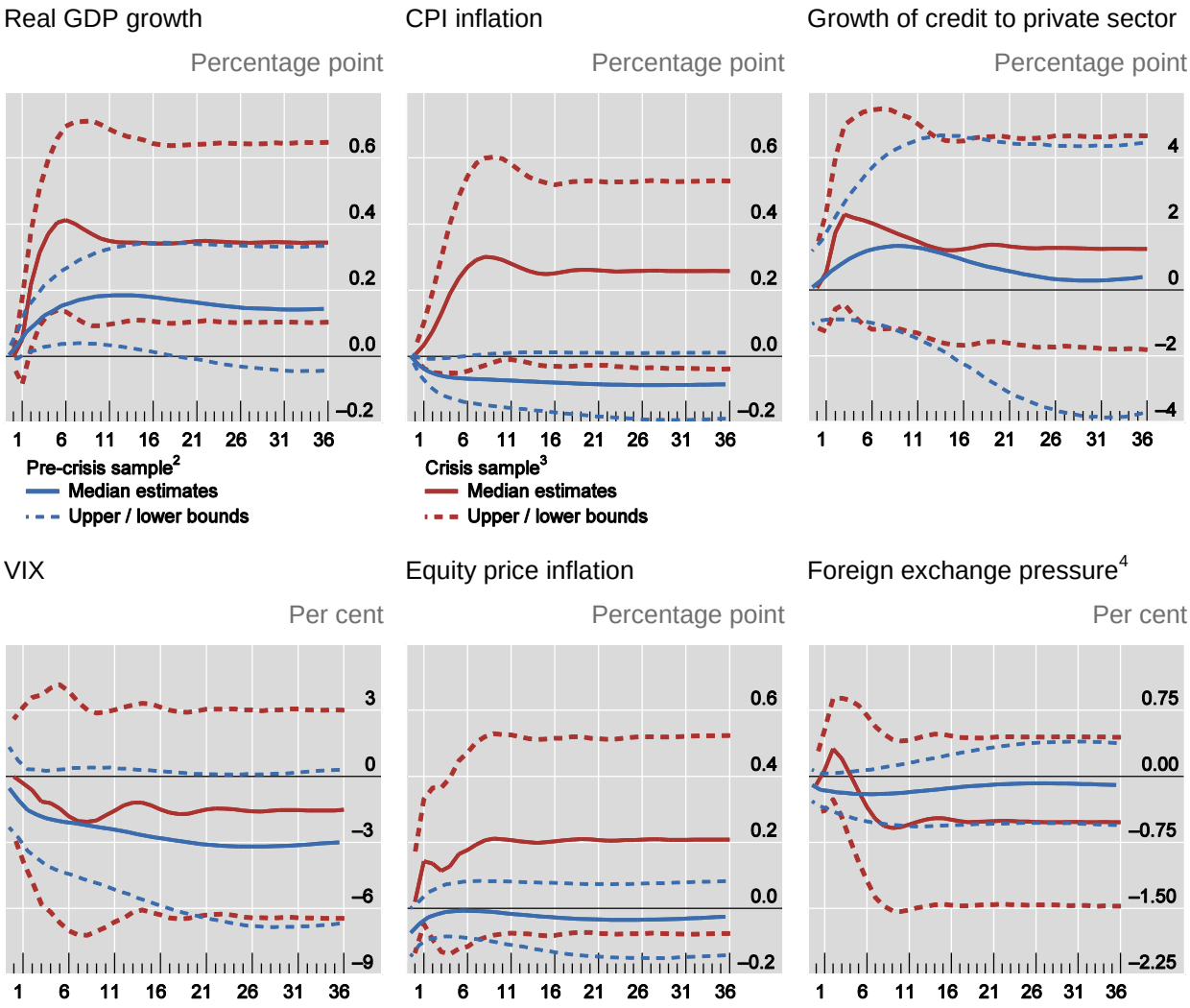
**Figure 3.2.2 Impulse Responses to a US VIX Shock: United States[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

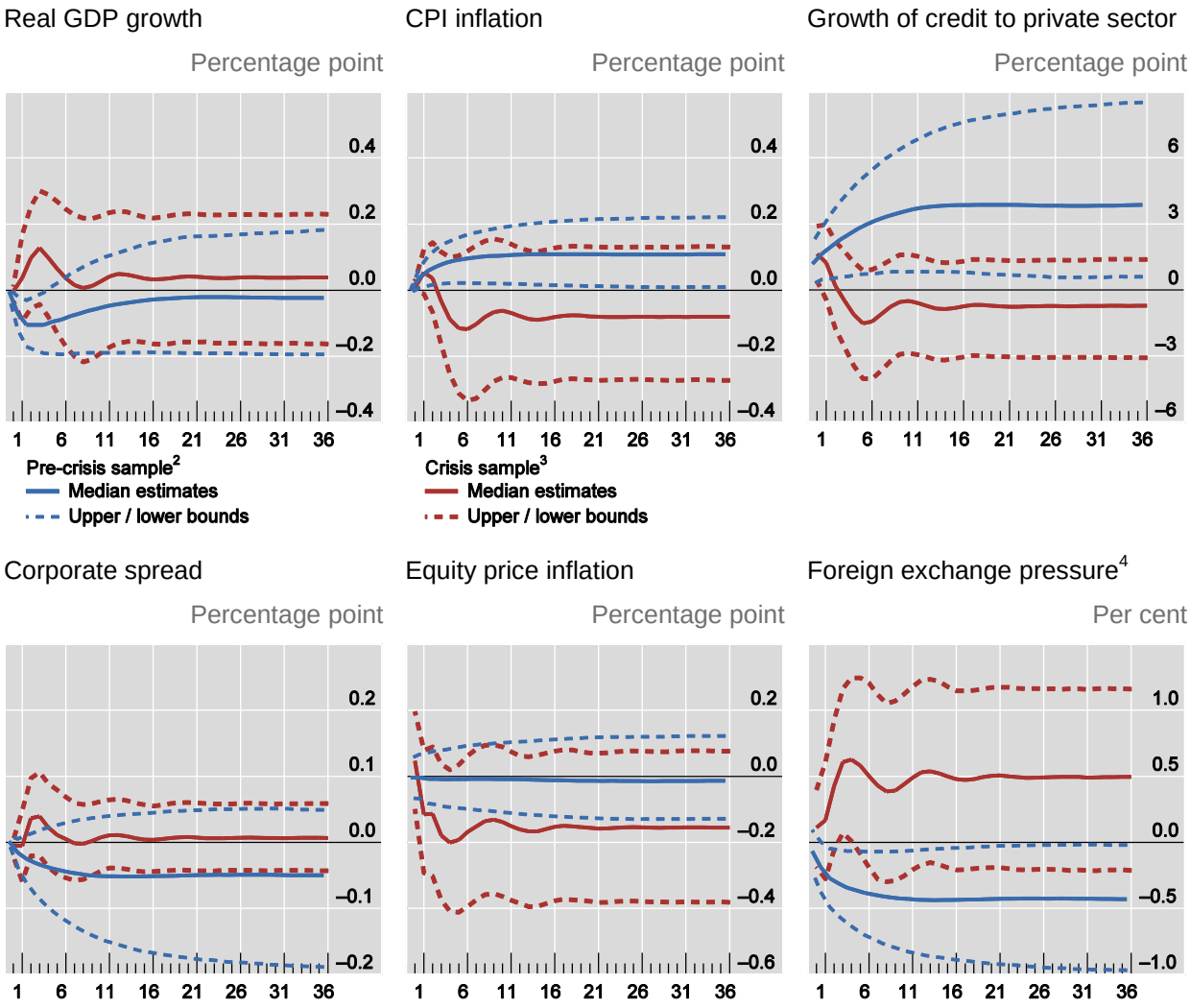
**Figure 3.2.3 Impulse Responses to a US Corporate Spread Shock: United States[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

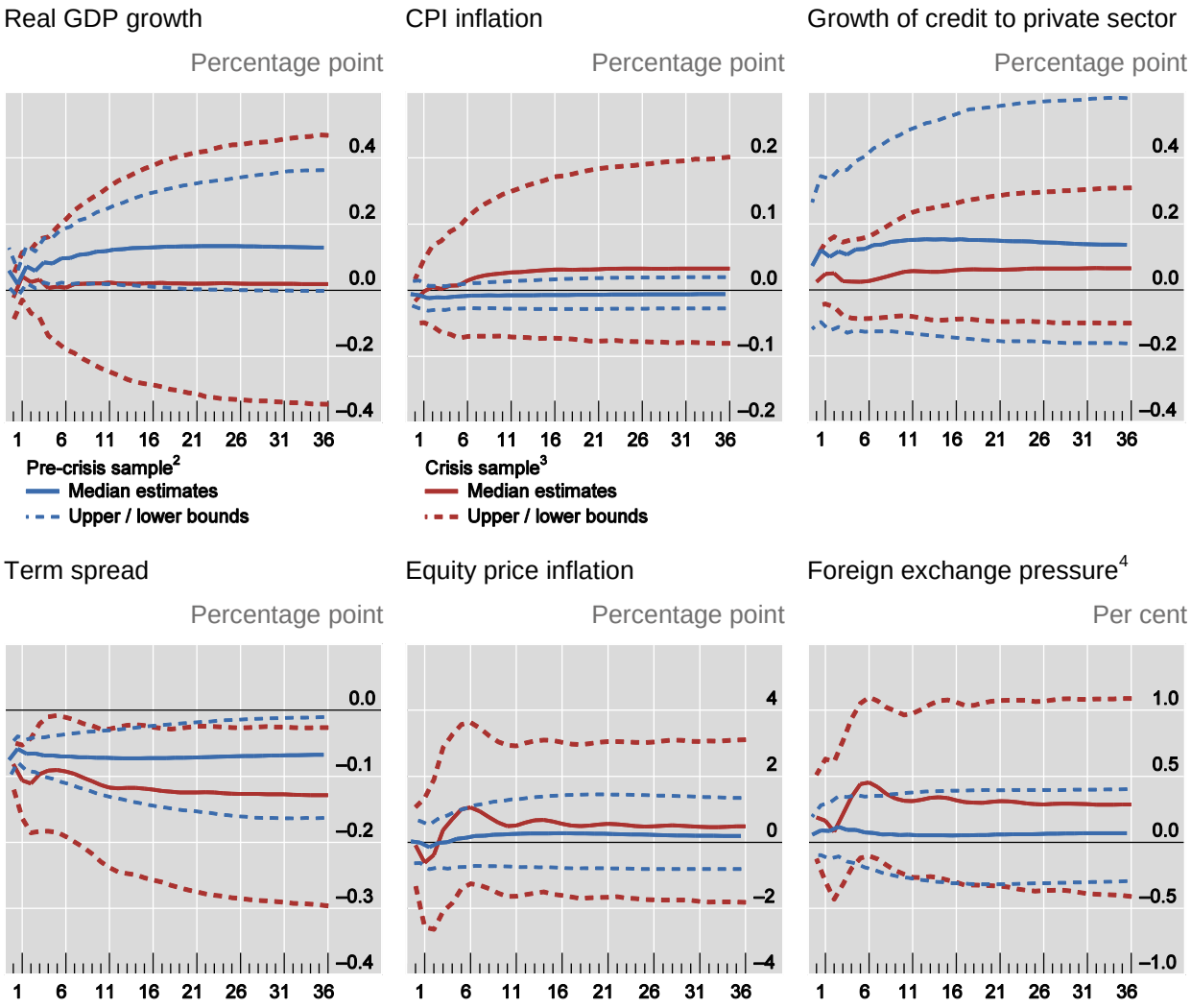
**Figure 3.2.4 Impulse Responses to a US VIX Shock: United States[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

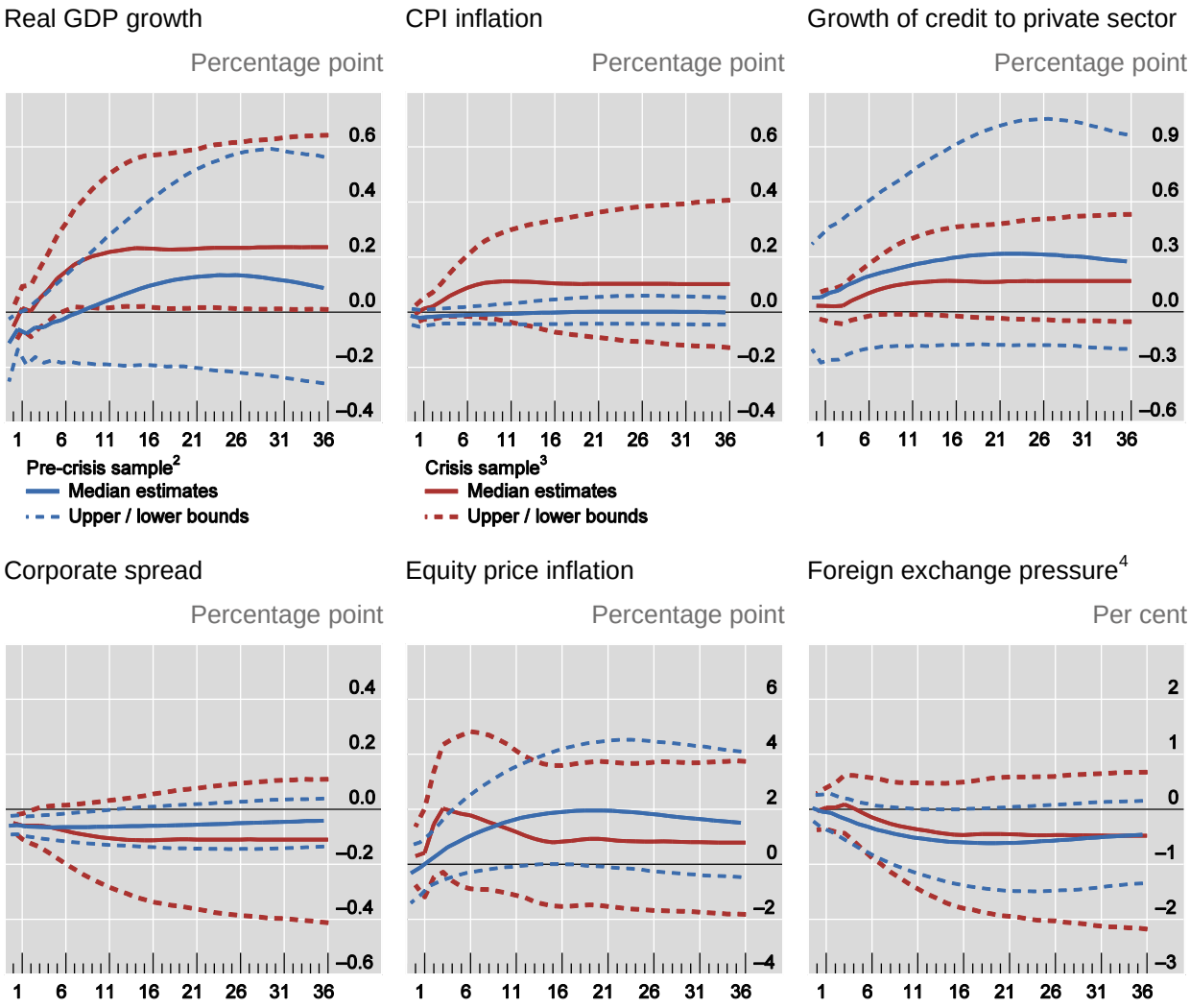
**Figure 3.2.5 Impulse Responses to a US Term Spread Shock: Euro Area[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

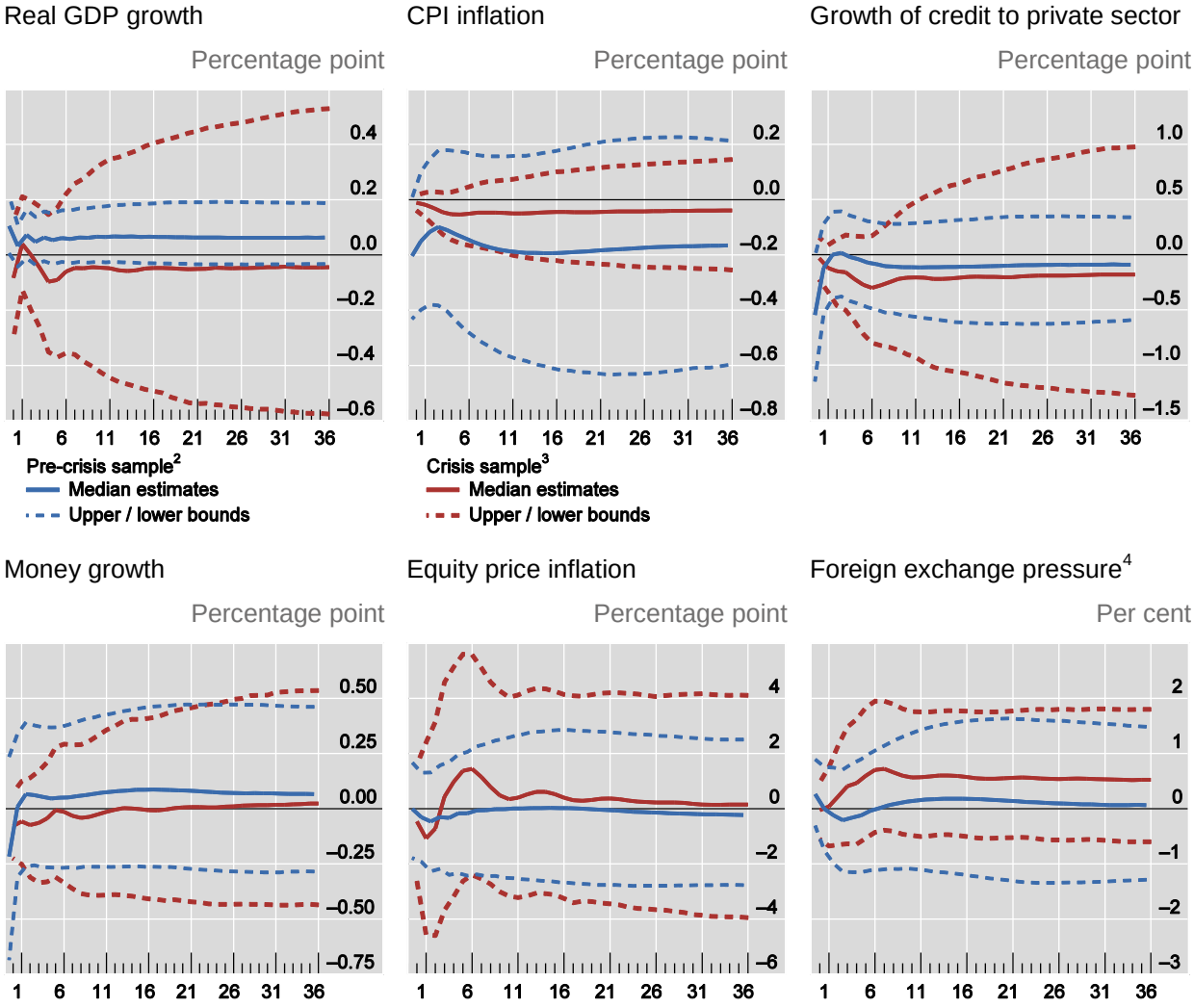
**Figure 3.2.6 Impulse Responses to a US Corporate Spread Shock: Euro Area[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

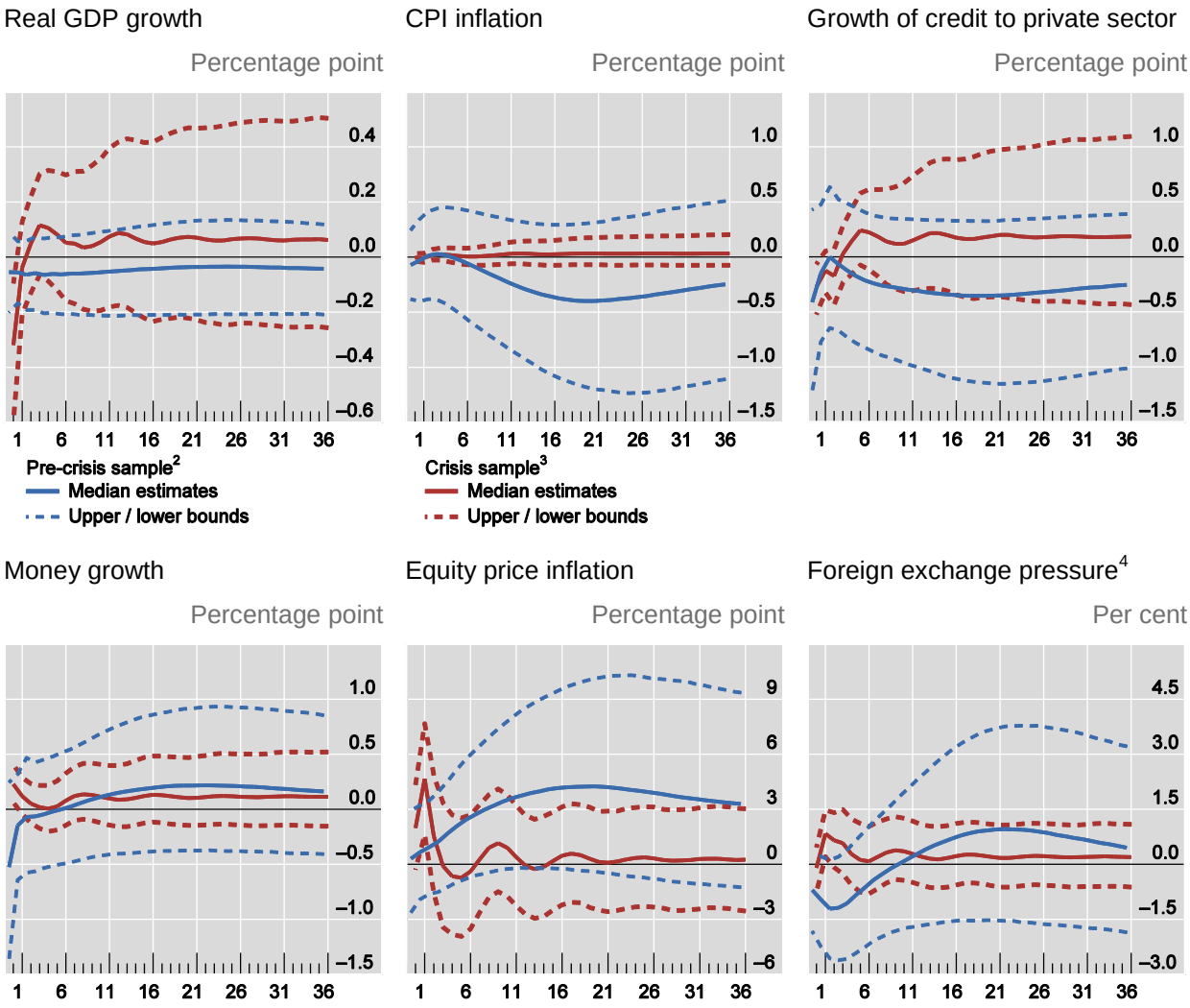
**Figure 3.2.7 Impulse Responses to a US Term Spread Shock: Brazil[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

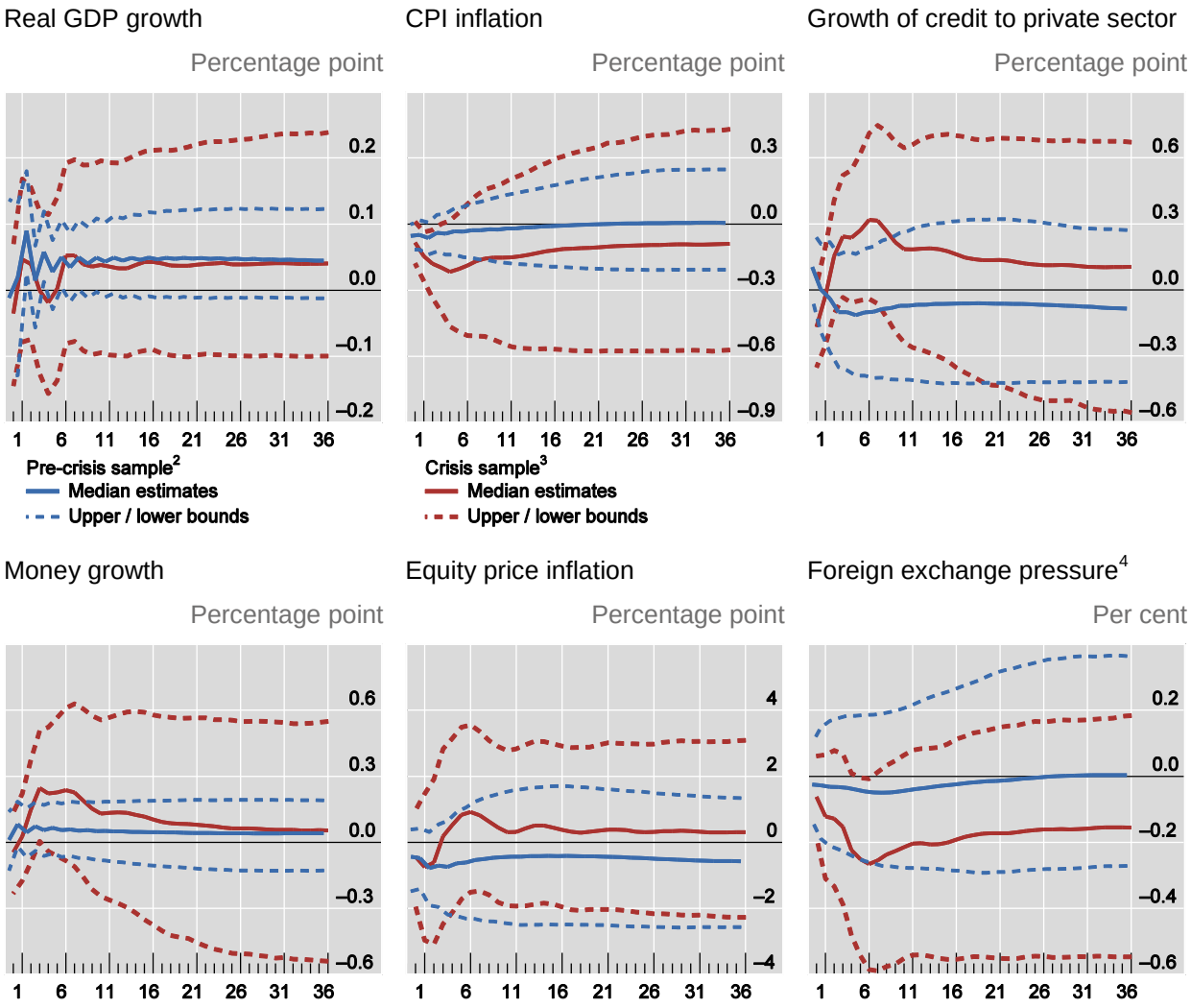
**Figure 3.2.8 Impulse Responses to a US Corporate Spread Shock: Brazil[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

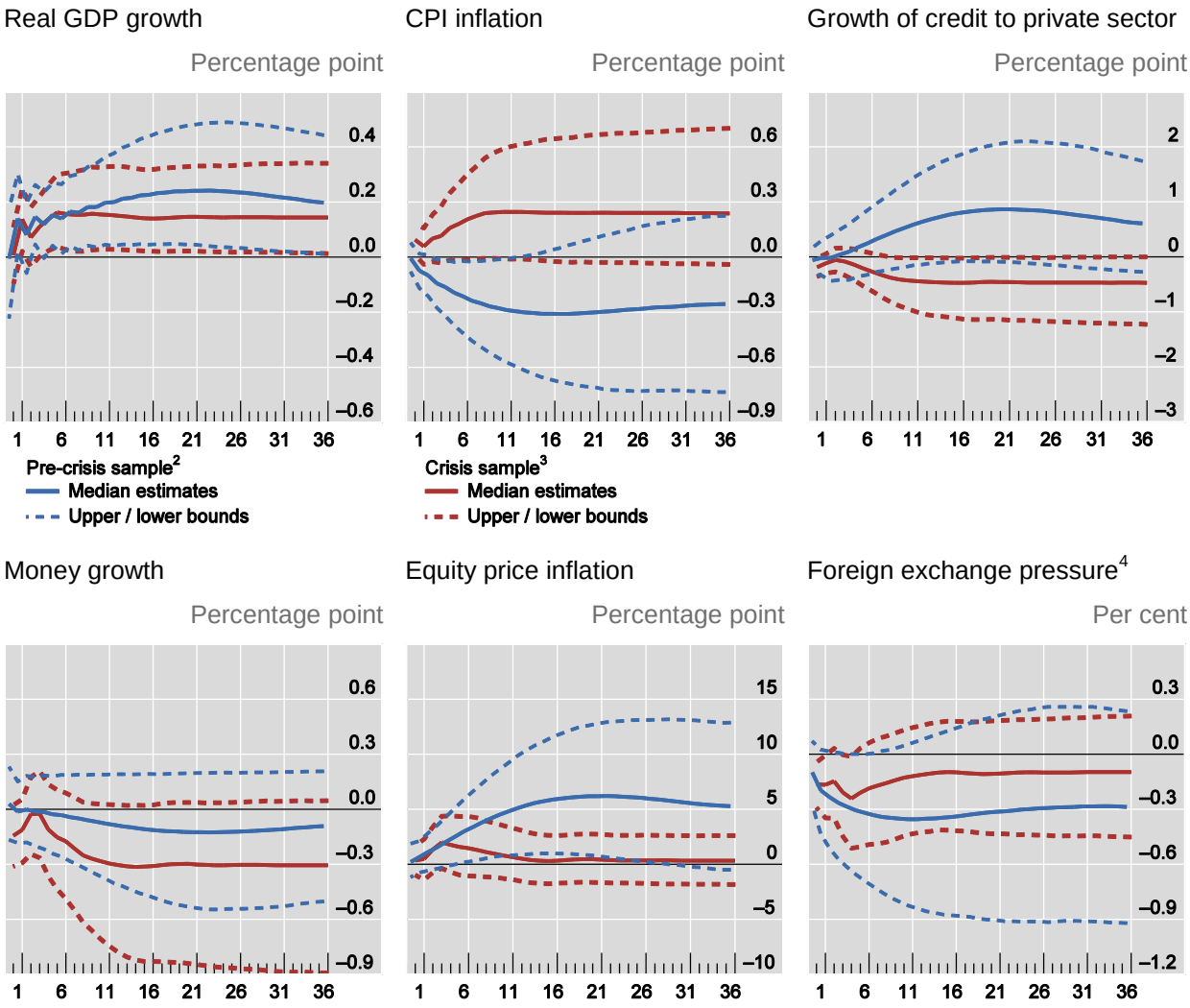
**Figure 3.2.9 Impulse Responses to a US Term Spread Shock: China[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.2.10 Impulse Responses to a US Corporate Spread Shock: China[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

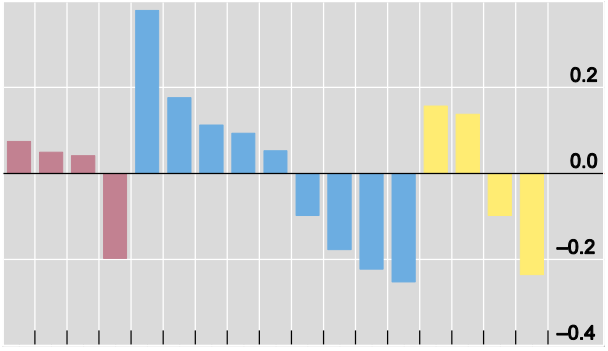
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.2.11 Maximum Impulse Responses to a US Term Spread Shock[1]**

Crisis sample[2]

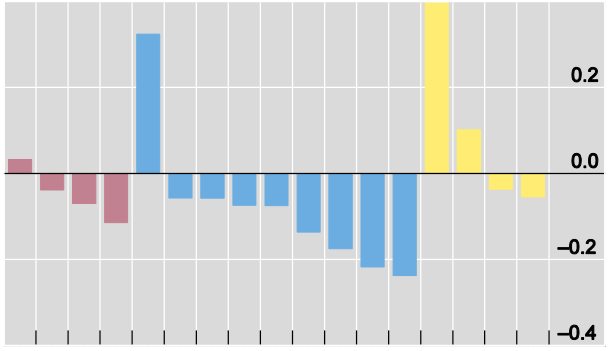
Real GDP growth

Percentage points



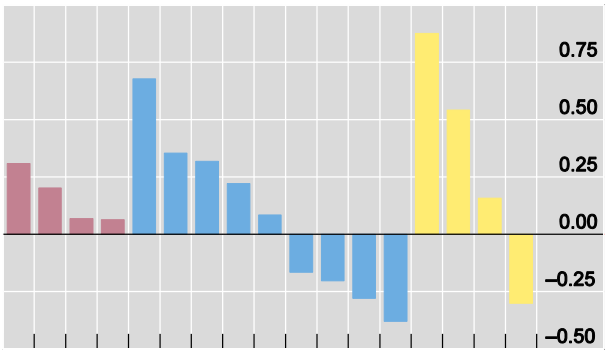

CPI Inflation

Percentage points



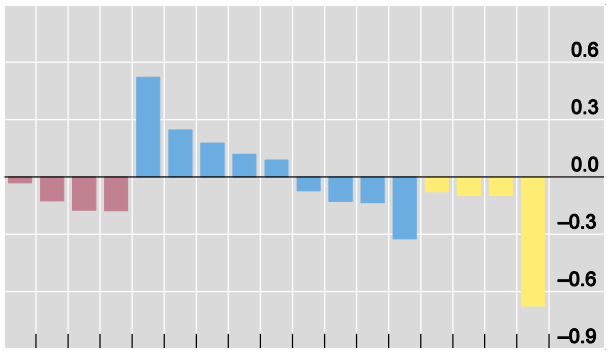

Credit growth to the private sector

Percentage points



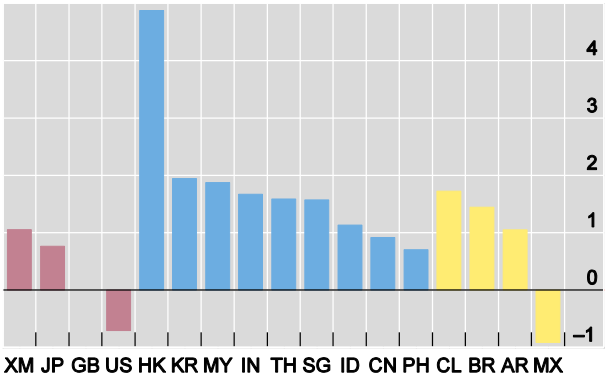

Monetary policy indicator[3]

Percentage points



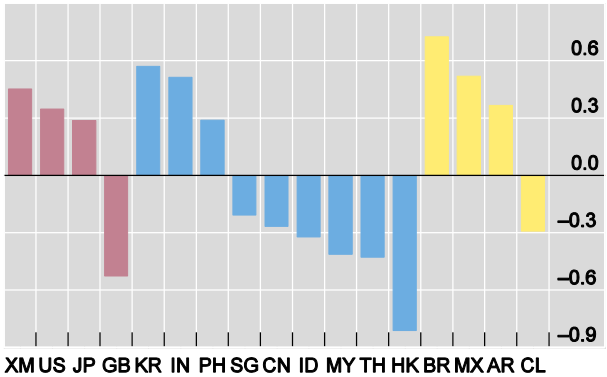

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US term spread shock is a one-standard deviation (i.e. 14.6 basis points) negative innovation to US term spread. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use term spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

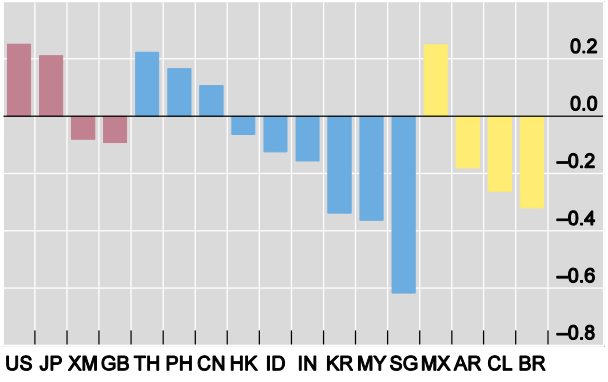
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.2.12 Maximum Impulse Responses to a US VIX Shock[1]**

