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MACROECONOMIC TRANSMISSION OF EUROZONE SHOCKS TO EMERGING ECONOMIES

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ABSTRACT. This paper analyzes the robustness of emerging economies growth performance to a number of external demand shocks using a Bayesian vector autoregressive (BVAR) model with informative priors on the steady state. We show that more than fifty percent of the variation in real GDP growth of Latin American emerging economies is explained by external factors, while it is slightly less than fifty percent for emerging Asia and China. Conditional forecasts of different scenarios indicate that a deepening of the Eurozone recession would create a severe and persistent contraction for emerging economies, depending on the response of the U.S. growth to this shock. Finally, forecasts suggest that a sharp slowdown in China's growth would have a significant negative impact on emerging economies' growth, and that the Latin American countries would be more severely hit than the Asian ones.

JEL Classification: F43; F44; F47.
Keywords: Eurozone Recession; Transmission of Shocks; Bayesian vector Autoregression; Emerging Economies; Growth Spillovers.

RÉSUMÉ. Cet article analyse la robustesse de la croissance des économies émergentes à divers chocs sur leur demande extérieure en utilisant un modèle vectoriel autorégressif bayésien incorporant des informations préalables sur l'état d'équilibre. Nous montrons que plus de 50% de la variation de la croissance du PIB réel dans les économies d'Amérique latine est expliquée par les facteurs extérieurs, contre un peu moins de 50% pour l'Asie émergente et la Chine. Les prévisions conditionnelles montrent qu'une récession profonde en zone euro créerait des baisses de croissance sévères et persistantes dans les économies émergentes et que ces répercussions sont modulées par la réaction de la croissance américaine à ce choc. Enfin, un ralentissement prononcé de la croissance chinoise aurait un impact négatif significatif sur la croissance des autres économies émergentes.

Classification *JEL* : F43 ; F44 ; F47.
Mots-clefs: Récession en zone euro ; transmission des chocs ; modèle vectoriel autorégressif bayésien ; pays émergents ; croissance.

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I. Introduction

Exploring macroeconomic spillover effects and their channels of transmission has become an area of intense research in the wake of the recent global crisis. The crisis laid bare the growing macroeconomic interdependencies among major regions of the world economy. The standard North-South distinctions began to blur as the emerging economies began to grow at rates much higher than those of advanced countries in a two-speed world recovery. They have shown a remarkable resilience despite the ongoing slowdown in the United States, the Eurozone economies, and Japan thanks to the cushion effect of accumulation of massive foreign exchange reserves and the lower levels of indebtedness providing them with space for countercyclical monetary and fiscal policies.

In Latin America, the contractionary effect of the crisis on GDP growth was felt sharply only for one year in 2009, followed by a strong recovery phase beginning in 2010. The recession was short-lived especially in comparison to the Asian crisis of 1997-98, whose impact lasted for six years in the region, and the Latin American debt crisis of the 1980s, which lasted for eight years. Similarly, emerging Asian economies had their average GDP growth contract for one year in 2009, followed by resuming growth in 2010, with the difference from Latin America that this region did not generally experience negative growth rates, but only a slowdown of growth.

The strong recovery phase in emerging Asia, in particular China, and the rebound in intraregional trade has been seen by some observers as the decoupling of emerging Asia from the industrial countries over the past decade (ADB 2010, Kose et al. 2008, among many others). The hypothesis of decoupling is based on the idea that domestic and regional market integration provides key internal dynamics of accumulation by reducing reliance on other regions' external demand for exports. If emerging Asia is going through the process of decoupling from advanced countries, its primary source of growth shifts towards domestic consumption, domestic investment, and intraregional exports, away from net exports to advanced countries.

The existing reliance of converging Asian and Latin American economies on exports to advanced country markets is obvious. Export to GDP ratios remain very high, and the share of Europe and the United States in the composition of exports is also relatively high. Undervaluation of currencies is also a common pattern among emerging Asian economies, which continues to shift resources to tradable goods sectors, making it difficult to move away from industrial country markets towards domestic consumption. Furthermore, given that in 2010 the strong recovery of many Asian economies relied heavily on credit and fiscal stimulus, the slowdown in the Eurozone economies and the weak employment growth in the United States is likely to pose serious constraints to an export-driven growth regime widely adopted in emerging economies of Asia as well as Latin America in the absence of a renewed stimulus. However, these weak external demand conditions may actually provide an additional incentive for emerging economies to reorient their growth strategy to one of internal integration both domestically and regionally in order to gradually decouple from advanced economies.

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In latest China Economic Outlook, the International Monetary Fund (IMF) warned China that its growth rate would fall suddenly if the Euro area experiences a sharp recession as the sovereign and bank funding pressures intensify generating a full-fledged credit and output contraction. The IMF predicted a fall of 4 percentage points in the growth rate of China in the downside scenario when the Euro area activity declines by about 4 percent relative to the previous forecasts, leading to a global growth contraction of 1¾ percentage points relative to the baseline (IMF, 2012c: 5-6). While China's closed capital account would provide some protection from financial spillovers, the IMF expects the Eurozone recession to be transmitted by trade linkages. As the primary market for China's exports is Europe (with a much higher share than the U.S.), the reduction in external demand would be reflected negatively in corporate and financial sector balance sheets, undermining the performance of the firms in tradable sector and forcing banks to deleverage. This would in turn have negative effects on investment, employment, and growth, and might lead to consumer and asset price deflation.[2]

The danger of a hard-landing in China in this exceedingly adverse environment is a threat to not only its own prospects, but also many emerging economies in Asia and Latin America that have fostered increasing trade and investment linkages with China. Share of trade with China in both manufactured goods and primary commodities has expanded significantly over the past decade and inward and outward FDI flows have also risen substantially. This leads to the central questions of this paper. Can the growth of emerging economies – including China, emerging Asia and Latin America – be expected to remain at high levels even though the external environment worsens? In other words, is there evidence of de-coupling from advanced economy business cycles? In particular, what would be the impact of a deepening Eurozone recession on the growth performance of China, emerging Asia and Latin America? In the event of a sharp contraction of growth in China, what would be the effect on the growth patterns of emerging economies in Asia and Latin America?

This paper aims to address these questions by making use of a fairly new empirical methodology known as the mean-adjusted Bayesian Vector Autoregressive (BVAR) model developed by Villani (2005, 2009). This involves placing informative priors not only on the dynamic coefficients as in standard BVAR models, but also on the constant of the model, in order to minimize the reduction in estimation precision due to the heavy parameterization of VARs. This modeling approach allows information from outside the model to be incorporated in the estimation process such that forecasts will be more consistent with extra-model information, improving the out-of-sample forecasting performance (see Osterholm and Zettelmeyer, 2008 and Utlaut and van Roye, 2010). The resulting gains in forecasting efficiency allows the estimations to yield precise results even in small samples.

2 . According to the IMF, China should respond by a new fiscal package of around 3 percent of GDP over 2012-13 to restrict the decline in its output growth to around 1 percent. It also suggests that the stimulus should be executed through the budget rather than the banking system. Finally, it notes that the weakness in global outlook emphasizes the importance of rebalancing China's economy by increased private consumption and reduced investment rates, and by changing incentives to save and consume through financial and corporate sector reforms (IMF, 2012c

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The rest of the paper is organized as follows. Section II provides a brief review of the literature on growth spillovers and transmission channels. Section III outlines the model specification and empirical implementation. Section IV is focused on the results from our estimation of the mean-adjusted BVAR model, analyzing the impulse response functions and variance decompositions for China, emerging Asia and Latin America. This section also conducts an analysis of two scenarios based on conditional forecasts. Section V draws conclusions and policy implications.

