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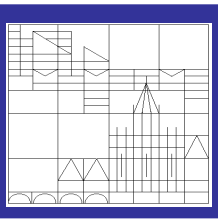

The Transmission of US Financial Stress: Evidence for Emerging Market Economies

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Working Paper Series
2013-01

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THE TRANSMISSION OF US FINANCIAL STRESS: EVIDENCE FOR EMERGING MARKET ECONOMIES*

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First Draft: February 15, 2012
This Draft: January 18, 2013

Abstract

We provide empirical evidence that US financial stress shocks (US-FSSs) are an important driver for economic dynamics and fluctuations in emerging market economies (EMEs). Applying a structural vector autoregression, we analyze the international transmission of US-FSSs to eight EMEs using monthly data from 1999 to 2012. US-FSSs are identified as unexpected changes in the financial conditions index of the Federal Reserve Bank of Chicago. Findings indicate that a typical EME experiences similar negative effects as the US economy in response to US-FSSs. Our results emphasize that the transmission through international financial interconnections is dominant, while contagion through trade is inessential. Further, with regard to fluctuations in real economic activity, US-FSSs are as important as all other external factors jointly. In general, US-FSSs represent a crucial driver for volatility in the emerging world; also at business cycle frequencies.

Keywords: Financial Stress Shocks · International Transmission · Emerging Markets · SVAR

JEL-**Codes**: E44 · F30 · G10

*Contact: fabian.fink@uni-konstanz.de, yves.schueler@uni-konstanz.de. We thank our supervisors Ralf Brüggemann and Almuth Scholl for ongoing support and helpful discussions. Furthermore, we received valuable comments and suggestions from Eduardo A. Cavallo, Matthias S. Hertweck, Kirstin Hubrich, Giorgio Primiceri, Andrew Powell, Alessandro Rebucci, Peter Rosenkranz, and audiences at various seminars. Fabian Fink acknowledges the hospitality of Northwestern University where part of this research was undertaken. The Ph.D. fellowship for Yves S. Schüler from the "Stiftung Geld und Währung" (Money and Currency Foundation) is gratefully acknowledged.

"... the [global financial] crisis has been a bitter reminder that, for all their benefits, deeper trade and financial linkages can serve as a mechanism for magnifying shocks and intensifying their effects on the real side of a nation's economy."

(Kose and Prasad, 2010, p.4)

1 Introduction

Emerging market economies (EMEs) share, in contrast to the advanced world, two distinct properties: first, EMEs are characterized by a high degree of fluctuations in economic fundamentals and second, EMEs are strongly vulnerable to external shocks. For instance, volatility of GDP has been about 50% higher than the respective figure for advanced economies from 1960 to 2008 (Kose and Prasad, 2010). External factors may actually explain parts of this high variability, i.e., international financial market transactions such as foreign capital flows have proven to be important determinants of booms and busts in EMEs (Calvo et al., 1993; Calvo, 1998). As the last global financial crisis has remarkably shown, the financial shock that originated in the US spread *rapidly* and *intensively* to the emerging world. Deeper trade relations and international financial linkages may have contributed to the extent of the contagion. Figure 1 shows growth rates of output for a group of emerging market countries and the US from the first quarter of 2006 to the fourth quarter of 2009. The synchronized performance of both time series underlines how quickly the US financial shock spread to the group of EMEs. However not only this event, but also past episodes of financial stress have highlighted that financial conditions in the US play an important role for the macroeconomic dynamics in emerging market economies. Thus, the analysis of *financial vulnerability* is key to guide future research and policies.

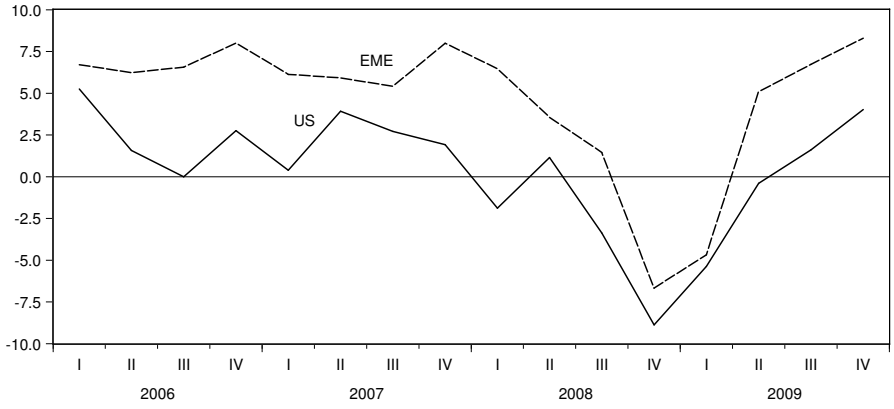


Figure 1: Growth in GDP in Emerging Market Economies and the United States, 2006-2009

Notes: This figure shows the annualized quarter over quarter real GDP growth rate, which is constructed as a weighted by GDP at purchasing power parity average. The EME series is based on 20 emerging market countries: Argentina, Brazil, Chile, Colombia, Estonia, Hungary, India, Indonesia, Korea, Latvia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey, and Venezuela. All countries, except for Korea, are classified as EMEs according to the IMF. Data are obtained from the IMF.

In this study we address the relevance of US financial stress for emerging market economies. In particular, we provide empirical evidence for the following three questions: 1) How does US financial stress affect the dynamics of macro-variables in EMEs? 2) Are international *trade* or *financial* linkages more important for the transmission? 3) How important is US financial stress for explaining the high volatility in the emerging world?

We examine the role of US financial stress for EMEs by employing a structural vector autoregression (VAR), which is estimated via Bayesian techniques. Our data set contains monthly data from 1999 to mid 2012 for eight EMEs (Brazil, Chile, Korea, Malaysia, Mexico, Philippines, South Africa, Thailand) and we conduct the study on a bilateral basis with the US and one emerging market country at a time. US financial stress shocks are identified as unexpected changes in the National Financial Conditions Index (NFCI). This financial conditions index is published by the Federal Reserve Bank of Chicago and contains systemically relevant financial variables from different US financial sectors. The NFCI comprises important information of risk, liquidity, and leverage in the money markets, debt and equity markets, and the banking system. The advantage of a financial conditions index is clearly the fact that it captures *overall* financial conditions in the US financial sector. This feature is particularly beneficial since the US financial system is highly interconnected and thus tighter financial linkages in the US lead to shocks that affect *general* financial conditions rather one specific sector as the last financial crisis has remarkably shown. Shocks in the US financial sector are then interpreted as financial stress shocks, i.e., a worsening of financial conditions in US financial markets.

Several findings emerge from our analysis: first, EMEs experience similar negative effects as the US economy in response to US financial stress shocks. After one year, the decline in real economic activity for most of the EMEs is even slightly more pronounced than the decrease in the US. Second, the transmission of US financial stress shocks occur through international financial linkages. An adverse shock to the US financial system dries up capital flows from the US to the EME. The decline in cross-border lending results in tighter financing conditions for EMEs. Capital inflow reversals generate a pressure on the currency of EMEs such that the exchange rate depreciates. Reduced international liquidity, thus tighter financing conditions, finally affect the EMEs real economy negatively. On the other hand, we do not find an important role for the transmission through the trade channel. Third, US financial stress that changes US financing conditions plays an important role in explaining fluctuations in EME macro-variables. On average, up to 21% of the variation in EME real GDP is due to US financial stress. Moreover, US financial stress shocks are as important as all other external shocks jointly in explaining the volatility in EMEs. In the short-run, i.e., at business cycle frequencies, our results indicate that US financial stress shocks account for a substantial fraction of cyclical variation in EME macro-variables. On average, up to 17% of the cyclical variation in real economic activity is due to the US financial stress shock.

This paper contributes to the empirical macroeconomic literature that focuses on the international transmission of shocks to EMEs: Canova (2005) analyzes the transmission of US real demand, real supply, and monetary policy shocks to Latin American countries. His results show that US monetary policy shocks affect the group of countries considered, while real demand and supply shocks generate insignificant responses. Mackowiak (2007) focuses on countries from different geographic regions (Asia and Latin America). Additionally to Canova (2005) he reports the proportions of the variation explained by monetary policy shocks and concludes that those are less important relative to other external shocks. However, both authors find that external shocks are important in explaining fluctuations in EMEs. We contribute to this strand of literature in three aspects. First, we focus on the international transmission of financial stress from the US to EMEs. Our framework enables us to isolate US financial stress from US monetary policy, which we exploit to compare their relative importance. Second, in contrast to previous studies we empirically assess which channels (trade and/or financial) are relevant for cross-country spill-overs. Third, our analysis gives detailed information on how much of the volatility in the emerging world is due to US financial stress, monetary, and all external shocks jointly. To our knowledge, this study is also the first empirical analysis that measures the contribution of US financial stress, US monetary, and all external shocks to the *cyclical* variation, i.e., at business cycle frequencies, of EMEs' macro-variables. With regard to the financial disruption of 2007, it represents a necessity to shed light on the macroeconomic consequences for the emerging world of deeper financial linkages.

Furthermore, our paper relates to the recent empirical macro-finance literature that considers the impact of financial shocks on the real economy, e.g., Lown and Morgan (2006), Gilchrist and Yankov (2009), Helbling et al. (2011), Kalemli-Ozcan et al. (2012), and Hristov et al. (2012). Hubrich and Tetlow (2012) employ, similar to the present study, an index of financial stress to analyze the transmission to the US real sector. While their study focuses on the macro-finance link in a closed economy setup, our paper contributes to this literature in deepening the understanding on how financial stress in the US affects the dynamics and the volatility in the emerging world. Finally, this paper is related to recently emerging VAR studies employing indices of overall conditions, see, e.g., Baker et al. (2013) for the impact of overall economic policy uncertainty shocks on the macroeconomy.