Crisis sample[2]

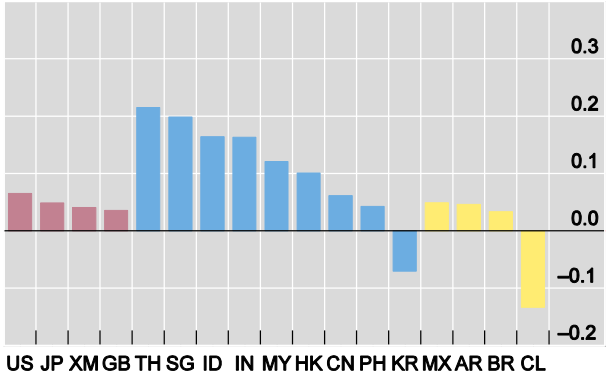
Real GDP growth

Percentage points



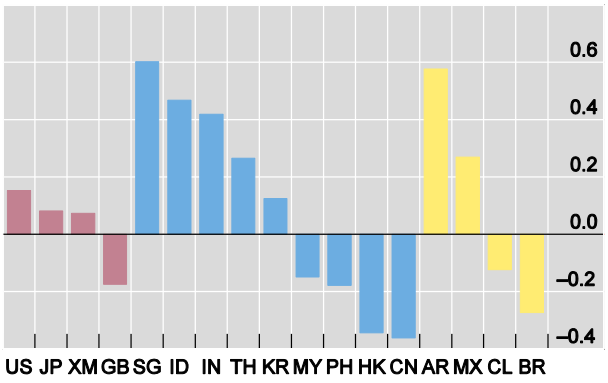

CPI Inflation

Percentage points



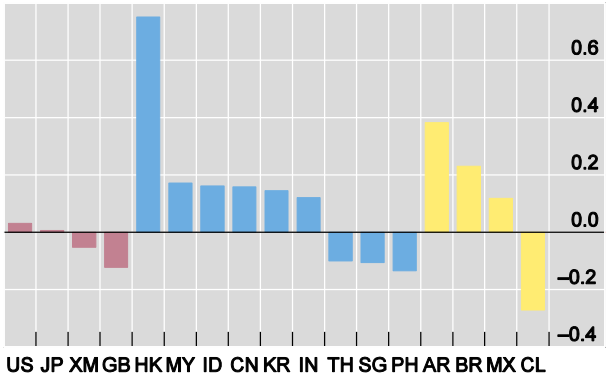

Credit growth to the private sector

Percentage points



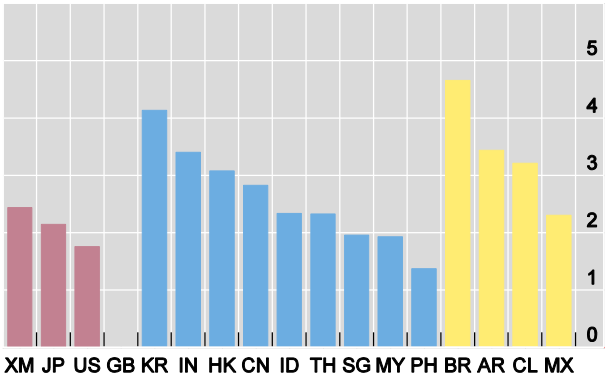

Monetary policy indicator[3]

Percentage points



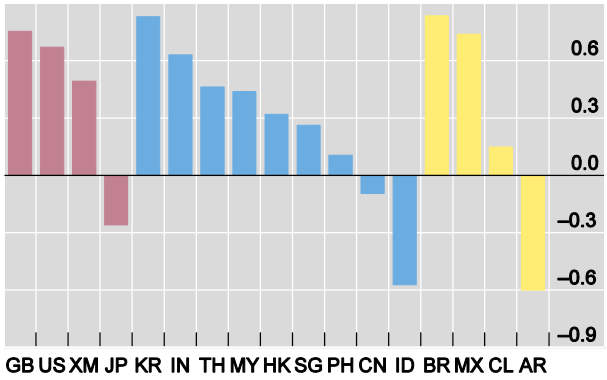

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use term spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

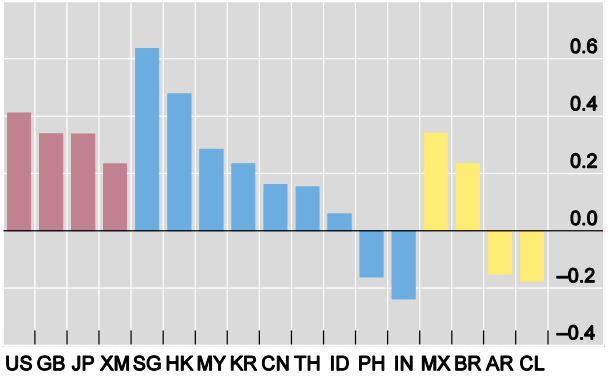
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.2.13 Maximum Impulse Responses to a US Corporate Spread Shock[1]**

Crisis sample[2]

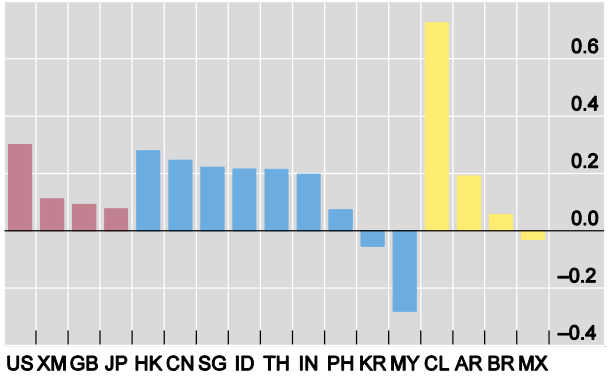
Real GDP growth

Percentage points



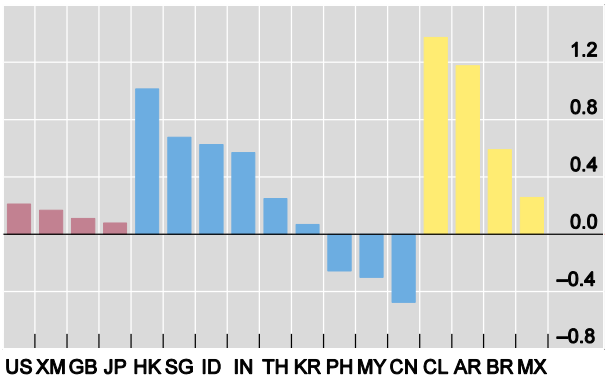

CPI Inflation

Percentage points



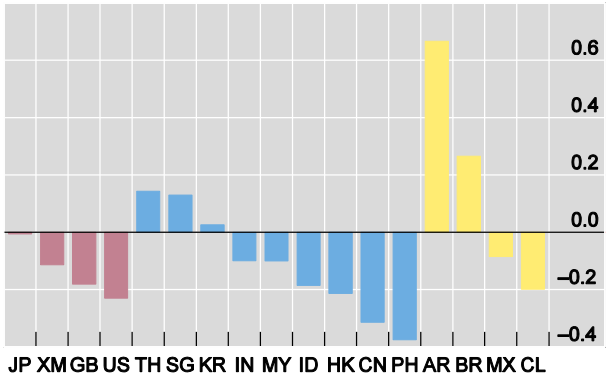

Credit growth to the private sector

Percentage points



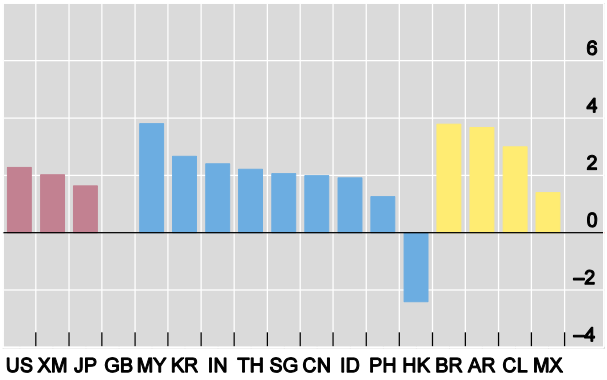

Monetary policy indicator[3]

Percentage points



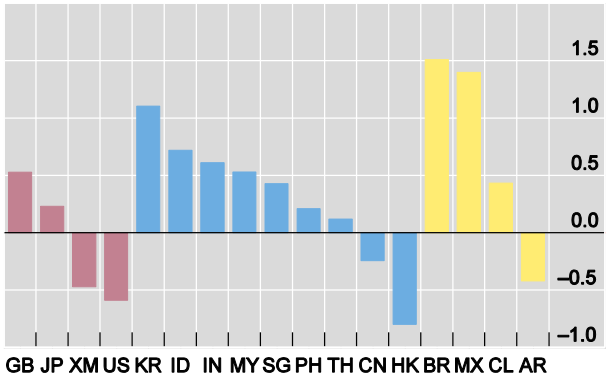

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

1 The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use corporate spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

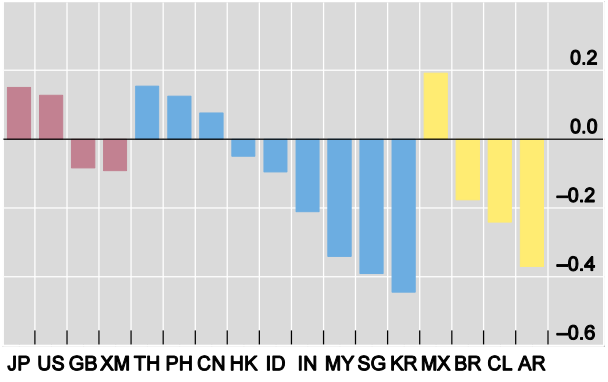
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.2.14 Maximum Impulse Responses to a US VIX Shock[1]**

Crisis sample[2]

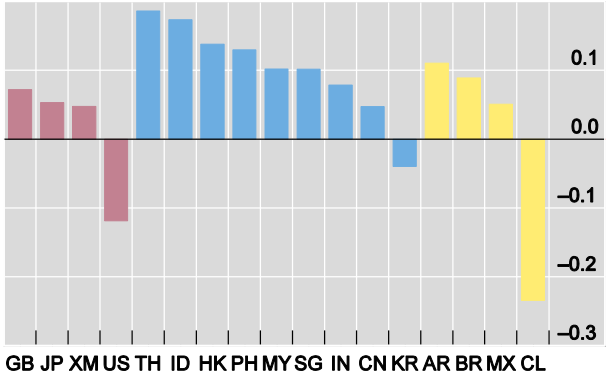
Real GDP growth

Percentage points



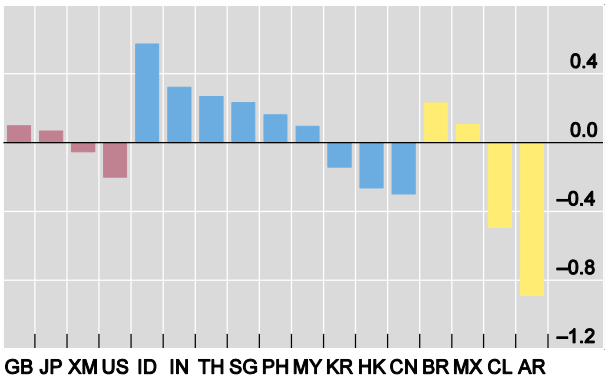

CPI Inflation

Percentage points



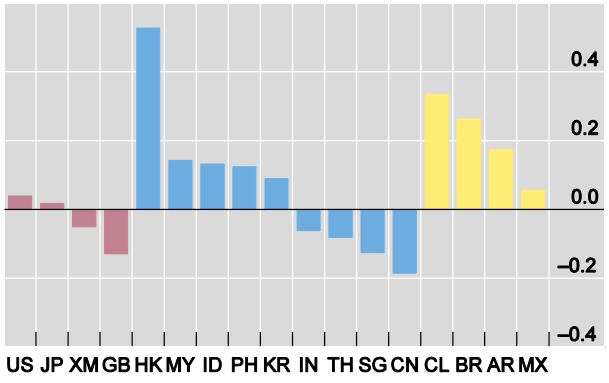

Credit growth to the private sector

Percentage points



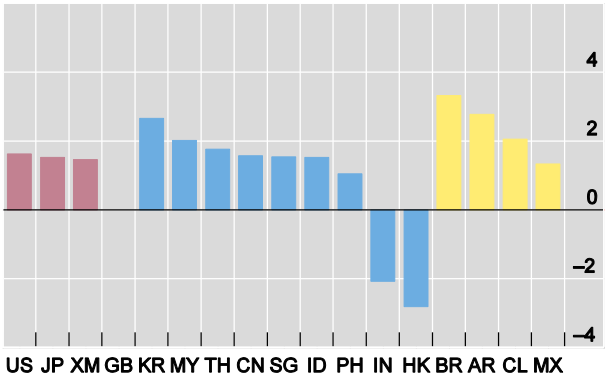

Monetary policy indicator[3]

Percentage points



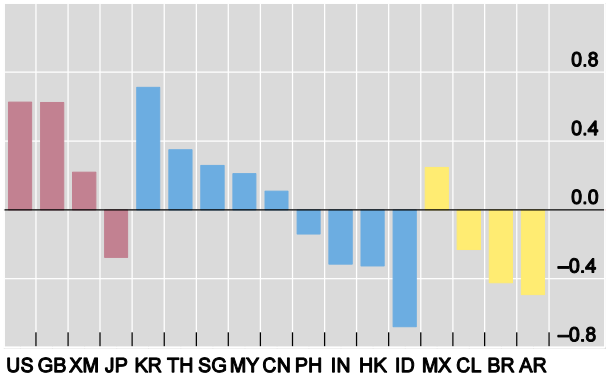

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent

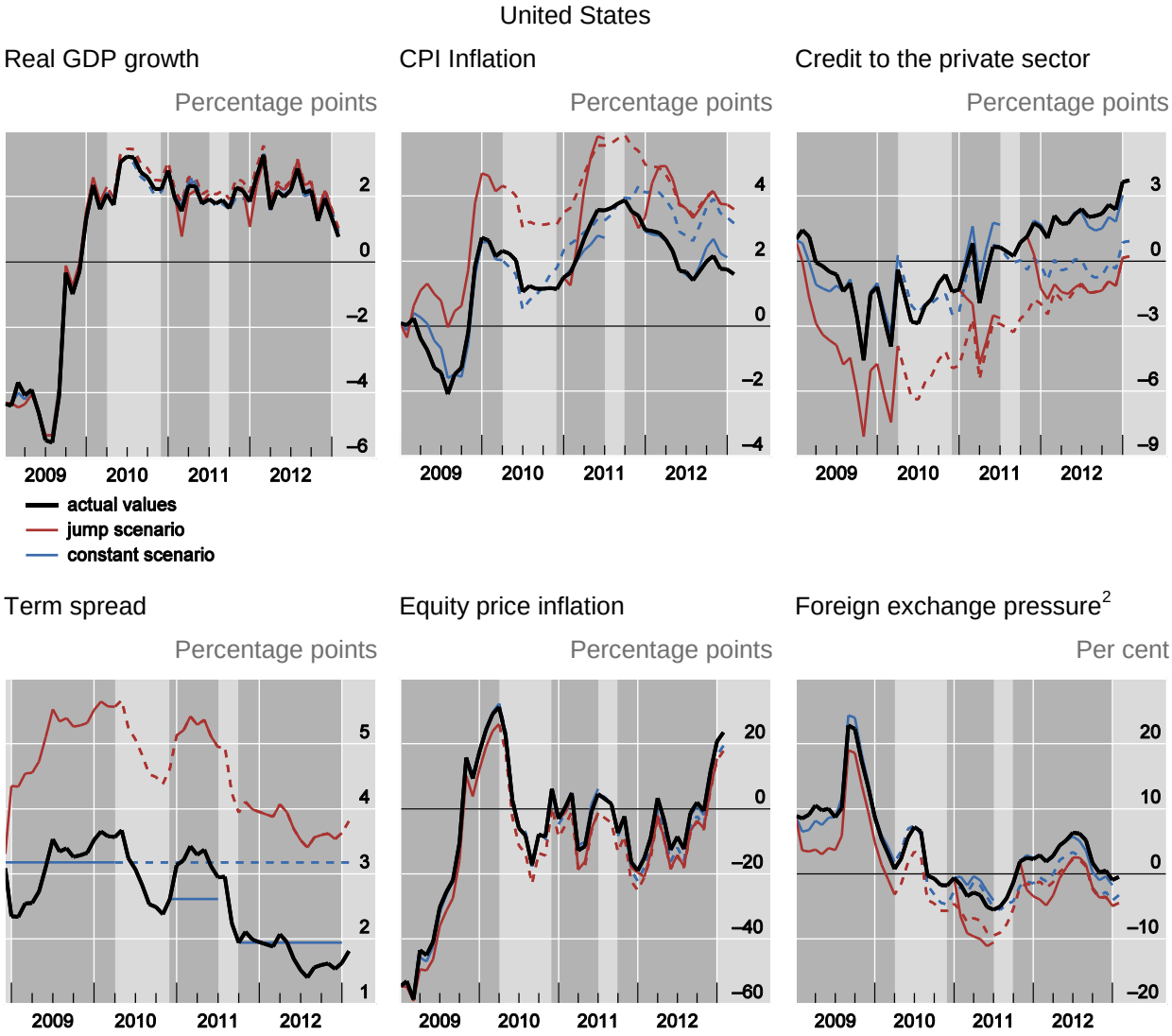



AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to CBOE Volatility Index. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use corporate spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

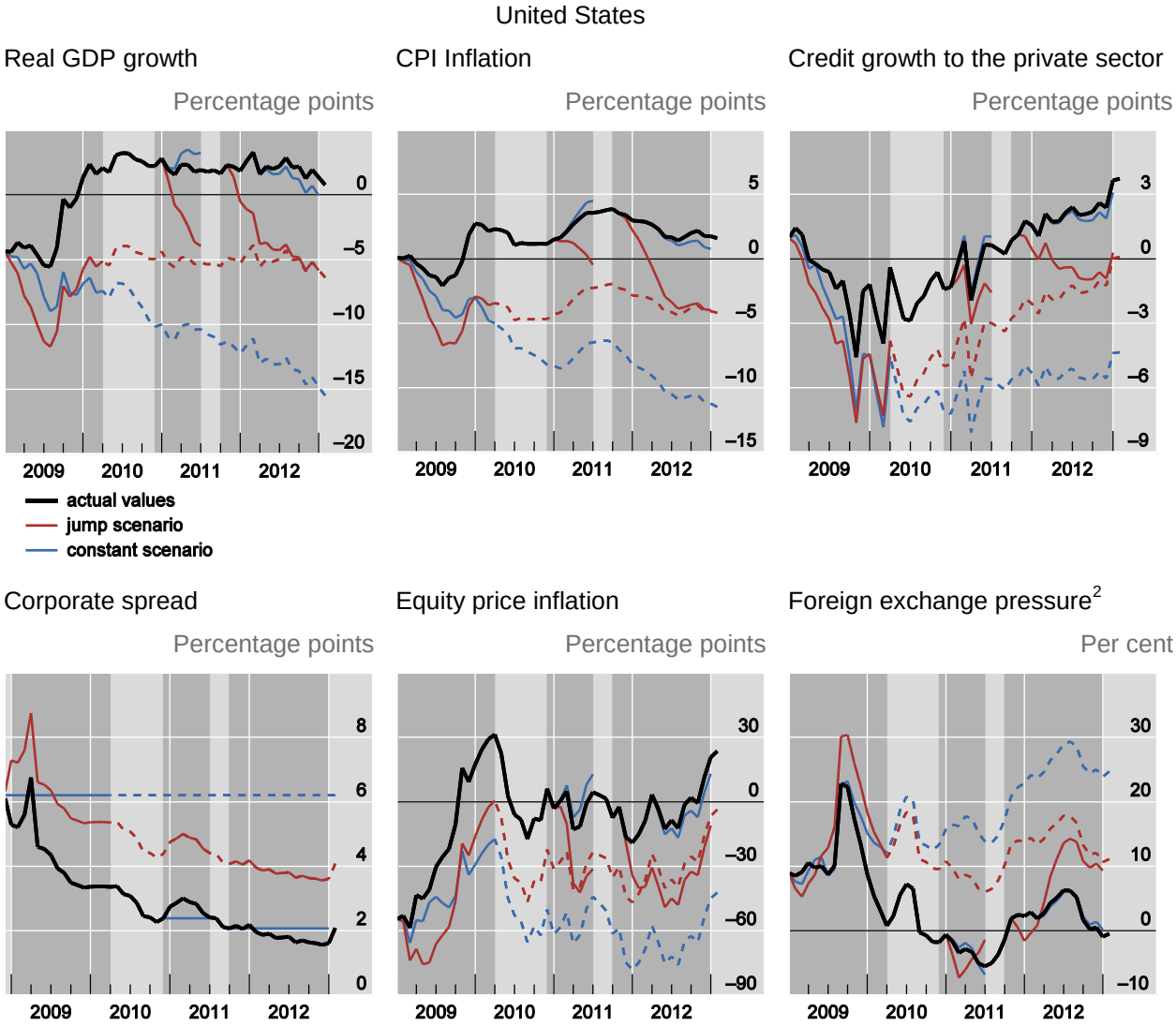
**Figure 3.3.1 Counterfactual Analysis: US Term Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

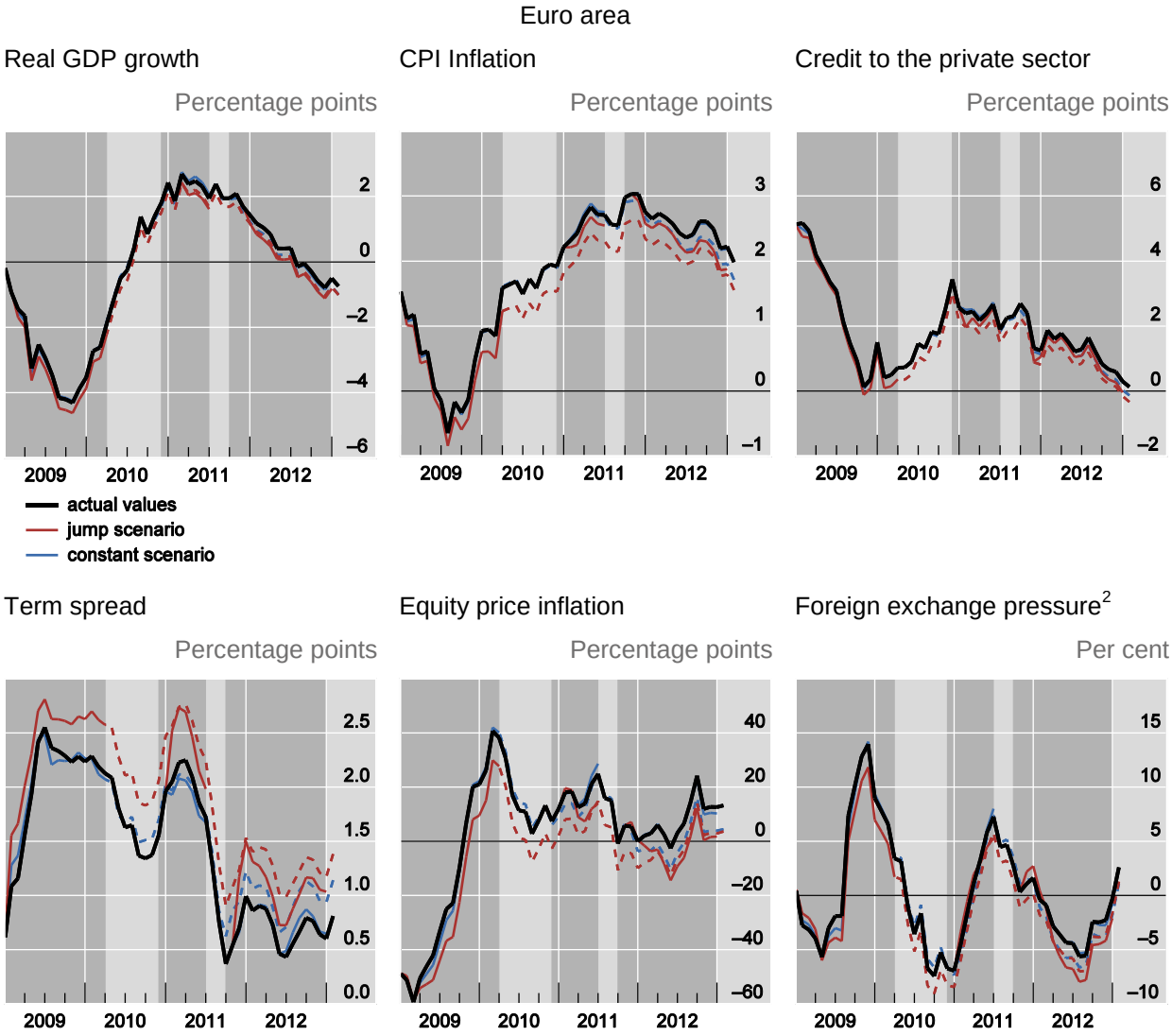
**Figure 3.3.2 Counterfactual Analysis: US Corporate Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

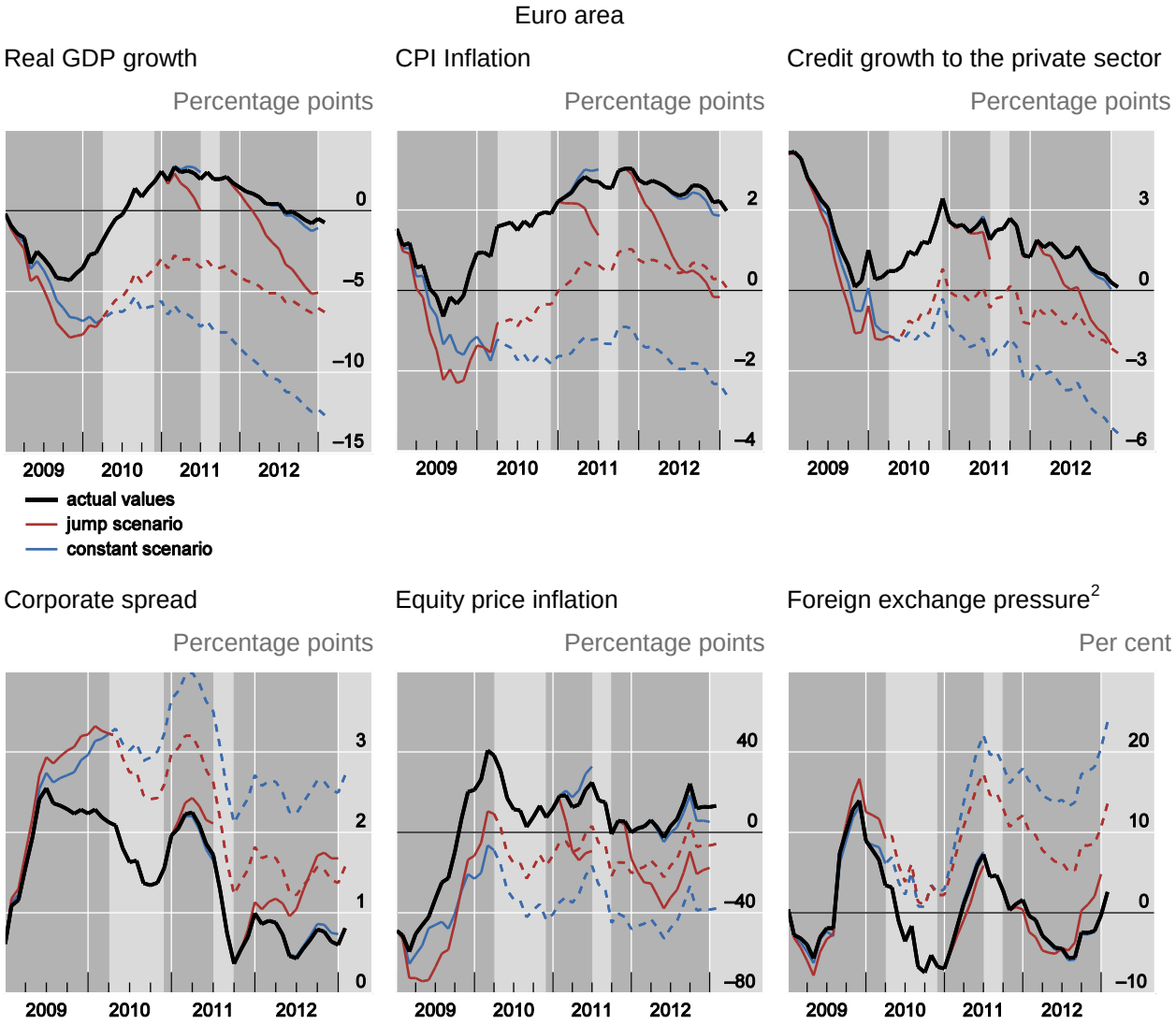
**Figure 3.3.3 Counterfactual Analysis: US Term Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

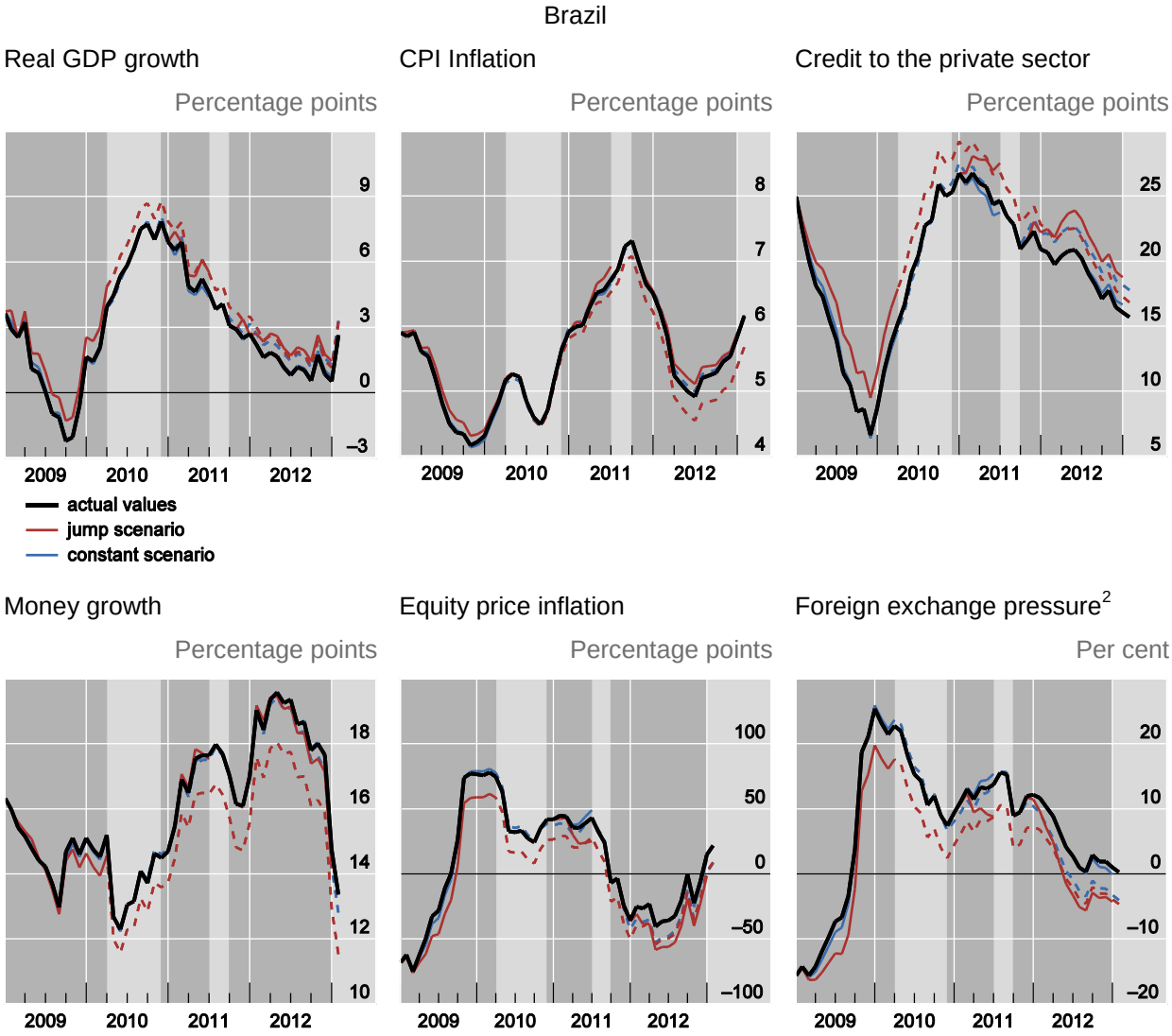
**Figure 3.3.4 Counterfactual Analysis: US Corporate Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

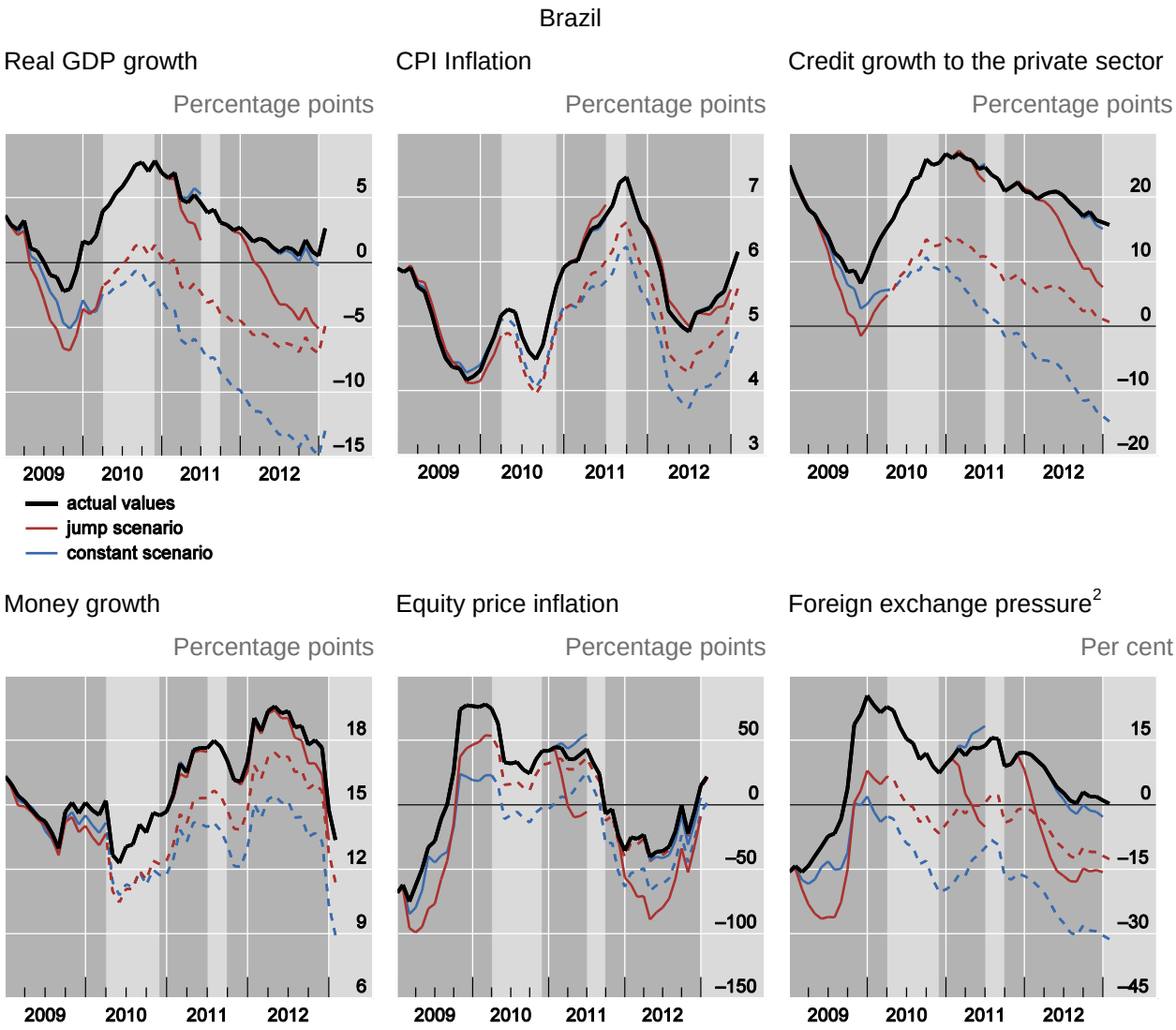
**Figure 3.3.5 Counterfactual Analysis: US Term Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.3.6 Counterfactual Analysis: US Corporate Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