2. Literature review on growth spillovers and transmission channels

Macroeconomists have long been interested in explaining the dynamics of business cycle fluctuations and disentangling the contribution of internal and external sources to them. A large number of empirical studies sought to measure the magnitude of growth spillovers from one set of countries to another and to distinguish among different channels of transmission (i.e. trade, finance, remittances) through which these spillover effects are passed over (see Ahmed et al. 1993, Calvo et al. 1993, Prasad 1999, Canova, 2005, Helbing et al. 2007, and see Poirson and Weber, 2011 for a survey on the recent literature).

In the aftermath of the recent global financial crisis, there have been a growing number of studies on business cycle transmission. Several IMF working papers focused on growth spillovers from systematically important countries, such as the United States, European Union, Japan, China, India, and BRICs as a whole, to other countries or regions (see IMF 2012b, Bayoumi and Swiston 2009, Arora and Vamvakidis, 2010, Samake and Yang, 2011, Poirson and Weber, 2011, and Ding and Masha, 2012). A major result of these studies is that the external shocks from systematically important countries explain a large portion of the variation in domestic GDP growth. For example, based on VARs of growth across industrial regions including the United States, the Eurozone, Japan, and an aggregate of small industrial countries, Bayoumi and Swiston (2009) find that the United States generates the largest spillovers to other regions, in which the effect on foreign output is about one-third to one-half of the size of the U.S. GDP shock. They also find that the shocks are transmitted through financial channels including short-term interest rates, bond yields, and equity prices.

Another key result of these studies is that emerging countries gaining systematic importance in recent decades began to have large growth spillover effects on other countries. Focusing on Chinese spillovers, Arora and Vamvakidis (2010) find that a one-standard deviation shock in China's growth receives a response from rest of the world of 0.4 percentage points over three years and 1 percentage point over five years, which is a sizable effect, and they also find that the effect of Chinese growth on other regions of the world economy has become stronger over the past couple of decades following China's integration. Another study focusing on the effect of BRICs on low-income countries using a global VAR model has found that spillovers from BRICs to low-income countries are significant and persistent, with bilateral trade playing the most important channel of transmission (Samake and Yang, 2011).

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The importance of growth spillovers and external conditions on business cycles of Latin American countries has been explored by Osterholm and Zettelmeyer (2008) using a mean-adjusted BVAR model similar to the one employed in this paper. Their estimations for the period 1994 to 2007 suggest that about fifty to sixty percent of the variation in Latin American GDP growth is explained by external factors including world GDP growth, short-term interest rates, JPMorgan emerging market bond index spread for Latin America, high-yield corporate bond spread in the United States, and commodity prices. Their scenario analysis also suggests that Latin American growth is robust to modest shocks in commodity prices and world GDP growth, but vulnerable to a sharp worsening in global financial conditions coupled with a slowdown in world GDP growth.

Another interesting paper by Utlaut and van Roye (2010) explored the role of external shocks on business cycles in emerging Asia using a mean-adjusted BVAR model. Their model estimations for the period 1993–2003 suggests that almost half of the variation in emerging Asian economies GDP growth can be explained by external factors composed on world GDP growth, global financial conditions, and China's GDP growth. The results of their forecasting analysis shows that the performance of emerging Asian economies depends more on the global GDP growth rate, and much less on the business cycles of China.

The analysis of growth spillovers across countries has generally employed VAR models as a tool to identify, measure, and forecast the dynamic impact of shocks from one economy to another. The standard VAR models, however, suffer from highly over-parameterization, which generates a poor forecasting performance in the absence of large samples of data. The forecasts are particularly poor at longer horizons since the estimated model parameters determine the levels at which the forecasts converge over the forecast horizon (Osterholm and Zettelmeyer, 2008).

Different approaches to VAR modeling have been developed to improve the identification power and forecasting performance of the model. These can be grouped into four categories: (i) factor VARs, (ii) global VARs, (iii) structural VARs, and (iv) Bayesian VARs with informative priors on the steady-state.

Factor VAR models reduce common variations of several variables across countries into common factors, which are used to analyze their impact on the individual country variables (Kose et al., 2008, Stock and Watson, 2005, and Bénassy-Quéré and Cimadomo, 2006). A major difficulty with the factor models is the difficulty in interpreting the common factors largely due to the atheoretical nature of the factor decomposition methods employed for extracting common factors, and the lack of a structural identification scheme (Bayoumi and Swiston, 2009). In contrast, global VARs reduce the spillovers of individual countries to their proportion in a weighted average for the variable of interest, and this weighted average is used to explain the dynamics of individual countries. This allows the spillover effects in global VARs to have an explicit interpretation in contrast to those in factor models (Bussiere et al. 2009). Structural VARs allow the use of structural identification schemes to avoid over-parameterization and provide also explicit ways to interpret spillover effects (Mackowiak 2007).

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Bayesian VARs with informative priors on the steady-state incorporate non-sample information on the prior probability density function to improve the forecasting performance of the model. The prior probability distribution becomes informative if the major part of the distribution is centered on a particular value considerably tight. The sample distribution is provided by the likelihood function, which is combined with the prior density function to generate a posterior probability density function to be used in parameter estimates. The use of "informative priors" in the model estimation provides important advantages compared to the traditional Bayesian VARs by significantly improving the analysis of dynamic responses from one variable to another and the forecasting analysis of alternative scenarios for future paths of the variables.

3. Empirical analysis

3.1. Model specification

Consider the general Bayesian VAR model with the following form:

$$G(L)\, x_t = \mu + \eta_t \tag{1}$$

where $G(L) = I - G_1 L - \ldots - G_p L^p$ is a lag polynomial of order p, x_t is an (n x 1) vector of stationary macroeconomic variables and ηt is an (n x 1) vector of i.i.d error terms satisfying $E(\eta_t) = 0$ and $E(\eta_t \eta_{t'}) = \Sigma$.

Since it has been complicated to specify a prior distribution for μ in Equation (1), the problem has been overcome by using a non-informative prior for these parameters instead. Yet Villani (2005, 2009) proposed an alternative specification of the model, which allows for the use of informative priors:

$$G(L)\, (x_t - \psi) = \eta_t, \tag{2}$$

where $G(L)$, x_t and η_t are defined as above. An important characteristic of this mean-adjusted version of Bayesian VAR model is that ψ represents the steady-state values of the variables in the system. This allows the researcher to determine the parameters of ψ based on out-of-sample information and research on what the means and the standard deviations of each variable are, and then use them as informative priors in the estimation.

Following Villani (2005, 2009) the form of priors imposed on each Σ, $G_1,\ldots, G_p$ and ψ is the following:

$$p(\Sigma) \propto |\Sigma|^{-(n+1)/2}$$

$$vec(G) \sim N_{pn^2}\, (\theta_G, \Omega_G)$$

$$\psi \sim N_n\, (\theta_\psi, \Omega_\psi).$$

These specifications imply that the prior on Σ is non-informative, while the priors on vectors of dynamic coefficients $vec(G)$ and steady-state parameters ψ are informative. The steady-state parameters ψ are assumed to be normally distributed and centered on the means of variables in the system. The parameters of the priors will be explained in detail in the following section. The combination of the priors with the data is obtained through the

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likelihood function, and the conditional posterior distributions of the variables are analytically derived in Villani (2005, 2009). The Gibbs sampler with the number of draws set to 10,000 provides the numerical evaluation of posterior distributions, which we will list in the following section for our data[3].