The remainder of the paper is structured as follows. In Section 2 we present the empirical model, the econometric approach, and the data set. Section 3 discusses how US financial stress shocks affect emerging market economies considering impulse responses and variance decompositions. Finally, Section 4 concludes.

2 THE EMPIRICAL MODEL

2.1 A Structural Vector Autoregression

Let y_t $(n \times 1)$ be a vector of random variables at time t, C a vector of constants, $\mathcal{A}$ and $\mathcal{A}_l$ coefficient matrices of size $n \times n$, and ε_t $(n \times 1)$ be the exogenous structural shocks at time t. n denotes the number of variables included in the model, T the sample size, and p the lag length. We consider the following structural VAR model:

$$y_t'\mathcal{A} = C + \sum_{l=1}^{p} y_{t-l}'\mathcal{A}_l + \varepsilon_t', \quad \forall \quad 1 \leq t \leq T. \tag{1}$$

The initial conditions $y_0, \ldots, y_{1-p}$ are fixed. Using this notation columns refer to equations, e.g., column i, where $i = 1, \ldots, n$, of matrix $\mathcal{A}$ $(\mathcal{A}_l)$ refers to equation i. Further, the structural innovations are assumed to be normally distributed with

$$E(\varepsilon_t | y_1, \ldots, y_{t-1}) = 0 \quad \text{and} \quad E(\varepsilon_t \varepsilon_t' | y_1, \ldots, y_{t-1}) = \mathbf{I}_n, \tag{2}$$

where $\mathbf{I}_n$ denotes the identity matrix of dimension n. To study the international transmission of US shocks we use a two-country setup, i.e., our analysis is conducted on a bilateral basis with the US and one EME at a time. We assume that the emerging market country behaves like a small open economy, i.e., the EME variables do not enter the equations of the US variables. The assumption of a small open economy is introduced to model (1) in the following way (see Cushman and Zha (1997)): let $y_{1,t}$ $(n_1 \times 1)$ reflect the variables pertaining to the US sector and $y_{2,t}$ $(n_2 \times 1)$ the time series belonging to the respective EME. Thus, $n = n_1 + n_2$ are the total number of variables considered in the VAR. This structural model with block exogeneity restrictions can be written as

$$y_t'\mathcal{A} = C + \sum_{l=1}^{p} \begin{bmatrix} y_{1,t-l}' & y_{2,t-l}' \end{bmatrix} \begin{bmatrix} \mathcal{A}_{11,l} & \mathcal{A}_{12,l} \\ 0 & \mathcal{A}_{22,l} \end{bmatrix} + \varepsilon_t'. \tag{3}$$

The compact form of model (3) is given by

$$y_t'\mathcal{A} = x_t'\mathcal{F} + \varepsilon_t', \tag{4}$$

where

$$x_t' = \begin{bmatrix} y_{t-1}' & \ldots & y_{t-p}' & 1 \end{bmatrix} \quad \text{and} \quad \mathcal{F}' = \begin{bmatrix} \mathcal{A}_1' & \ldots & \mathcal{A}_p' & C' \end{bmatrix}.$$

The dimension of $\mathcal{F}$ is $n \times k$, where $k = np + 1$. The parameters of the structural model are $(\mathcal{A}, \mathcal{F})$.

2.2 *Bayesian Inference*

The structural VAR model with identifying restrictions on $\mathcal{A}$ and zero restrictions on $\mathcal{F}$ is estimated with Bayesian techniques. To obtain small-sample inferences of $(\mathcal{A}, \mathcal{F})$ we follow the method proposed by Waggoner and Zha (2003) and simulate the joint posterior distribution of the structural parameters given the data. Gibbs sampling requires to draw first $\mathcal{A}$ from its marginal posterior distribution and given each draw of $\mathcal{A}$ we simulate draws of $\mathcal{F}$ from its conditional posterior distribution. We consider 25,000 replications where 5,000 are discarded as burn-in draws.[1] Further, we introduce Bayesian prior information according to Sims and Zha (1998). This informative prior extends the commonly known *random-walk prior* (Litterman, 1986) to structural vector autoregressions. Thus, the prior expresses the beliefs that in the reduced form model each variable in the system follows a random-walk. Besides this, a lag-decay prior is imposed on the conditional prior covariance matrix of $\mathcal{F}$ that effectively dampens the effects of long lags. Therefore this informative prior decreases the risk of over-fitting of richly parameterized structural VAR models. In addition, we follow Sims and Zha (1998) and introduce dummy observations as a component of the prior that favor unit roots and cointegration. Literally speaking, we simply add artificial observations to the data matrix considered in our estimation. Without dummy observations as a part of the prior an unreasonable large share of variation is attributed to the deterministic component.[2] Thus, the described Bayesian approach with prior information is particularly suitable for this class of model because our structural VAR model is of high dimension and the degrees of freedom are low.

2.3 *Data Set*

The time frame of our analysis covers the period from 1999M1 until 2012M6. We consider this specific period for two reasons: first, for this period macro-variables are available at the monthly frequency for all emerging market countries in our sample. Second, this period coincides with a rapid increase in financial linkages between the emerging and advanced world (Kose and Prasad, 2010). As we employ monthly data we specify the lag length of our model in (3) to be $p = 12$.

We study eight countries from different geographic regions (Latin America, Asia, and Africa) that are classified as emerging markets economies: Brazil (BR), Chile (CL), Korea (KR), Malaysia (MY), Mexico (MX), Philippines (PH), Thailand (TH), and South Africa (ZA).[3] For each EME we consider six different variables that measure real economic activity, trade relations with the US, foreign capital flows from the US, interest rates, international competitiveness, and inflation. The time series applied

[1] We monitor and ensure convergence through trace plots.

[2] The hyperparameters of this prior are set to standard values previously used in Bayesian structural VAR analysis (see, e.g., Sims and Zha (1998), Robertson and Tallman (2001), Sims and Zha (2006b)). In the notation of Sims and Zha (1998), we employ $\lambda_0 = 0.6$, $\lambda_1 = 0.1$, $\lambda_2 = 1.0$, $\lambda_3 = 1.2$, $\lambda_4 = 0.1$, $\mu_5 = 5.0$, and $\mu_6 = 5.0$.

[3] All countries, but Korea, are classified as EMEs by the IMF. Korea is listed as an EME by, e.g., MSCI. However, its status is debated as some indexes already include Korea in the group of advanced countries.

for this purpose are real GDP (q), bilateral exports over imports (x), bilateral net accumulation of foreign stocks (b), the prime lending rate (i), the real effective exchange rate (s), and the consumer price index (π).

We model the US economy by including five variables. These measure real economic activity, world prices, inflation, interest rates, and financial stress in the US financial system. For real economic activity real GDP (q^*) is used; for world prices we consider the IMF index of world commodity prices (p^*); for inflation the consumer price index (π^*) is employed, and for interest rates we include the effective federal funds rate (i^*). Moreover, US financial stress (f^*) is captured by the National Financial Conditions Index of the Federal Reserve Bank of Chicago. The time series for real GDP series are interpolated from quarterly to monthly frequency using the method described by Bernanke et al. (1997). All variables are employed in levels. Further, all time series are log-transformed, except for the interest rates, the trade ratio, and the financial conditions index. The data for the US and the emerging market countries are obtained from Datastream and seasonally adjusted when necessary. The exact sources, transformations, and descriptions are depicted in Appendix A.

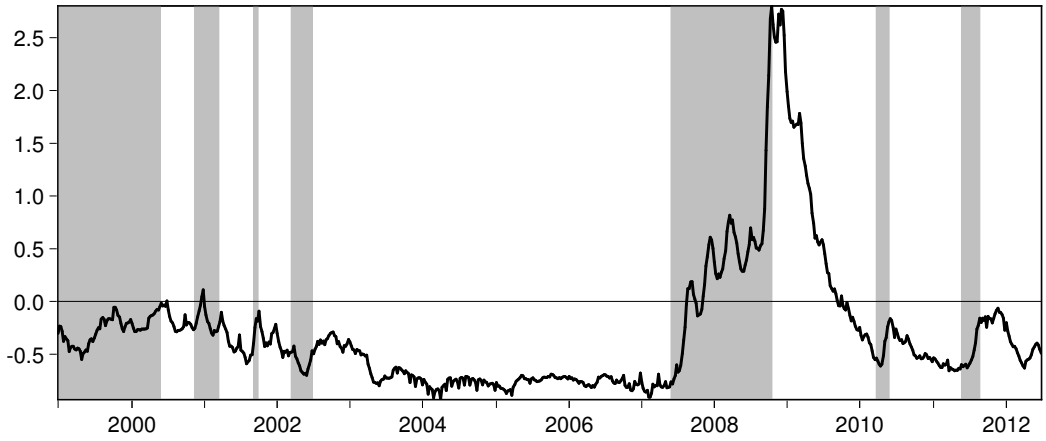


Figure 2: National Financial Conditions Index

Notes: Shaded areas mark times of deteriorating US financial conditions. Details are provided in the text.