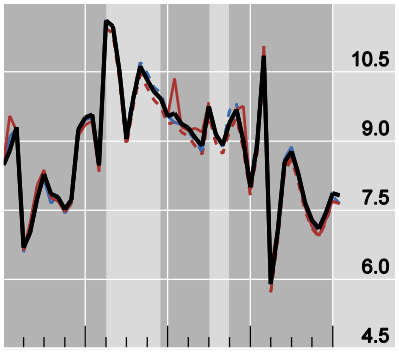
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.3.7 Counterfactual Analysis: US Term Spread[1]**

China

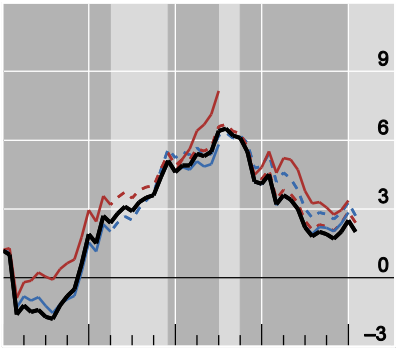
Real GDP growth

Percentage points



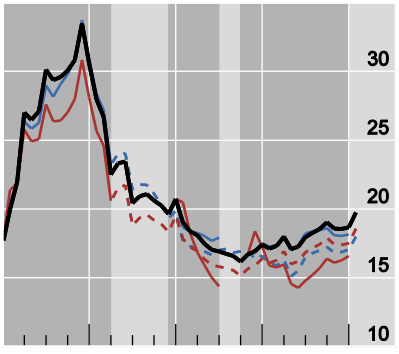

CPI Inflation

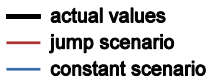
Percentage points




Credit to the private sector

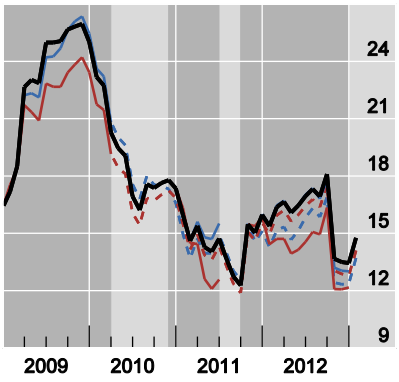
Percentage points



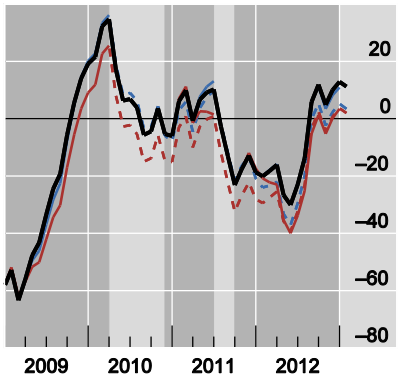

Money growth

Percentage points



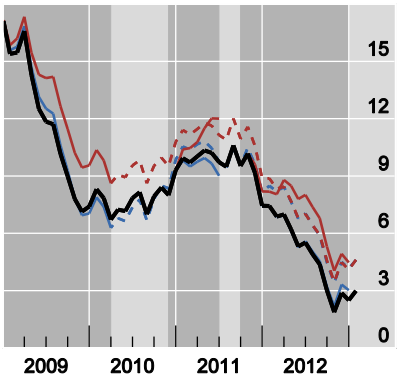

Equity price inflation

Percentage points




Foreign exchange pressure[2]

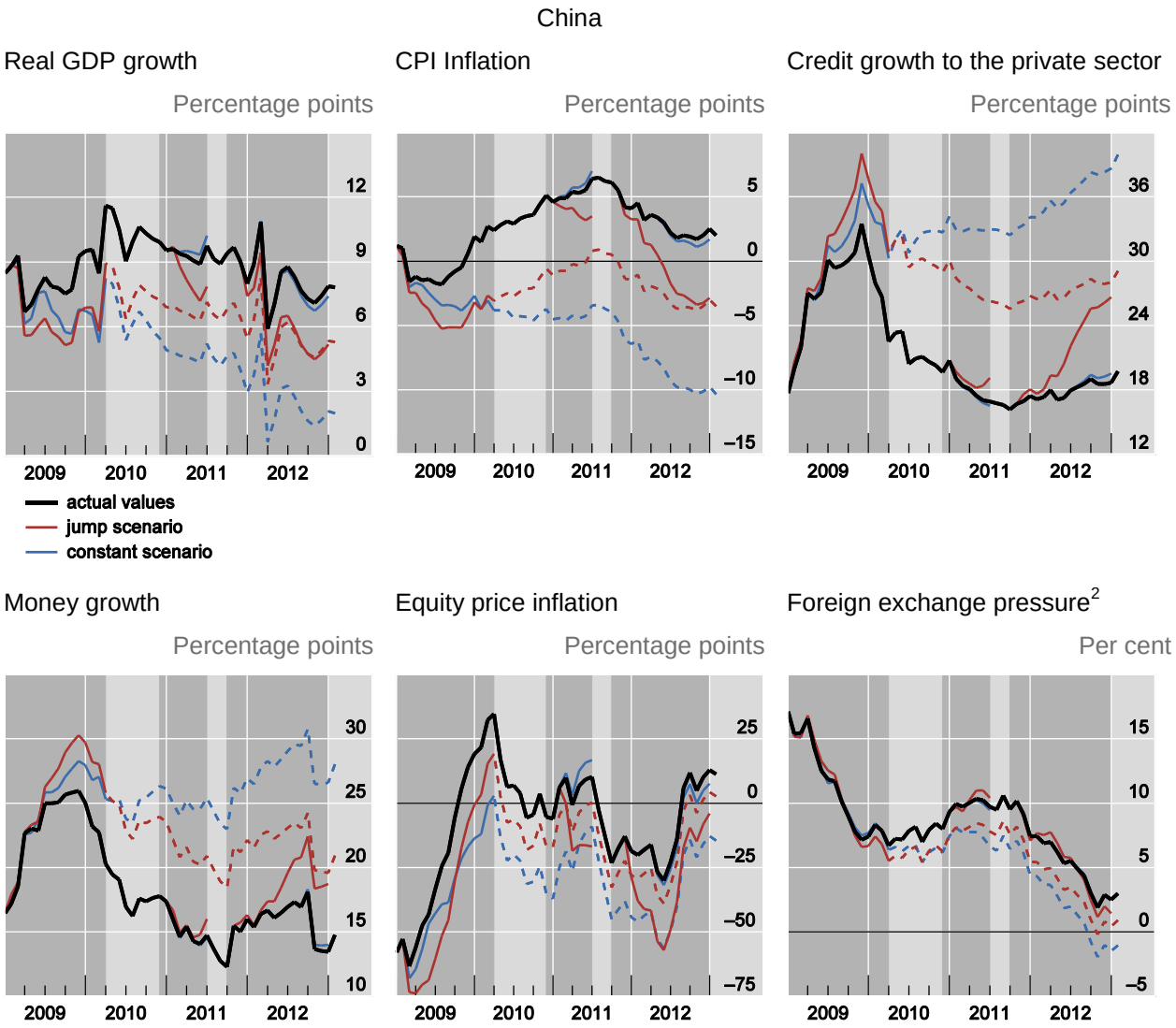
Per cent




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 3.3.8 Counterfactual Analysis: US Corporate Spread[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

# 5. Appendices: Methodology and Data

### Appendix 5.1 Structure of the GVECM Model

The structure of the Global Vector Error Correction model (GVECM) model can be described as follows. Consider $N+1$ economies, indexed by $i = 0, 1, 2, \ldots, N$ and a vector $\{x_{it}, t = 1, 2, \ldots, T\}$ of $k_i$ domestic variables for each economy. Stacking the vectors of country-specific variables,

$$\mathbf{x}_t = \left( \mathbf{x}_{0t}', \quad \mathbf{x}_{1t}', \quad ..., \quad \mathbf{x}_{Nt}' \right) \tag{1}$$

A VECM in $\mathbf{x}_t$ would contain too many parameters to be estimated if the time dimension $T$ of the data is not much larger than $N$. Instead of regressing, without any restrictions, $\mathbf{x}_{i,t}$ on

$$\mathbf{x}_{-i,t} = \left( \mathbf{x}_{0t}', \quad \mathbf{x}_{1t}', \quad ,..., \quad \mathbf{x}_{i-1,t}', \quad \mathbf{x}_{i+1,t}', \quad ,..., \quad \mathbf{x}_{N,t}' \right) \tag{2}$$

the GVECM links $\mathbf{x}_{i,t}$ to a $k_i^* \times 1$ vector $\mathbf{x}^*_{i,t}$, where

$$x^*_{\ell it} = \sum_{j=0}^{N} \omega_{\ell ij} x_{\ell jt}, \quad \ell = 1, 2, ..., k_i^*. \tag{3}$$

The weight $\omega_{lij}$ captures the spillover effect of variable l of foreign economy j on variable l of domestic economy i. Since $\omega_{lij}$ measures the relative importance of economy j to economy i, the spillover effect of variable l is in proportion to the weight chosen to measure the relative importance. Therefore, each economy's component of GVECM is given as a VARX $(p_i, q_i)$:

$$\mathbf{x}_{it} = \mathbf{a}_{io} + \mathbf{a}_{i1} \cdot t + \sum_{s=1}^{p_i} \mathbf{\Phi}_{is} \mathbf{x}_{i,t-s} + \sum_{s=0}^{q_i} \mathbf{\Lambda}_{is} \mathbf{x}^*_{i,t-s} + \sum_{s=0}^{r_i} \mathbf{\Psi}_{is} \mathbf{d}_{t-s} + \mathbf{u}_{it} \tag{4}$$

with $u_{it} \overset{iid}{\sim} (0, \sum_i)$,

where $\mathbf{d}_{t-s}$ is the observed common factor of $q \times 1$ dimension and $\boldsymbol{\varepsilon}_{it}$ is iid across time. Country-specific vector $\mathbf{x}^*_{i,t-s}$ reflects interdependence among economies and serves as a proxy for the unobserved common effects across economies. The country-specific foreign variables and common factors are treated as weakly exogenous (if confirmed by statistical tests), i.e., they are "long-run forcing" country-specific domestic variables. The term "long-run forcing" means that in the equations

for foreign variables, the coefficients on the error-correction terms are set to zero. The dynamics of foreign variables are not influenced by deviations from the long-run equilibrium path, in contrast to the dynamics of domestic variables.

The VARX can be estimated economy by economy using the ordinary least squares (OLS) method or rank-reduced approach if the cross-dependence of the idiosyncratic shock is sufficiently small; that is:

$$\sum_{j=0}^{N} Cov\left(\varepsilon_{\ell it}, \varepsilon_{sjt}\right) / N \to 0, \tag{5}$$

all $i \neq j$ , *I and s.*

From equation (3), it can be seen that

$$\mathbf{z}_{it} = \mathbf{W}_i \mathbf{x}_t \qquad i = 1, 2, \ldots, N \tag{6}$$

Where $\mathbf{z}_{it} = \left(\mathbf{x}_{it}^{'} \quad \mathbf{x}_{it}^{*'}\right)$, and where $\mathbf{W}_i$ is an appropriately defined weighting scheme. Thus, stacking (4) across $i$ , the endogenous variables can be solved for in a global system:

$$\mathbf{G}\mathbf{x}_t = \mathbf{a}_{i0} + \mathbf{a}_{i1} \cdot t + \sum_{s=1}^{p} \mathbf{\Phi}_s \mathbf{x}_{t-s} + \sum_{s=0}^{r} \mathbf{\Psi}_s \mathbf{d}_{t-s} + \mathbf{u}_t \tag{7}$$

Thus:

$$\mathbf{x}_t = \mathbf{G}^{-1}\mathbf{a}_{i0} + \mathbf{G}^{-1}\mathbf{a}_{i1} \cdot t + \mathbf{G}^{-1}\sum_{s=1}^{p} \mathbf{\Phi}_s \mathbf{x}_{t-s} + \mathbf{G}^{-1}\sum_{s=0}^{r} \mathbf{\Psi}_s \mathbf{d}_{t-s} + \mathbf{G}^{-1}\mathbf{u}_t \tag{8}$$

where $p = \max\left\{p_i, q_i\right\}$, $r = \max\left\{r_i\right\}$, and

$$G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_N W_N \end{pmatrix}, \quad H_s = \begin{pmatrix} B_{s,0} W_0 \\ B_{s,1} W_1 \\ \vdots \\ B_{s,N} W_N \end{pmatrix}, \quad u_t = \begin{pmatrix} u_{0,t} \\ u_{1,t} \\ \vdots \\ u_{N,t} \end{pmatrix}. \tag{9}$$

Equation (8) is a VAR for the complete set of domestic variables for all economies.

The advantage of the GVECM model is that it makes the estimation of (8) feasible by accounting for interdependence among economies and then estimating the partial system on an economy-by-

economy basis, which implies allowing for modelling a large number of economies. The impulse response is computed based on (8).

### Appendix 5.2 Constructing a Foreign Exchange Pressure Index

The exchange pressure index $EMP_t$ measures the pressure of capital inflows. In economies with flexible exchange rate regimes, strong net capital inflows push up the demand for domestic currency, which in turn leads to an appreciation of the domestic currency. If the authorities intervene in the foreign exchange market by purchasing foreign currency with domestic currency, we may not observe significant changes in the exchange rate of the domestic currency, but rather an increase in foreign reserves of the authorities' balance sheet. In economies with fixed exchange rate regimes, strong net capital inflows are reflected in an increase of foreign reserves only. Therefore, the foreign exchange pressure index is constructed in the following way, which is a variation of the index proposed by Eichengreen, Ross and Wyplosz (1995):

$$EMP_t = 100 \cdot (w_{t,e} e_t + w_{t,rev} rev_t)$$

where

$w_{t,X} = \dfrac{\sigma_{t,X}^{-1}}{\sigma_{t,e}^{-1} + \sigma_{t,rev}^{-1}}$ for $X = e, rev$, with $\sigma_t$ being the standard deviation of the corresponding variable in the previous five years, for weights of the sixth year onward. For weights of the first five years, the standard deviation computed from data covering the first five years is used.

Moreover, $e_t = \ln(E_t) - \ln(E_{t-12})$ and $rev_t = \ln(R_t) - \ln(R_{t-12})$, where $E_t$ is the NEER and $R_t$ denotes the foreign reserves.

### Appendix 5.3 Constructing Time-Varying Weights for Foreign Variables

The weight of country I assigned to country j at year t is written as

$$W_{ij,t}^{agg} = w_{i,t}^T W_{ij,t}^T + w_{i,t}^F W_{ij,t}^F, \text{ for all } i \neq j,$$

where $W_{ij,t}^T$ and $W_{ij,t}^F$ are the bilateral trade and financial weight computed based on the capital inflow and outflow in the previous year. $w_{i,t}^T$ and $w_{i,t}^F$ are the relative importance of trade flow and capital flow in a country respectively. They are computed according to the value of the respective aggregate trade flow (export and import) and capital flow (capital inflow and outflow) relative to the total value of

these two types of flow in the previous year. The financial weight of countries without capital flow data in the 1990s is set to zero.

**Appendix 5.4 Data**

Data sources include the Bank for International Settlement (BIS), the International Monetary Fund's International Financial Statistics, CEIC, Bloomberg and Datastream.

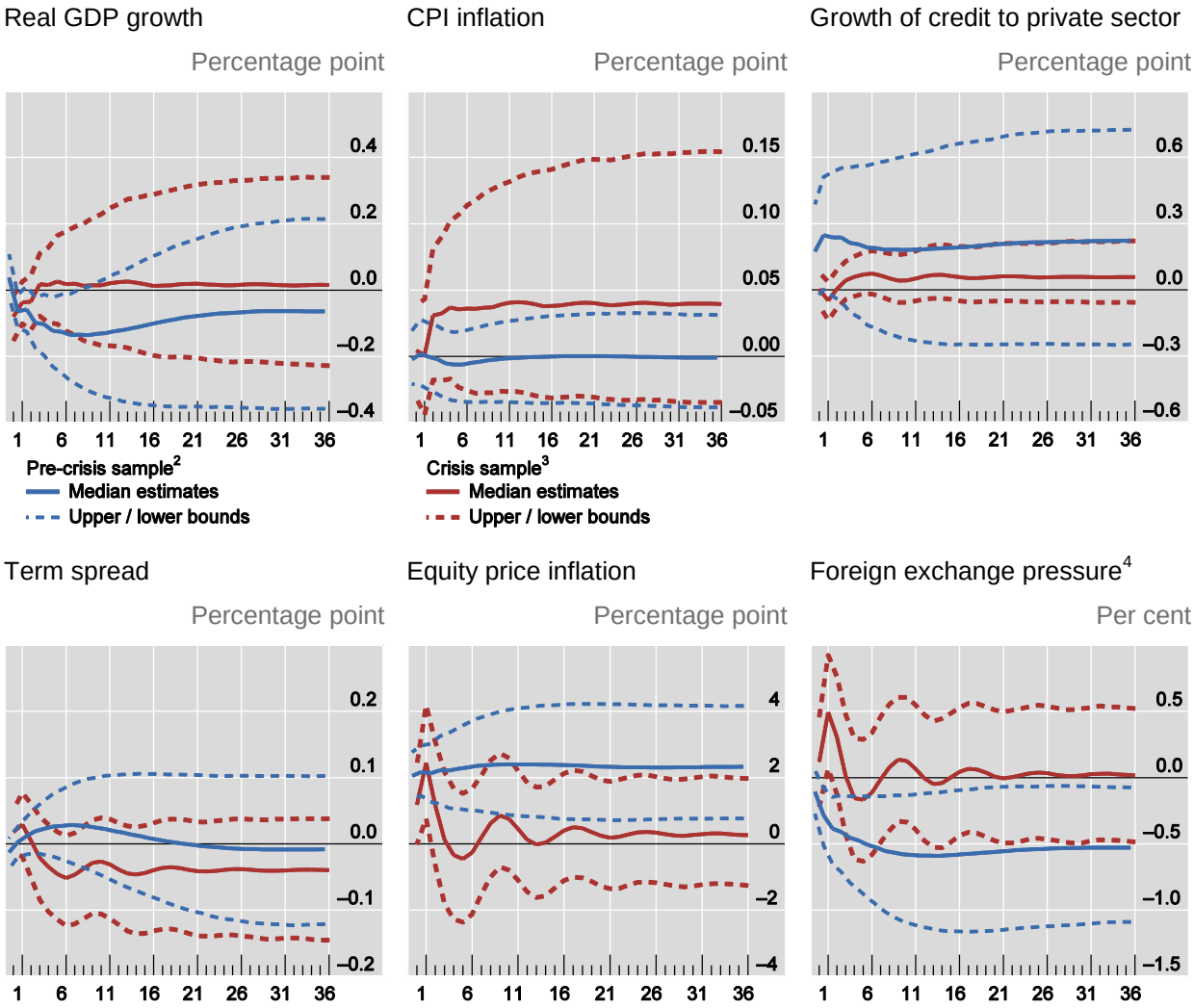
| Variable | Description | Source | Notes |
|---|---|---|---|
| Real GDP | | IMF IFS, national data | Real GDP of China is at 1990 prices, those of other countries at 2005 prices (billions of domestic currency units). The monthly time series are interpolated using method of Chow and Lin (1971) with industrial production series as a reference. Series for HK is interpolated using compound growth rate due to unavailability of monthly industrial production. |
| CPI inflation | Year-on-year change in consumer price index | CEIC, IMF IFS, national data | |
| Credit to the private sector | | | In billions of domestic currency units. Data before Sept. 1997 is computed using growth rate of banks' loan to non-government and non-banks; for China, data before Jun 1999 is interpolated from quarterly data, using monthly data on loans in China with Chow and Lin (1971) method. |
| Term Spread | Interest rate spreads between 10-year and 3-month Treasury bill yield | CEIC, IMF, IFS, national data | For euro are, due to data limitations, the main refinancing rate is used in the stead of 3-month government bond yield. |
| Corporate Spread | BofA Merrill Lynch US Corporate AAA minus BBB. | CEIC, IMF, IFS, national data | For euro area, due to data limitations, the main refinancing rate is used in the stead of 3-month government bond yield. |
| VIX | CBOE Volatility Index; In natural logarithm | CBOE | VIX is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. |
| Money Growth | Year-on-year M2 growth rate | CEIC, IMF IFS | Billions of domestic currency units. |
| Equity price inflation | Stock price index | Bloomberg | Index of stock prices in each country is in "List of Stock Price Index". |
| | Nominal effective exchange rate | BIS | Period average; 2005 = 100. |
| Foreign Exchange Pressure | Foreign Reserve | IMF IFS | Total reserves minus gold, in billions of USD. Euro area data starting from Jan 1999 are official reserves as published by ECB; data before 1999 either is estimated or is the aggregate reserves of 11 EU Member States participating in the euro area in 1999. |
| Oil price | spot oil price | IMF IFS | Brent crude oil, US dollar per barrel; period end data. |
| Export/import | | IMF IFS | Millions of USD. |
| Cross-border bank lending | BIS reporting banks' cross-border claims | BIS | |
| Capital inflow/outflow | | IMF IFS | |

| List of stock price index | |
|---|---|
| United Kingdom | FTSE 100 Index |
| Japan | Nikkei 225 Index |
| United States | S&P 500 Index |
| Euro area | Euro Stoxx 50 (Price) Index |
| China | Shanghai A-share Stock Price Index |
| Hong Kong SAR | Hang Seng Index |
| India | Bombay Stock Exchange Sensitive Index |
| Korea | KOSPI Index |
| Indonesia | Jakarta Equity price inflation Index |
| Malaysia | FTSE Bursa Malaysia KLCI Index |
| Philippines | Philippine Stock Exchange PSEi Index |
| Singapore | FTSE Straits Times Index |
| Thailand | Bangkok SET Index |
| Argentina | Buenos Aires Stock Exchange Merval Index |
| Brazil | São Paulo Stock Exchange Boverspa Index |
| Chile | Santiago Stock Exchange IGPA Index |
| Mexico | Mexican IPC Index |

## Appendix 5.5 Additional Figures Based on GVECM Model Estimates

### Appendix 5.5.1 Impulse Responses to US Term Spread and VIX Shocks

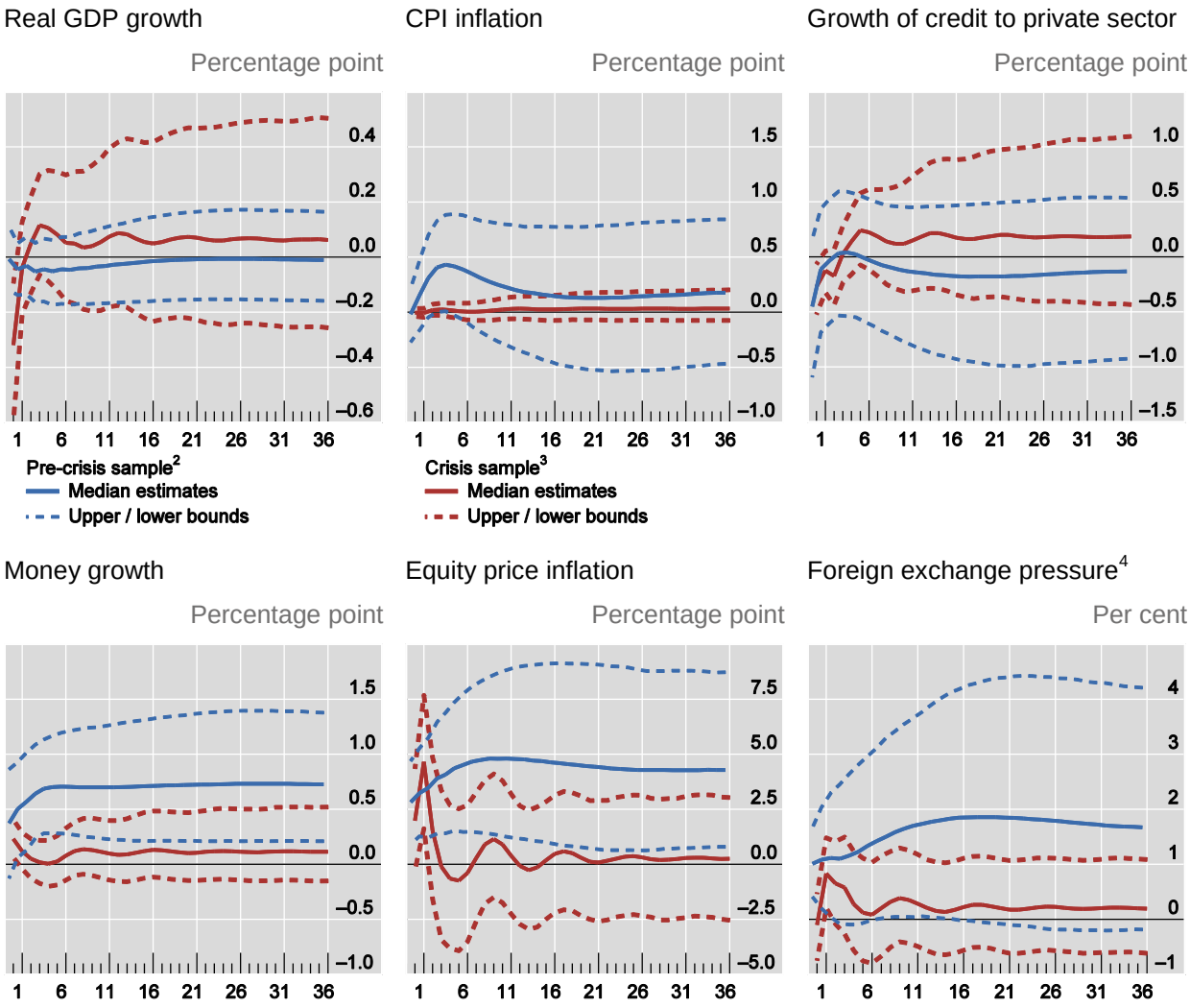
**Figure 5.5.1.1 Impulse Responses to a US VIX Shock: Euro Area[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

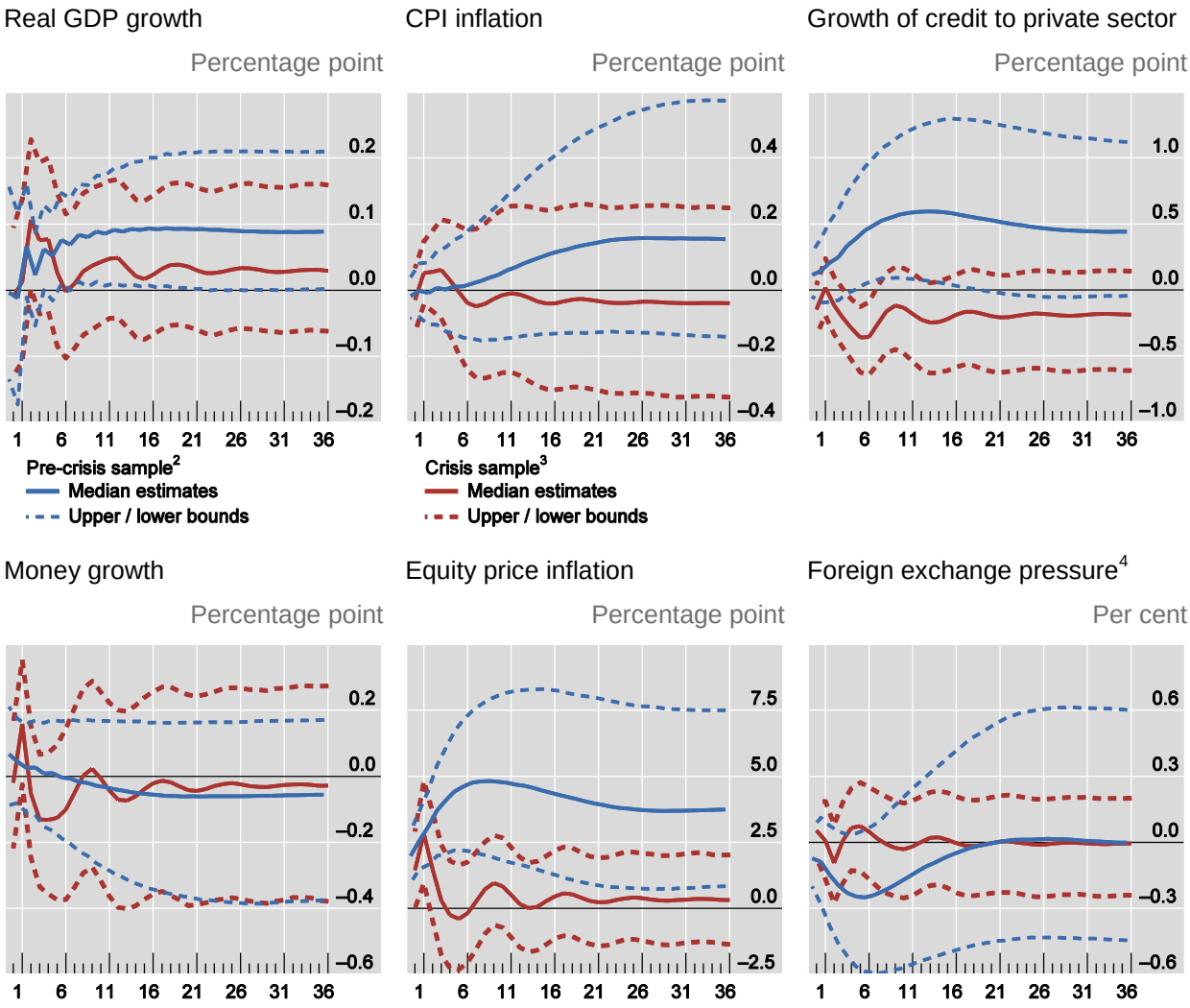
**Figure 5.5.1.2 Impulse Responses to a US VIX Shock: Brazil[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

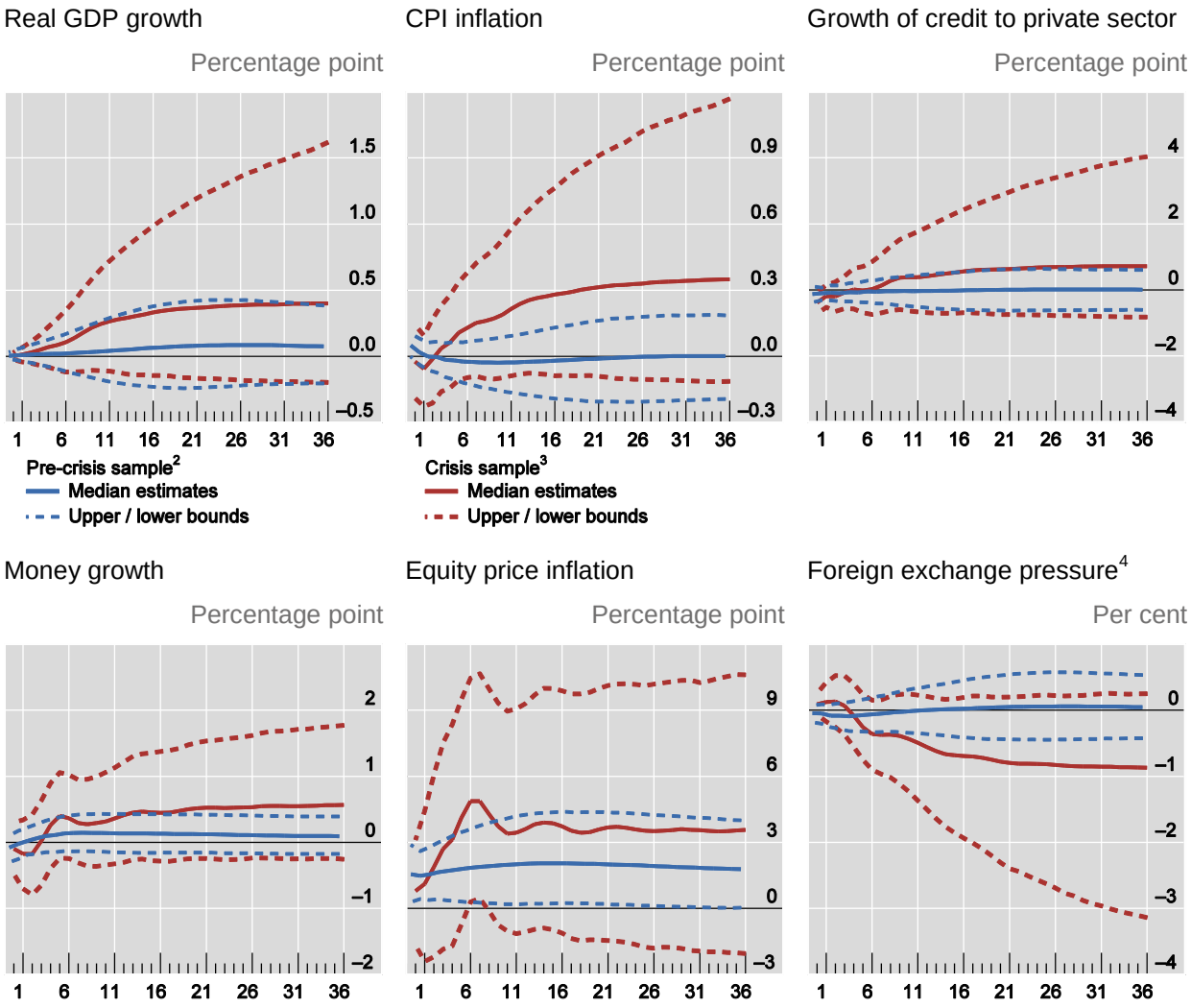
**Figure 5.5.1.3 Impulse Responses to a US VIX Shock: China[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