3.2. Empirical implementation

A main purpose of the empirical analysis is to examine the growth spillovers from advanced economies to emerging economies, and in so doing, to differentiate between the effect of the spillovers from the United States and the Eurozone to emerging Asia, emerging Latin America, and China. This differentiation allows us to not only measure the effects of the shock from the Eurozone recession on emerging economies, but also demonstrate with a forecasting analysis how severely each region would be affected if the recession worsens. A complementary forecasting analysis will measure the effects of a slowdown in China's growth on other emerging economies to test the reliance of their growth performance on China.

Business cycles in emerging economies are driven by a combination of internal and external factors, and previous studies have shown that external factors explain a large portion of business cycle fluctuations in emerging economies (Mackowiak, 2007, Osterholm and Zettelmeyer, 2008). Our paper focuses on external demand and global financial conditions as major external factors influencing business cycles of emerging economies. In the model, external demand is represented by two variables: the real GDP growth rates for the United States and the Eurozone countries. The latter is a weighted-GDP index where the weights are the shares of each country in total Eurozone GDP and it is provided by the Datastream. Global financial conditions are captured by two variables: global investor risk perception – proxied by the Chicago Board of Trade Volatility Index (VIX) – and the abundance of global liquidity – proxied by the U.S. 3-month Treasury bill rate. Finally, the model includes the real GDP growth rates of three groups of emerging economies: China, emerging Asia, and emerging Latin America. As a measure of emerging Asian growth, a weighted index for Hong Kong, South Korea, Malaysia, Thailand, Indonesia, Taiwan, Singapore, and Philippines was used following Utlaut and van Roye (2010). As a measure for Latin American growth, a weighted index for Argentina, Brazil, Chile, Colombia, Mexico, and Peru (referred as LA6 below) was used following Osterholm and Zettelmeyer (2008)[4]. Both the Latin American and Asian countries included in the weighted indices account for almost 90 percent of the Latin American output and the Asian output excluding China, respectively. Hence, once the order of integration is determined, the vector of stationary macroeconomic variables is the following:

$$x_t = (\Delta y_t^{US} \quad i_t^{US} \quad \Delta y_t^{Eurozone} \quad VIX_t \quad \Delta y_t^{China} \quad \Delta y_t^{Asia} \quad \Delta y_t^{LA6}) \tag{3}$$

3 . In designing our sampler, we followed the literature with respect to the choice of the number of draws, burn-in, and thinning. The sampler is a simple conjugate update which typically converges very quickly and displays little dependence, which indicates that the standard practice is sufficient.
4 . For data sources, see the appendix table.

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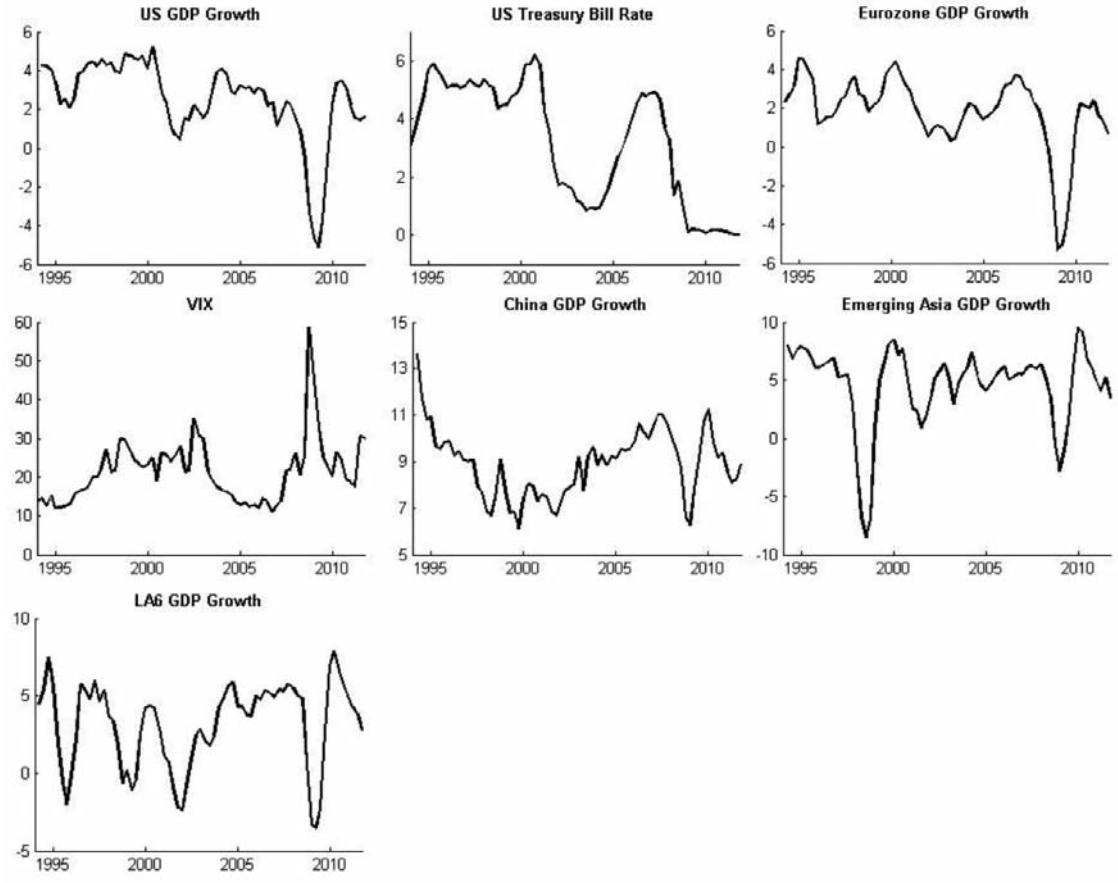
where Δy_t^{US} is the growth rate of the United States' GDP, i_t^{US} is the 3-month U.S. Treasury bill rate, $\Delta y_t^{Eurozone}$ is the growth rate of Eurozone GDP, *VIX* is the trade volatility index, Δy_t^{China} is the growth rate of China's GDP, Δy_t^{Asia} is the growth rate of aggregate real GDP for emerging Asia, and Δy_t^{LA6} is the growth rate of aggregate real GDP for LA6 countries.

The U.S. and the Eurozone growth and the global financial variables are treated as block exogenous with respect to the emerging economies variables, similar to Osterholm and Zettelmeyer (2008) and Utlaut and van Roye (2010). Rather than following the standard practice of directly imposing exogeneity, we allow the assumption of exogeneity to be relaxed through the introduction of hyperparameters. A dirac mass at zero for these parameters would correspond to direct imposition – forcing the posterior to conform to exogeneity. Instead, we use a prior distribution with mean zero and small variance to encourage exogeneity, but allowing for non-zero posterior estimates if the data strongly opposes this belief.

Figure 1 – Time series data used in the BVAR estimation



Source: See Appendix.
Note: Growth rates are expressed as percentage changes with respect to the same quarter in the preceding year.

5 . The rapidly changing patterns over the sample period might influence the results.

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Quarterly data displayed in Figure 1 was used in the model estimation for the period 1993:Q2 and 2011:Q4[5].