Provided that the measure of US financial stress is the key variable of this analysis, the following presents it in more detail. The Federal Reserve Bank of Chicago constructs a measure of US financial conditions to monitor the stability of the whole US financial system with a focus on traditional and newly developed financial markets and their interconnections. The NFCI is regularly updated and constructed as a weighted average of a series of financial indicators.[4] The weights are determined by principal component analysis, however allowing for a variation in the frequency and availability of the time series. It summarizes 100 systemically relevant financial variables from money markets,

[4]The NFCI time series commences in 1973.

debt and equity markets as well as from the banking system. Table 4 in Appendix A provides an overview of the financial sectors covered. In the money markets greatest weights are attached to US commercial paper spreads indicating a risk of default, US interest rate swap spreads reflecting investors perceptions of credit risk, and the TED spreads which serve as an indicator of credit risk as well. Furthermore, the debt and equity markets are mostly driven by corporate bond spreads and the VIX, a volatility measure of the US stock market. Survey-based indicators of credit conditions for consumers and businesses are the key variables in the banking system. In sum, the NFCI measures overall financial conditions. It does not contain variables that function as indicators of US monetary policy.

Figure 2 displays the NFCI from 1999M1 to 2012M6. In general an increase in its value marks a deterioration of US financial conditions. More specifically, it reflects a rise in, for instance, the US commercial paper spreads, the US interest rate swap spreads, or the VIX. Further, it represents a decrease, e.g., in the credit conditions for consumers. The zero line corresponds to a situation where the US financial system operates at the historical average state of financial conditions. Positive values indicate episodes where the US financial system experiences tighter financial conditions compared to its historical average. As the NFCI is updated on a regular basis the historical average is allowed to adjust to new developments. The graph shows clearly that the NFCI is able to match historical episodes of stress in US financial markets (shaded grey areas). At the beginning of our period one can relate the steady increase of the index to the events related to the dot-com bubble. Between the end of 2000 and 2001, we see the effects of the Argentine Crisis. Succeeding, there is a spike that can be related to the terrorist attacks ("9/11"). Also the post "9/11" stock market crash in mid 2002 is visible, which happened as a second wave of turmoil in response to the attacks starting from March 2002. It coincides with the bankruptcy of Enron that raises concerns about the correctness of companies' accounts. In the following, conditions were rather smooth until the outbreak of the financial crisis. Two events are captured clearly by the NFCI: mid 2007, where fears on losses on US subprime mortgages loans led to system wide financial stress and the peak of the financial crisis, which occurred with the bankruptcy of Lehman Brothers mid 2008. Further, the NFCI portrays signs of the sovereign debt crisis at the beginning of 2010. The deterioration of financial conditions mid 2011 can be related to the US debt crisis in which the US congress disagreed about raising the debt ceiling that led to system wide financial stress.

In line with the above discussion, Brave and Butters (2012) show via the receiver operator characteristics (ROC) methodology that the NFCI identifies with 95% accuracy historical episodes of financial turmoil contemporaneously and 80% at a lead of up to one year. Next to major financial crises, the study also considers episodes of financial stress that had less magnitude on the US financial markets.

2.4 *Identification and Structural Interpretation*

The identification strategy employed is non-recursive and we impose overidentifying restrictions on $\mathcal{A}_{11}$, i.e., the US block of $\mathcal{A}$. The identification approach follows the structural VAR literature on monetary policy shocks, e.g., Leeper and Zha (2003), Sims and Zha (2006a), and Sims and Zha (2006b), adjusted for the fact that we consider US financial conditions in our model. Hence, the approach in this paper serves the purpose to identify a US financial stress and a monetary policy shock. The contemporaneous restrictions are set as follows:

$$\mathcal{A}_{11} = \begin{array}{c} \\ q^* \\ \pi^* \\ i^* \\ f^* \\ p^* \end{array} \begin{array}{c} \begin{array}{ccccc} \text{PS} & \text{PS} & \text{MP} & \text{FS} & \text{Inf} \end{array} \\ \begin{pmatrix} a_{11,11} & a_{11,12} & 0 & a_{11,14} & a_{11,15} \\ 0 & a_{11,22} & 0 & a_{11,24} & a_{11,25} \\ 0 & 0 & a_{11,33} & a_{11,34} & a_{11,35} \\ 0 & 0 & 0 & a_{11,44} & a_{11,45} \\ 0 & 0 & 0 & 0 & a_{11,55} \end{pmatrix} \end{array}. \tag{5}$$

To the left of matrix $\mathcal{A}_{11}$ in (5) the respective variables are depicted. Above this matrix, we provide the names of the sectors, in which shocks arise.

Production Sector (PS): This identification scheme assumes that the production sector (q^*, π^*) does not react contemporaneously to changes in the rest of the system. This assumptions reflects the belief that production and prices do not respond to shocks from outside the sector. The relation of the variables belonging to the production sector is not distinctly modeled and we assume for simplicity an upper triangular structure.

Monetary Policy (MP): The federal funds rate (i^*) is assumed to be the instrument of the US monetary authority. It is assumed that within the month the monetary authority does not observe the variables of the production sector q^* and π^*, which are typically available only at a lower frequency (e.g., quarterly). For this reason the production sector variables do not enter the information set of the monetary authority. Moreover, we impose the restriction that the monetary authority does not immediately react to stress in the US financial system. This assumption is motivated by the fact that during the recent financial crisis the Federal Reserve responded to the financial shock with a delay of at least 2 months.[5]

Financial Sector (FS): The third sector corresponds to the US financial system and is represented by the financial conditions index. Since the financial conditions index contains fast-moving variables the production sector as well as changes in the monetary policy are allowed to affect the US financial system contemporaneously.

[5]For the timeline of policy responses to the Global Financial Crisis we refer to www.newyorkfed.org/research/global_economy/policyresponses.html (Accessed January 22,2013).

Information (Inf): The fourth sector is called "Inf", depicting that it responds quickly to new information. The identified shock has no clear economic meaning as the behavior within this sector is not specified. Nonetheless, it relates to other disturbances that are not explained by the production sector, monetary policy, or financial stress.

The identification of the EME block is recursive (upper triangular). The ordering of the variables in this block is arbitrary as it does not affect our analysis of the US financial stress or monetary policy shock.

The identification scheme discussed leads to a SVAR model that is globally identified. This result is obtained by applying the rank conditions for global identification of identified structural models established in Rubio-Ramírez et al. (2010). Further, to investigate whether our identification strategy is meaningful, we plot in Appendix B Figure 4 our identified shock series of financial stress. We conclude that the identification approach followed in this paper recovers innovations that are structurally meaningful. Major shocks can sensibly be related to past difficulties that arose within the US financial sector. It should be noted that the identified financial innovations series represent shocks that do not depend on general economic conditions. Thus, we recover structural residuals that do not present the effects of, e.g., recessions or booms. Further, the inclusion of the price index of world commodities assures that our financial shock does not relate to any adverse events associated with world prices. This is an important aspect when analyzing countries that are heavily dependent on commodity markets.

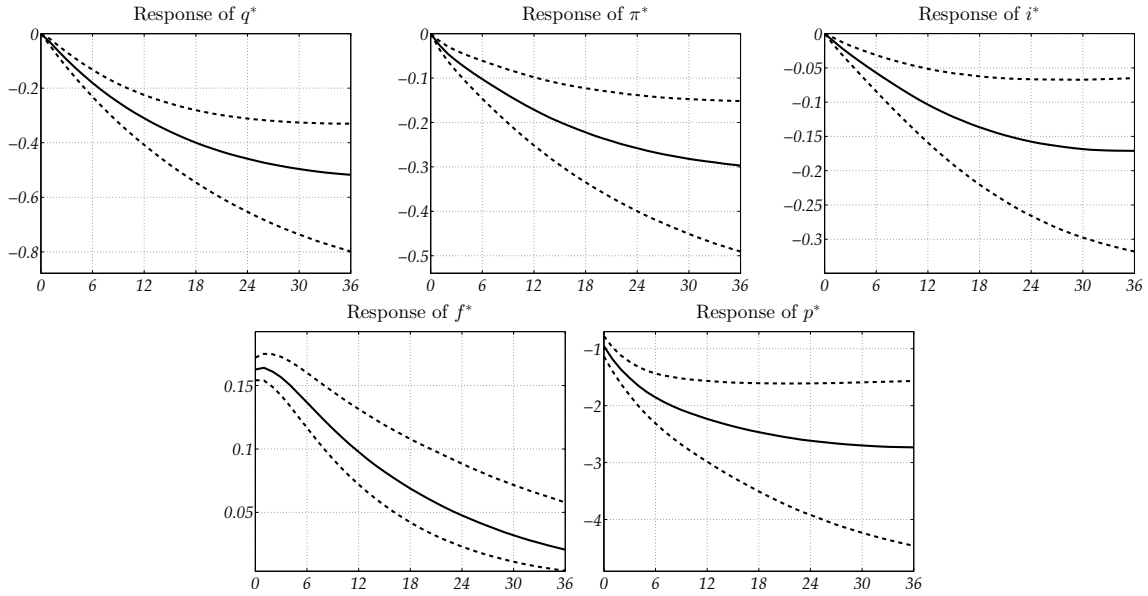
3 The Transmission of US Financial Stress

3.1 The Dynamics of US Financial Stress Shocks

This section examines the dynamics of the US and a typical emerging market country in response to a financial stress shock to the US financial system. The impulse response functions are presented with posterior 68% probability bands as proposed by Sims and Zha (1999). The point estimate corresponds to the median. The maximum of the time horizon is set to 36 months. Due to the multitude of emerging market countries in our sample the analysis faces the problem to sieve and expose the most important findings in a condensed manner. Due to the homogeneity of our results across countries, we aggregate the findings over all EMEs by using a variance weighting scheme. That is, the median response of a particular point in time for each country is weighted by the inverse of its variance relative to the sum of the inverse of the variances of the median responses for all countries. Hence, this weighting scheme down-weights the noisiest response. For completeness, Appendix C depicts the plots of the impulse responses for each emerging market country with posterior 68% probability bands separately.