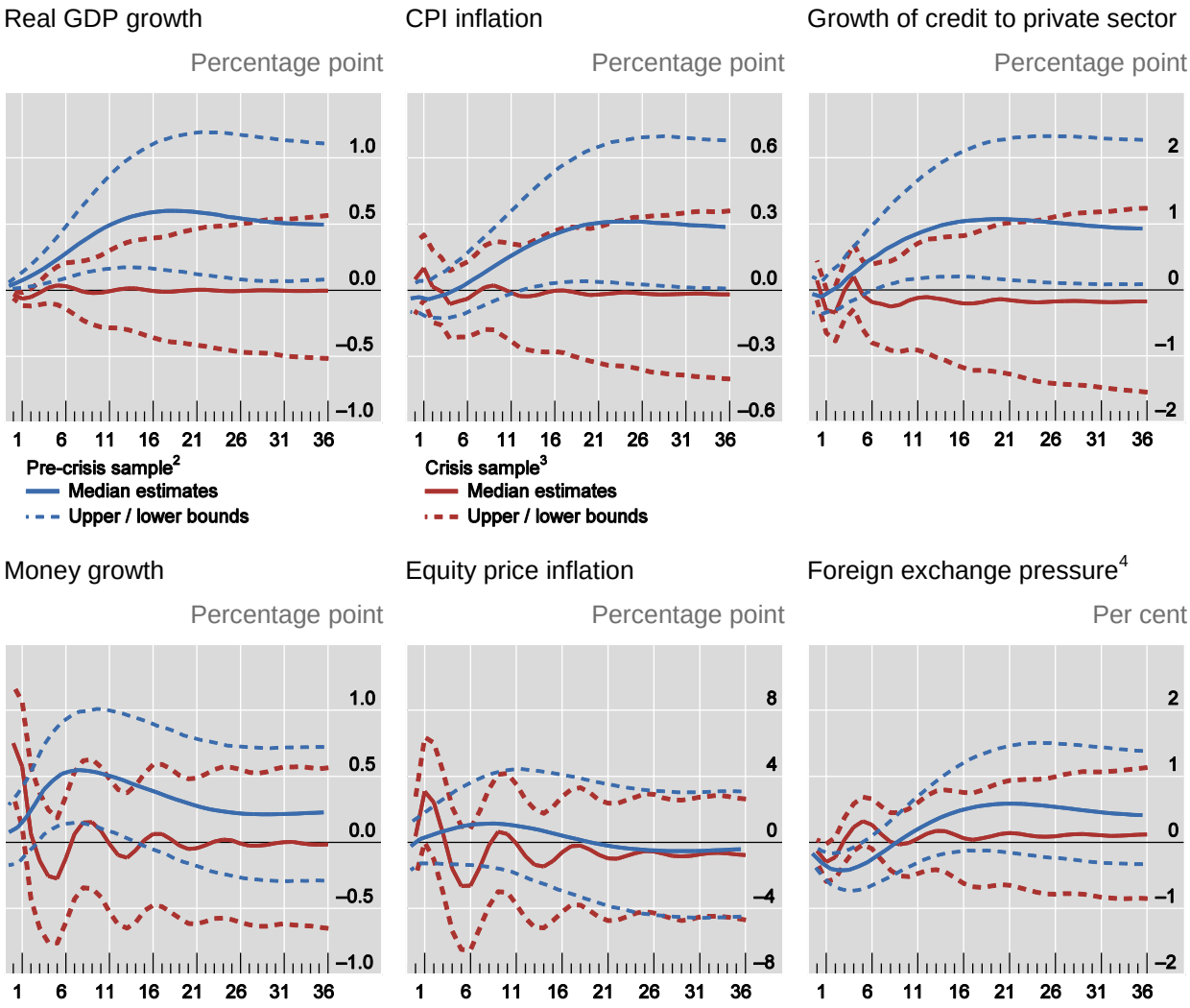
**Figure 5.5.1.4 Impulse Responses to a US Term Spread Shock: Hong Kong SAR[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

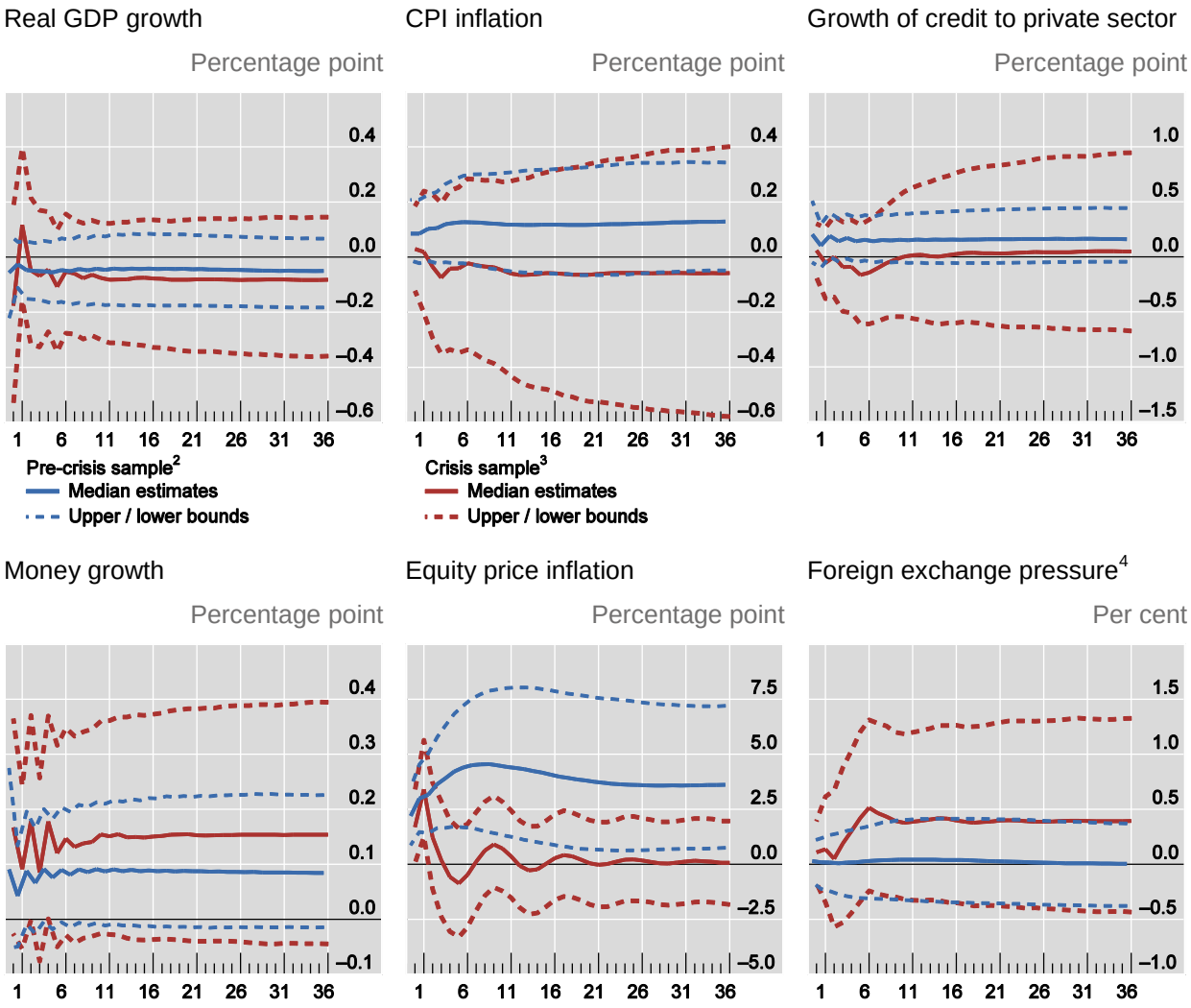
**Figure 5.5.1.5 Impulse Responses to a US VIX Shock: Hong Kong SAR[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

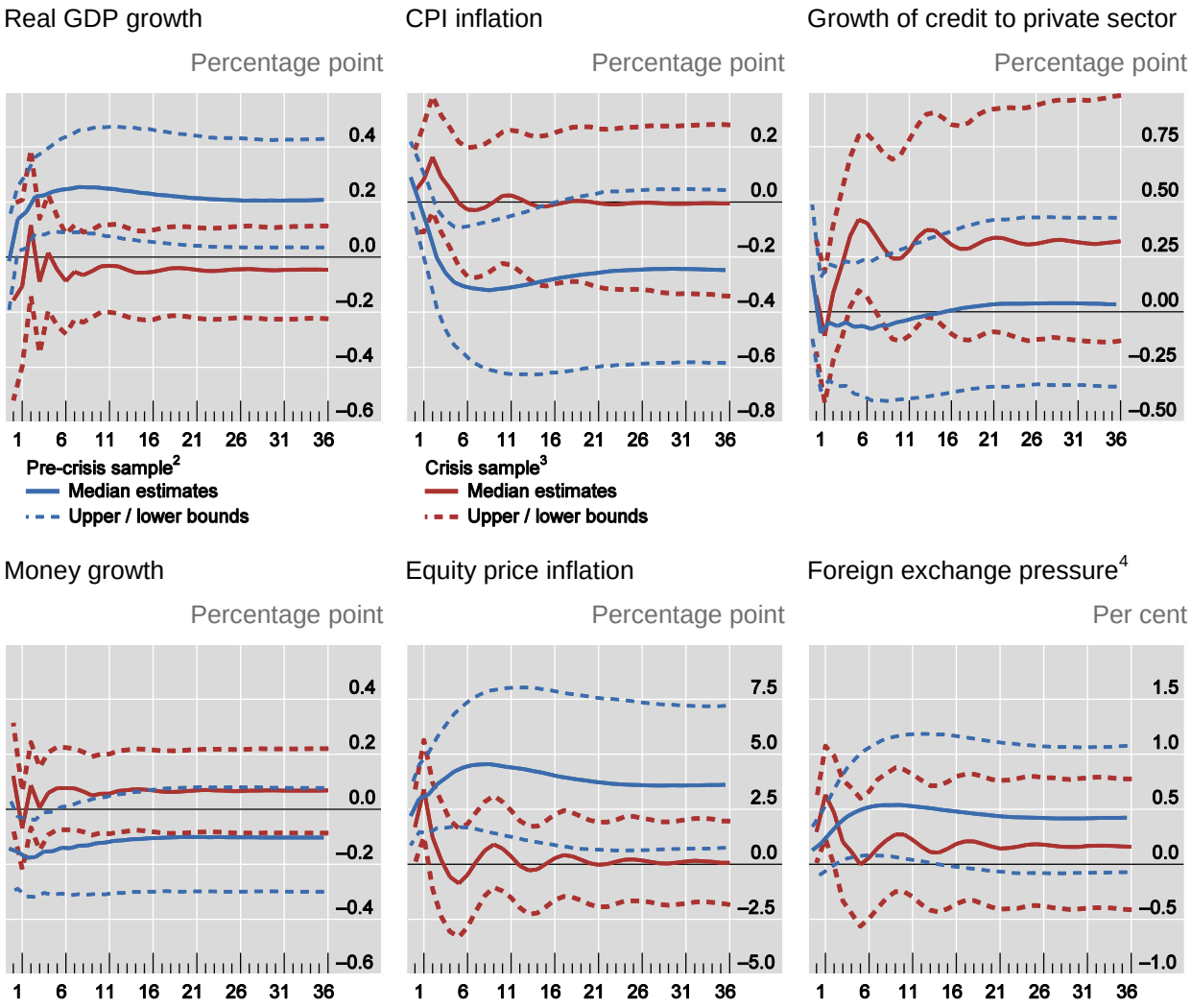
**Figure 5.5.1.6 Impulse Responses to a US Term Spread Shock: India[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

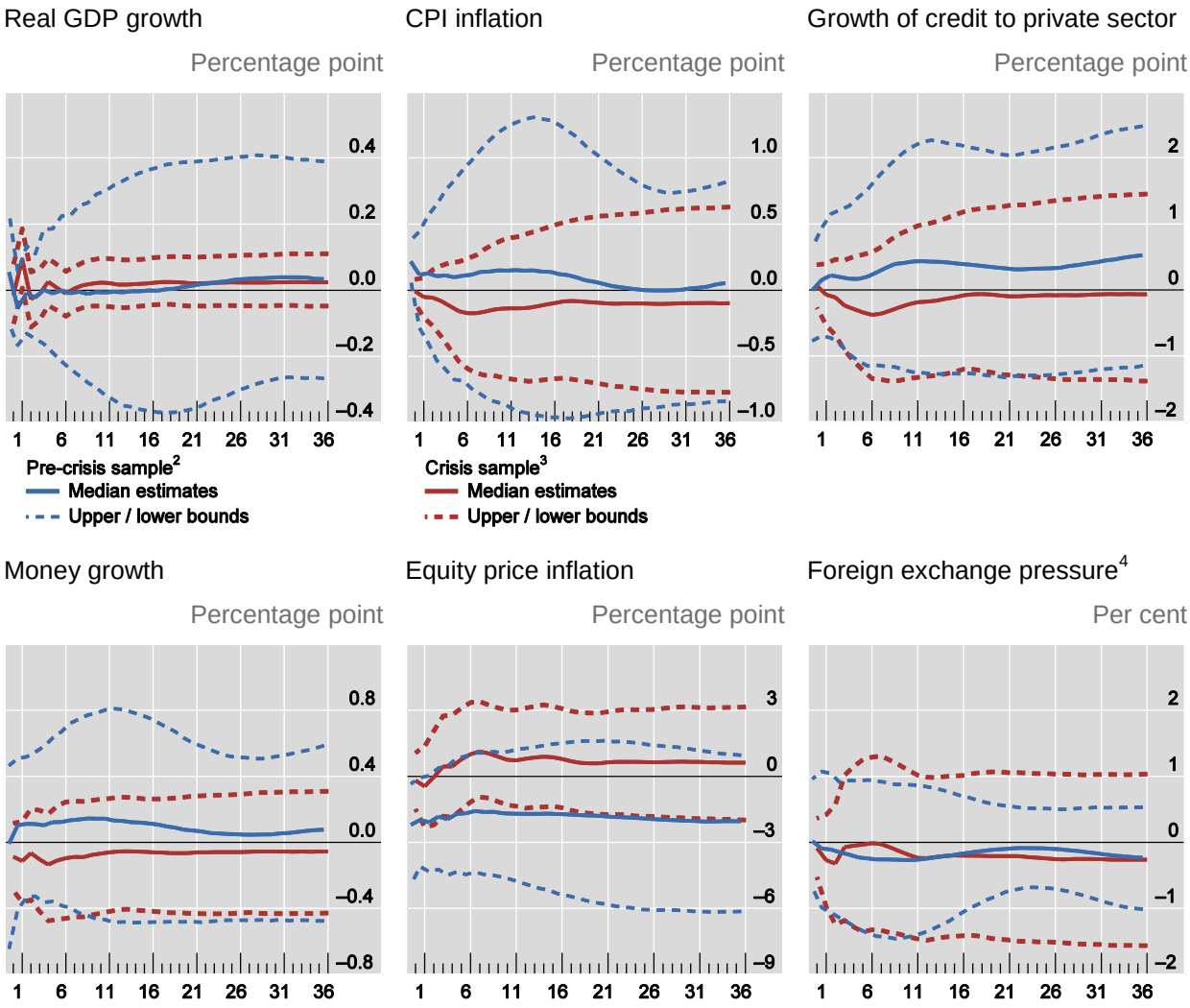
**Figure 5.5.1.7 Impulse Responses to a US VIX Shock: India[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

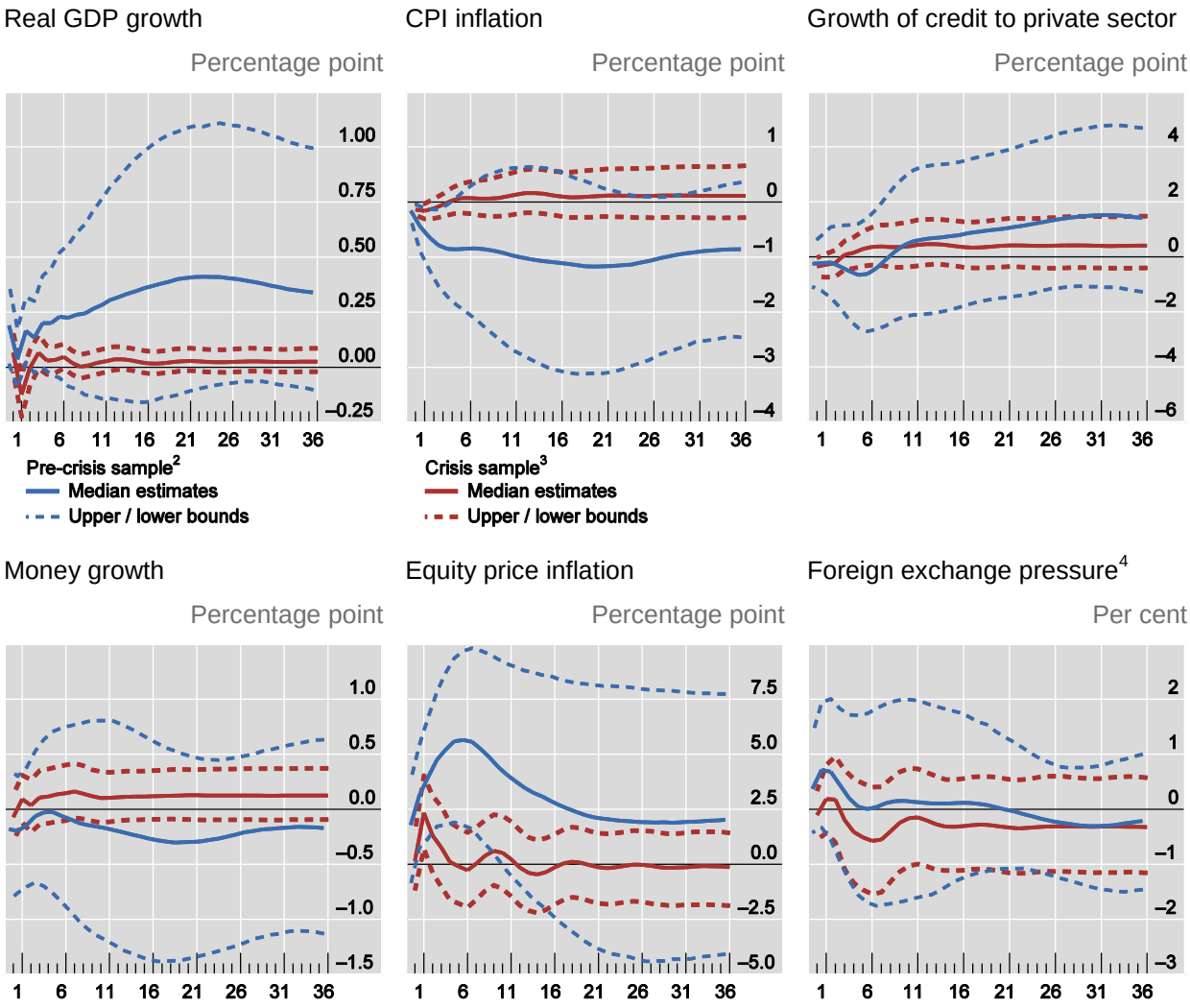
**Figure 5.5.1.8 Impulse Responses to a US Term Spread Shock: Indonesia[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.1.9 Impulse Responses to a US VIX Shock: Indonesia[1]**

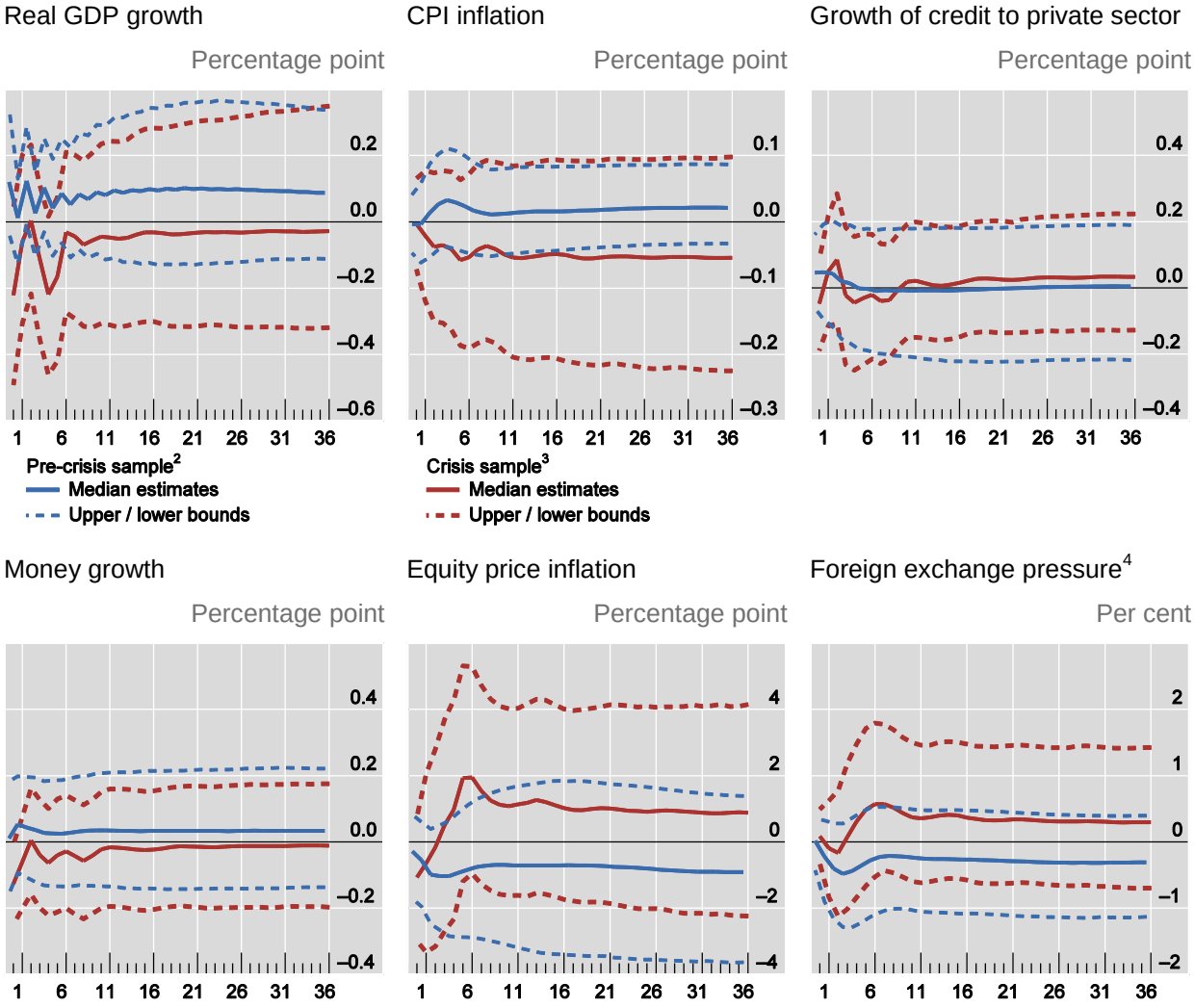



1 The US VIX

2 Shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

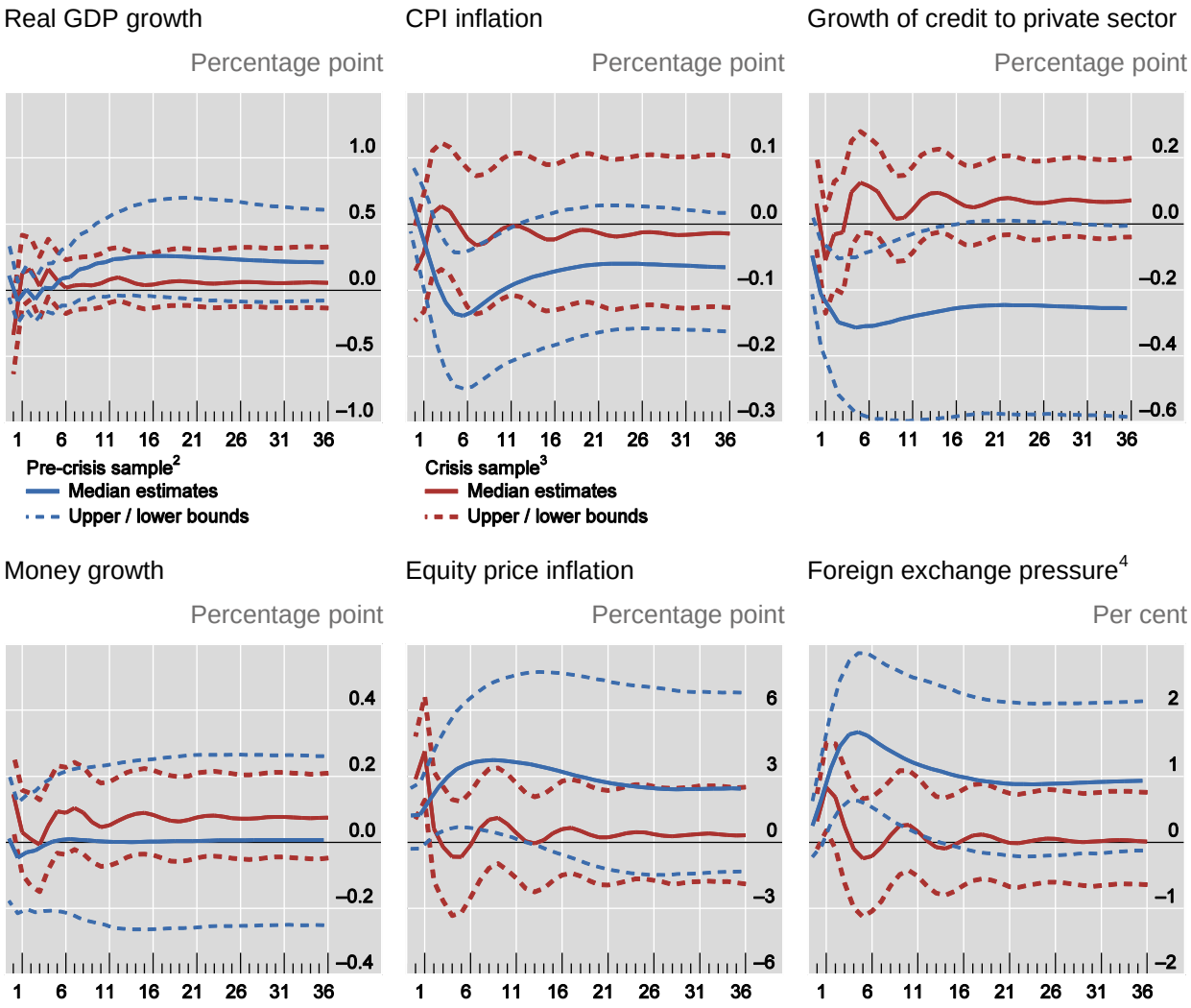
**Figure 5.5.1.10 Impulse Responses to a US Term Spread Shock: Korea[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

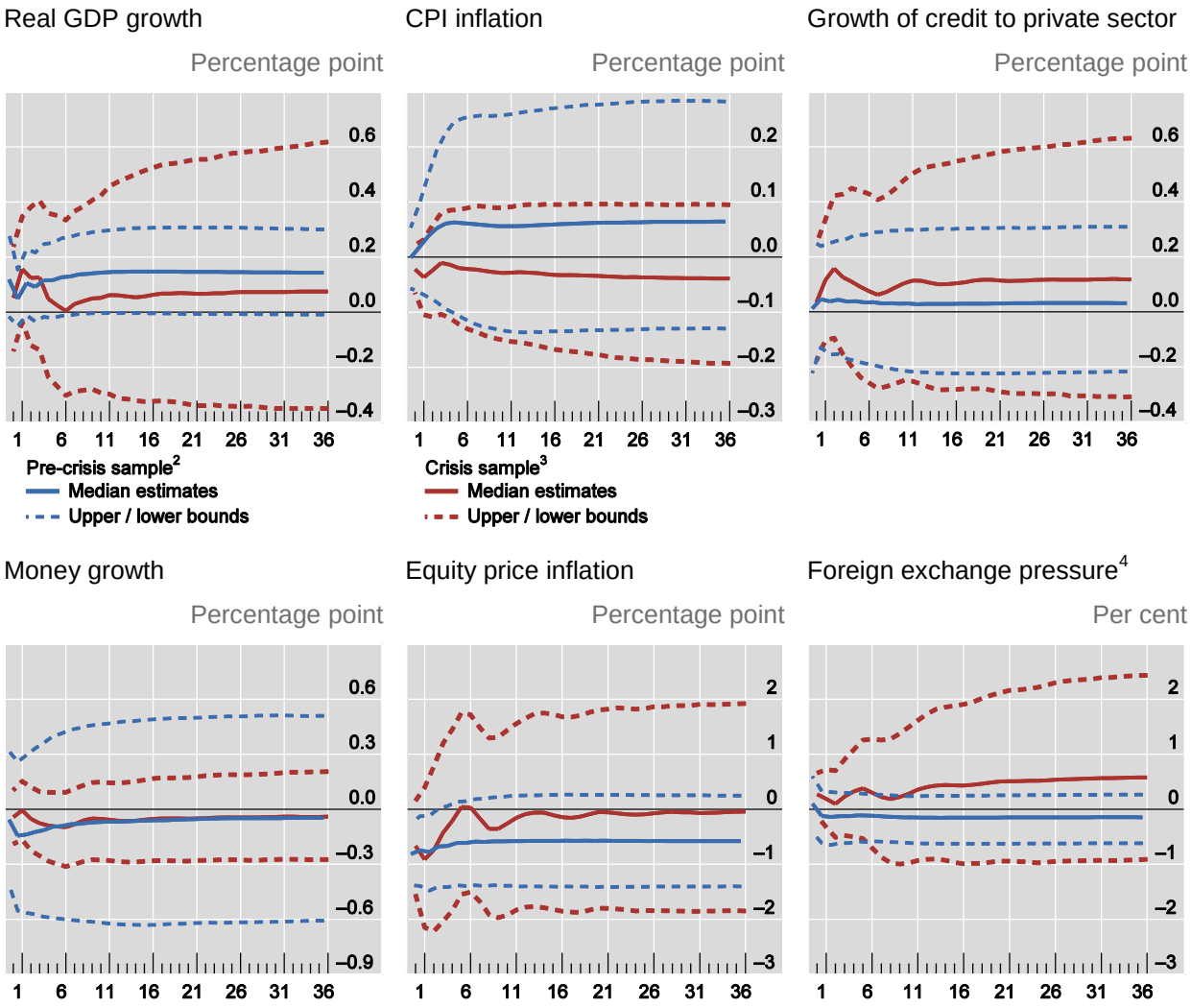
**Figure 5.5.1.11 Impulse Responses to a US VIX Shock: Korea[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

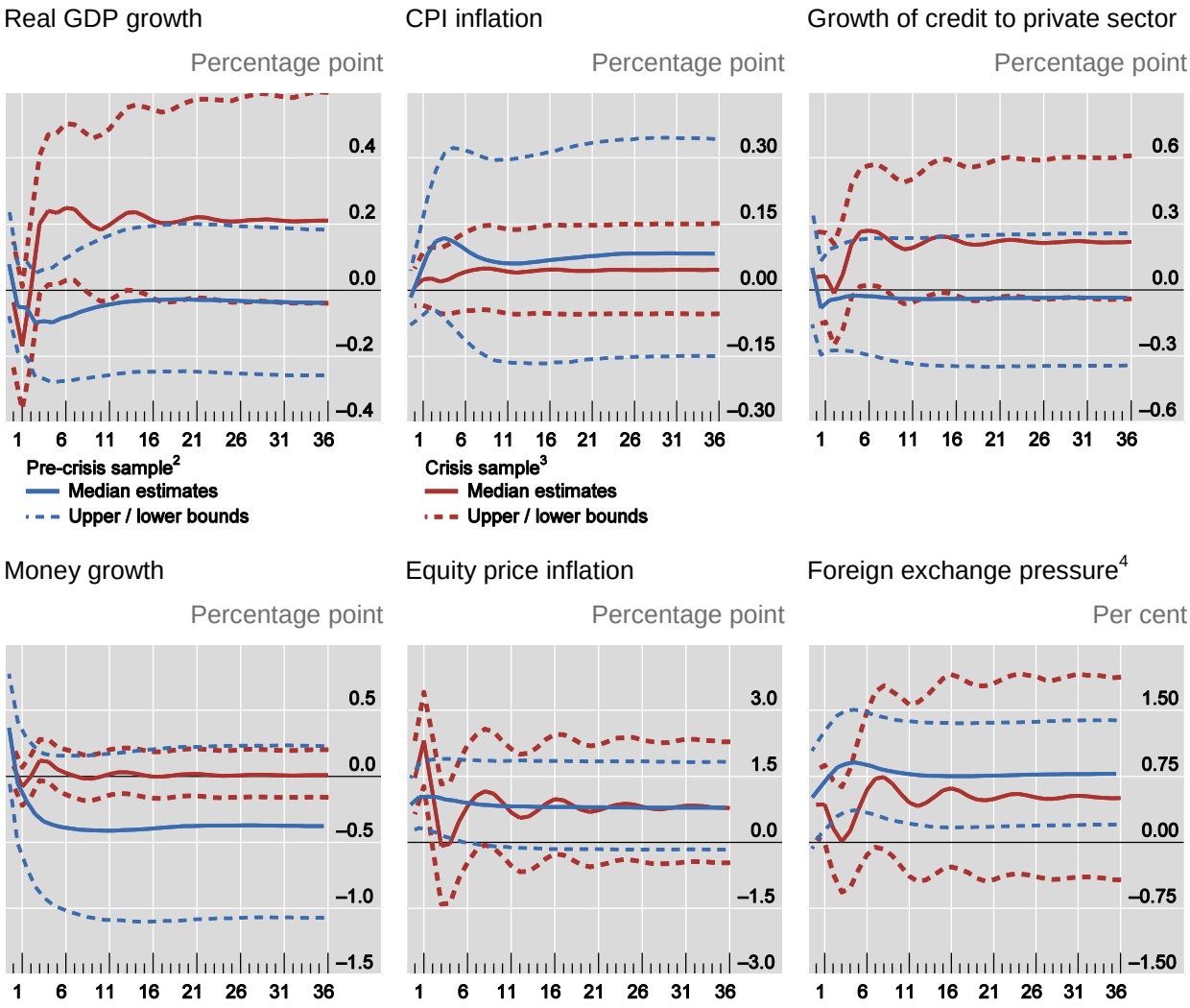
**Figure 5.5.1.12 Impulse Responses to a US Term Spread Shock: Mexico[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

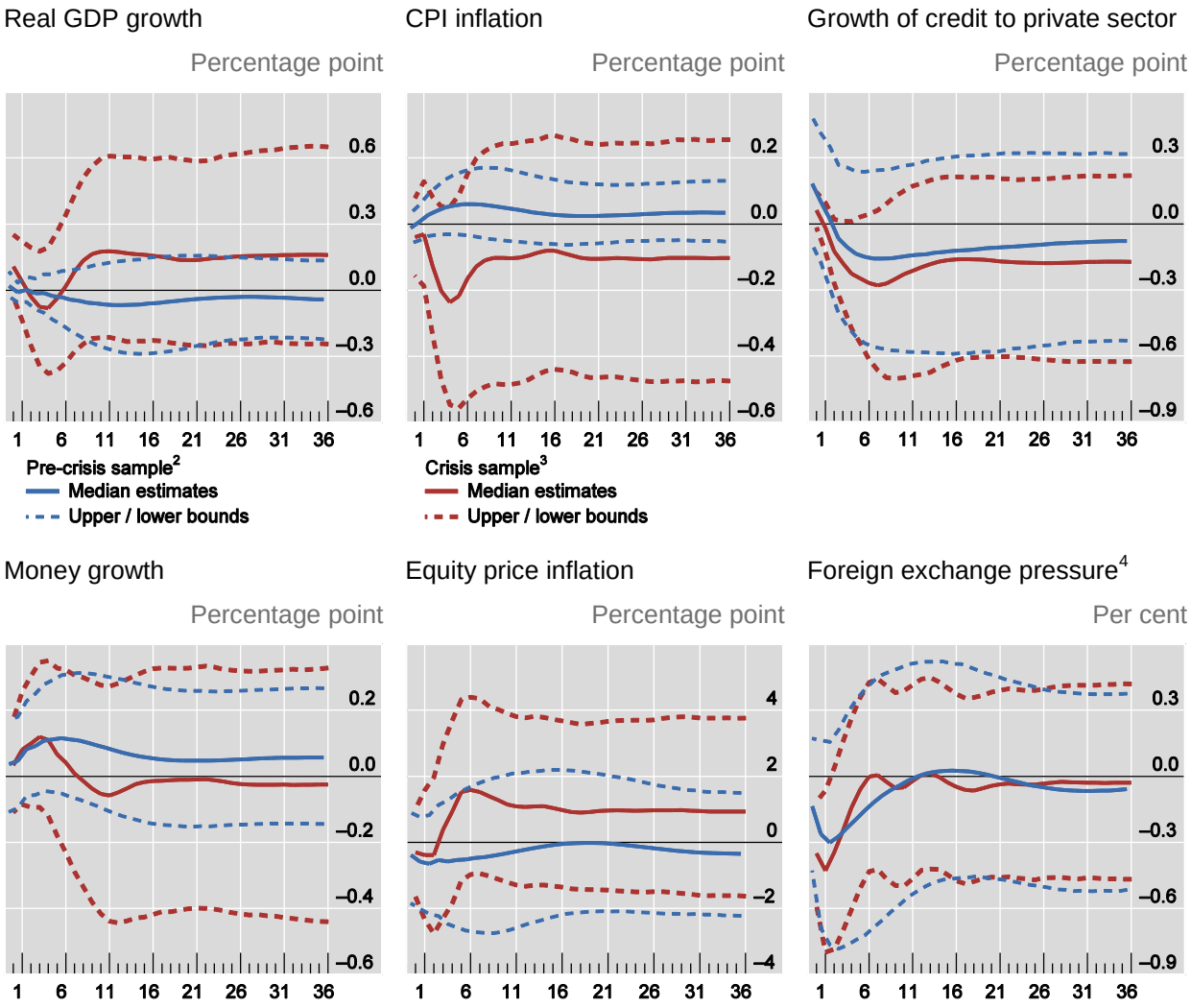
**Figure 5.5.1.13 Impulse Responses to a US VIX Shock: Mexico[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