Specific priors were defined for the steady-state values of ψ and *vec*(*G*). Table 1 presents the means and 95% probability intervals of the prior and the posterior distributions for the Bayesian VAR. Appendix section includes a list of model and prior options including tightness parameters chosen to estimate the model.

Table 1 – Prior and posterior distributions in the steady-state

	Prior		Posterior	
	Mean	95 % probability interval	Mean	95 % probability interval
U.S. GDP growth	3	(2.0, 4.0)	3.0	(2.3, 3.7)
3-m treasury bill rate	4	(3.0, 5.0)	3.8	(3.0, 4.6)
Eurozone GDP growth	2	(1.0, 3.0)	2.25	(1.7, 2.8)
VIX	20	(10.0, 30.0)	20.0	(16.7, 23.3)
China GDP growth	8.25	(7.0, 9.5)	8.9	(8.3, 9.5)
Emerging Asia GDP growth	5.5	(3.5, 7.5)	5	(3.6, 6.4)
LA6 GDP growth	4.25	(3.5, 5.0)	4.1	(3.5, 4.7)

Source: Author's evaluations and see the discussion below.
Note: The GDP growth rates are expressed in percent at annualized rates. The 3-m Treasury bill rate is annualized and expressed in percentage points. The VIX is expressed as index numbers. See Appendix for additional model and prior options including the tightness parameters chosen to estimate the model.

The U.S. GDP growth is assumed to have a steady-state growth rate of 3 percent and a standard deviation of 0.5 percent, which are based on the medium-term projections of the IMF's World Economic Outlook. The mean prior for the U.S. three-month Treasury bill rate was set to 4 percent corresponding to the U.S. inflation target and an equilibrium real interest rate of about 2 percent for each (Osterholm and Zettelmeyer 2008, Clarida et al. 1998, Utlaut and van Roye 2010). The steady-state prior for Eurozone growth, centered on 2 percent, was based on the medium-term projections of the IMF's WEO Update 2012 (IMF 2012a), similar to the basis for the U.S. growth rate.

Since there is no prior information from theory or empirics about the trade volatility index, following Utlaut and van Roye (2010) we take the mean average of a longer sample of data as the mean prior and assume a diffuse distribution with a large standard deviation. The mean prior for the real GDP growth of China is chosen as 8.25 percent, which is based on the long-run growth potential of China until 2020 (Holz, 2005, Utlaut and van Roye 2010). The mean prior for the growth of Latin America was chosen as 4.25 percent following Osterholm and Zettelmeyer (2008), which was based on the estimates of long-run growth in Latin America (Loayza et al. 2004). Following Utlaut and van Roye (2010), the steady-state real GDP growth rate for emerging Asia is set to 5.5 percent, which is the mean of the sample over 1993-2011 excluding sharp recessionary periods of the Asian crisis and the recent global crisis.

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As seen in Table 1, the 95% confidence intervals of the posterior distributions estimated by the model are within the prior intervals assumed. These assumed priors do not impose a prejudgment on the forecasts of the model in the short-run because non-informative priors result in similar estimates but are quantitatively much less precise. We used a lag length of 2 or 4, which did not generate different results, and reported the results with a lag length of 2.

4. Results

This section presents the results obtained from the model, including the impulse response functions, the variance decompositions, and forecasting analysis.

4.1. Impulse responses and variance decompositions

The main focus of this section is the discussion of the results for emerging economies growth, that is, China, emerging Asia, and emerging Latin America's real GDP growth rates. The full set of impulse response functions and variance decomposition results are presented in Figures A1 and A2 in the Appendix. The impulse response functions and variance decomposition are generated by the standard practice of following a Cholesky decomposition of the variance-covariance matrix. That is, independent standard normal shocks are identified based on the estimated reduced form shocks, and the order of the variables is the one in Equation 3. This implies that U.S. GDP growth is assumed to be contemporaneously independent of all shocks except its own; the U.S. Treasury bill rates are assumed to contemporaneously depend on U.S. GDP shocks and its own; and so on.

Note that the Eurozone GDP growth is contemporaneously affected by the U.S. Treasury bill, but the opposite is not true. The reason for this ordering is that the interest rates in the U.S. are foremost set according to the growth patterns in the U.S, but that they have a direct impact on the Eurozone economies through their impact on global liquidity. The results did not differ if we reversed the ordering of the U.S. Treasury bill rate with the Eurozone GDP growth.

Among the emerging economies, the growth rate of China is assumed to be contemporaneously independent of all emerging economy shocks except its own while the growth rates of emerging Asia and Latin America are assumed to contemporaneously depend on China's GDP shocks and their own. This assumption is based on the recent patterns of international trade in which China plays a crucial role as an importer of intermediate and capital goods mainly from other Asian economies and primary commodities from major Latin American countries, and becomes an important external push factor to affect business cycles in these economies.

The primary focus of our analysis is estimating the effect of shocks from the advanced economies to emerging economies, and not vice versa. The ordering allows the emerging

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economies' growth to be contemporaneously affected by advanced economies' growth dynamics but not vice versa. This can be justified by the fact that the emerging economy crises in late 1990s – early 2000s did not pull advanced economies into crisis, while the recent crisis emerging in the United States and spreading to European countries had a sharp simultaneous impact on emerging economies, which could have been even worse in the absence of stimulus plans. A related point to underscore is that our ordering captures the properties of a key currency system in which all emerging economies are linked through the role of global liquidity, allowing the structure of the international monetary system to have a direct impact on macroeconomic interdependencies.

Figure 2 displays the response of real GDP growth of China, emerging Asia, and emerging Latin America to various external shocks. The darker and lighter shades represent 50% and 95% confidence intervals, respectively. The magnitude of standard deviation of each variable is given by the impulse response at horizon zero of each diagonal panel. The standard deviations are 0.61 percentage points for the U.S. growth, 43 basis points for the U.S. Treasury bill rate, 0.36 percentage points for the Eurozone growth, 4.94 units for the VIX, 0.58 percentage points for China, 0.93 percentage points for the emerging Asia and 0.77 percentage points for emerging Latin America. The following effects of the external shocks on emerging economies' growth are estimated:

- Increases in U.S. growth leads to rising growth in emerging Asia and Latin America in a ratio of one-to-one, but the impact is about half as strong in the case of China. An increase of the U.S. GDP of 0.61 percentage points results in an increase in China's growth by about 0.33 percentage points within the first quarter (this effect declines to about 0.14 percentage points after three quarters, which shows that the effect is not persistent over time). The same shock creates a much stronger effect for other emerging economies. Emerging Asia and Latin America respond with an increase of 0.62 and 0.78 percentage points in their aggregate growth rates within the first quarter respectively.[6]
- A worsening in financial conditions generates a negative impact on emerging economies growth performance. While a contractive interest rate shock leads to a more muted reaction, an increase in financial volatility reflected by a higher VIX index creates very strong negative responses that also persist over time. The channel in which an increase in VIX index is transmitted to emerging economies is a rise in risk in financial markets, which leads investors to respond with higher levels of risk aversion. This results in capital outflows from emerging economies and a slump in asset prices. Domestic policy response often takes the form of tighter monetary policy to control and reduce capital flight. Our estimation results show that a standard deviation VIX shock of 4.94 units results in a decline in emerging Latin American growth of 0.77 percentage points followed by emerging Asia of 0.54 percentage points and China of 0.43 percentage points in

6 . The maximum effects reach 0.68 percentage points in two quarters for emerging Asia and 1 percentage points in three quarters for emerging Latin America.