The first part of Figure 3 portrays how the US economy reacts to a financial stress shock of about

Responses of US Sector



Responses of EME Sector

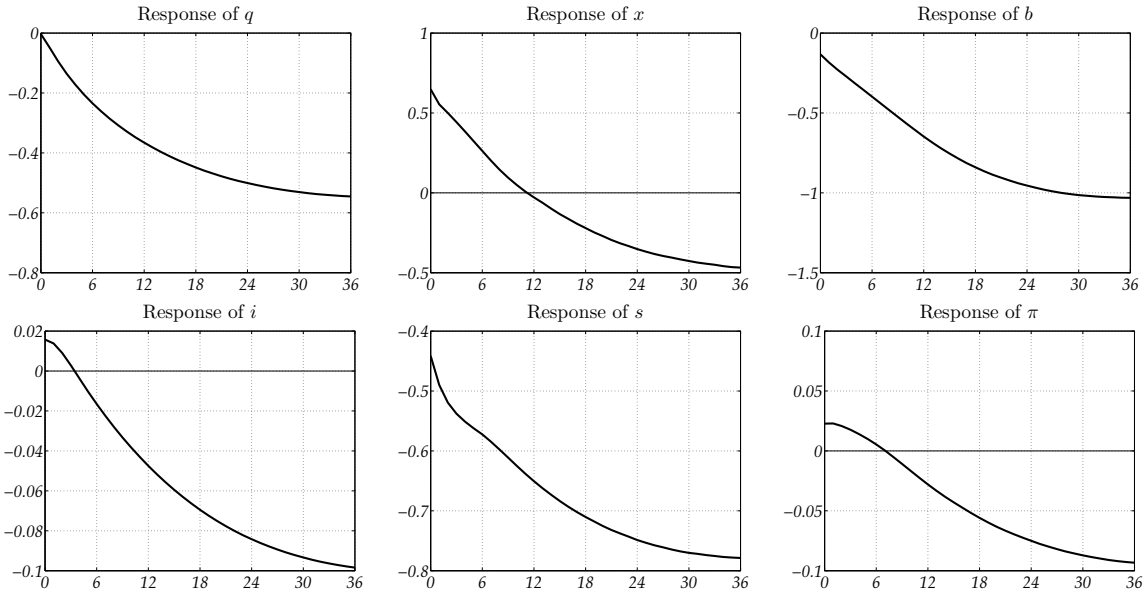


Figure 3: Response Functions of the US and a Typical EME to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i, i^*) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The US response functions are presented with posterior 68% probability bands (dashed lines). The EME response functions are volatility weighted averages across all countries. f^* denotes the measure of US financial conditions; q^* (q) log of real GDP; π^* (π) log of consumer price index; i^* (i) interest rate; p^* log of world price index; x exports over imports; b log of net accumulated foreign stocks; s log of real effective exchange rate.

one standard deviation.[6] The positive deviation of US financial conditions (f^*) indicates that actual and expected financing conditions for households and businesses deteriorate, uncertainty in equity markets rise, and spreads in money and debt markets increase. This general worsening in US financial conditions leads to a sharp decline in US real economic activity (q^*) in the following months. After one year, i.e., the response at month twelve, real GDP declines by about 0.31%. US inflation (π^*) and world commodity prices (p^*) fall in response, whereas the drop in world commodity prices is contemporaneously. A financial stress shock leads to a US deflation of about 0.17% and world commodity prices fall by 2.24% after one year. Furthermore, the monetary authority reacts to a US financial stress shock by decreasing the federal funds rate. After one year the rate is lowered by approximately 0.10 basis points. Thus, the responses for the US are significant, have the expected sign, and make intuitively sense: In reply to a worsening of US financing conditions aggregate demand for goods and services as well as investments fall due to financially constrained households and firms. The slowdown in demand forces the price level in the US down. However, the decline in aggregate demand and investment both have adverse effects on real economic activity. In order to absorb the contagion of the negative real effects of the financial stress shock the monetary authority reacts by an expansionary monetary policy to stimulate the recovery of the US economy.

The second part of Figure 3 displays the transmission dynamics of US financial stress to a typical emerging market country. Several findings emerge: the economy of a typical emerging market country is affected by the US financial stress shock as strongly as the US economy itself. We find a sharp negative response in real economic activity and the economy continues to slow down for the following months. After one year our estimate reports a decline of about 0.41% on average. The median decline in real GDP at month twelve is larger than in the US for all EMEs in our sample, except for the Philippines. Mexico and Thailand are affected most strongly and experience a reduction of 0.56% and 0.63%, respectively. The adverse effect on real economic activity is significant for all countries.

The transmission of US financial stress shocks can mainly occur through international trade linkages or financial markets: first, our measure of trade relations (x) increases contemporaneously by 0.65 basis points (b.p.), which means that a typical EME exports more relative to its imports in response to a financial stress shock. After one year these dynamics reverse. However, the country by country analysis reveals that this effect is only significant for Mexico (0.72 b.p.), and Philippines (1.18 b.p). Second, a typical emerging market country experiences noticeable foreign capital outflows (b). Regarding the timing we find that the drop in foreign capital flows is contemporaneously with a magnitude of about 0.13%. After one year we observe a decline of about 0.64%. The country by country analysis points out that the negative response of foreign capital flows is significant for all countries, except for Chile, where we find an inflow of foreign capital. Thus, for almost all EMEs our results

[6] To interpret the effects of a financial stress shock correctly it is important to note that the recent financial crisis led in our analysis to a worsening of financial conditions by more than eight standard deviations in mid 2007.

indicate that the dynamics of trade are not significant. On the other hand, we find strong negative effects on foreign capital flows in response to financial stress in the US financial system. Hence, these findings clearly highlight the propagation of financial stress shocks through international financial markets.

The monetary authority in a typical EME responds first with an increase in its interest rate (i) of about 0.02 basis points. After six months it reacts to the ongoing in the economy with an expansionary monetary policy. The exceptions are Mexico and Philippines, which respond with a contemporaneously increase in its interest rate but they do not follow an expansionary monetary policy path afterwards. Further, in a typical EME the currency depreciates instantaneously in response to a US financial stress shock. The contemporaneously drop in the exchange rate (s) is of about 0.44%. We find evidence for an exchange rate depreciation in response to a US financial stress shock for all countries, except for the cases of Chile and Malaysia, where responses are not significant. The reaction of inflation (π) is ambiguous across countries. For most of the countries the response of inflation is not significant.

The dynamics of the EME variables are in line with theoretical considerations. A typical emerging market country depends heavily on foreign capital inflows which render the economy highly vulnerable to external shocks (Calvo, 1998). Conclusively, financial stress in the US financial system may lead to a sudden stop of foreign capital inflows in a typical emerging market country. Foreign capital inflow reversals generate a downward pressure on the currency leading to a depreciation of the real exchange rate. The monetary authority defends the pressure on the currency by increasing the interest rate and to avoid further foreign capital outflows. Furthermore, US credit market conditions tighten such that a typical emerging market country becomes financially constrained. Tight domestic credit conditions limit the space of financial resources and lead to a slowdown in real economic activity.

3.2 The Importance of US Financial Stress Shocks

This section discusses the importance of financial stress shocks in explaining the high volatility in emerging markets' macroeconomic variables. Besides this, we relate our findings to the role of monetary policy shocks and emphasize on the joint importance of external shocks. Table 1 summarizes the results of our forecast error variance decomposition exercise for all EMEs. For comparative purposes Table 1 displays the fraction of the variance in US real economic activity, the federal funds rate, and US inflation explained by US financial stress shocks. We report the average forecast error variance decompositions over two sets of horizons: from month 1 until 24 and month 25 up to 48. To summarize the most important results it suffices to focus on the horizon from month 25 to 48. This is done subsequently.