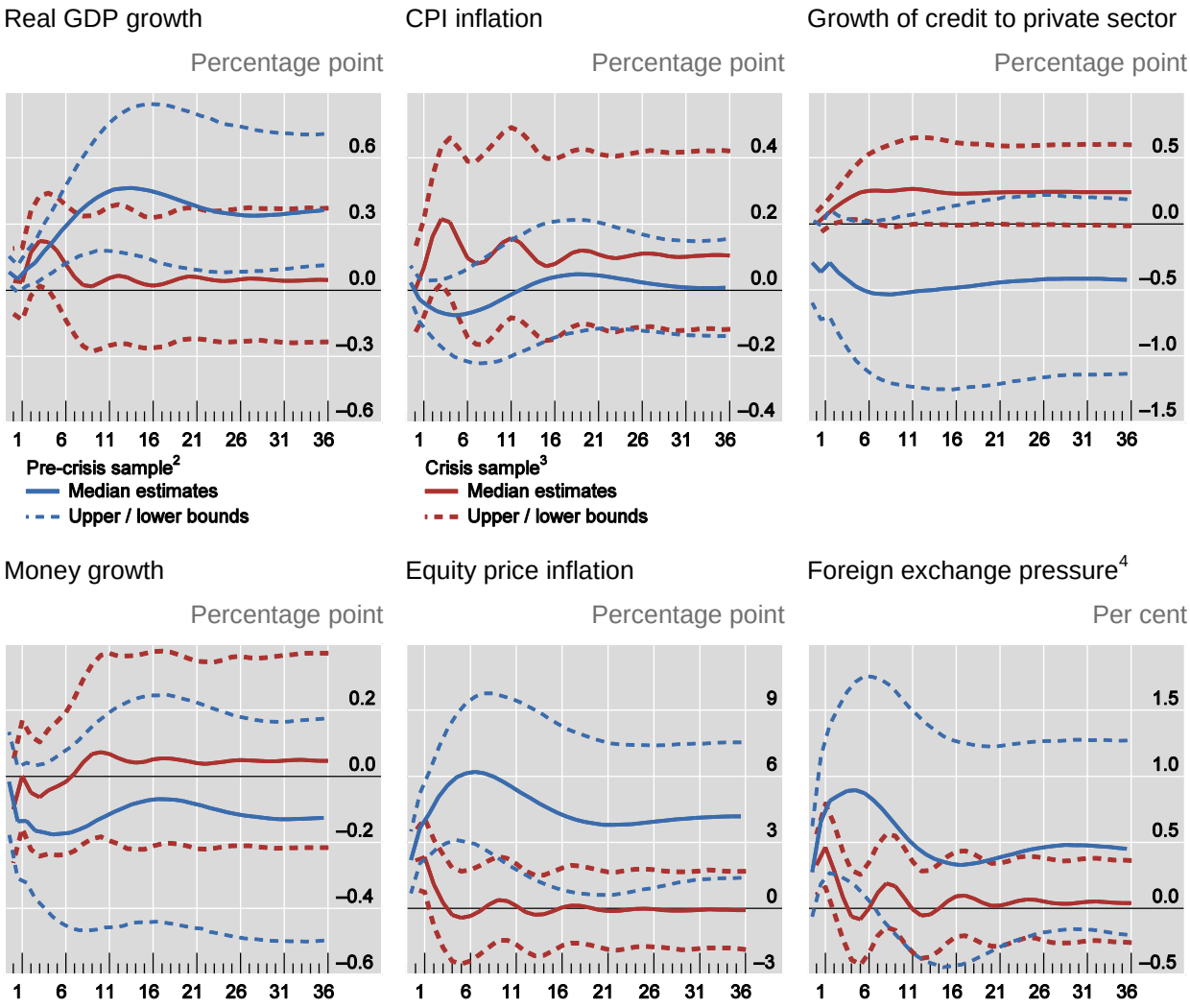
**Figure 5.5.1.14 Impulse Responses to a US Term Spread Shock: Thailand[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

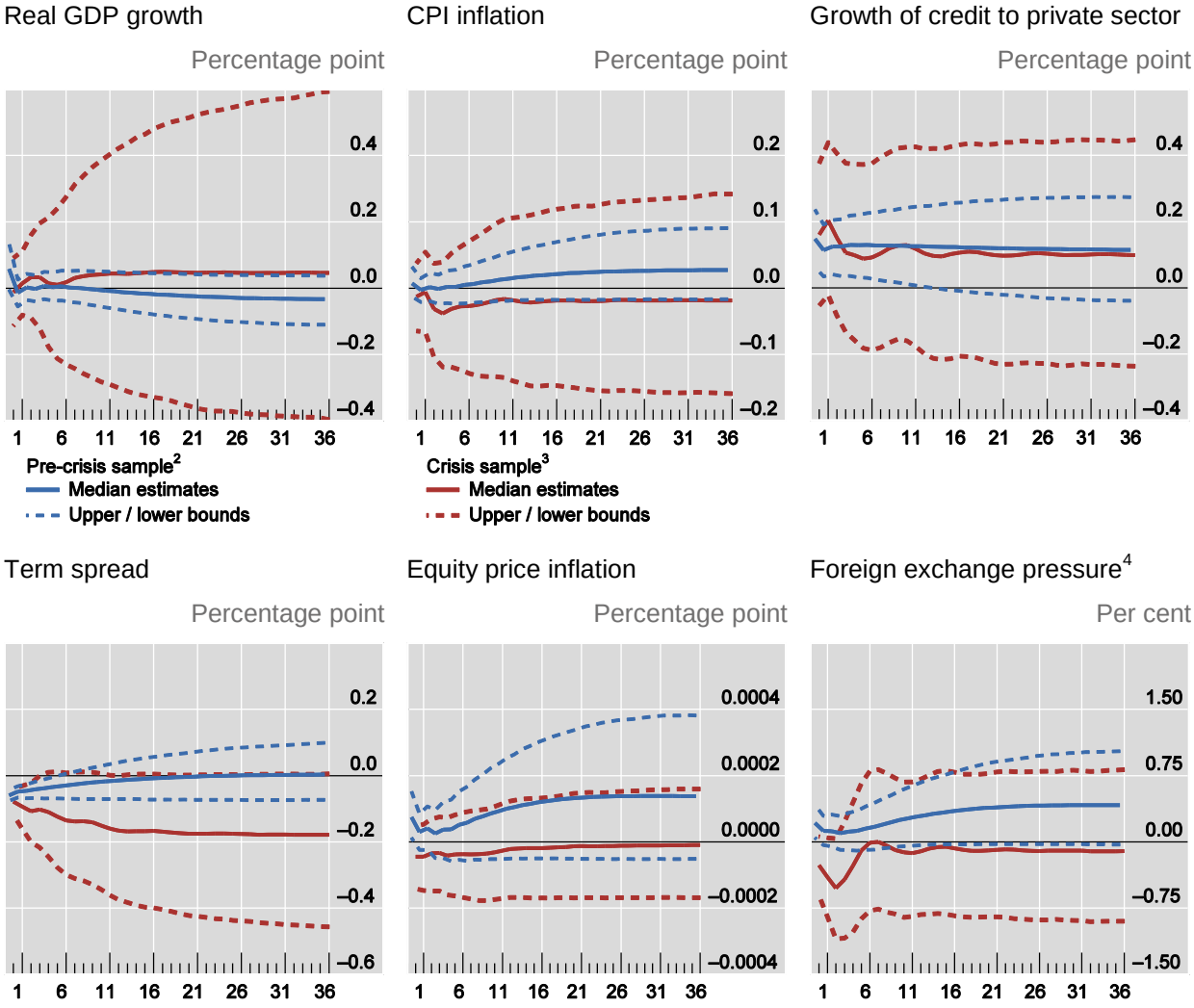
**Figure 5.5.1.15 Impulse Responses to a US VIX Shock: Thailand[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

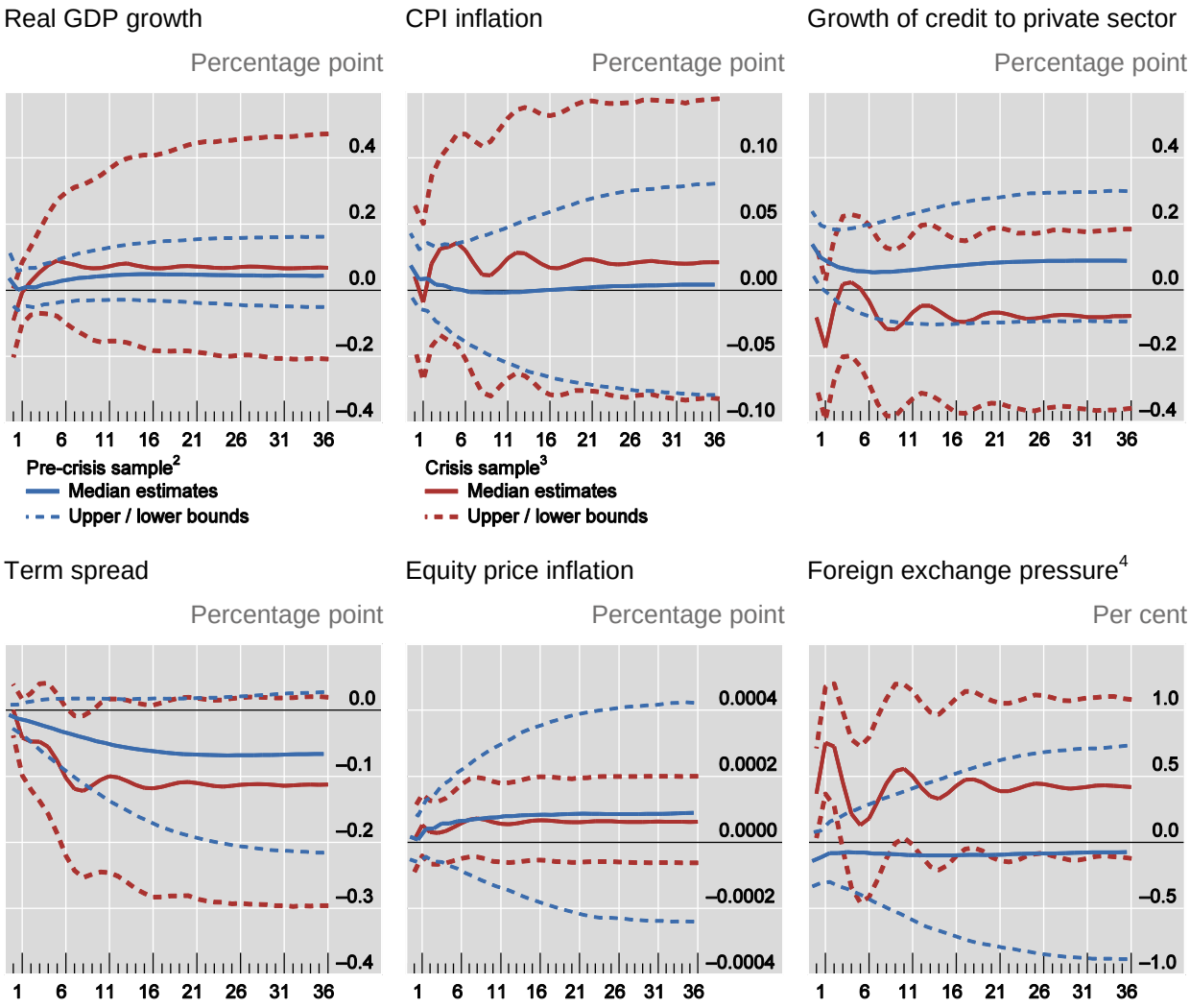
**Figure 5.5.1.16 Impulse Responses to a US Term Spread Shock: United Kingdom[1]**




[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.1.17 Impulse Responses to a US VIX Shock: United Kingdom[1]**

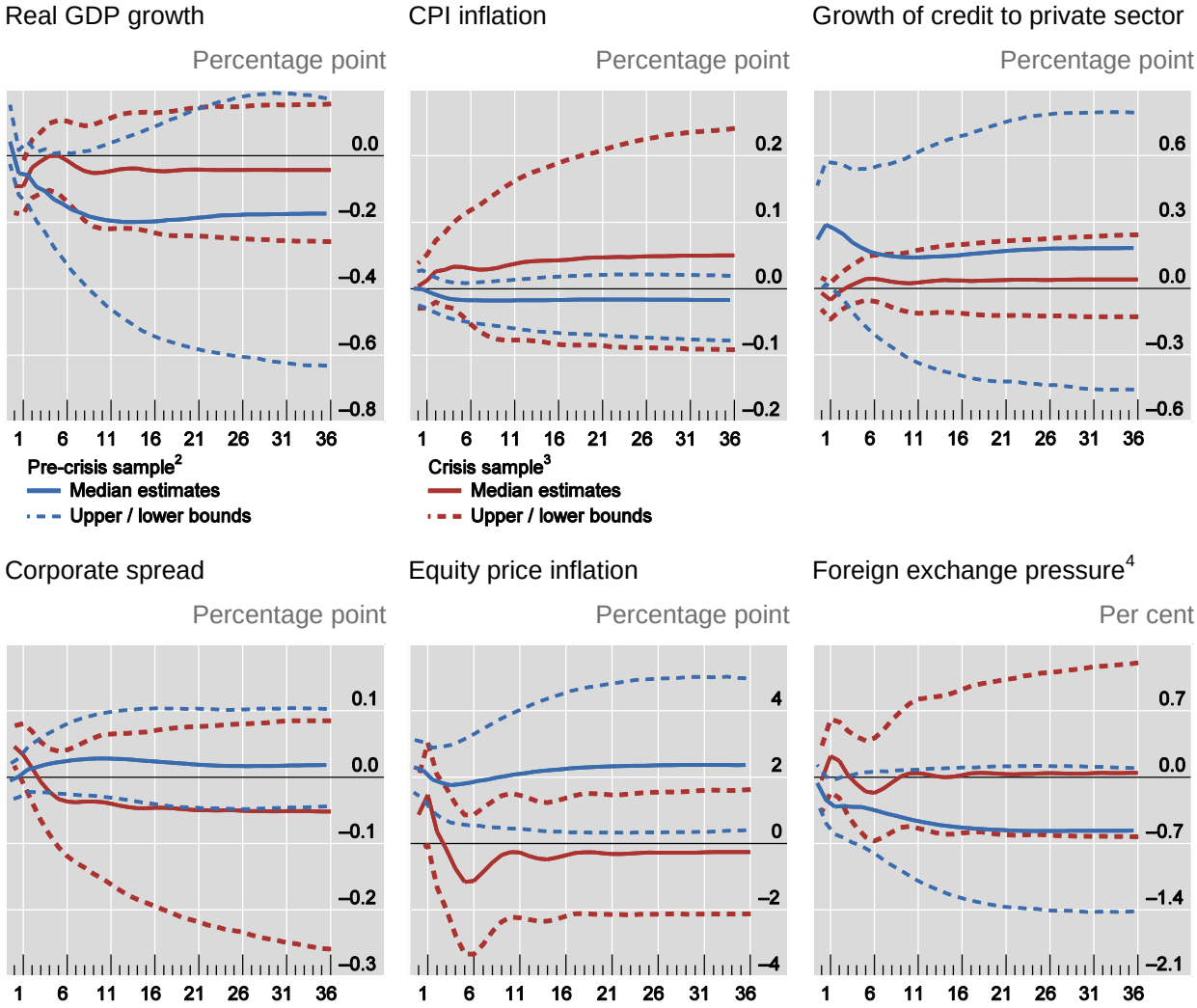



[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

## Appendix 5.5.2 Impulse Responses to US Corporate Spread and VIX Shocks

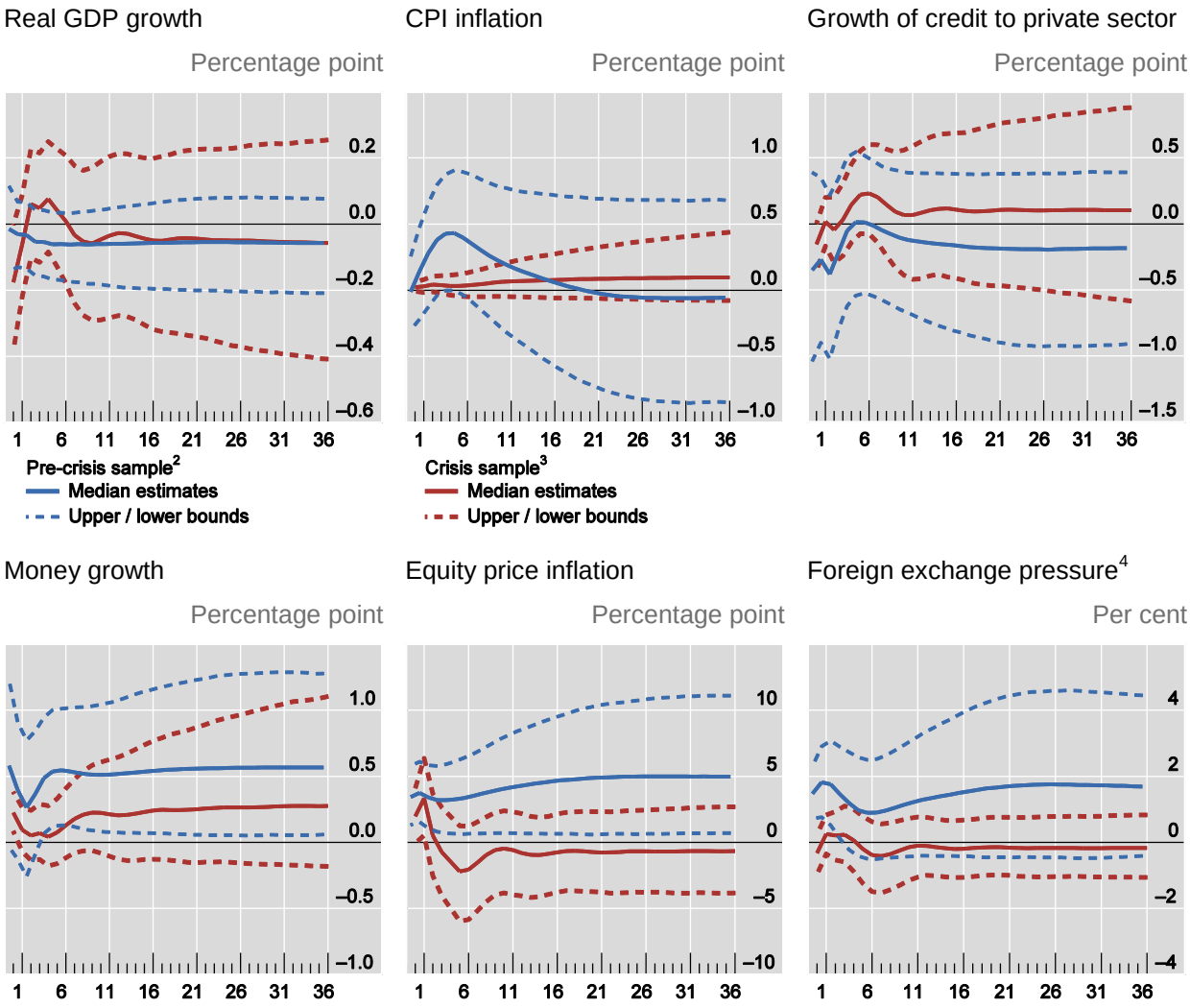
### Figure 5.5.2.1 Impulse Responses to a US VIX Shock: Euro Area[1]




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

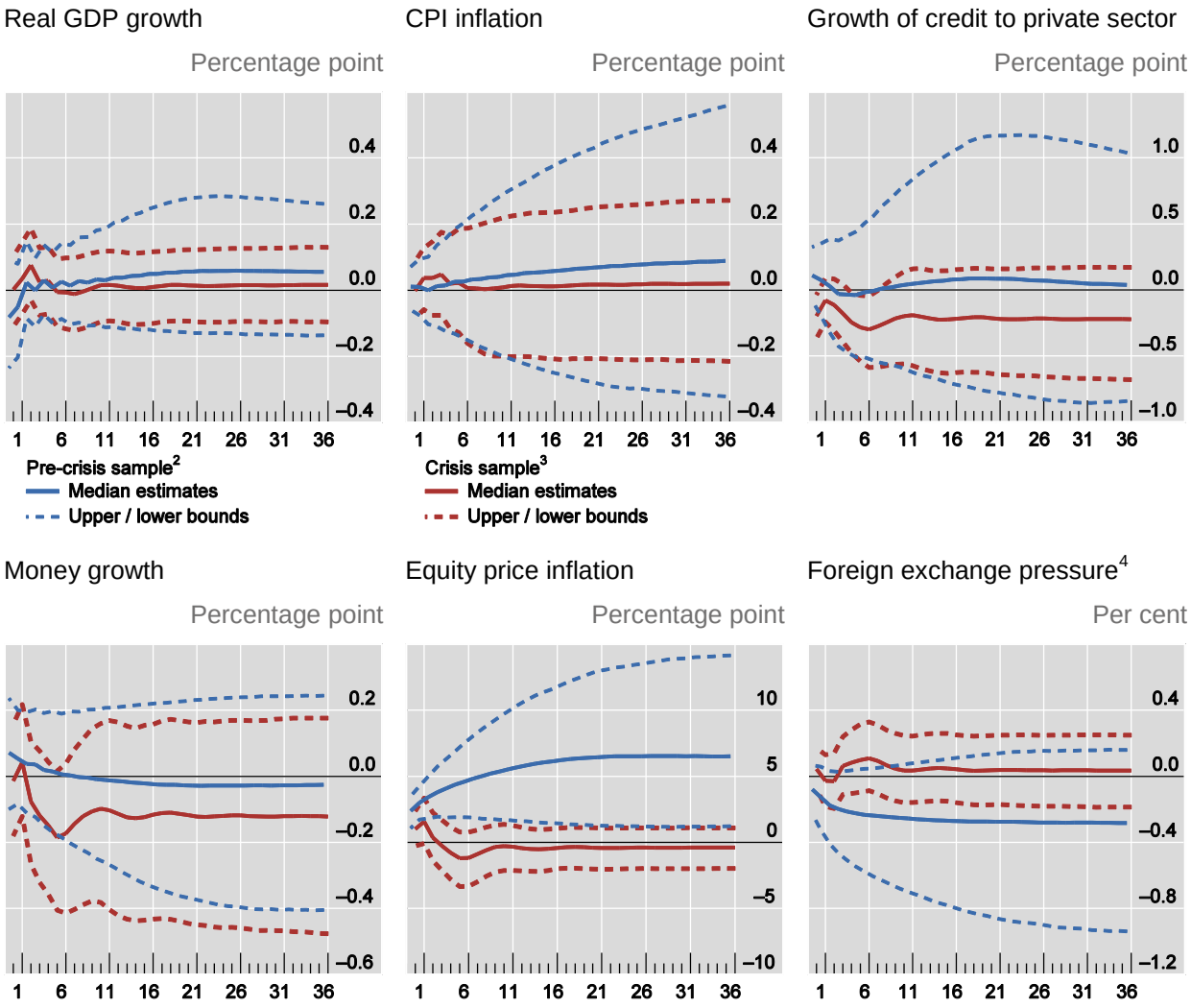
**Figure 5.5.2.2 Impulse Responses to a US VIX Shock: Brazil[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

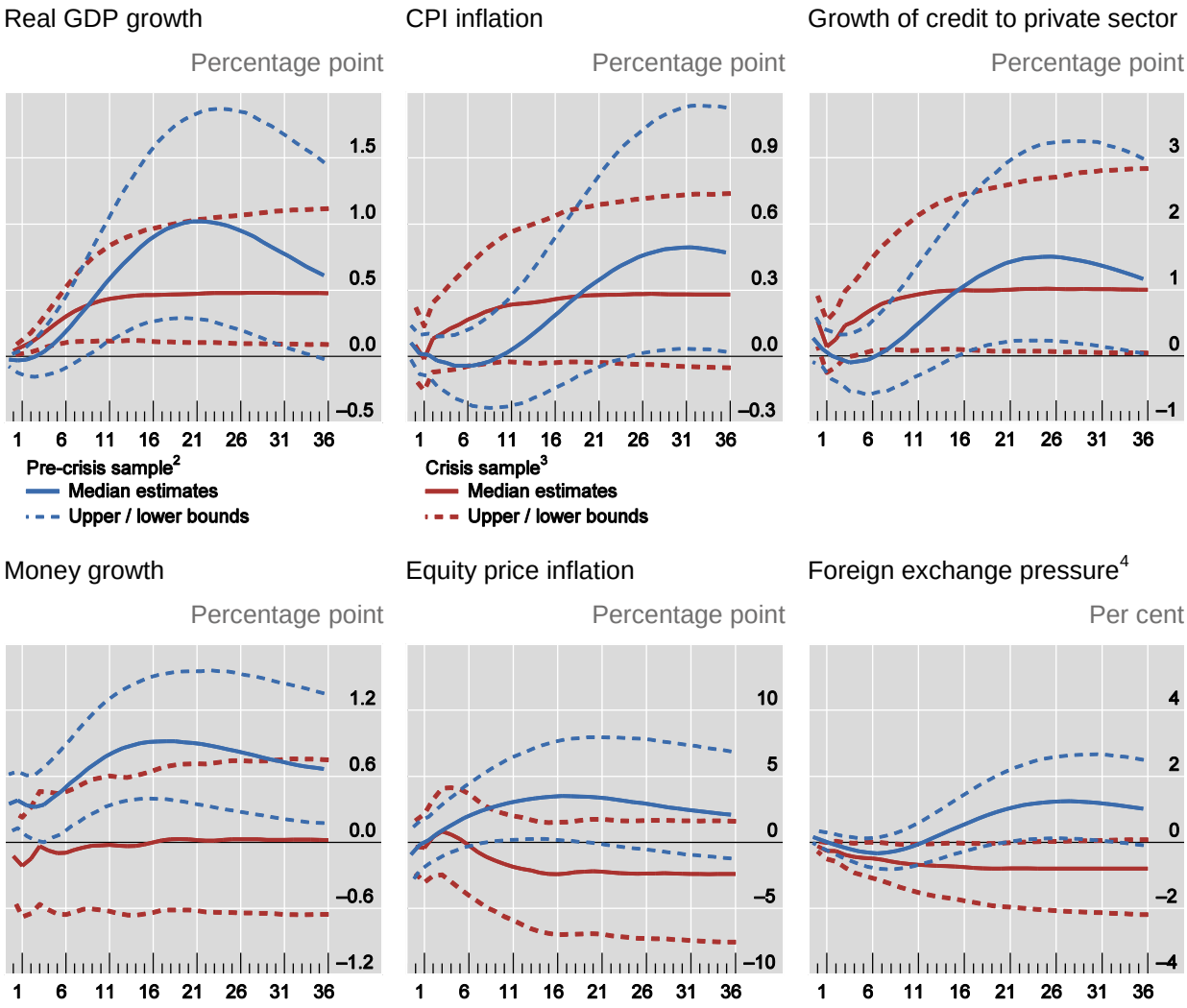
**Figure 5.5.2.3 Impulse Responses to a US VIX Shock: China[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

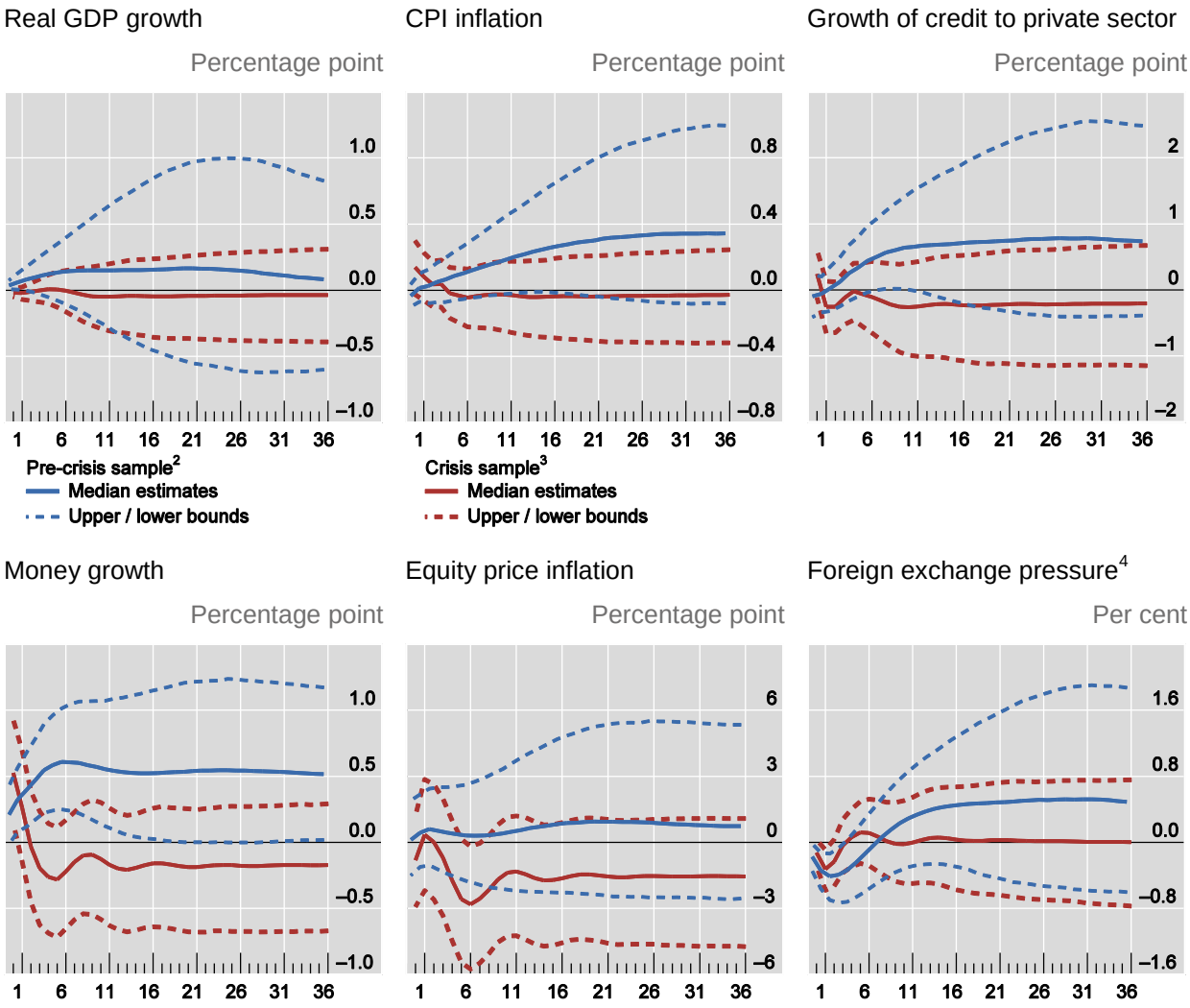
**Figure 5.5.2.4 Impulse Responses to a US Corporate Spread Shock: Hong Kong SAR[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

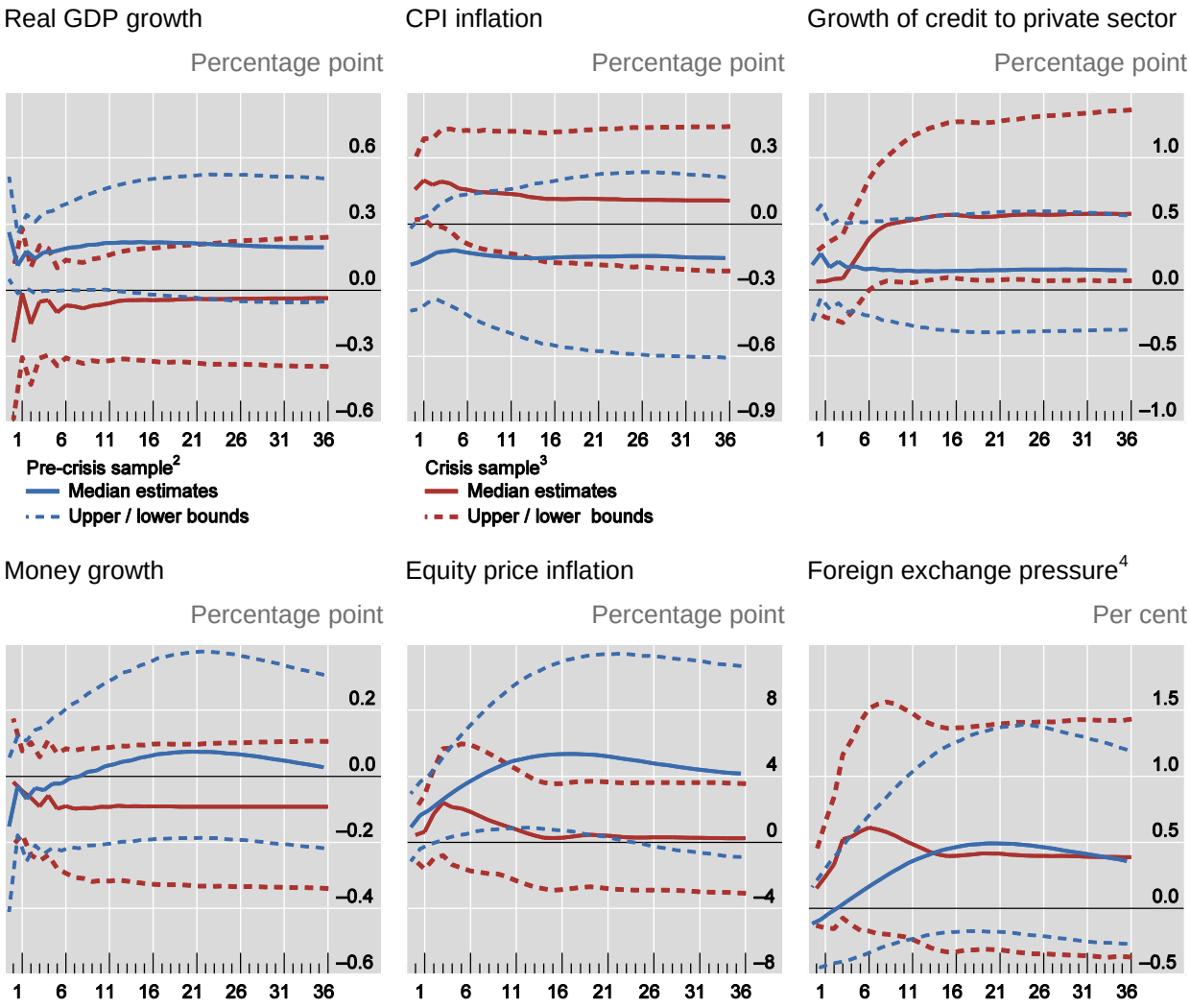
**Figure 5.5.2.5 Impulse Responses to a US VIX Shock: Hong Kong SAR[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