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three quarters[7]. This finding shows that more financially open economies such as Latin American countries are more negatively affected by negative financial shocks than those that are less financially open or even with relatively closed capital accounts such as China.

- A boost in Eurozone growth leads to a strong positive impact for emerging Asia, followed by China and Latin America. A standard deviation (0.36 percentage points) rise in Eurozone GDP growth leads to a step-wise rise in growth of China by about 0.11 percentage points after six quarters. This shock generates a stronger reaction from emerging Asia, whose growth rises about 0.27 percentage points after three quarters, and a weaker reaction from emerging Latin America with a rise in growth of 0.09 percentage points within the first quarter and deteriorating afterwards. The unexpected rise in demand for primary commodities from Latin American economies brings them quickly to the production capacity limits, especially since these economies suffer from a lack of productive investment. Reaching the production capacity generates a jump in inflation levels, and leads to a restrictive monetary policy response from domestic monetary authorities, eventually creating a reduction in the growth rate. In fact, these booms and busts driven by external demand is a widely accepted characteristic of Latin American economies, and our estimation results support this view. One of the reasons for the Asian economies to absorb the external shocks in a smoother fashion is that they have a more diversified production structure.
- Increases in Chinese growth generate increases in growth of other emerging economies with slightly stronger effects for emerging Asian countries. One standard deviation rise in China's GDP growth of 0.58 percentage points results in an increase in growth of emerging Asia and Latin America's growth by about 0.47 and 0.45 percentage points after three quarters, respectively.[8] It is also seen that an increase in emerging Asian growth has a positive effect on emerging Latin America. A standard deviation rise in emerging Asian growth of 0.93 percentage points leads to a rise in emerging Latin American growth of 0.4 percentage points after three quarters.[9]

Table 2 shows the output elasticities of external demand shocks in China, emerging Asia and Latin America as indicated by the impulse response functions discussed above. The stronger effect of the shocks from U.S. GDP growth on emerging Asian and Latin American economies relative to China can also be seen in elasticity terms. One percentage point increase in U.S. growth rate leads to 1.11 percentage point rise in emerging Asian growth rate and 1.64 percentage point rise in Latin American growth rate after three quarters, both of which are much larger than the effect in China of 0.23 percentage

7 . This result is the opposite of what Utlaut and van Roye (2010) have found, which was that China is more negatively affected than emerging Asia from financial shocks.

8 . This finding again differs from Utlaut and van Roye's (2010) results for the impact of China's growth on emerging Asia, which appeared as a weak response of only 0.2 percentage points.

9 . The reaction of emerging Asia to Latin American growth shocks is left out of the discussion because of the block exogeneity assumption that implies that emerging Asia's business cycles are not contemporaneously affected by Latin American cycles, but the reserve may be true.

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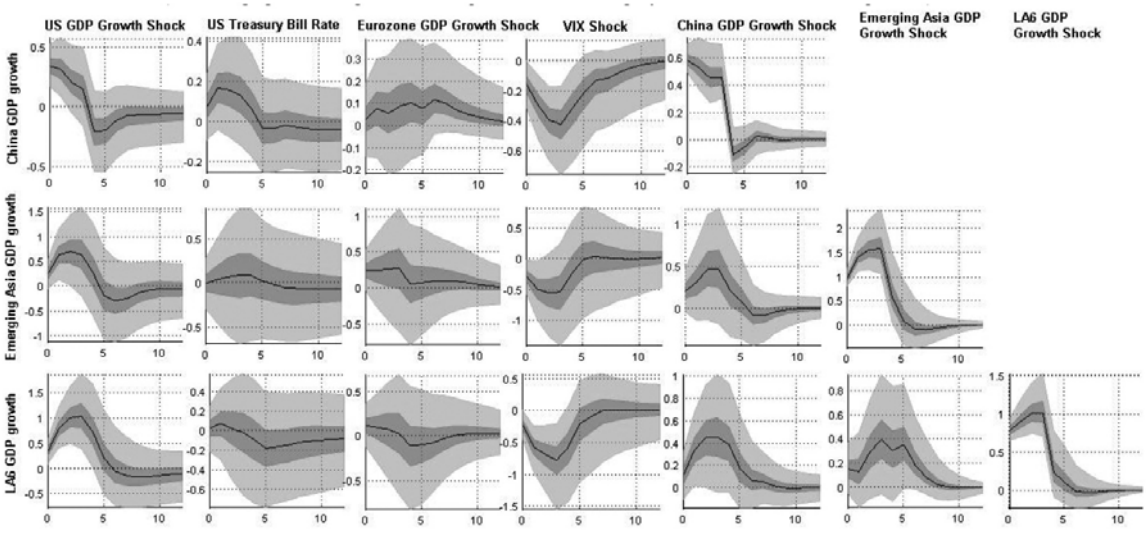
Figure 2 – Responses of emerging economies' growth with respect to one standard deviation external shocks
(Percentage point change from four quarters earlier; displayed over a horizon of 12 quarters)



Source: This figure displays the impulse response functions of the emerging economies' growth – that is, the growth of China, emerging Asia, and emerging Latin America – with respect to one standard deviation external shocks including 0.61 percentage points for the U.S. growth, 43 basis points for the U.S. Treasury bill rate, 0.36 percentage points for the Eurozone growth, and 4.94 units for the Chicago Board of Trade Volatility Index (VIX) as a proxy for global investor risk perception. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix. The darker shade represents 50% confidence interval, and the lighter shade represents 95% confidence interval.

point increase after three quarters. It is also seen that China's output elasticity with respect to the Eurozone growth is larger than that of the U.S. growth in a three-quarter horizon, whereas the opposite applies for other emerging economies examined. Finally, it is seen that a one-percentage-point jump in Chinese growth leads to 0.81 percentage point rise in emerging Asian growth and 0.78 percentage point rise in Latin American growth.

The analysis of the degree in which each external shock contributes to growth in emerging economies can be conducted through a variance decomposition. Figure 3 shows the variance decompositions for China, emerging Asia, and emerging Latin America (for the full system, see Table A2 in Appendix). While more than half (about 63 percent) of the forecast error variance of Latin American GDP growth is explained by external factors, only slightly less

Table 2 – Output elasticities of external demand shocks in China, emerging Asia and emerging Latin America

	China		Emerging Asia		Emerging Latin America	
	1Q	3Q	1Q	3Q	1Q	3Q
U.S. GDP Growth	0.54	0.23	1.02	1.11	1.28	1.64
Eurozone GDP Growth	0.22	0.31	0.06	0.75	0.25	0.25
China GDP Growth	-	-	0.53	0.81	0.70	0.78
Emerging Asia GDP Growth	-	-	-	-	0.24	0.43

Source: Author's calculations from impulse response functions.
Notes: The elasticities represent the percentage point response of growth rates for each emerging economy to a one-percentage-point shock in external demand. The figures for 1Q and 3Q represent elasticities after one quarter and three quarters respectively.