Three important results emerge from this analysis: first, US financial stress accounts for a sizeable portion of fluctuations in EME real economic activity (q), foreign capital flows (b), interest rates

Table 1: Forecast Error Variance Decomposition Analysis

			BR	CL	KR	MX	MY	PH	TH	ZA	Av.	US
q	*Financial Stress*	*1-24*	10	5	10	11	9	7	9	11	9	17
		25-48	20	14	18	27	23	19	18	30	21	41
	Monetary Policy	*1-24*	4	2	2	3	2	2	2	3	2	2
		25-48	6	3	4	6	4	3	3	5	4	5
	All External Shocks	*1-24*	43	15	26	27	29	38	20	24	28	100
		25-48	52	27	35	45	43	52	31	47	42	100
x	*Financial Stress*	*1-24*	3	3	3	3	3	4	2	3	3	-
		25-48	9	8	7	7	8	8	7	8	8	-
	Monetary Policy	*1-24*	2	3	2	2	2	2	2	2	2	-
		25-48	4	5	4	4	3	3	4	4	4	-
	All External Shocks	*1-24*	11	10	9	10	8	13	9	9	10	-
		25-48	20	18	16	16	16	20	17	17	18	-
b	*Financial Stress*	*1-24*	3	7	9	3	14	7	9	5	7	-
		25-48	8	13	12	8	29	20	24	18	17	-
	Monetary Policy	*1-24*	2	2	2	2	2	2	5	4	2	-
		25-48	4	4	4	4	4	6	8	7	5	-
	All External Shocks	*1-24*	25	14	20	14	24	13	19	13	18	-
		25-48	35	22	27	25	42	32	36	30	31	-
i	*Financial Stress*	*1-24*	2	8	9	6	9	3	11	6	7	6
		25-48	6	15	21	8	28	7	33	23	18	18
	Monetary Policy	*1-24*	6	4	8	4	10	2	7	2	5	91
		25-48	8	4	17	7	17	3	12	6	9	77
	All External Shocks	*1-24*	13	18	29	15	24	10	31	12	19	100
		25-48	20	28	47	21	52	17	56	34	34	100
s	*Financial Stress*	*1-24*	18	2	41	31	4	3	20	13	17	-
		25-48	20	7	48	37	9	9	33	13	22	-
	Monetary Policy	*1-24*	4	3	12	3	2	2	2	9	5	-
		25-48	5	5	12	7	4	5	4	8	6	-
	All External Shocks	*1-24*	29	12	60	47	13	11	44	28	31	-
		25-48	34	19	67	56	22	21	54	28	38	-
π	*Financial Stress*	*1-24*	3	7	2	4	4	2	6	3	4	9
		25-48	8	13	6	8	13	7	17	7	10	25
	Monetary Policy	*1-24*	5	3	5	2	1	2	1	2	3	1
		25-48	10	4	9	4	3	4	3	5	5	4
	All External Shocks	*1-24*	22	48	32	13	35	28	44	27	31	100
		25-48	36	58	45	24	49	41	54	38	43	100

Notes: "All External Shocks" denotes the fraction of the variance of a given variable explained by all external shocks jointly. "*1-24*" and "*25-48*" depict the average value of the forecast error variance decomposition (in percent) between the forecast horizon 1 to 24 and 25 to 48, respectively. The last column "US" only contains the results for the variables included in the US block. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

(i), and exchange rates (s). On average, US financial stress accounts for 21% in the variation of real economic activity, 17% in the variation of foreign capital flows, 18% in the variation of interest

rates, and 22% in the variation of the exchange rate. Moreover, the results for real economic activity become more striking if we relate the variation explained by the financial stress shock to the variation explained by the *remaining* external shocks for each country. This figure underscores the importance of financial stress shock for the volatility in real economic activity, as the fraction of the variance of the latter variable explained by the US financial stress shock is of the same size as the fraction of the variance accounted for by the remaining external shocks. Relating these findings to the estimates for the US economy the result of large spill-over effects is emphasized. In the case of real GDP of a typical EME, the variation explained by US financial stress (21%) is more than a half of the variation in US real economy (41%); for interest rates we find extensive spill-overs to EMEs since US financial stress shocks explain of about the same portion (18%) in both variables (i, i^*).

Second, US monetary policy shocks are not important for emerging market economies relative to US financial stress and other external shocks. For a typical emerging market country, US monetary policy accounts on average for about 4-6% in the variation in real economic activity, trade, foreign capital flows, exchange rate, and inflation. 9% in the variation are explained in the case of interest rates.[7]

Third, our findings indicate that external shocks are in general an important source for fluctuations in emerging market economies. For instance, all external shocks jointly account for 42% in the variation of real economic activity, 18% of the variation in trade, 31% in the variation of foreign capital flows, 34% in the variation of interest rates, 38% in the variation of exchange rates, and 43% in the variation of inflation.[8]

3.3 The Contribution of US Financial Stress Shocks to Cyclical Fluctuations

This section discusses the contribution of US financial stress shocks to the *cyclical* variation of economic time series in the emerging world. Moreover, we relate our findings to the contribution of monetary policy shocks and external shocks jointly to the variation at business cycle frequencies. Table 2 summarizes the decomposition of variance that can be related to business cycles frequencies (24 to 96 months). We apply the method by Altig et al. (2011) and use spectral decompositions to obtain the median fraction of variance in the business cycle frequencies accounted for by the US financial stress shock, the monetary policy shock, and all external shocks jointly.

Looking at the findings, we emphasize in what follows three results: first, for a typical emerging market country US financial conditions are important in the short-run relative to other external and

[7] Compared to, e.g., Uhlig (2005), our number related to the variance in US output explained by a US monetary policy shock is slightly smaller. We attribute this to the fact that our time horizon differs. This includes the argument that the federal funds rate is close to the zero lower bound at the end of our sample, which possibly mitigated the responsiveness to monetary policy.

[8] The strong differences in the results for the variation explained in exchange rates can be related to the exchange rate regime followed by the respective country. EMEs that pursue a managed floating regime or crawling peg show higher sensitivity, while countries with fixed pegs and bands less.

Table 2: Decomposition of Variance: Business Cycle Frequencies

		BR	CL	KR	MX	MY	PH	TH	ZA	Av.	US
q	*Financial Stress*	15	11	14	21	19	16	13	26	17	36
	Monetary Policy	5	3	3	7	5	3	3	5	4	6
	All External Shocks	53	27	33	44	44	52	27	47	41	100
x	*Financial Stress*	5	4	5	5	4	5	4	4	5	-
	Monetary Policy	3	3	3	3	2	2	2	2	3	-
	All External Shocks	17	14	15	15	13	18	15	13	15	-
b	*Financial Stress*	5	11	11	6	24	13	18	15	13	-
	Monetary Policy	4	3	3	3	3	5	11	5	5	-
	All External Shocks	34	22	28	25	38	26	37	28	30	-
i	*Financial Stress*	4	24	22	10	26	5	27	21	17	13
	Monetary Policy	9	7	15	6	19	3	11	6	9	81
	All External Shocks	23	41	53	25	53	15	55	36	38	100
s	*Financial Stress*	17	5	42	31	5	5	24	13	18	-
	Monetary Policy	4	4	15	4	4	4	3	11	6	-
	All External Shocks	32	19	68	51	21	18	49	33	37	-
π	*Financial Stress*	6	18	4	6	10	4	12	6	8	17
	Monetary Policy	6	6	5	3	2	2	3	4	4	4
	All External Shocks	33	66	42	24	49	39	55	38	43	100

Notes: Numbers are the median fraction of variance in the business cycle frequencies, 24 to 96 months, accounted for by the financial stress shock, monetary policy shock, and all external shocks jointly. Av. indicates the average across EME. The last column "US" only contains the results for the variables included in the US block. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

internal shocks. US financial stress shocks account for 17% of the cyclical variation in real economic activity (q), 13% of the cyclical variation in foreign capital flows (b), 17% of the cyclical variation in interest rates (i), and 18% in the cyclical variation of exchange rates (s). For the cyclical variation in trade (x) and inflation (π) we find that US financial shocks play only a minor role, i.e., 5% and 8%, respectively. Comparing the estimates for the US with a typical emerging market economy the results indicate that the spill-overs from the US to the emerging world are remarkable. For real economic activity we find on average for an EME that 17% of the cyclical variation is explained by US financial stress, whereas for the US the fraction of the cyclical variance is about 36%. For interest rates the results are more striking because the estimates indicate that the cyclical variation explained by the US financial stress shock is larger than in the US $(17\%$ vs. $13\%)$. Besides this, our results reveal that a US financial stress shock contributes more to the cyclical fluctuations than other external shocks, except for the cyclical variation in trade and inflation.

Second, US monetary policy shocks are not important for the cyclical variation in EME macro-variables. The largest contribution of monetary policy shocks to the cyclical variation in EME vari-

ables is found for interest rates (9% on average).
Third, our estimates indicate that external shocks contribute significantly to the cyclical variation in EMEs. External shocks jointly account for 41% of the cyclical variation in real economic activity, 30% of the cyclical variation in foreign capital flows, 38% of the cyclical variation in interest rates, 37% of the cyclical variation in exchange rates, and 43% of the cyclical variation in inflation. Among these, the US financial stress shock reflects the most important driver of the external factors for the cyclical variation in EMEs.

3.4 Robustness of the Empirical Results

In order to assess the sensitivity of the empirical findings, we conduct several robustness checks addressing our measure of financial stress. Rather than using the aggregate measure of financial stress (NFCI), we re-estimate our VAR replacing the NFCI with three different sub-indexes one at a time that form a sub-set of the latter metrics. That is, the Federal Reserve Bank of Chicago constructs three sub-indexes of the NFCI (risk, credit, and leverage). Each sub-index contains a subset of financial variables used in the NFCI. The risk sub-index captures financial uncertainty and funding risk in the US financial sector; the credit sub-index measures credit conditions of businesses and households; and the leverage sub-index is composed of measures for debt and equity markets.
The main results are supported by this exercise. Nonetheless, some differences emerge: for the risk and credit sub-index results are qualitatively similar but weaker than in our benchmark case using the NFCI. Moreover, we find partially insignificant results for the leverage sub-index. The sub-index that reaches closest to the original results of our paper is the risk sub-index. This stresses our interpretation of our financial sector shock as financial stress.