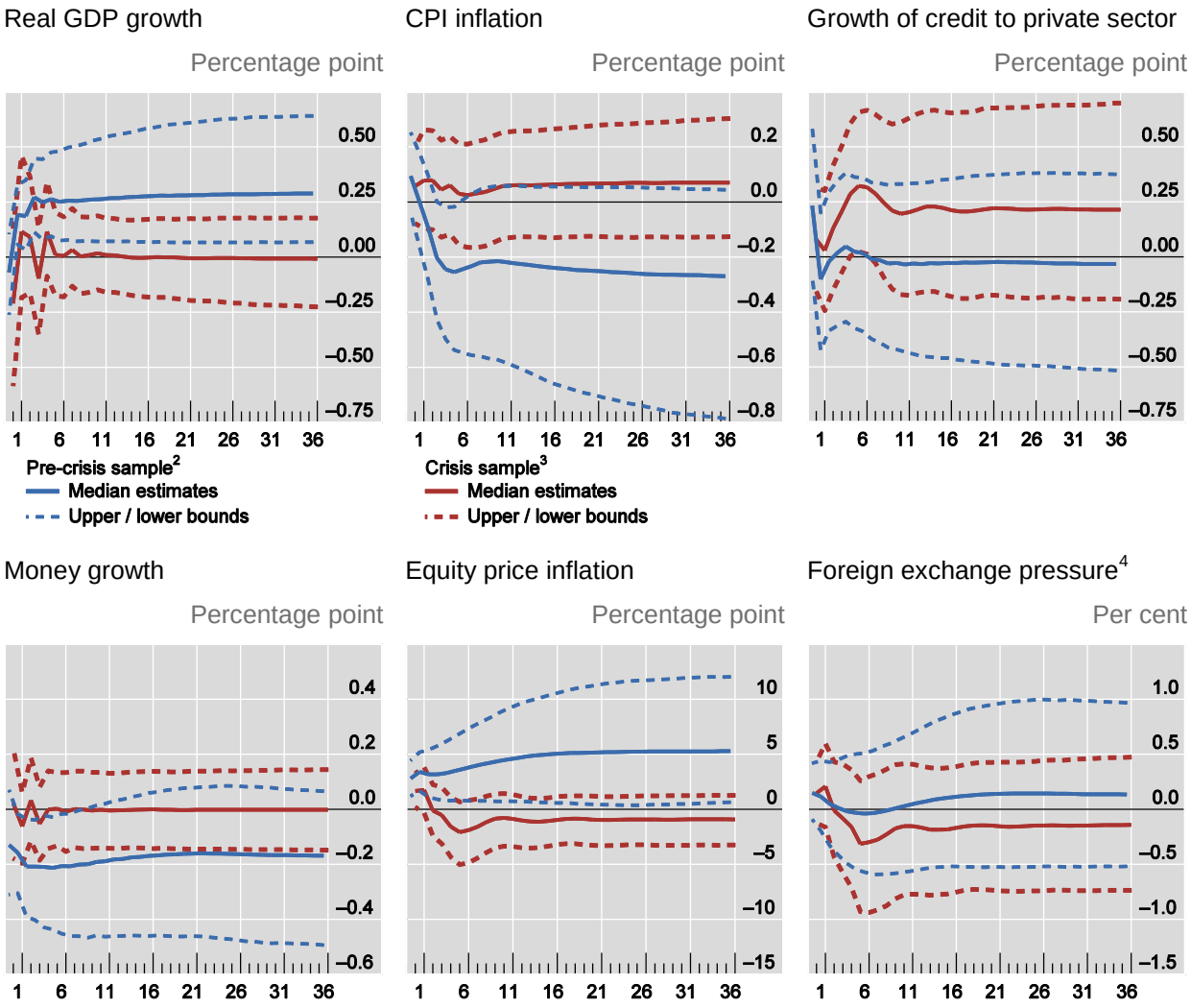
**Figure 5.5.2.6 Impulse Responses to a US Corporate Spread Shock: India[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

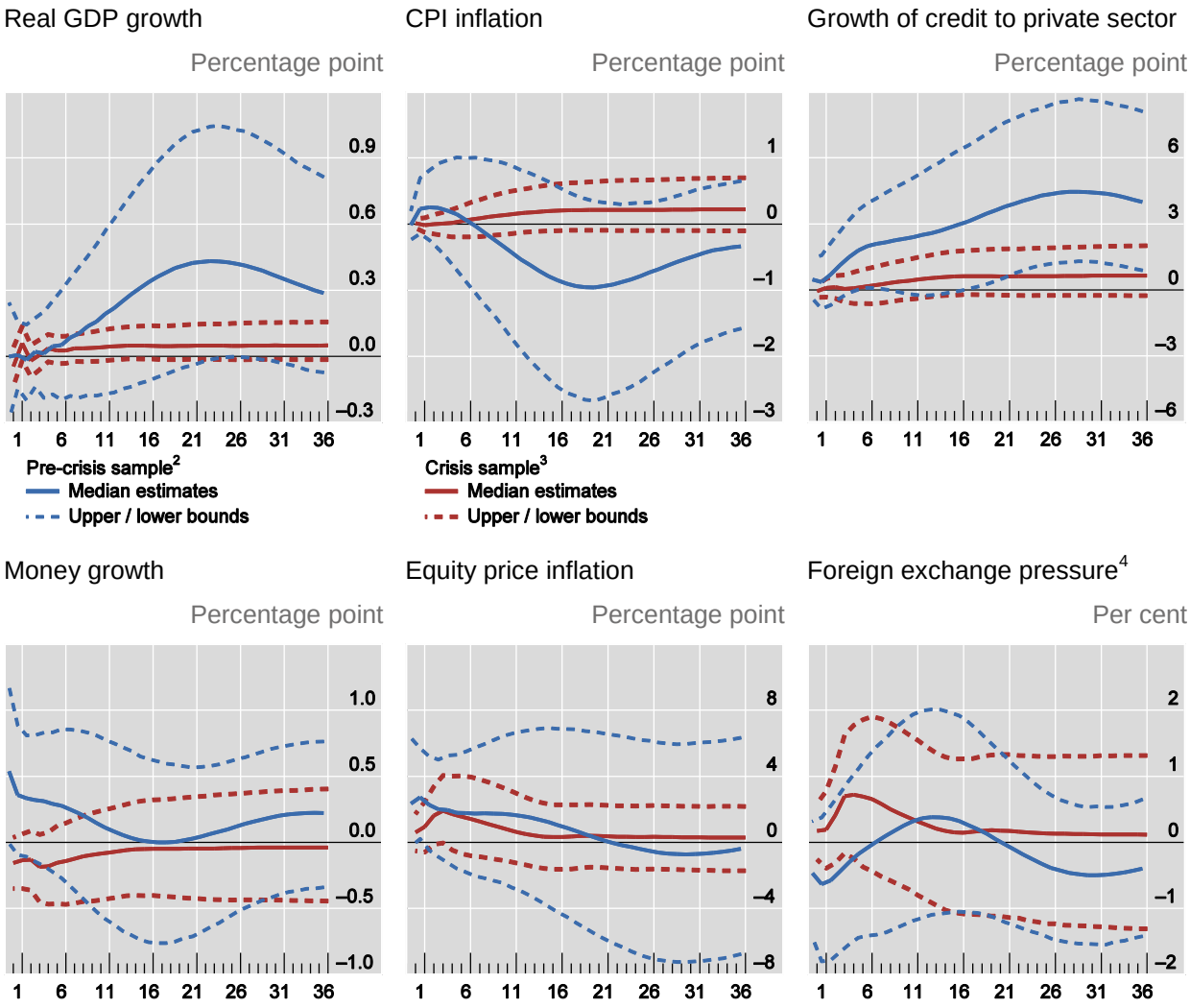
**Figure 5.5.2.7 Impulse Responses to a US VIX Shock: India[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

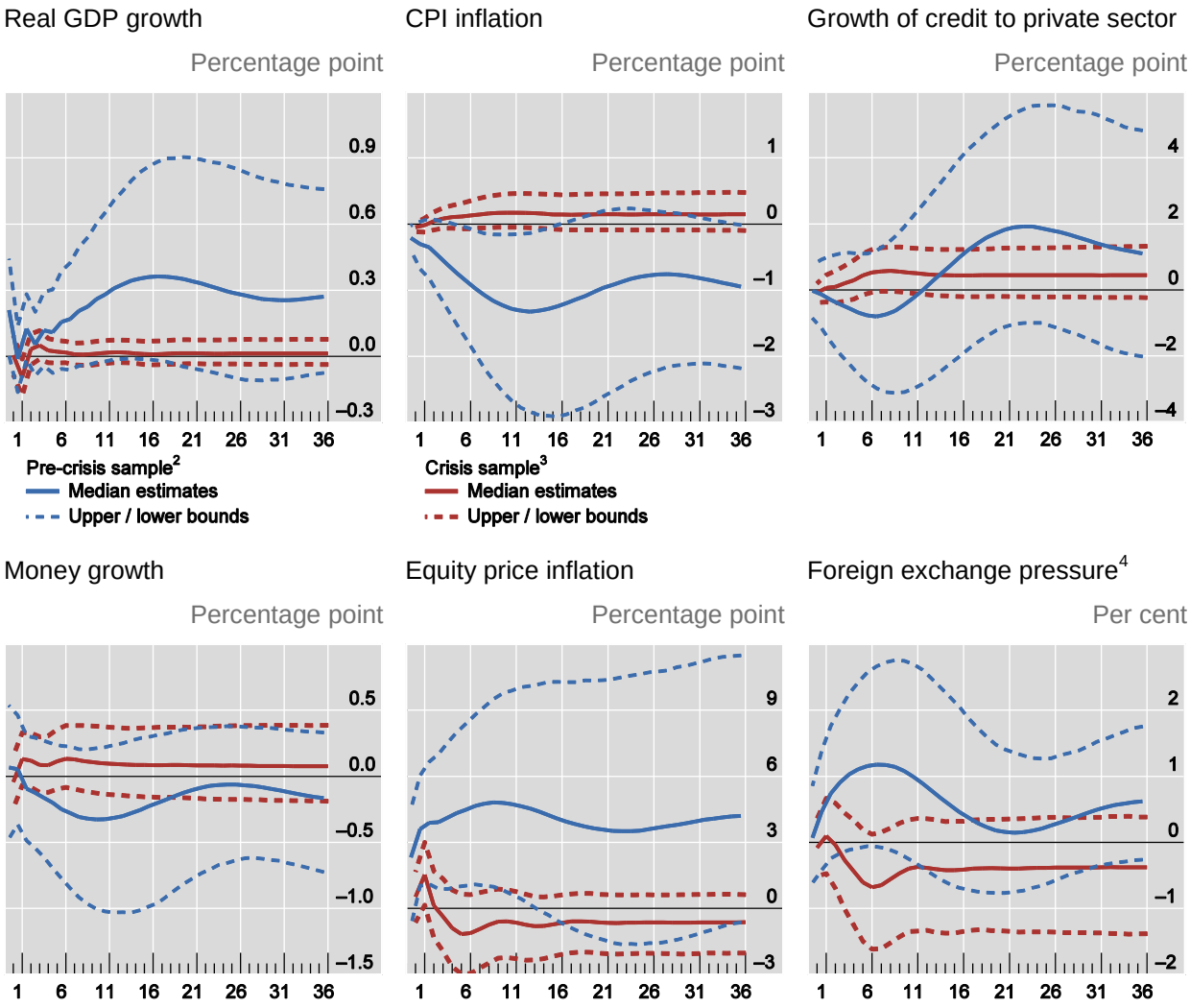
**Figure 5.5.2.8 Impulse Responses to a US Corporate Spread Shock: Indonesia[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

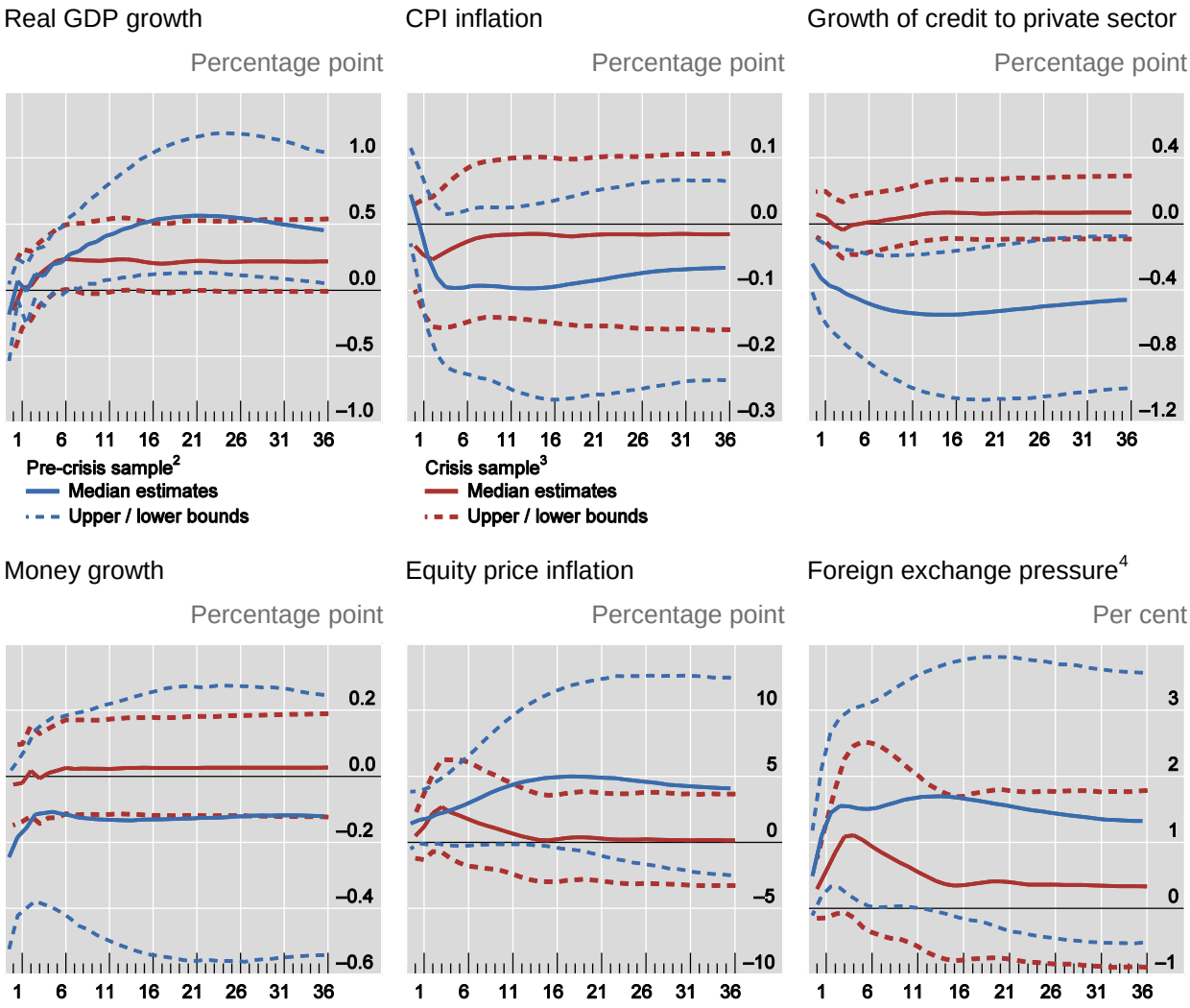
**Figure 5.5.2.9 Impulse Responses to a US VIX Shock: Indonesia[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

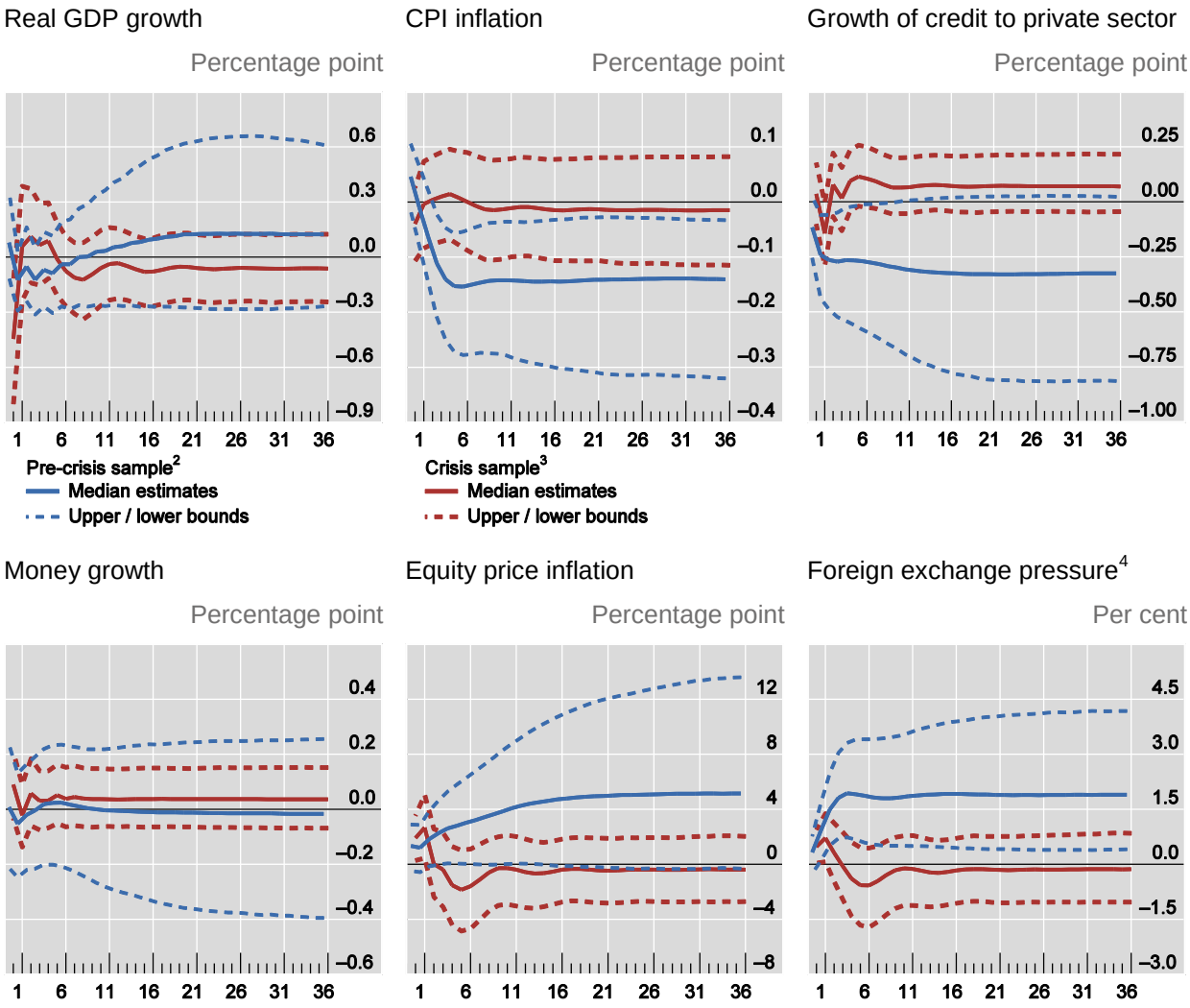
**Figure 5.5.2.10 Impulse Responses to a US Corporate Spread Shock: Korea[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

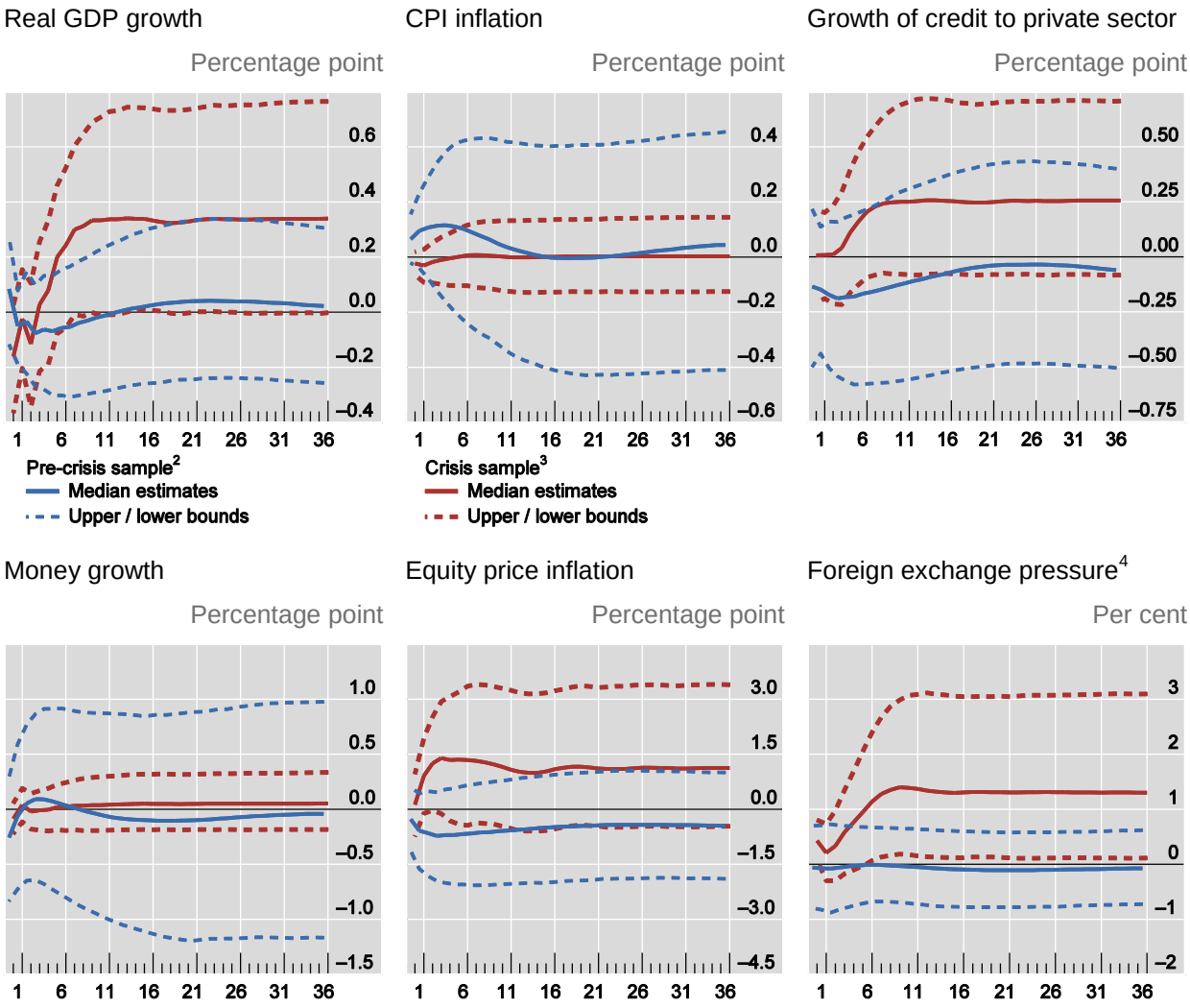
**Figure 5.5.2.11 Impulse Responses to a US VIX Shock: Korea[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

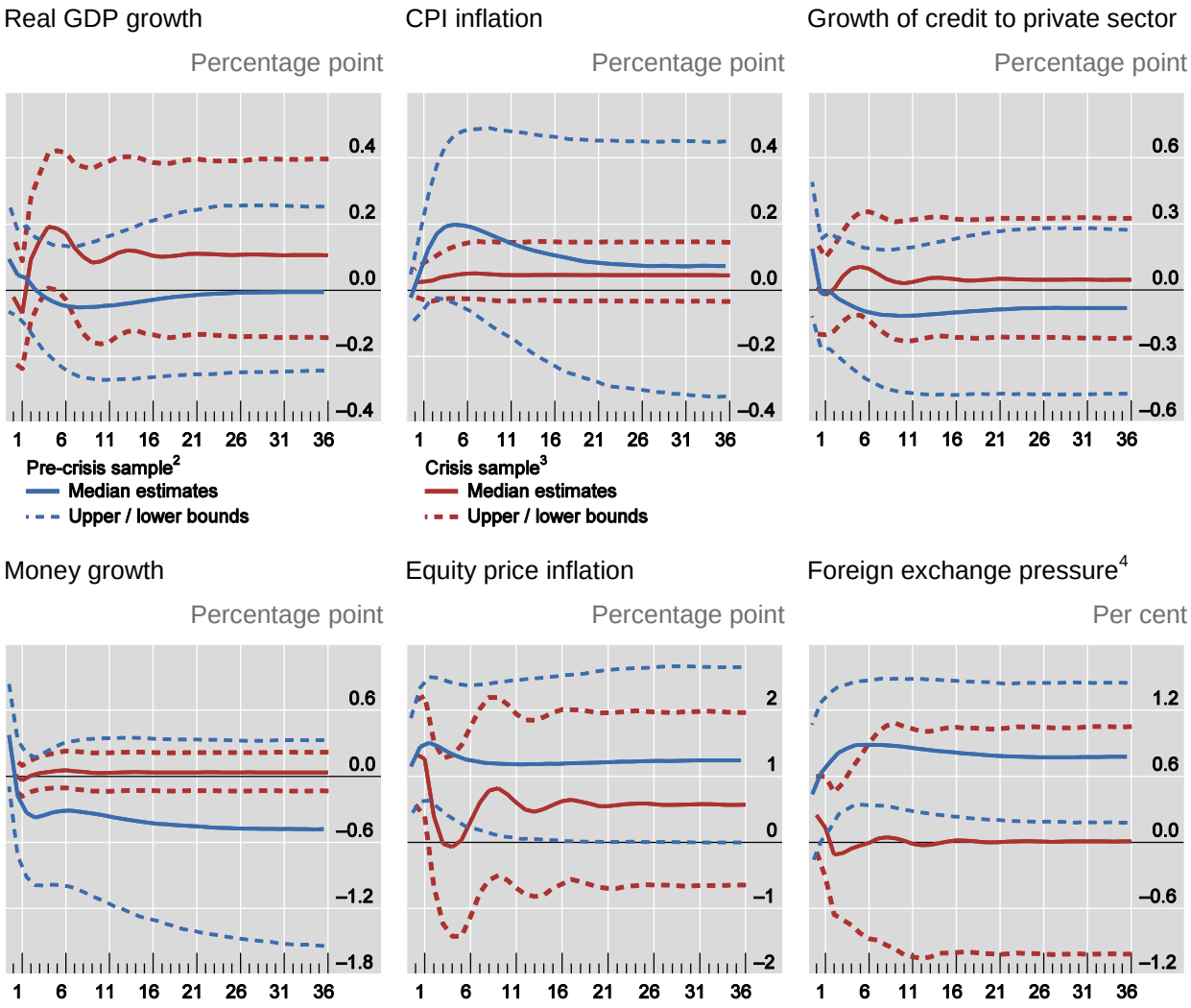
**Figure 5.5.2.12 Impulse Responses to a US Corporate Spread Shock: Mexico[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

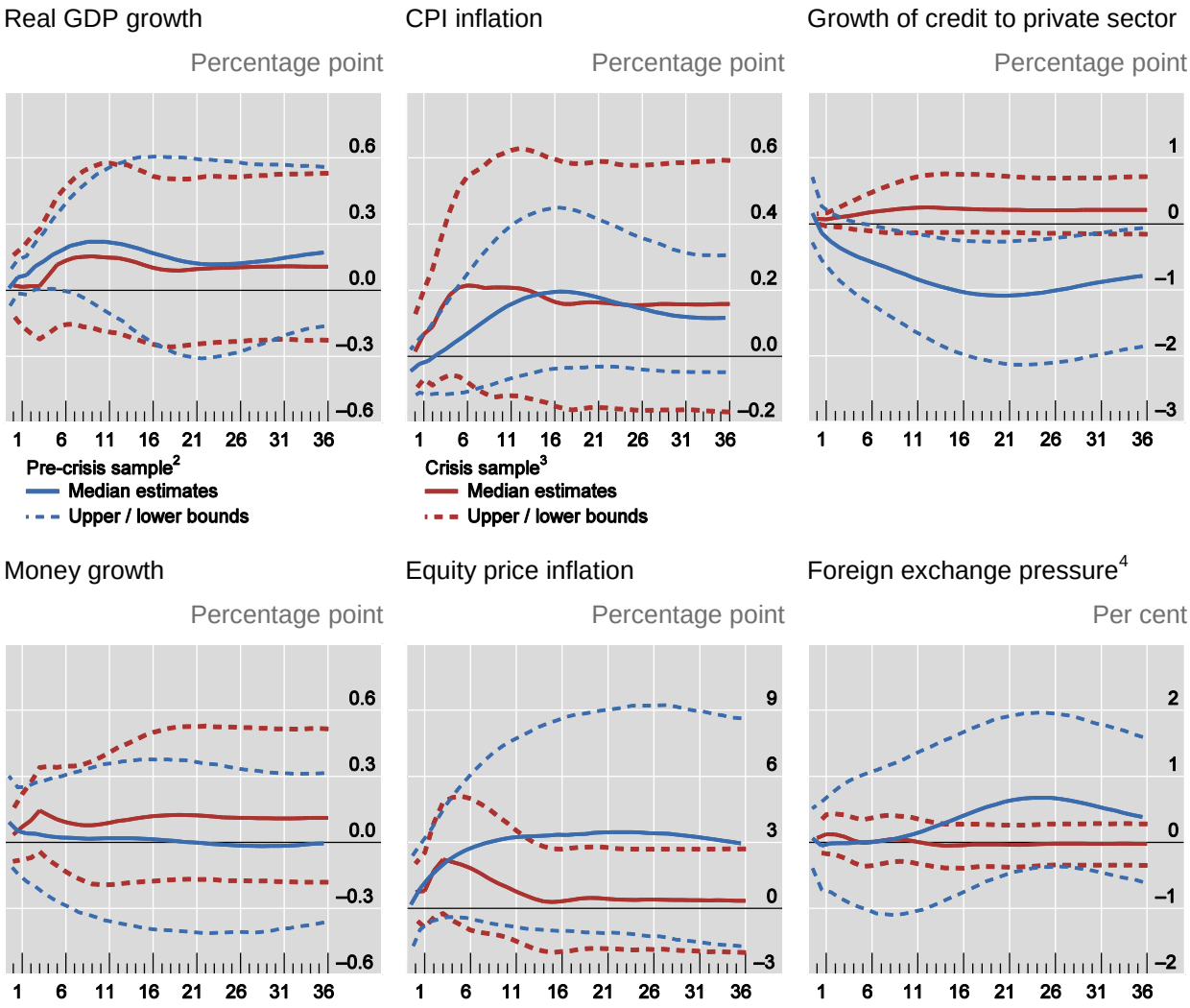
**Figure 5.5.2.13 Impulse Responses to a US VIX Shock: Mexico[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

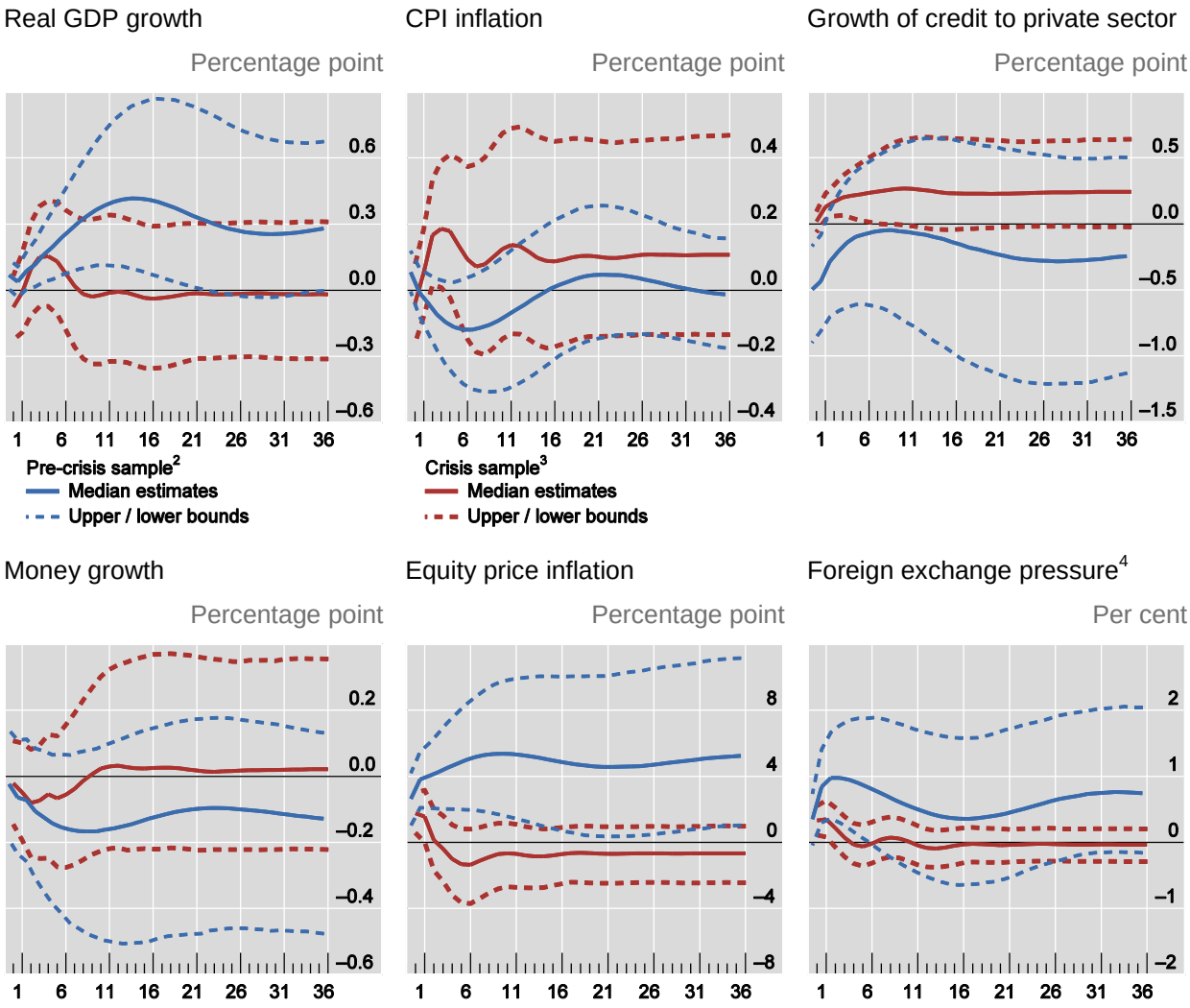
**Figure 5.5.2.14 Impulse Responses to a US Corporate Spread Shock: Thailand[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

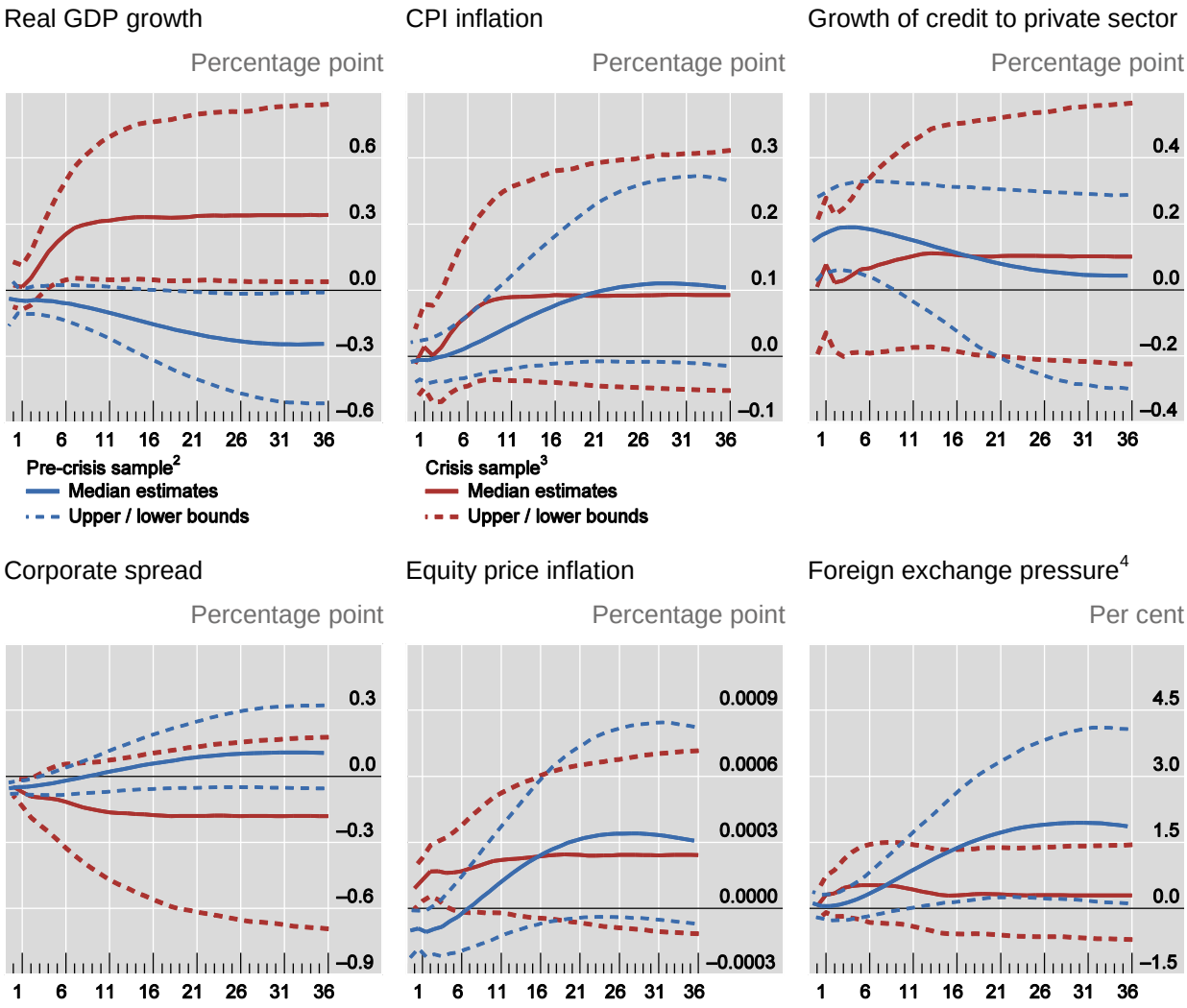
**Figure 5.5.2.15 Impulse Responses to a US VIX Shock: Thailand[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