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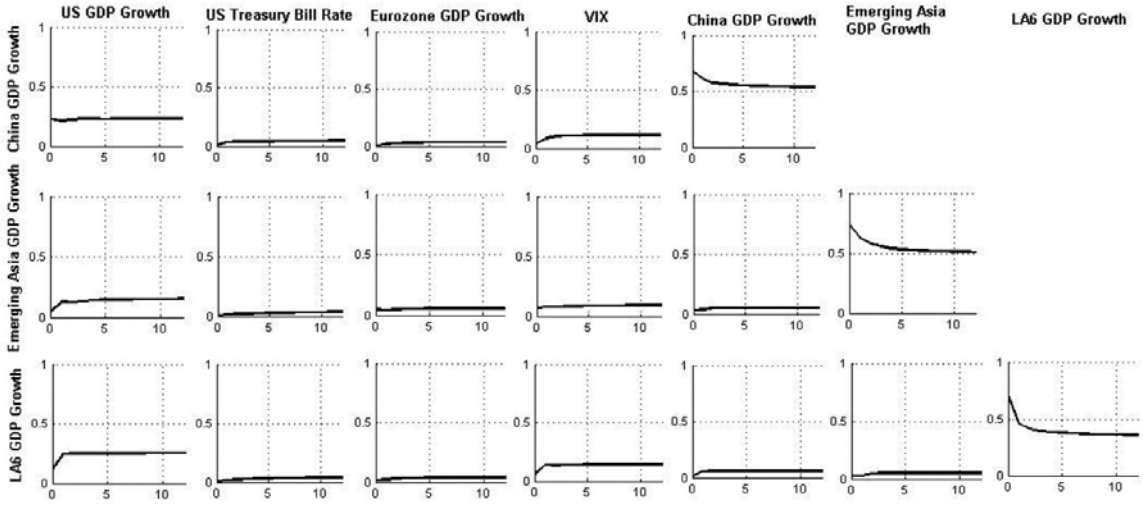
than half of the forecast error variance of emerging Asia and China is explained by external factors (about 49 and 46 percent respectively). Shocks from the U.S. growth contribute about 23 percent to China's growth, 15 percent to emerging Asia's growth, and 25 percent to Latin American growth. Other shocks have less weight: VIX contributes about 10 to 15 percent, U.S. interest rate about 5 percent, Eurozone growth about 4 to 6 percent, China's growth about 5 to 6 percent, and emerging Asia's growth about 5 percent.

Figure 3 – Variance decomposition from the Bayesian VAR with informative priors



Source: This figure displays the variance decompositions of the emerging economies' growth – that is, the growth of China, emerging Asia, and emerging Latin America. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix.

4.2. Unconditional forecasts

Figure 4 presents the unconditional forecasts of the endogenous variables for the mean-adjusted BVAR model[10]. The darker and lighter shades represent 50% and 95% confidence intervals, respectively. It can be observed that the fully endogenous forecasts since the fourth quarter of 2011 predict a phase of recovery in the growth rates of the U.S. economy to pre-crisis levels of around three percent for the next three years. For the same period, the Eurozone economies are expected to grow at an average rate of slightly below two percent while the U.S. short term interest rates gradually rise back to around two percent. The model also predicts a recovery in emerging economies. However, their growth rates are expected to stabilize around levels below the pre-crisis rates: slightly above five percent for the emerging Asia and slightly below five percent for the emerging Latin American economies. Similarly, China's growth rate is expected to remain strong,

10 . There are different ways of creating conditional forecasts. In this paper, we take the following approach: let x1(t) be the sub-vector of x(t) containing conditioning variables (the Eurozone growth notably) and x2(t) be the remaining variables. Then the forecasts for x2(t) use Equation (1) to compute recursively x2(t+1), x2(t+2), etc. while imposing η=0. Formally, this yields to the following forecasts: *E(x2(t+h)|x1(t),...,x1(t+h- 1))*. An alternative would be to compute E(x2(t+h)|x1(t),...,x1(t+h),...,x(t+H)).

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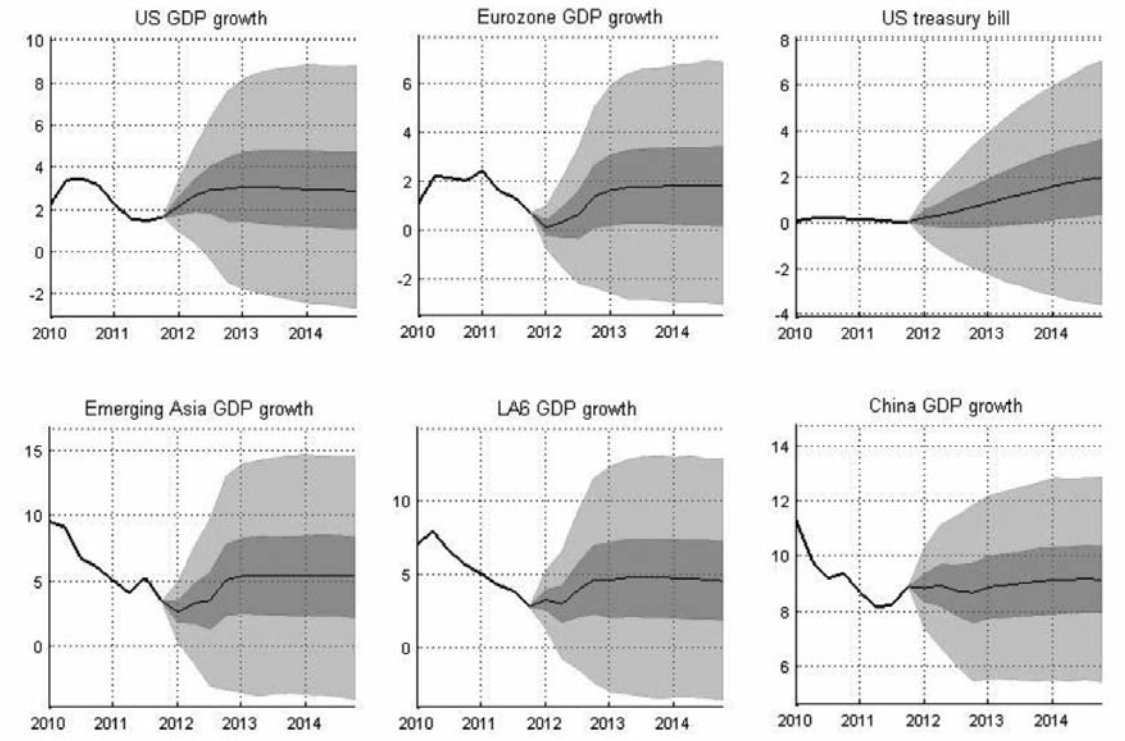
stabilizing around nine percent. These endogenous model predictions could be seen as a plausible forecast only if the world economy had begun to experience a strong period of recovery without any debt overhang or deterioration in financial balance sheets.

Figure 4 – Unconditional forecasts of the Bayesian VAR with informative priors



Source: This figure displays the unconditional forecasts of the endogenous variables in the model since the third quarter of 2011. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix. The darker shade represents 50% confidence interval, and the lighter shade represents 95% confidence interval.

However, the ongoing process of recovery has been weak and the deleveraging efforts of the private and public financial sectors continue to keep the credit squeeze on the real economic activity. For this reason it is important to take the depressed state of the world economy in mind, and simulate the effect of downside risks on the future paths of endogenous variables. In fact, the mean-adjusted BVAR is a convenient model to carry out conditional forecasts involving specific external events by introducing assumptions about certain endogenous variables to predict their impact on the performance of other endogenous variables. In this sense, conditional forecasts can be seen as a method of integrating information outside of the model, or judgment (Svenson, 2005), into the forecasting exercise in order to create more informed predictions.