4 Concluding Remarks

This paper evaluates the role of US financial stress for the economic dynamics and fluctuations of emerging market economies. We provide for a large set of emerging market countries empirical evidence on the vulnerability to US financial stress shocks.
Our findings suggest that these shocks have been important in driving the dynamics and fluctuations in EMEs. US financial stress shocks affect EMEs as strongly as the US economy. We find evidence that cross-country spill-overs occur through international financial markets, i.e., a drop in capital flows from the US to EMEs. Moreover, US financial stress accounts for a large portion in emerging market economies, even at business cycle frequencies.
Since our empirical findings strongly support the view that EMEs are highly vulnerable to US financial shocks it is worth for policy makers to think about options that dampen the international transmission. In this paper we discuss two main channels for the transmission of US financial shocks:

sudden stops of foreign capital inflows and a decline in export demand. We find that the trade channel is not the main driver of the sparked recessions in response to a financial stress shock. Our analysis rather points in the direction that policies should address problems related to sudden stops of foreign capital inflows. On a national level, capital controls may alleviate the problem of ceasing capital inflows. Further, we find a depreciation of the currency of EMEs. In this context debt restructuring mechanisms are vital by, e.g., lowering the exposure to foreign denominated debt (Calvo, 2007). Of course, classical policy measures such as monetary and fiscal policy provide means to cushion the effects of recessionary pressure as well. Due to the fact, that the sudden stop of capital inflows does not originate from a loss in confidence of investors, but rather because of a decrease in global investment, regulators should focus on an easing of monetary policy. Further, foreign exchange reserves can on the one hand be used to stabilize the value of the domestic currency and on the other to ease the access of foreign currency for the private sector. In light of financially constrained governments, aid provided at an international level is of vital importance. For example fast lending without conditionality which is, e.g., provided by the International Monetary Fund, reflects an important tool to bridge temporary fiscal constraints. Further, closer cooperation between regional funds and global institutions might help to coordinate resources more efficiently.

With regard to future research, one could investigate which sector of the US financial system is most responsible for the negative cross-country transmission. The present study uses a global measure of US financial conditions to highlight the general importance of financial stress for EMEs. Having presented the results of this paper, it is the next step to pin down the relative importance of *specific* US financial shocks for the emerging world. Further, theoretical research could provide insights why trade channels are inessential and deliver options to encounter the contagion through financial markets.

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A DATA

Table 3: Definitions and Symbols of Variables Employed in the SVAR

	Variable	Symbol	Definition
EME Sector	Real economic activity	q_t	Log of EME real GDP
	Bilateral trade	x_t	EME export / import (in %)
	Bilateral fgn. capital	b_t	Log of net accumulation of fgn. stocks
	Interest rate	i_t	EME prime lending (money market)
	Exchange rate	s_t	Log of real effective exchange rate
	Inflation	π_t	Log of EME CPI
US Sector	Financial conditions	f_t^*	US financial conditions index
	Real economic activity	q_t^*	Log of US real GDP
	Inflation	π_t^*	Log of US CPI
	Interest rate	i_t^*	US Federal Funds rate (in %)
	World commodity prices	p_t^*	Log of IMF world price index

Table 4: National Financial Conditions Index: Coverage of the US Financial System

	Financial Market	Number of Indicators
Money Markets	Repurchase Agreements	10
	Treasuries	9
	Commercial Paper	5
	Interbank Lending	4
Debt and Equity Markets	Corporate Bonds	8
	Securitized Debt	6
	Stock Markets	6
	Municipal Bonds	4
	Collateral Prices	3
Banking System	Consumer Credit Conditions	12
	Banking System Conditions	9
	Shadow Bank Assets and Liabilities	9
	Business Credit Conditions	8
	Commercial Bank Assets and Liabilities	7

Source: Brave and Butters (2011, 2012)

Table 5: Data Sources and Descriptions

EMERGING MARKET ECONOMIES

		Economic Activity		Bilateral Trade		Bilateral Foreign Capital		Interest Rate	Exchange Rate	Inflation
		GDP	IP	US Imports	US Exports	US purchases	US sales			
BR	*Mnemonic*	BRGDP...G	BRI66..CE	USIMPCBRA	USEXCBR.A	USWSWKBRA	USWPWKBRA	BRI60P..	BRMGTWRB	BRI64...F
	Source	NS	IFS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
CL	*Mnemonic*	CLI99BVPH	CLIPMAN.H	USIMPCCIA	USEXCCI.A	USWSWKCIA	USWPWKCIA	CLI60P..	CLMGTWRB	CLCONPRCF
	Source	IFS	NS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	NS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
KR	*Mnemonic*	KOI99BVPH	KOI66..CE	USIMPCKSA	USEXCKS.A	USWSWKKSA	USWPWKKSA	KOBANKR.	KOMGTWRB	KOI64...F
	Source	IFS	IFS	NS (US)	NS (US)	TIC	TIC	NS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
MX	*Mnemonic*	MXGDP...D	MXI66...F	USIMPCMXA	USEXCMX.A	USWSWKMXA	USWPWKMXA	MXI60P..	MXMGTWRB	MXI64...F
	Source	NS	IFS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
MY	*Mnemonic*	MYI99BVPH	MYI66...F	USIMPCMYA	USEXCMY.A	USWSWKMYA	USWPWKMYA	MYI60P..	MYMGTWRB	MYI64...F
	Source	IFS	IFS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
PH	*Mnemonic*	PHGDP...D	PHIPMAN.F	USIMPCRPA	USEXCRP.A	USWSWKRPA	USWPWKRPA	PHI60P..	PHMGTWRB	PHI64...F
	Source	NS	NS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Prime lending	Real effective	CPI
TH	*Mnemonic*	THI99BVPH	THIPMAN.H	USIMPCTHA	USEXCTH.A	USWSWKTHA	USWPWKTHA	THI60B..	THMGTWRB	THI64...F
	Source	IFS	NS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Money market	Real effective	CPI
ZA	*Mnemonic*	SAI99BVRG	SAI66EYCE	USIMPCSFA	USEXCSF.A	USWSWKSFA	USWPWKSFA	SAI60B..	SAMGTWRB	SAI64...F
	Source	IFS	IFS	NS (US)	NS (US)	TIC	TIC	IFS	JP Morgan	IFS
	Comment	Real GDP	Ind. Prod.	US from EME	US to EME	Fgn. stocks	Fgn. stocks	Money market	Real effective	CPI

UNITED STATES & WORLD

	Financial Conditions	Economic Activity		Inflation	Interest Rate	World Commodity Prices
		GDP	IP			
Mnemonic	-	USI99BVRG	USIPTOT.G	USI64...F	USFEDFUN	WDI76NFDF
Source	Chicago FED	IFS	NS	IFS	NS	IFS
Comment	-	Real GDP	Ind. Prod.	CPI	Money market	IMF price index

Notes: Data codes from Datastream (Thomson Financial) are provided for each variable used in the analysis. Data sources are either from the National Statistics Office (NS) or the International Financial Statistics (IFS) database of the IMF. Real effective exchange rates are from JP Morgan; bilateral foreign capital flows are from the Treasury International Capital System (TIC). All data are seasonally adjusted if necessary. The time series of real GDP are interpolated to a monthly frequency using the method described in Bernanke et al. (1997).

B US FINANCIAL STRESS

It is important to ensure that our identified financial stress shock is indeed a shock that can be related to events in the financial sector. For this reason our shock series should clearly reflect past episodes of financial stress. Let this estimated structural innovation series be $\hat{\varepsilon}_t^{f^*}$ for $t \in \{1, \ldots, T\}$. In Figure 4 we plot the three-months moving average of the this time series $(\hat{\varepsilon}_{t-1}^{f^*} + \hat{\varepsilon}_t^{f^*} + \hat{\varepsilon}_{t+1}^{f^*})/3$. This suppresses the noise implied by serially uncorrelated innovations and allows for a clearer picture of the estimated financial stress shock series.[9]

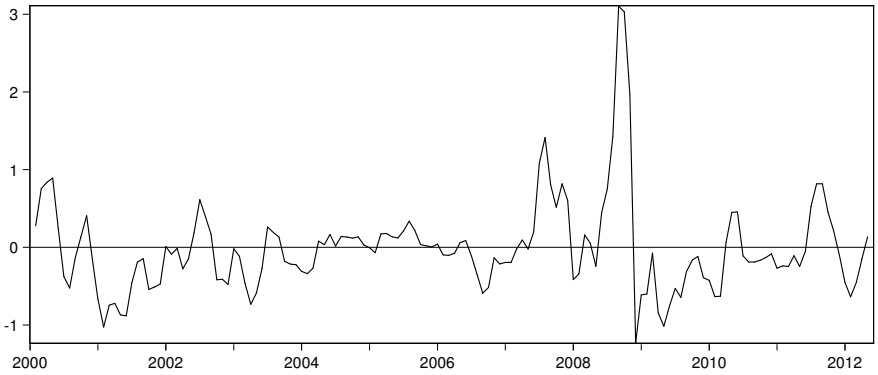

Figure 4: Estimated US Financial Stress Shock: Three-Months Moving Average

Relative to the financial conditions index, our identified shock series emphasizes times of market turmoil, i.e. strong positive deviations accentuate the events discussed in Section 2.3. This is possible since our setup removes variation that is explained by e.g. recessions, booms, or other movements that are explained by the variables included in our US sector. All events discussed are clearly depicted: dot-com bubble (2000), Argentine Crisis (end 2000), "9/11" and its aftermath (2002), the global financial crisis (mid 2007), the bankruptcy of Lehman Brothers (mid 2008), the inception of the sovereign debt crisis (beginning of 2010), and the dispute over the US budget (mid 2011). Even other important events become even visible, as for instance the inception of the war on Iraq (2003) or the uncertainty caused by hurricane Katrina (mid 2005).