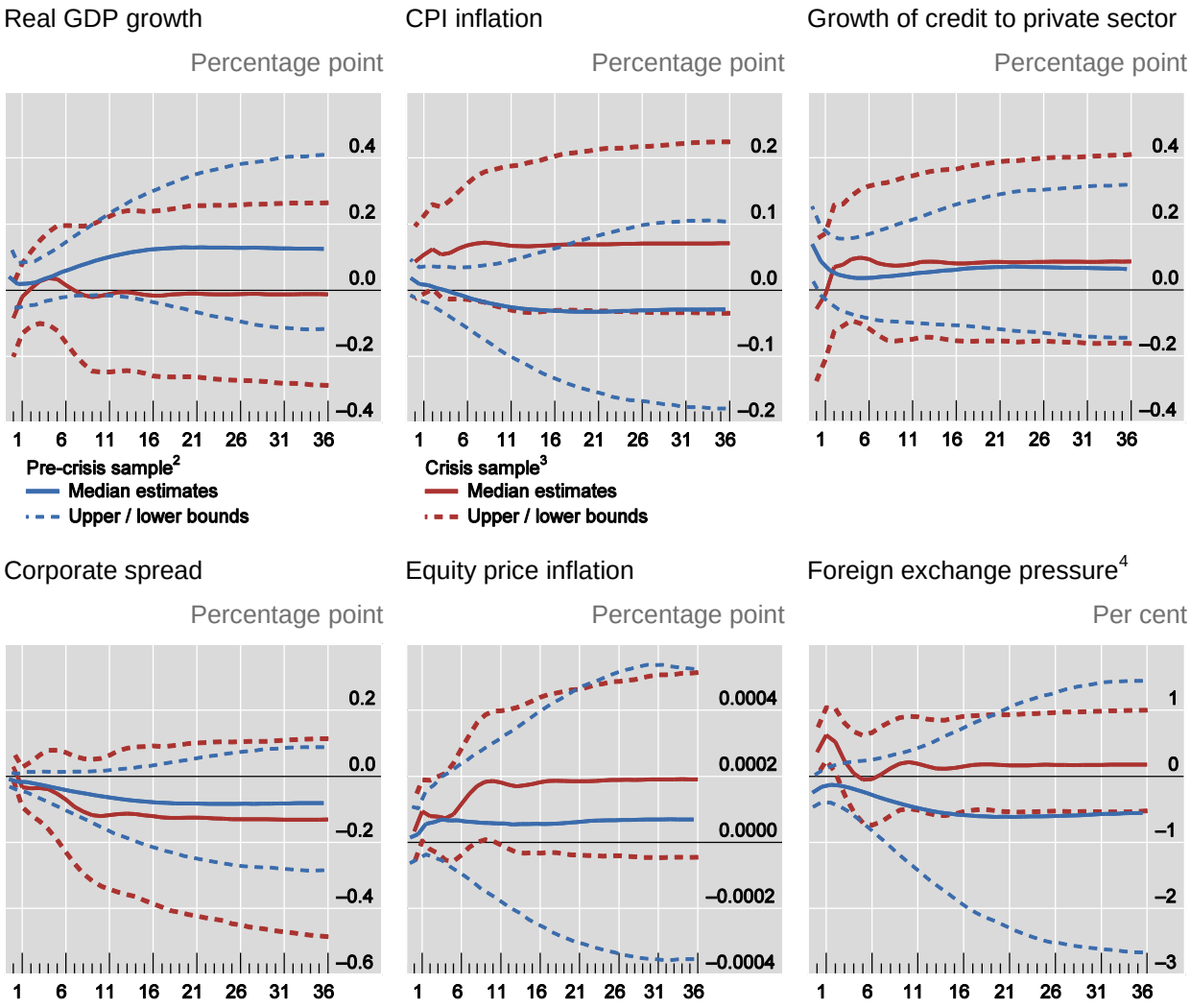
**Figure 5.5.2.16 Impulse Responses to a US Corporate Spread Shock: United Kingdom[1]**




[1] The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.2.17 Impulse Responses to a US VIX Shock: United Kingdom[1]**




[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to US VIX index (in natural logarithm). [2] The pre-crisis sample ranges from February 1995 to June 2007. [3] The crisis sample ranges from July 2007 to February 2013. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

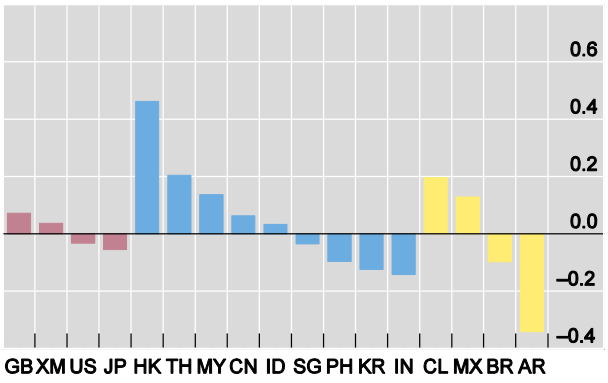
## Appendix 5.5.3 Cumulative Responses to US Term Spread and VIX Shocks

### Figure 5.5.3.1 Cumulative Impulse Responses to a US Term Spread Shock[1]

Crisis sample[2]

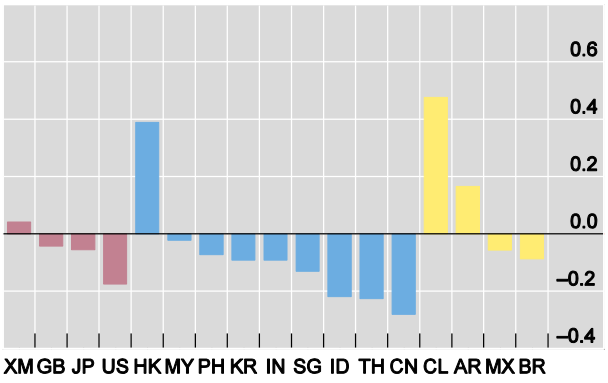
Real GDP growth

Percentage points



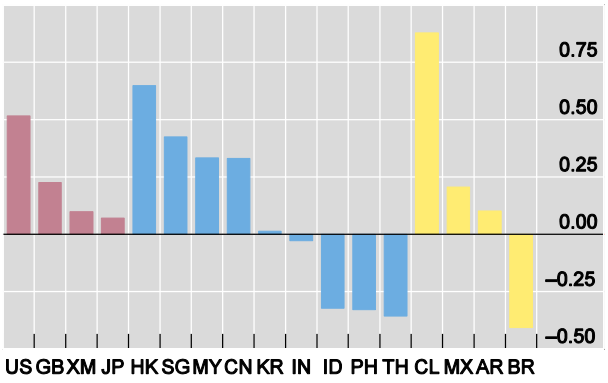

CPI Inflation

Percentage points



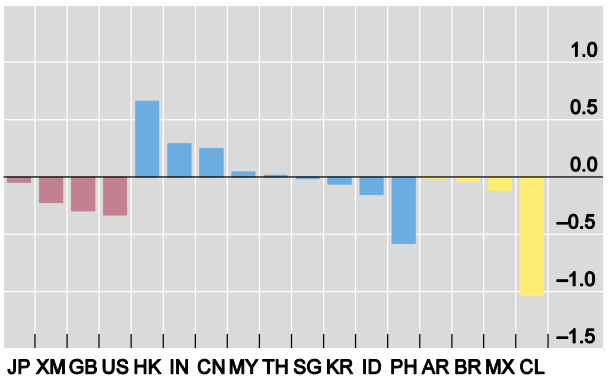

Credit growth to the private sector

Percentage points



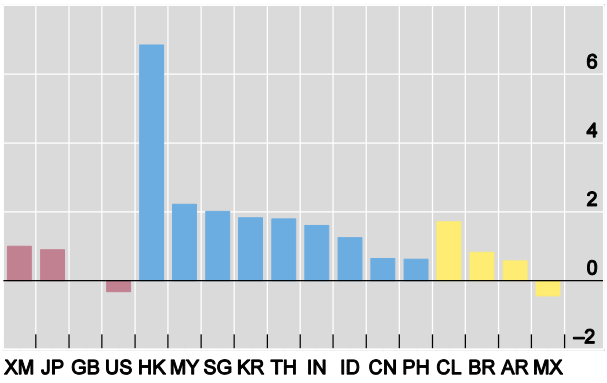

Monetary policy indicator[3]

Percentage points



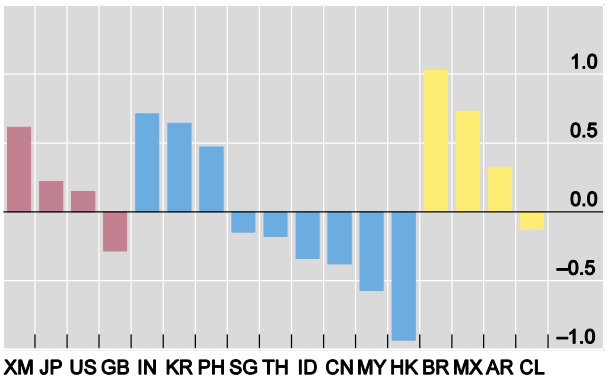

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US term spread shock is a one-standard-deviation (i.e. 14.6 basis points) negative innovation to US term spread. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use term spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

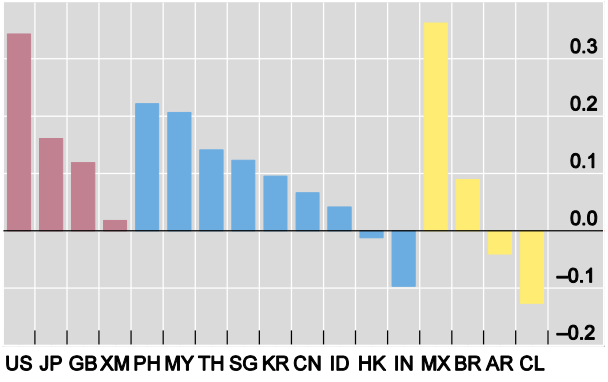
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.3.2 Cumulative Impulse Responses to a US VIX Shock[1]**

Crisis sample[2]

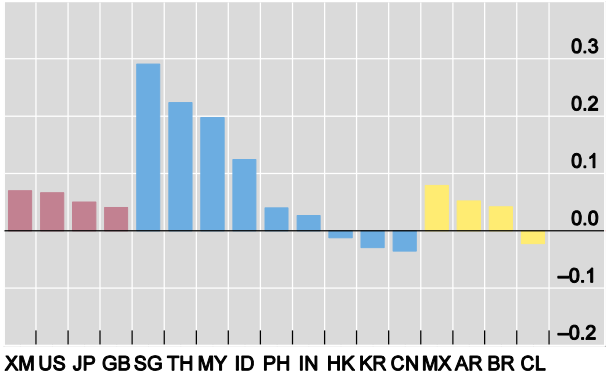
Real GDP growth

Percentage points



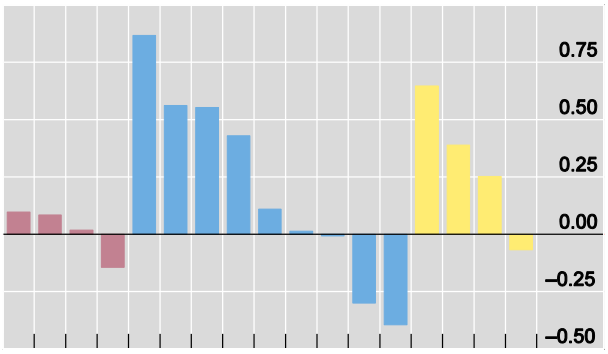

CPI Inflation

Percentage points



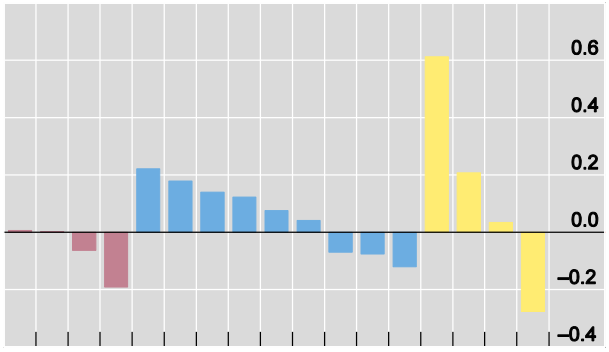

Credit growth to the private sector

Percentage points



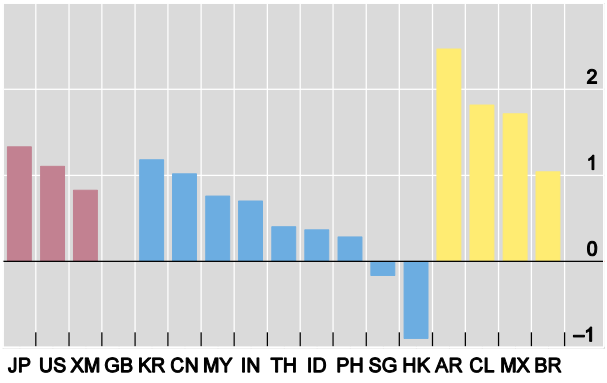

Monetary policy indicator[3]

Percentage points



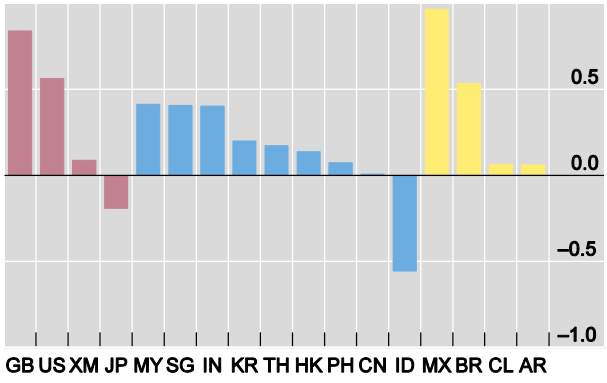

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US VIX shock is a one-standard-deviation (i.e. 8.7 per cent change) negative innovation to CBOE Volatility Index. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use term spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

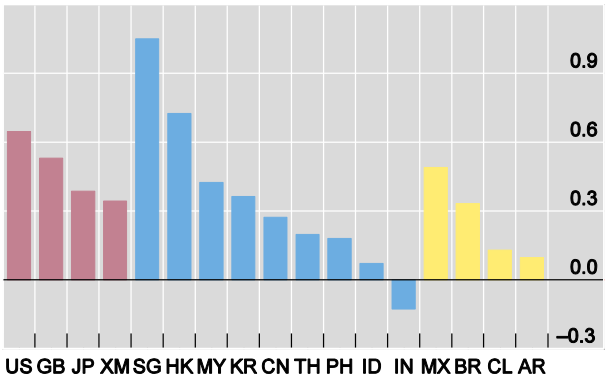
## Appendix 5.5.4 Cumulative Responses to US Corporate Spread & VIX Shocks

### Figure 5.5.4.1 Cumulative Impulse Responses to a US Corporate Spread Shock[1]

Crisis sample[2]

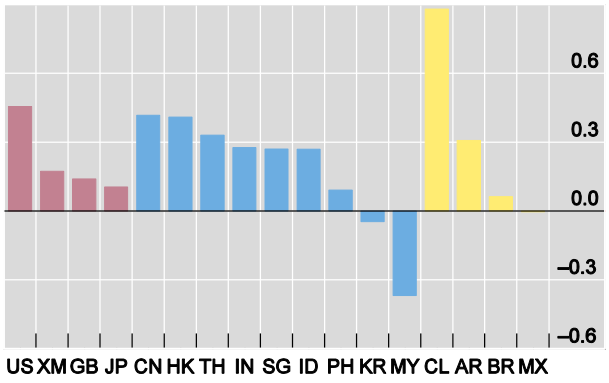
Real GDP growth

Percentage points



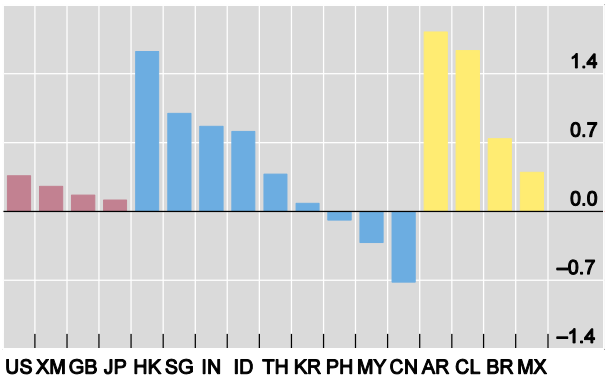

CPI Inflation

Percentage points



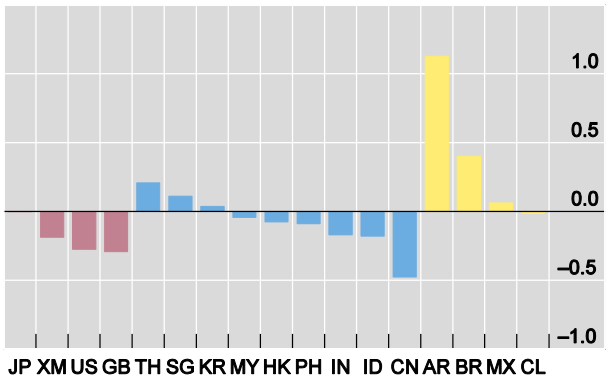

Credit growth to the private sector

Percentage points



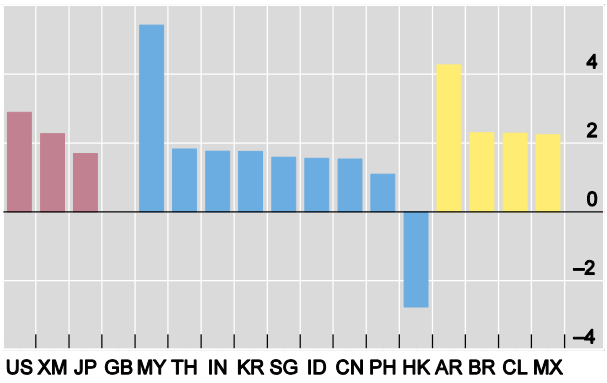

Monetary policy indicator[3]

Percentage points



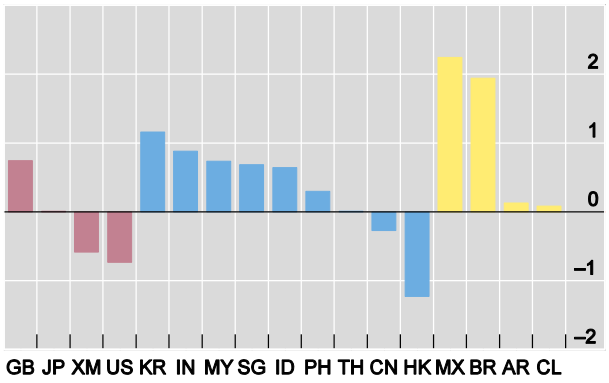

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent




AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

1 The US corporate spread shock is a one-standard-deviation (i.e. 22.9 basis points) negative innovation to US corporate spread. 2 The crisis sample ranges from July 2007 to February 2013. 3 For monetary policy indicators, we use corporate spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. 4 A rise in the foreign exchange pressure index represents stronger appreciation pressure.

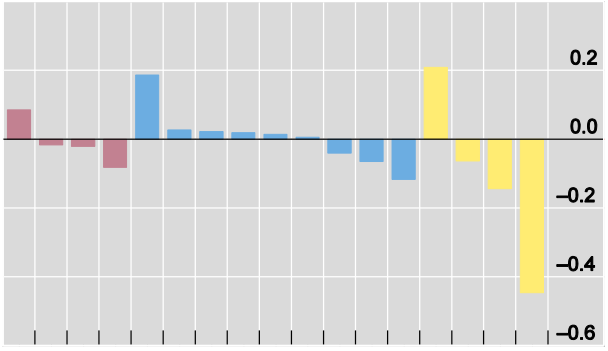
Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.4.2 Cumulative Impulse Responses to a US VIX Shock[1]**

Crisis sample[2]

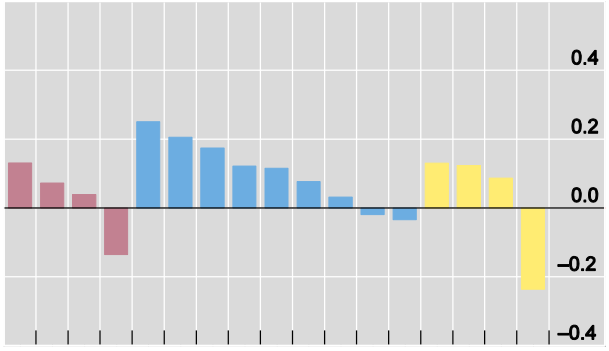
Real GDP growth

Percentage points



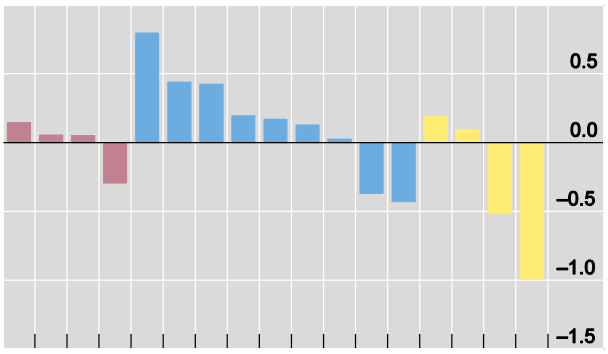

CPI Inflation

Percentage points



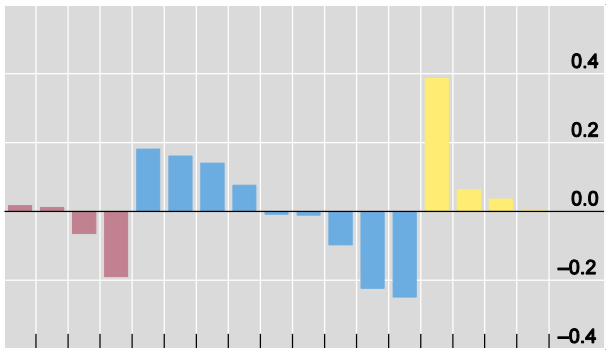

Credit growth to the private sector

Percentage points



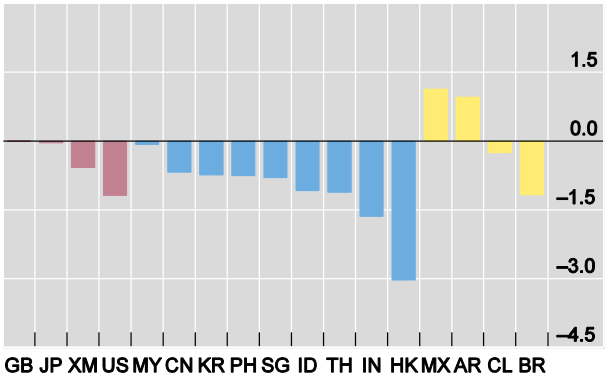

Monetary policy indicator[3]

Percentage points



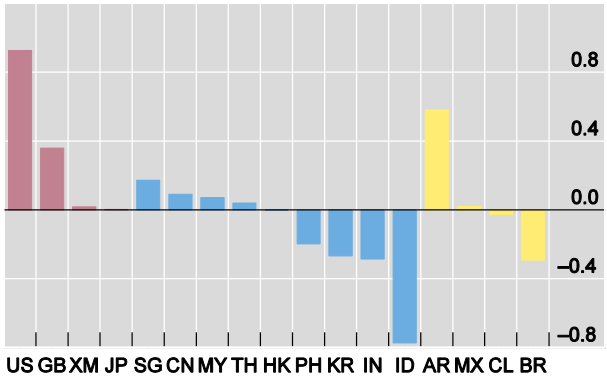

Equity price inflation

Percentage points




Foreign exchange pressure[4]

Per cent



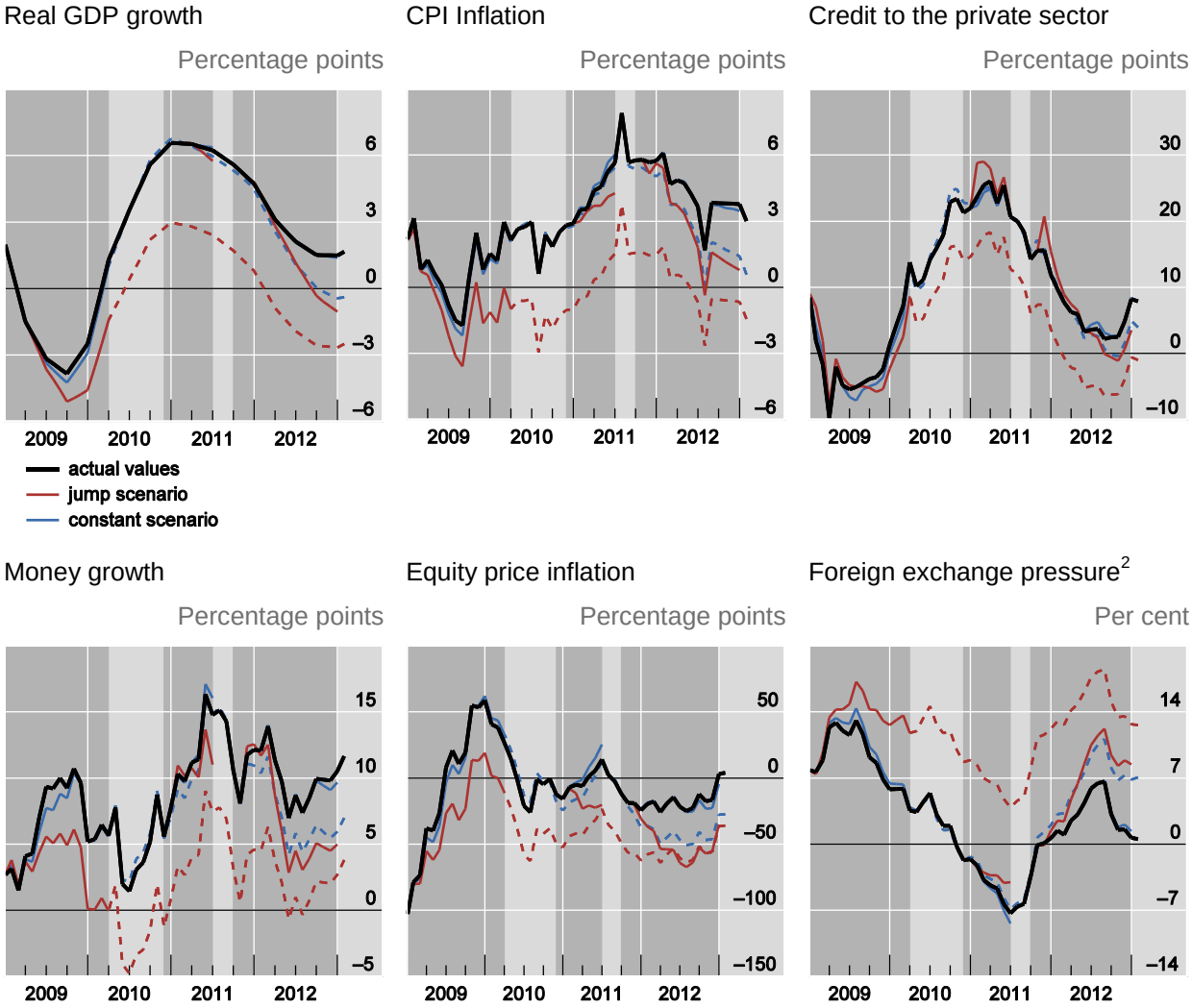

AR = Argentina; BR = Brazil; CL = Chile; CN = China; GB = United Kingdom; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; US = United States; XM = Euro area.

[1] The US VIX shock is a one-standard-deviation (i.e. 10 per cent change) negative innovation to CBOE Volatility Index. 2 The crisis sample ranges from July 2007 to February 2013. [3] For monetary policy indicators, we use corporate spreads for the advanced economies, and the growth rates of a broad monetary aggregate for emerging economies. [4] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

## Appendix 5.5.5 Counterfactual Analysis: US Term Spread Shock

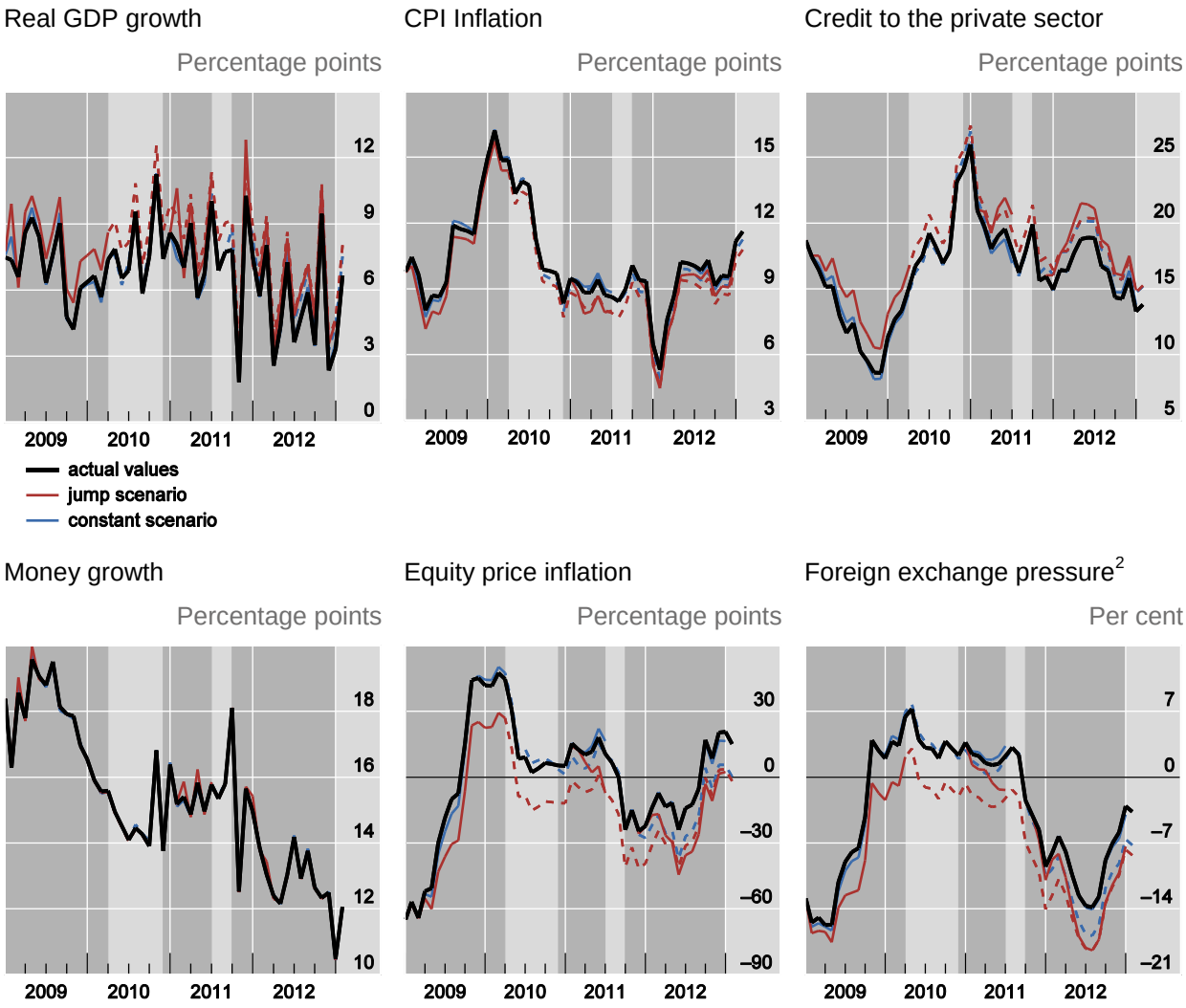
### Figure 5.5.5.1 Counterfactual Analysis: Hong Kong SAR[1]




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

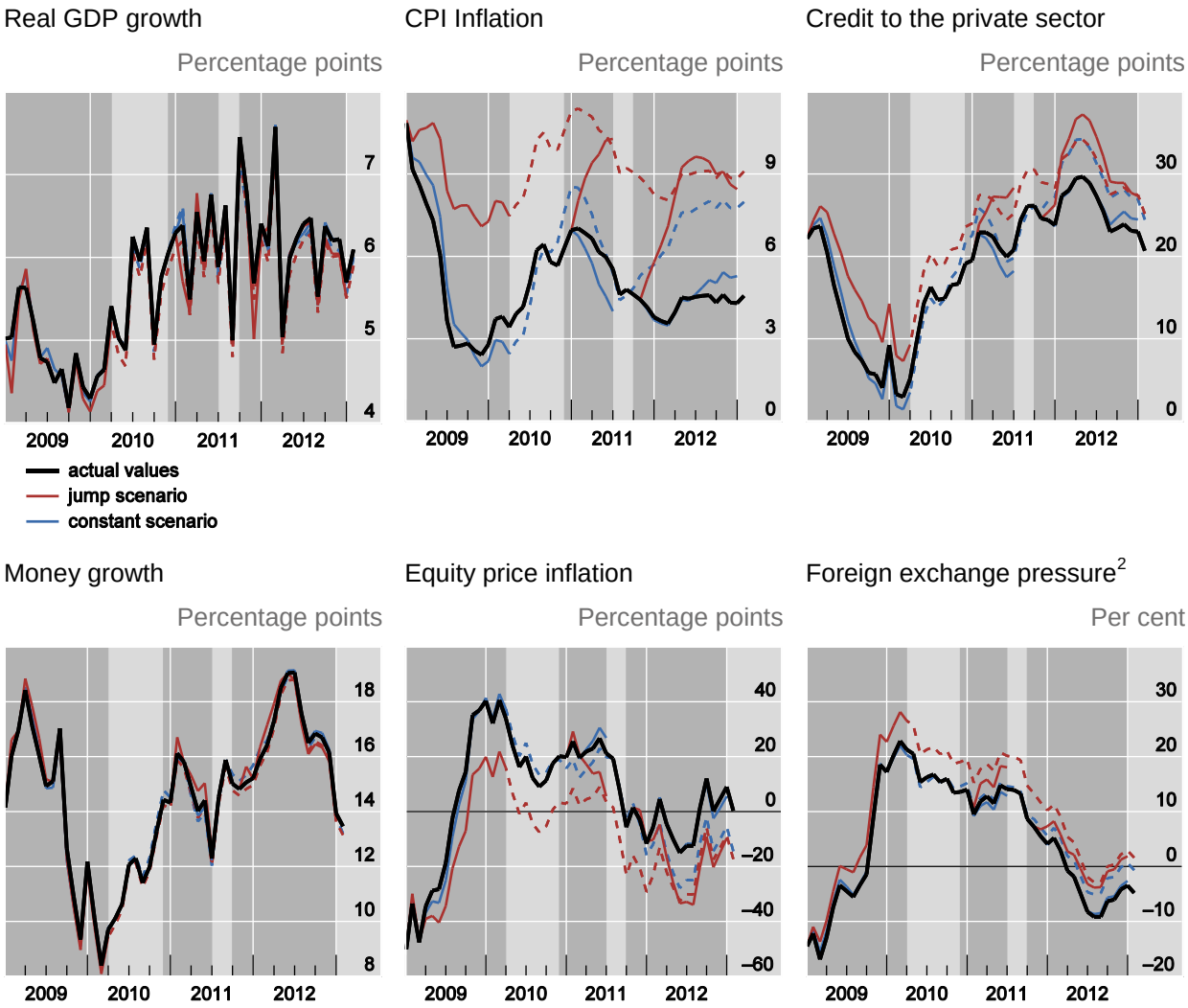
**Figure 5.5.5.2 Counterfactual Analysis: India[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