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4.3. Conditional forecasts and scenario analysis

This section focuses on two downside risk scenarios about the current global macroeconomic outlook that are currently debated in media, academic, and business world. The effects of different scenarios on emerging economies depend on the magnitude of shocks chosen in the conditional forecasts. That is, smaller (larger) shocks relative to the ones chosen in conditional forecasts are likely to create smaller (larger) spillover effects in emerging economies than those in conditional forecasts.

The first scenario analyzes the impact of a deepening Eurozone recession on emerging economies' growth performance, while the second examines the effects of a slowdown in China's growth on emerging Asian and Latin American economies. Analyses of these adverse external risks allow us to address the following questions:

(i) Is the growth performance of emerging economies resilient to a worsening of the recession in the Eurozone economies, which are as a whole among the largest trading partners of emerging economies? Another way to pose the question is the following: Is there evidence of a decoupling of emerging economies from advanced ones and having a more independent phase of self-sustained growth?

(ii) As China's trading volumes with other emerging economies continues to rise and the investment flows in the South-South nexus keep on increasing, how will a possible deceleration in China's growth rate affect other emerging economies? This is particularly important not only for many Asian economies which have strong intra-industry trade ties with China, but also commodity exporting Latin American economies, whose buyer often ends up being China. There is also evidence that China's recent phase of accelerated growth has been a major factor in keeping commodity prices high (Erten and Ocampo, 2012), which was an important factor for many Latin American countries that experienced improved terms of trade and augmented output growth associated to the commodity price boom. Hence the question becomes, in the absence of a strong demand pull from China's manufacturing power house will the emerging economies be able to sustain high rates of expansion in economic activity?

4.4. Effects of a severe eurozone recession on China, emerging Asia, and emerging Latin America

One of the most important external risks facing China and other emerging economies today is the possibility that a worsening Eurozone debt crisis may intensify the mild recession in the Euro area, turning into a more severe recession as consumer confidence declines, European governments continue implementing austerity programs, and bank deleveraging leads to large contractions in credit and output in Europe. To illustrate the impact of a severe Eurozone recession, this section assumes a scenario in which the Eurozone growth contracts sharply in the fourth quarter of 2011 from -0.3 percent to -1 percent in first quarter of 2012 and then to -3 percent, remaining at -3 percent for the rest of the forecasting horizon. In addition,

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the U.S. short-term interest rates are assumed to stay at its current level of 0.02 percent until the end of the forecasting horizon. Given these pre-specified paths, real GDP growth of China, emerging Asia and Latin America responds endogenously to a worsening in the Eurozone recession.

It is important to note that the magnitude of the spillover from a Eurozone recession to emerging economies will depend on the assumptions regarding the behavior of the U.S. GDP growth:

(i) The first option is to let the U.S. GDP growth respond endogenously to the Eurozone recession and the zero level of short-term interest rates. Given that the typical response of the U.S. GDP growth to the Eurozone growth during the estimation period of 1993–2011 is rather muted (see impulse responses in Table A1), this generates a gradual endogenous return of the U.S. GDP growth to the steady-state level of three percent following a Eurozone shock.

(ii) The second option is to assume a path for the U.S. GDP growth in which a severe Eurozone recession will create a sharp decline in U.S. exports (as the Euro area is the primary export market for the U.S. exports), and generate a significant deterioration in the growth rate of U.S. real GDP. In particular, this could reverse the recovery gains and result in a zero rate of growth for the U.S. economy after two quarters. In the event of a deep and protracted Eurozone recession, the second option is more likely to take place relative to the first one. In this case, the United States would need an active government policy to recover, however, the monetary policy alone may not be sufficient and the high level of indebtedness may hamper a new stimulating fiscal policy to be implemented.

Figure 5a shows the conditional forecasting results of the simulation of a severe Eurozone recession allowing the U.S. GDP growth to respond endogenously – that is, the first option. The darker and lighter shades represent 50% and 95% confidence intervals, respectively. The model predicts that a contractive Eurozone output shock would result in a slowdown in China's GDP growth to 7.8 percent in three quarters, and gradually decline to 7.4 percent in 2014. The magnitude of the predicted slowdown is not large (about 1 percent in the first year after the shock and 1.4 percent after three years), although the growth rate does not return to the pre-crisis level of higher than 8 percent. This implies that the deepening of the Eurozone recession would have a persistent depressive effect on China's economy, but the magnitude of the effect will remain limited and in fact within the targeted range by the Chinese government.

The effects of a deepening Eurozone recession on emerging Asia and Latin America are predicted to be more severe. In emerging Asia, the real GDP growth would respond by declining for two quarters from 3.5 to 1.4 percent – that is, over a 2 percent decline in a very short period of time. However, the forecasts show that the recovery would be just as quick as the real GDP growth climbs back to 3 percent in the following two quarters. Yet the results show that it would not recover completely, and in fact, the opposite effect of a persistent sluggish growth would result. By the end of the forecasting horizon, the real

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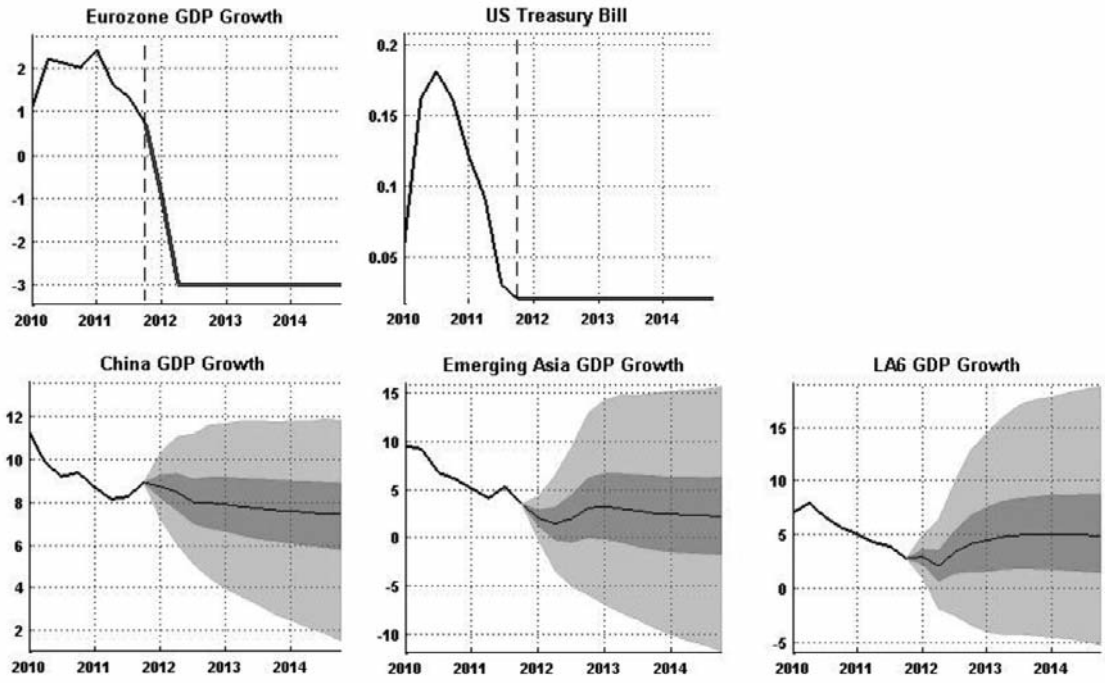
GDP growth in emerging Asia is expected to slow down to 2.2 percent, well below the pre-crisis levels. On the other hand, emerging Latin America (LA6) would experience a milder slowdown in its growth rate for two quarters from 2.8 to 2 percent, and a faster recovery in its growth rate to 3.3 percent in one quarter and to 4.9 percent in four quarters. The results suggest that China and emerging Asian economies are more exposed to adverse shocks emanating from the Euro area than emerging Latin American economies, as predicted by the impulse response analysis.