[9]The estimated financial stress shock series is the same for all emerging market countries since the EME variables do not enter the US block.

C IMPULSE RESPONSE FUNCTIONS

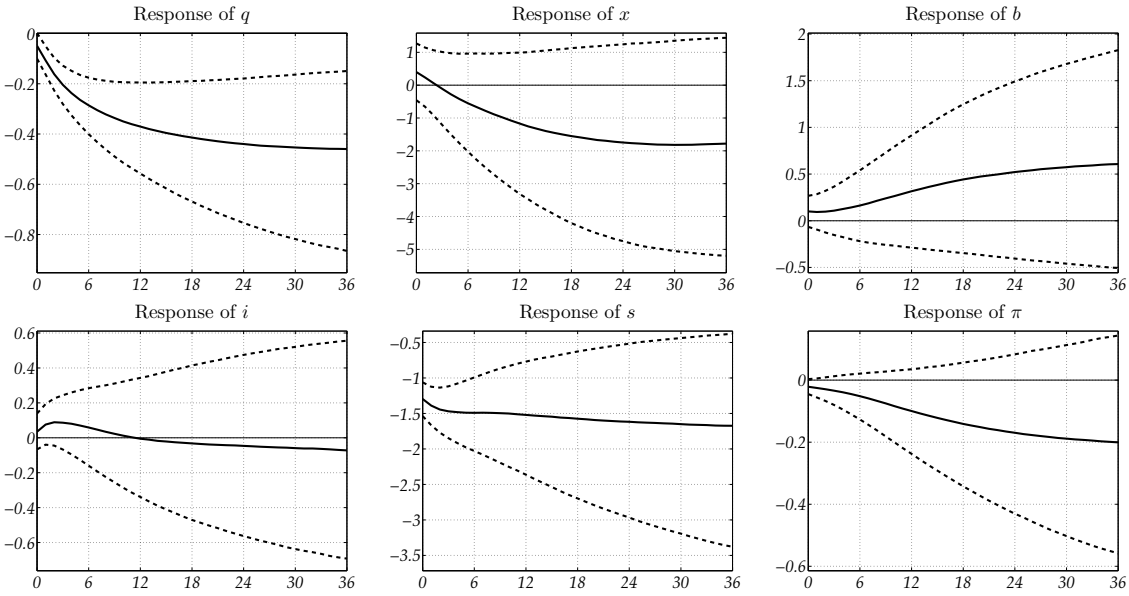

Figure 5: Response Functions of Brazil to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

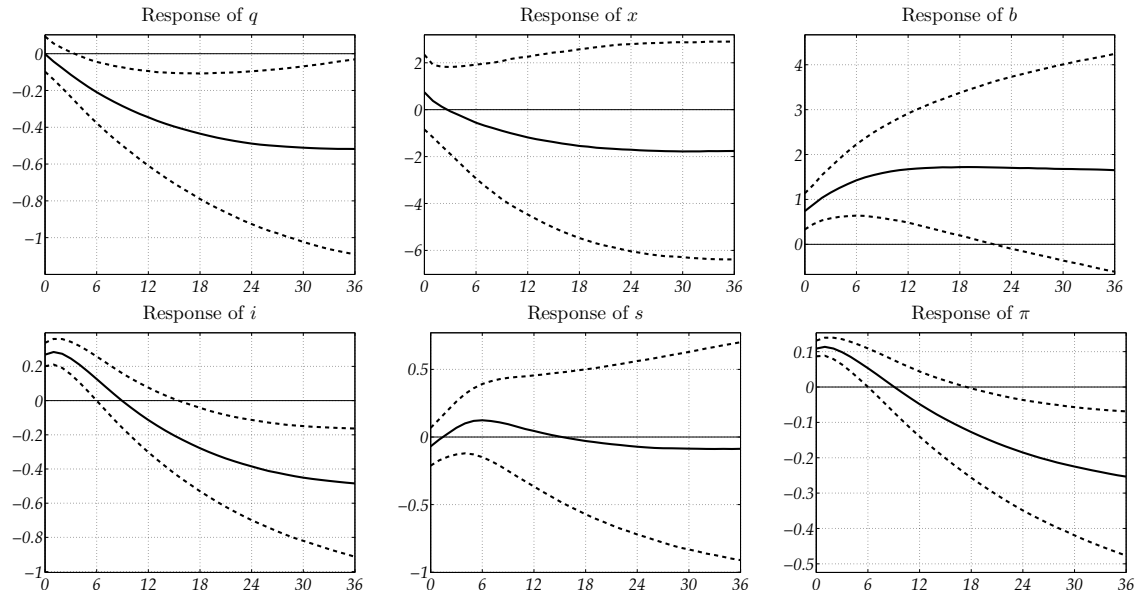

Figure 6: Response Functions of Chile to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

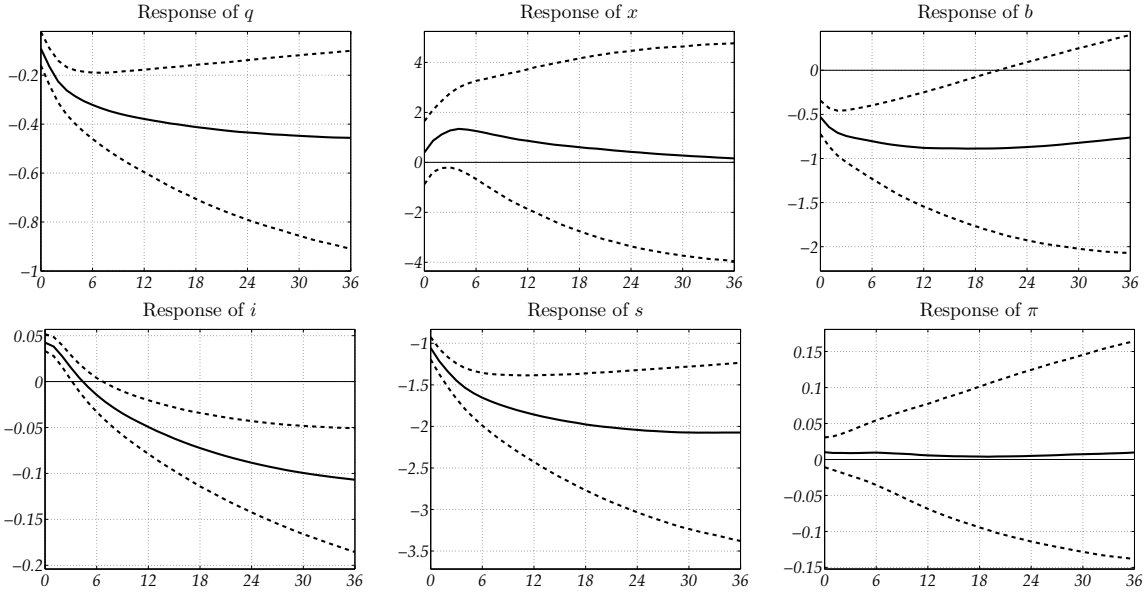

Figure 7: Response Functions of Korea to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

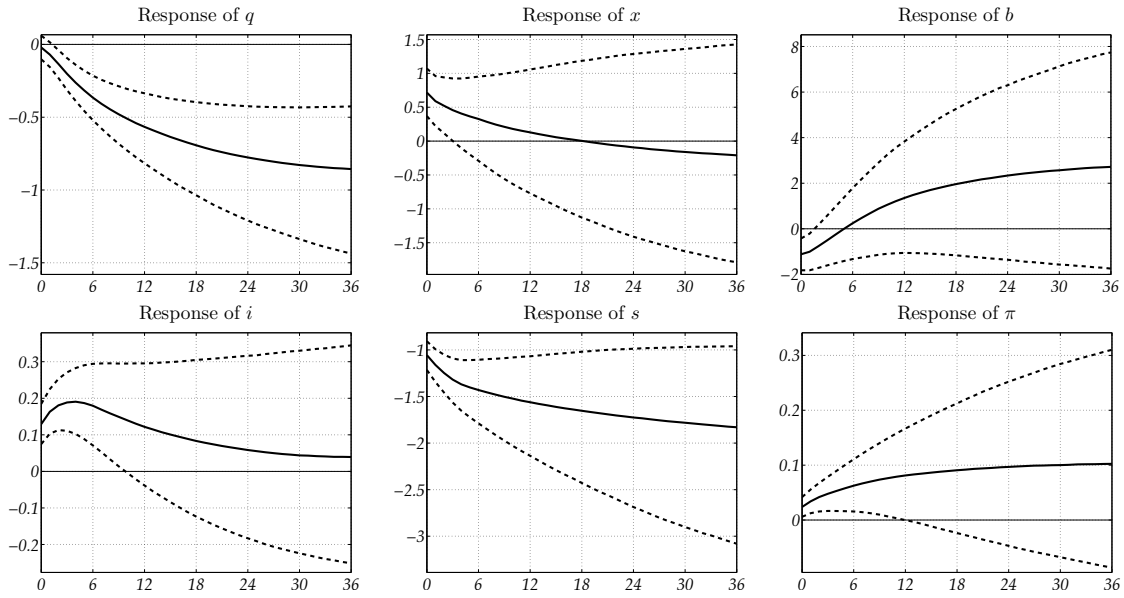

Figure 8: Response Functions of Mexico to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