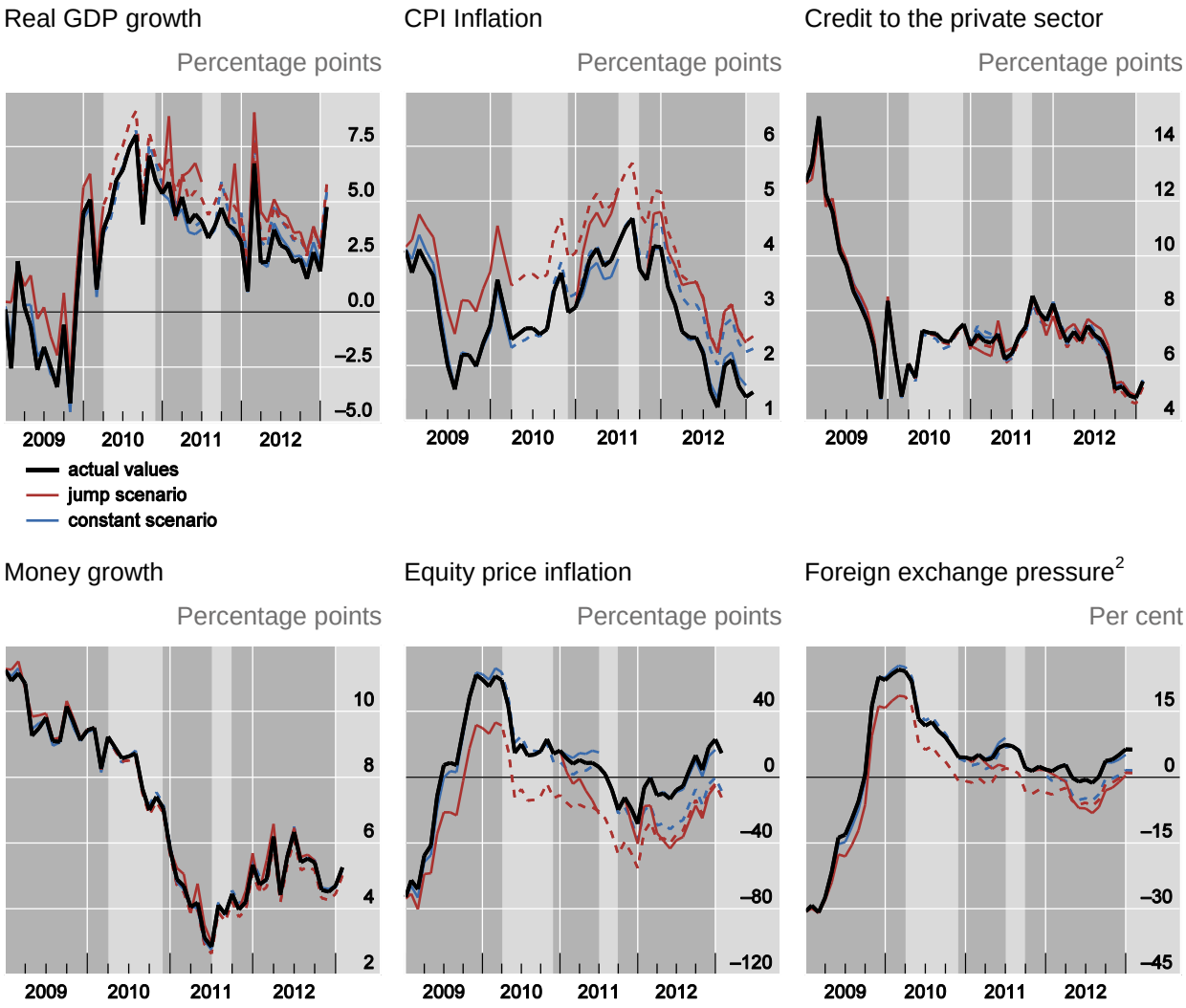
**Figure 5.5.5.3 Counterfactual Analysis: Indonesia[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

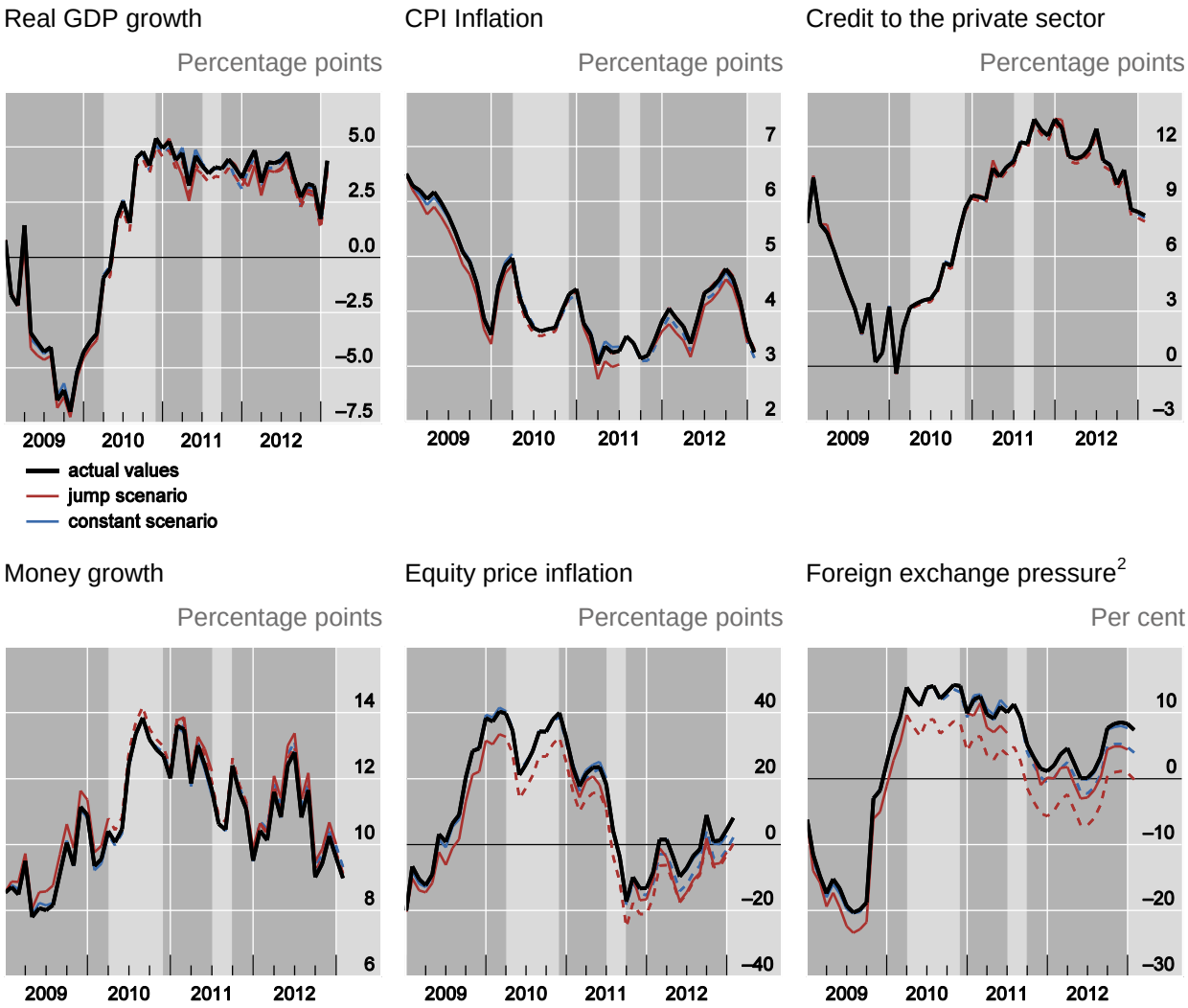
**Figure 5.5.5.4 Counterfactual Analysis: Korea[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

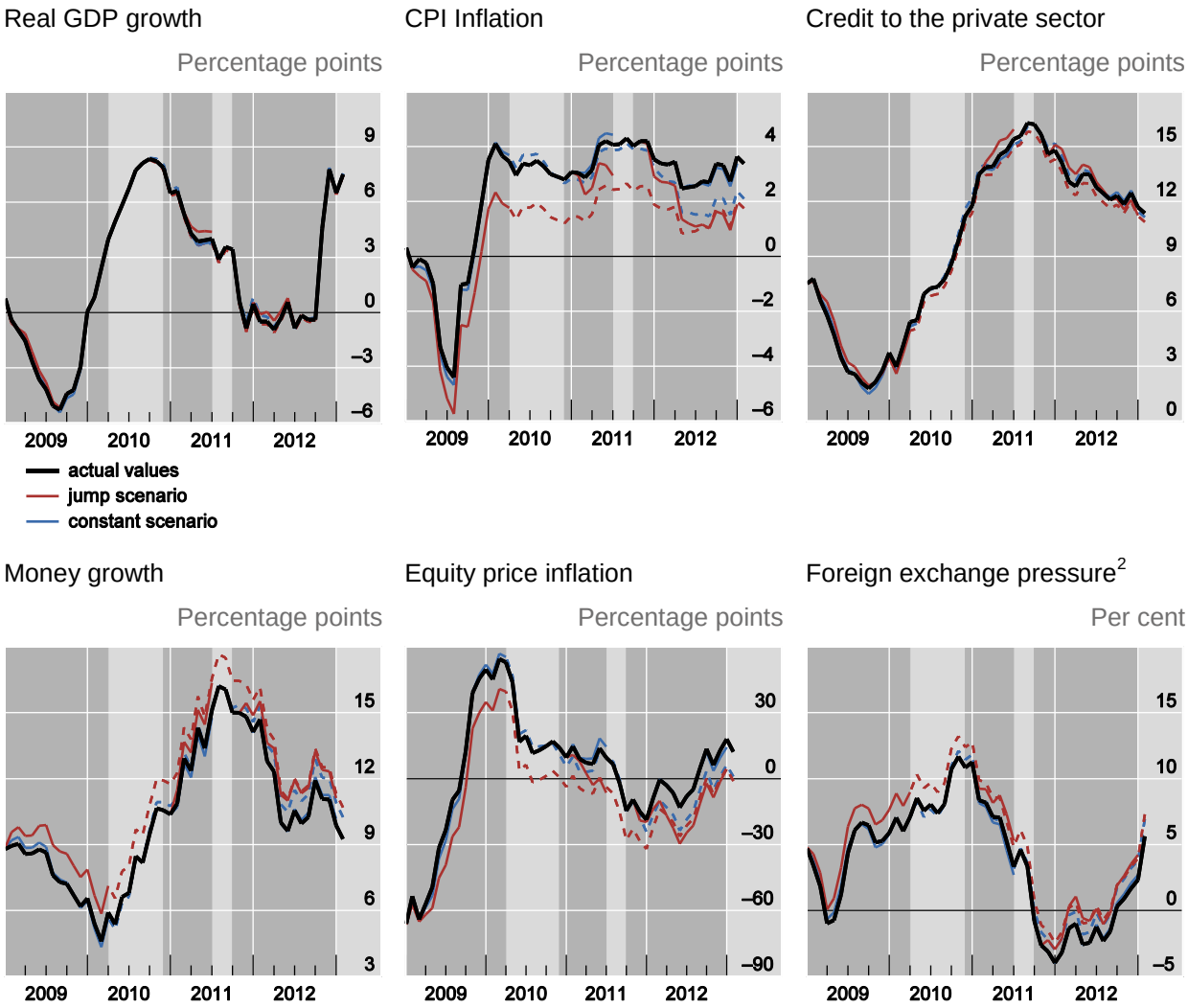
**Figure 5.5.5.5 Counterfactual Analysis: Mexico[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.5.6 Counterfactual Analysis: Thailand[1]**

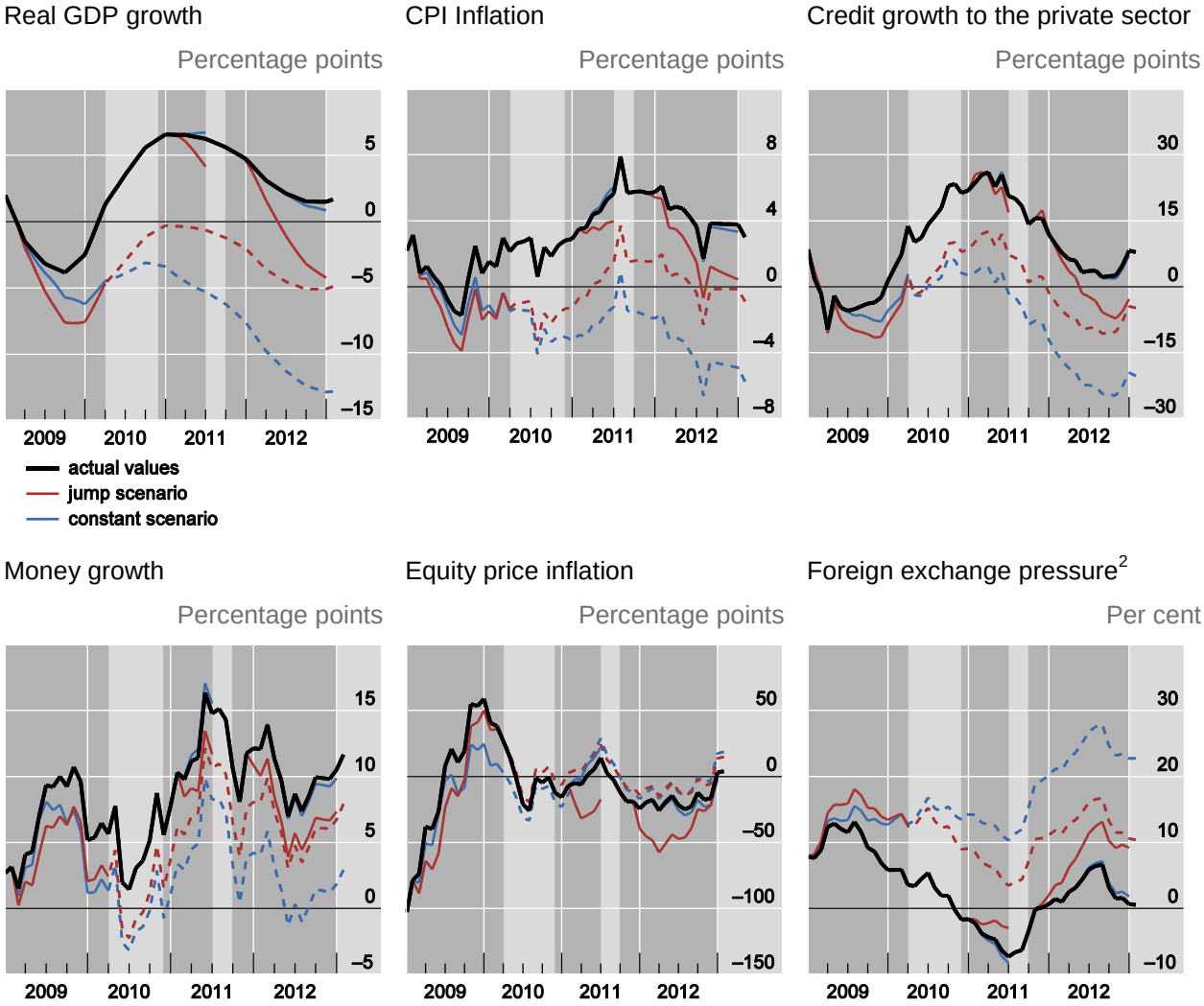



[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US term spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US term spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

## Appendix 5.5.6 Counterfactual Analysis: US Corporate Spread Shock

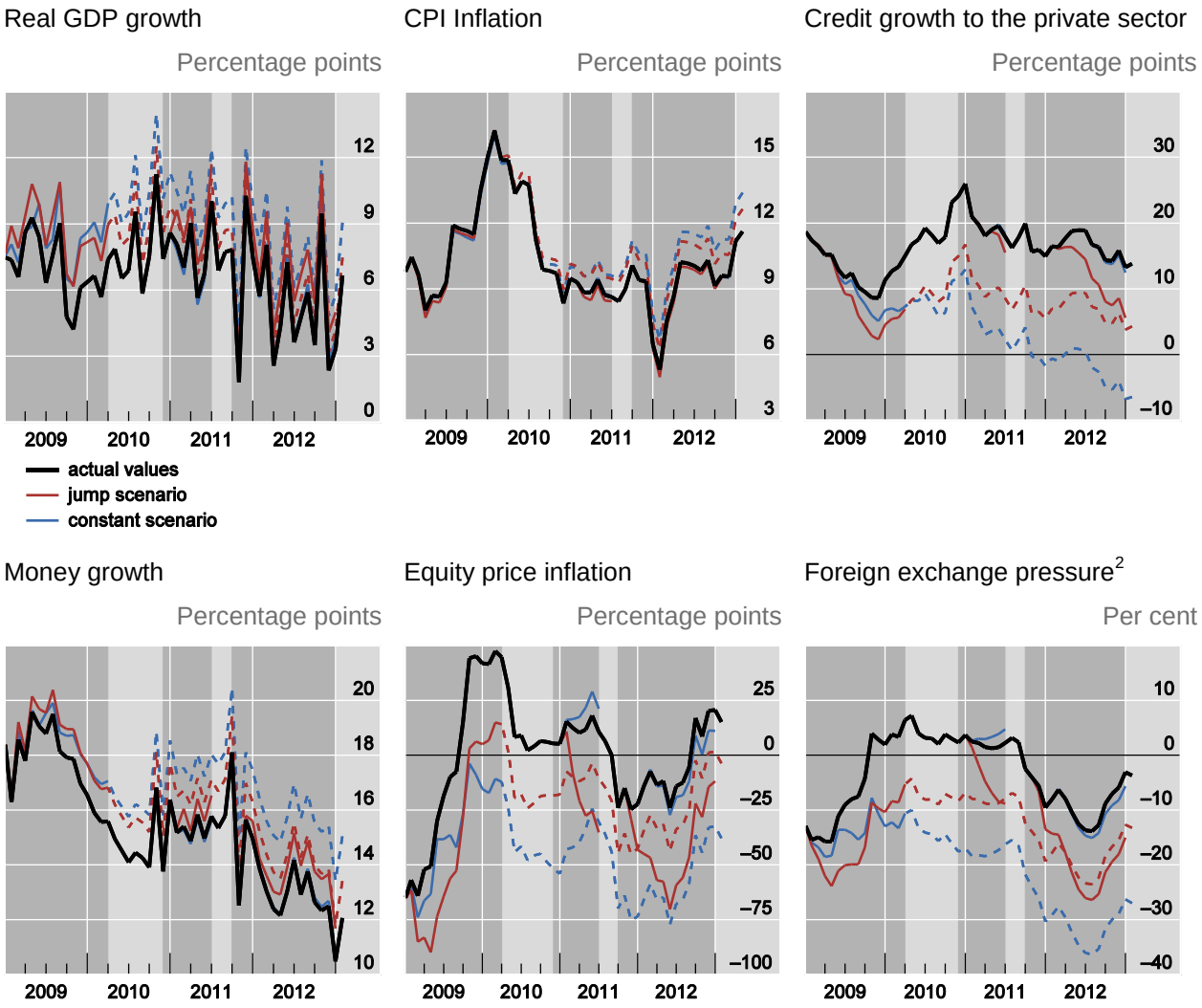
### Figure 5.5.5.7 Counterfactual Analysis: Hong Kong SAR[1]




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

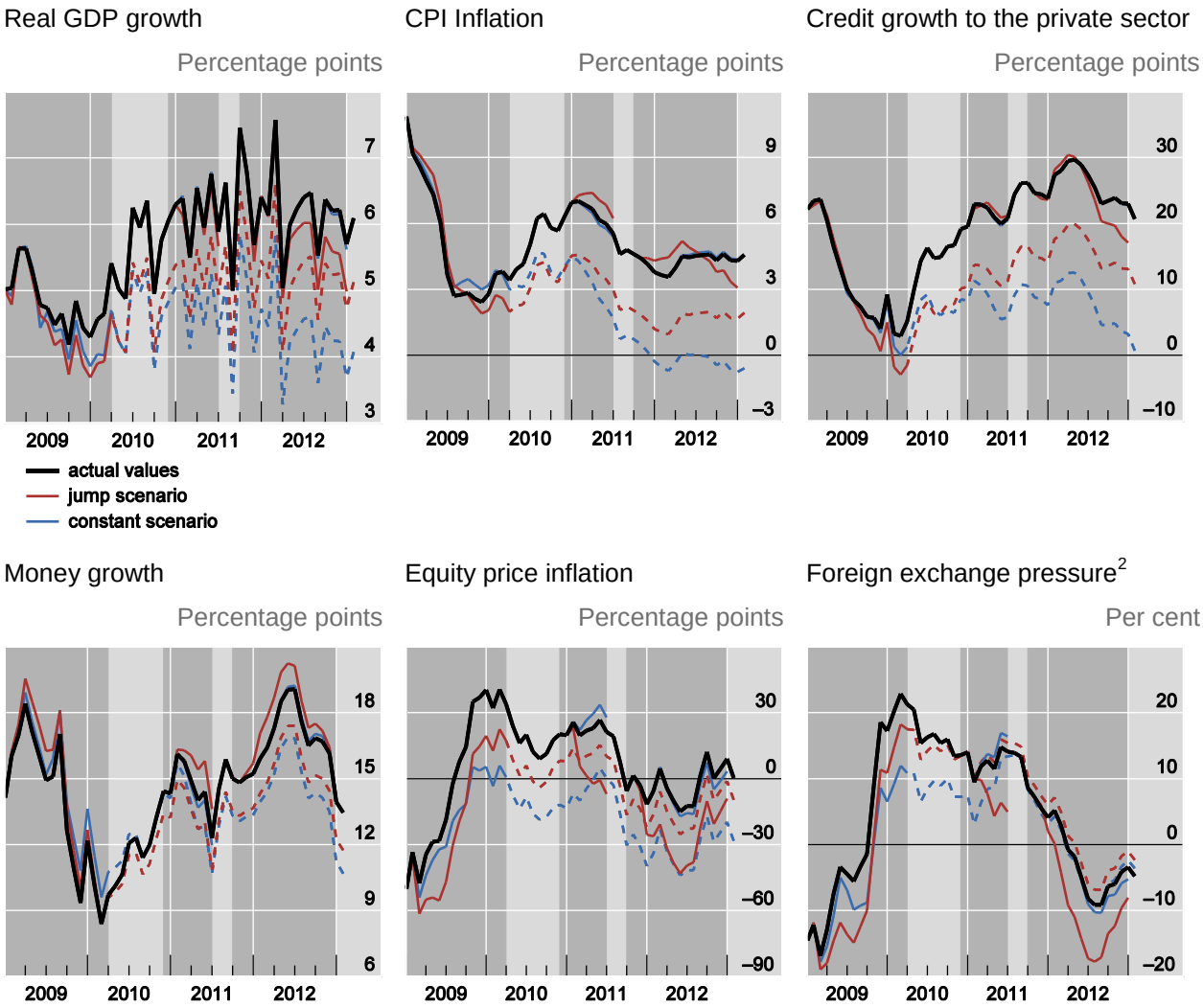
**Figure 5.5.5.8 Counterfactual Analysis: India** [1]




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

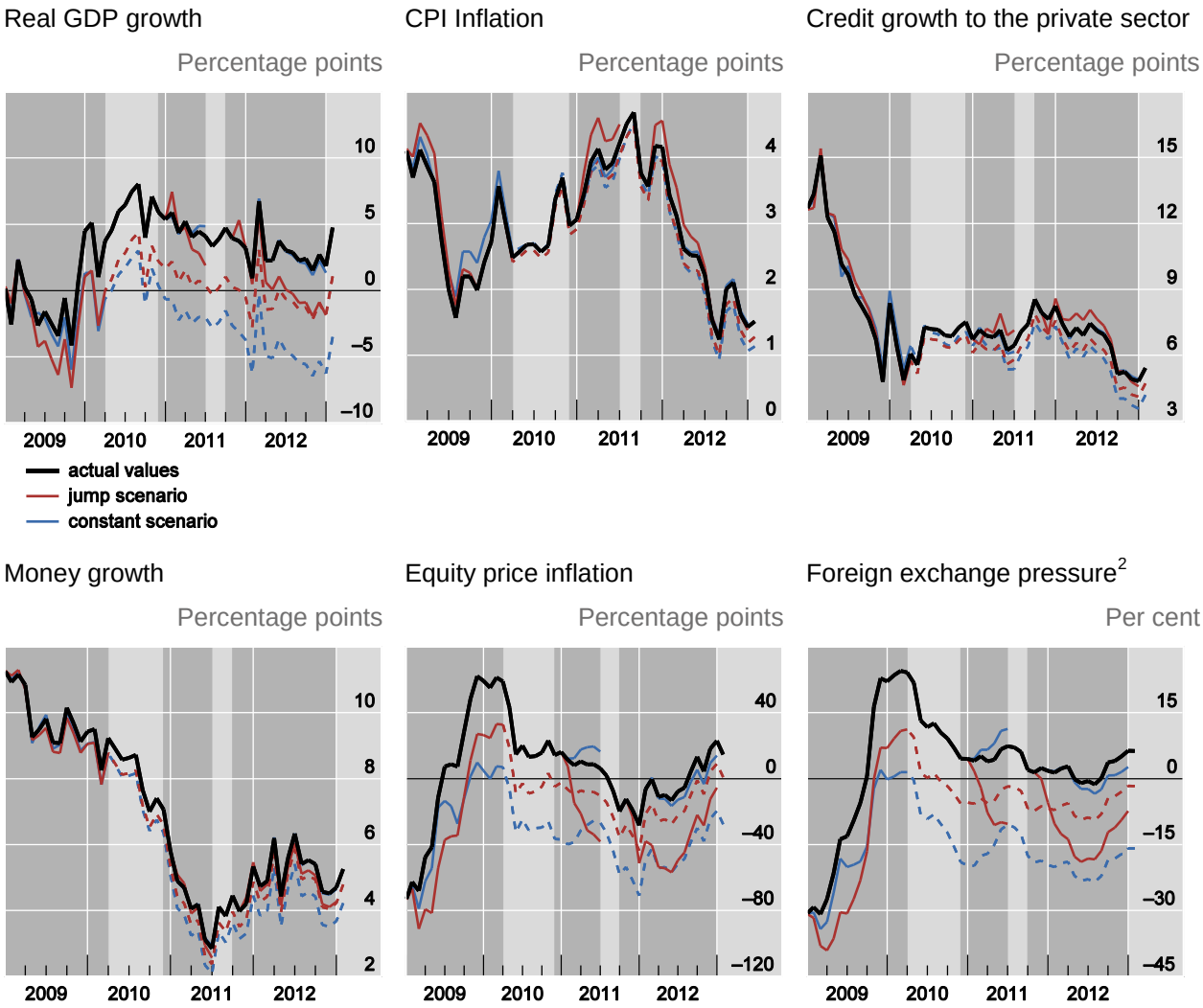
**Figure 5.5.5.9 Counterfactual Analysis: Indonesia[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

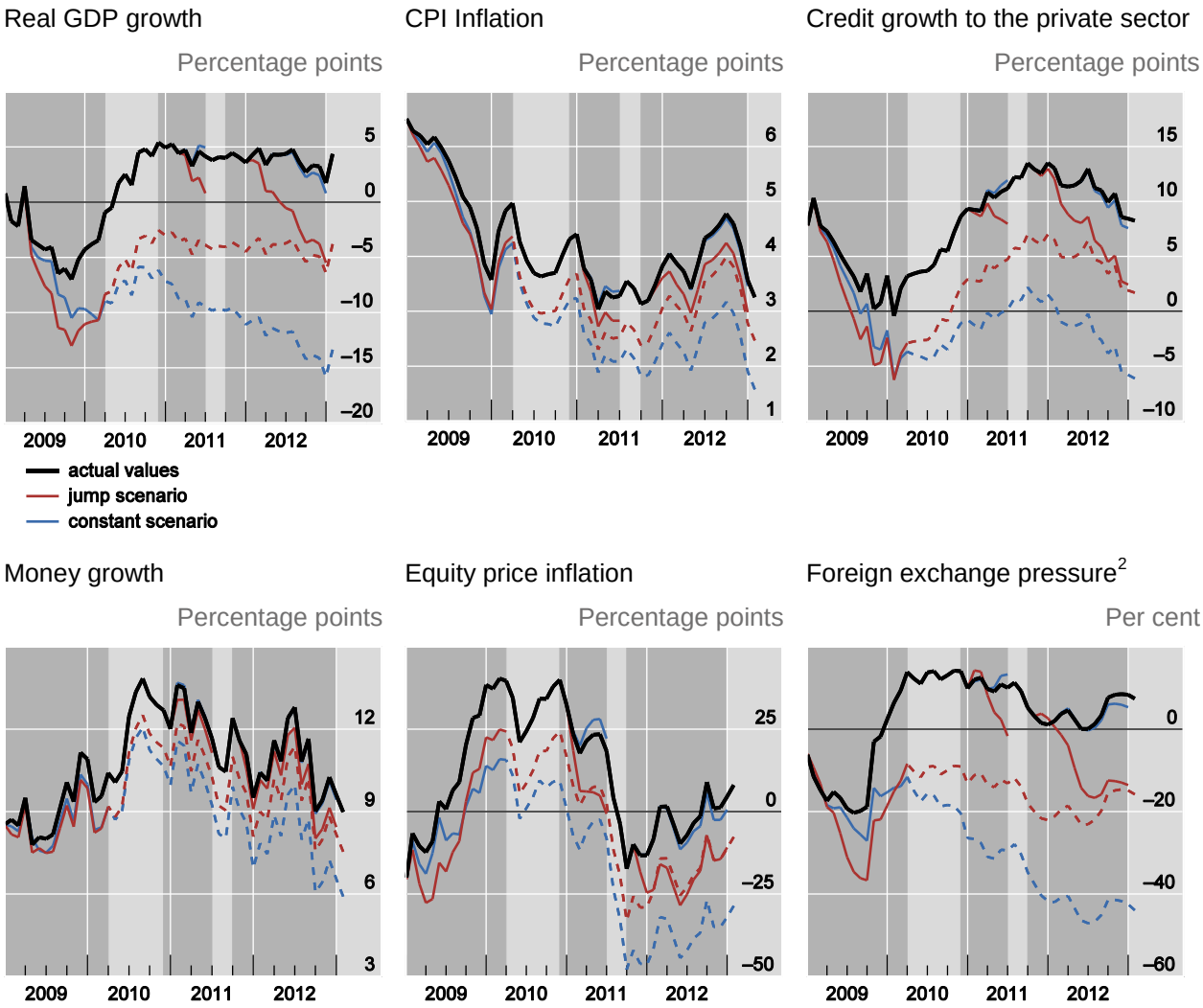
**Figure 5.5.5.10 Counterfactual Analysis: Korea[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

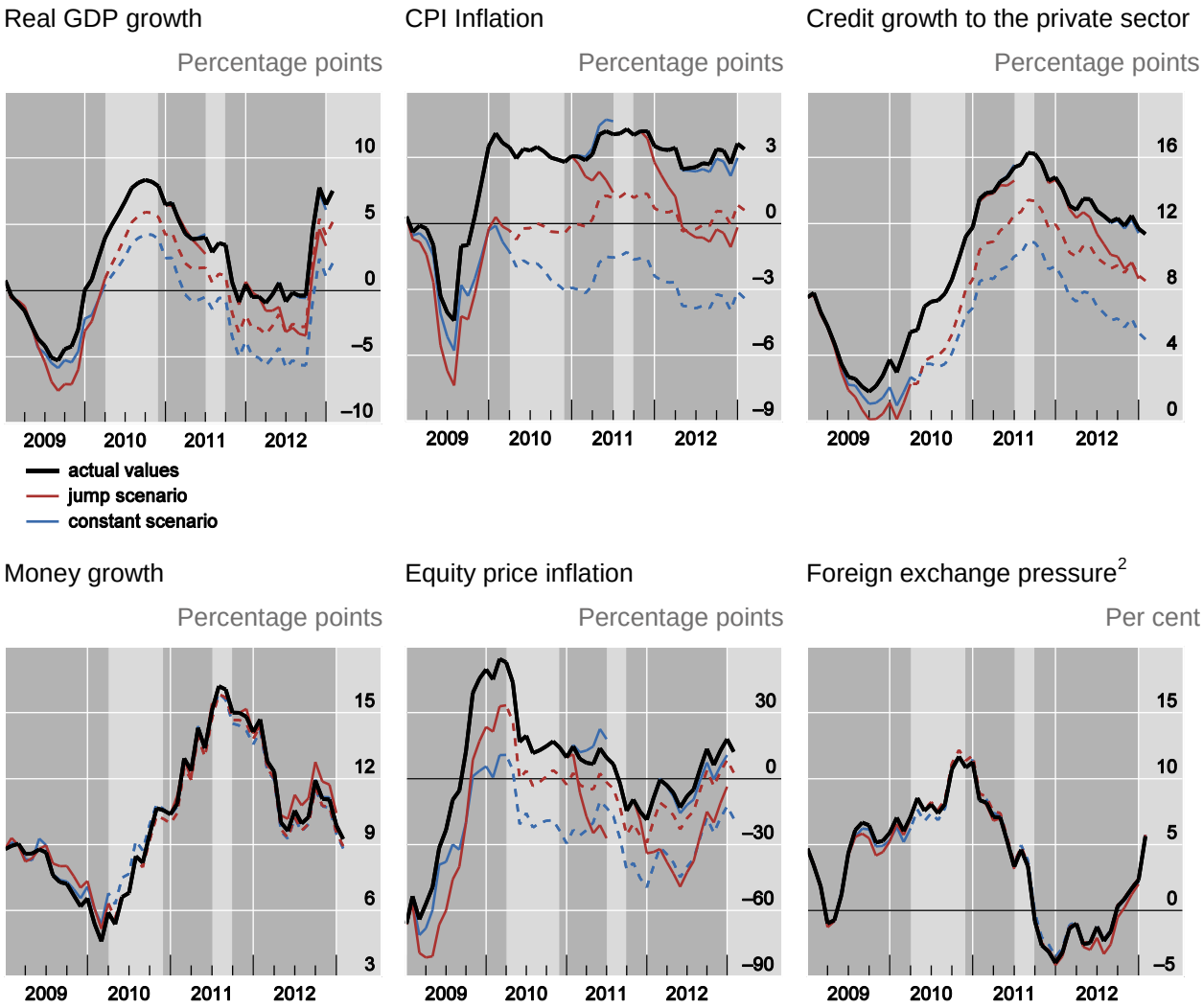
**Figure 5.5.5.11 Counterfactual Analysis: Mexico[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.

**Figure 5.5.5.12 Counterfactual Analysis: Thailand[1]**




[1] The grey areas indicates the periods of implementation of LSAP1, LSAP2 and MEP. The black lines are actual values. The red lines are the values associated with the jump scenario where US corporate spread jumps by 200 basis points and stays 200 basis points above the actual levels throughout the respective QE programme, and the blue lines depict the scenario where US corporate spread stays equal to the actual level observe just before the QE programme. [2] A rise in the foreign exchange pressure index represents stronger appreciation pressure.

Source: Authors' calculations based on an estimated Global Vector Error Correction model.