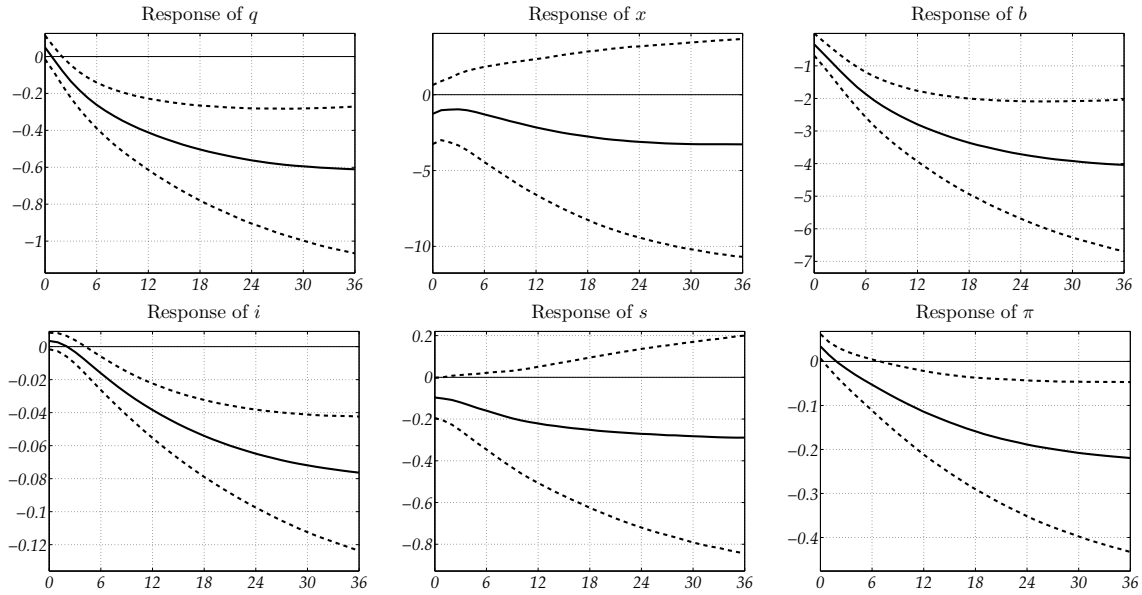

Figure 9: Response Functions of Malaysia to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

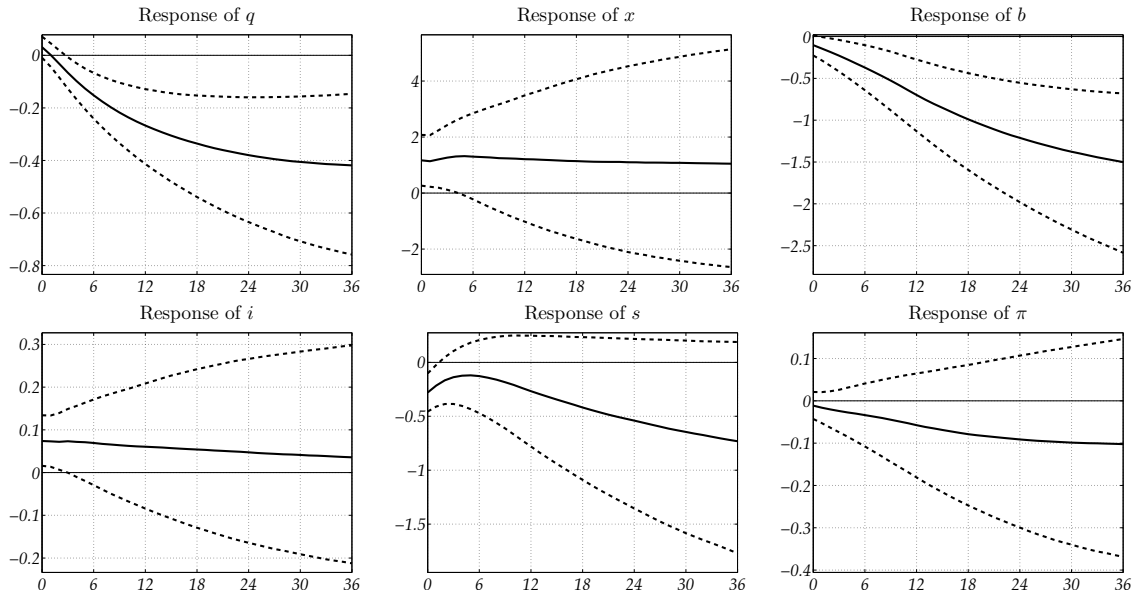

Figure 10: Response Functions of Philippines to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

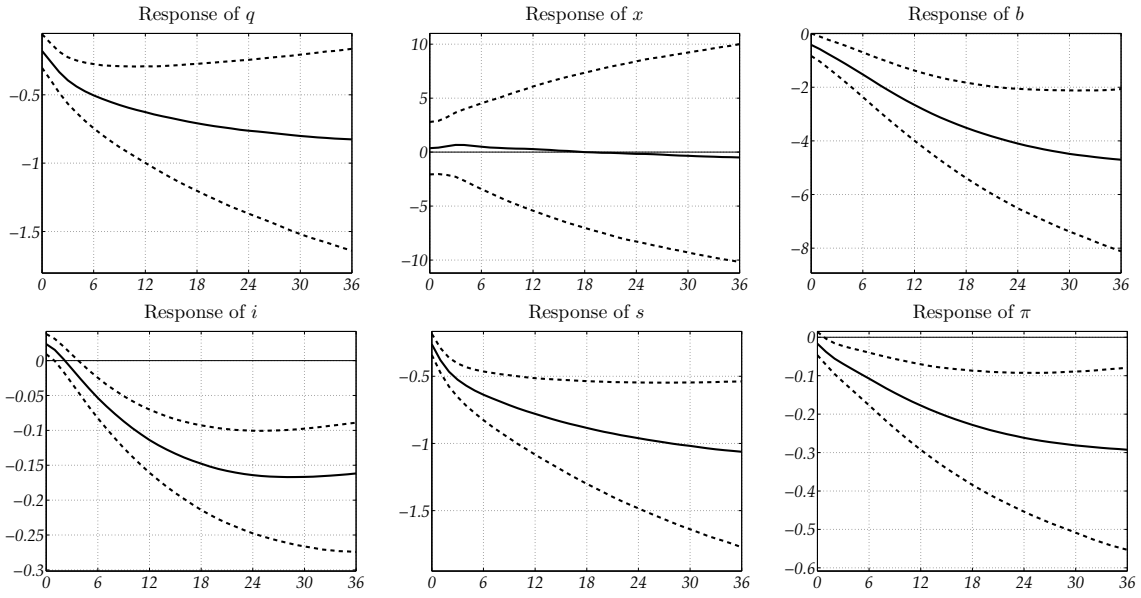

Figure 11: Response Functions of Thailand to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.

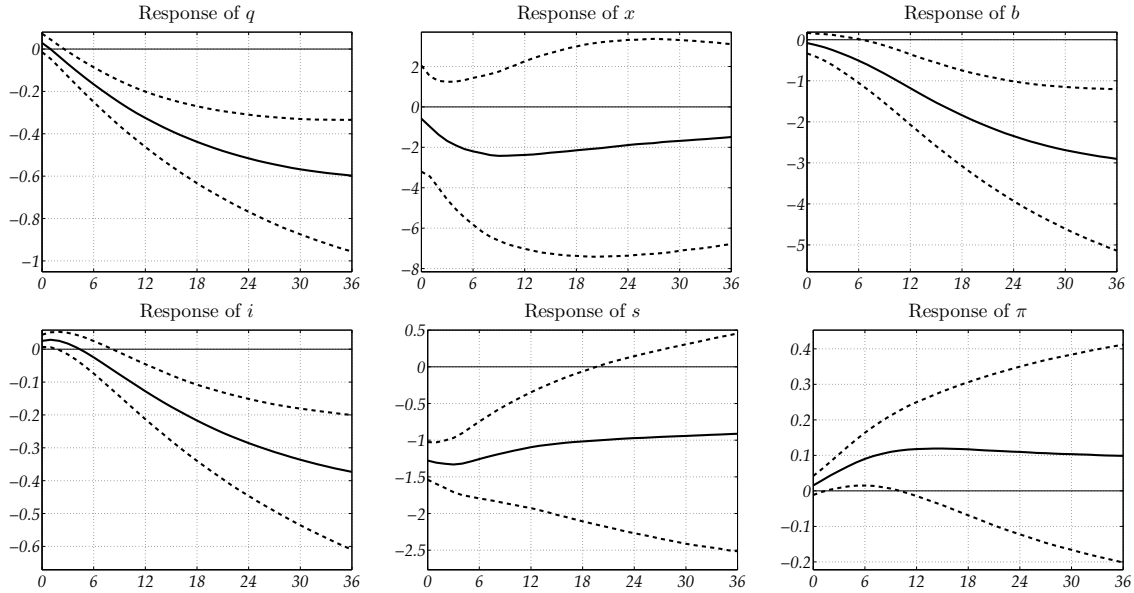

Figure 12: Response Functions of South Africa to a US Financial Stress Shock

Notes: The impulse responses are all in percentage deviations (y-axis) except for the responses of interest rates (i) and trade relations (x) that are deviations in basis points. The x-axis represents months after the shock. The dashed lines correspond to posterior 68% probability bands. q denotes log of real GDP; x exports over imports; b net accumulated foreign stocks; i interest rate; s real effective exchange rate; π log of consumer price index.