Figure 5a – Simulation of a severe eurozone recession with endogenous U.S. GDP Growth



Source: This figure shows the conditional forecasts of the emerging economies' growth – that is, the growth of China, emerging Asia, and emerging Latin America – in response to the reduction of Eurozone growth sharply in the fourth quarter of 2011from -0.3 percent to -1 percent in first quarter of 2012 and then to -3 percent for the rest of the forecasting horizon, and the endogenous response of the U.S growth. The U.S. short-term interest rates are assumed to stay at its current level of 0.02 percent until the end of the forecasting horizon. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix. The darker shade represents 50% confidence interval, and the lighter shade represents 95% confidence interval.

Figure 5b displays the results of conditional forecasting for the simulation a severe Eurozone recession with the assumption that the U.S. economy will be hit severely, as its growth rate falls to zero percent after two quarters. The darker and lighter shades represent 50% and 95% confidence intervals, respectively. The model predictions for China and other emerging economies deteriorate significantly. In China, the real GDP growth would respond by declining for two quarters from 8.9 to 7.5 percent in two quarters. However, it recovers quickly in fourth quarter to 8.2 percent and remains at this level until the end of the forecasting period. Interestingly, compared to the previous scenario where China's GDP growth remains depressed for a long period at levels below 8 percent, this scenario predicts China to

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attain a growth rate that is above 8 percent despite the more negative conditioning of the U.S. GDP growth. The latter is reflected in a sharper decline in Chinese growth rate in a shorter period of time.

The explanation for the fact that China endogenously achieves a higher rate of growth within a few years in more depressed external demand conditions could be tentatively given as follows. If a deepening Eurozone recession results in a slowdown in the U.S. economy, the weakening demand for primary commodities could result in depressed commodity prices. This decline in commodity prices implies a rising purchasing power for China, which is a major importer of primary commodities for its industrial production. This would result in a positive supply shock in China, giving rise to a higher level of income and growth potential despite a worsening in external demand conditions. In other words, the channel in which China attains a higher rate of growth could be the primary commodity channel.

The response of emerging Asia and Latin America to a combined slowdown in Eurozone and the U.S. economies is more negative relative to the previous scenario. In emerging Asia, the real GDP growth is predicted to respond by collapsing from 3.5 to 0.4 percent after two quarters. The forecast results predict the Asian recovery to take place fairly quickly reaching a 2.9 percent growth after three quarters following the slump, and stabilize around 2.6 percent by the end of the forecasting period. The effect of a double slowdown on Latin American economies is also worse than that of the Eurozone on its own. The forecasting results show that the real GDP growth would decline from 2.8 percent to 0.4 percent after two quarters, and recover to 2.8 percent in the following four quarters, stabilizing around 2.9 percent by the end of the forecasting period. This is much lower than 4.9 percent growth attained by Latin American economies as a response to the Eurozone shock in the previous scenario. This result reflects the closer ties between the U.S. economy and the Latin American economies, and confirms other studies' findings that the shocks from the U.S. have rather sharp and persistent effects on Latin America (Canova 2005).

4.5. Effects of a slowdown in China's growth on emerging Asia and Latin America

Another external risk that might challenge the high rates of economic growth in emerging countries in Asia and Latin America is the possibility of a hard-landing in Chinese economy which might experience a long phase of stagnated growth or a medium-income trap. We simulated the response of emerging Asia and Latin America to about a three percentage point decline in China's real GDP growth rate (from 8.8 to 6 percent). The results show that emerging Asia's growth would decelerate from 3.5 percent to 1.7 percent in two quarters, which is a decline of 1.8 percent that is slightly less than the negative effect of the Eurozone recession (0.3 percentage points). The recovery takes two quarters and reaches a maximum of 2.9 percent, which is slightly less than the growth rate of 3 percent attained after the Eurozone recession. Hence, despite the smaller magnitude of the slowdown in emerging Asia, its effect is persistent over the forecasting horizon keeping the growth rate at 2.9 percent, a level significantly less than the steady-state growth rate of 5 percent.

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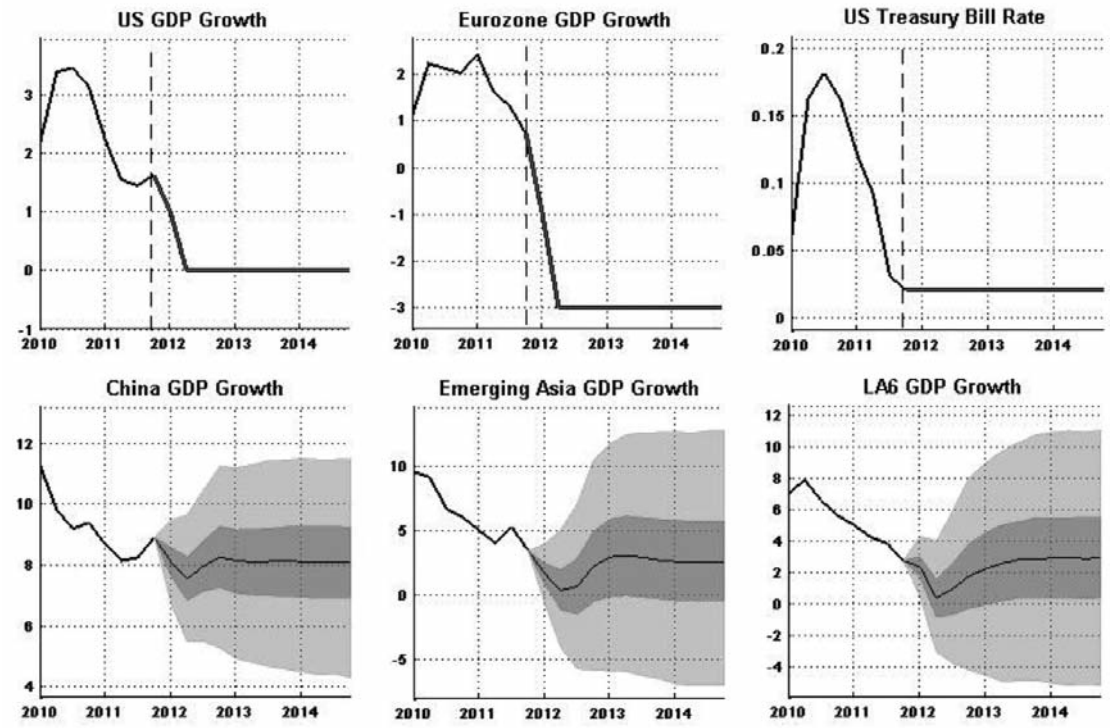
Figure 5b – Simulation of a severe eurozone recession with conditioned U.S. GDP Growth



Source: This figure shows the conditional forecasts of the emerging economies' growth – that is, the growth of China, emerging Asia, and emerging Latin America – in response to the reduction of Eurozone growth sharply in the fourth quarter of 2011from -0.3 percent to -1 percent in first quarter of 2012 and then to -3 percent for the rest of the forecasting horizon, and the decline of the U.S growth to zero percent in the second quarter of 2012. The U.S. short-term interest rates are assumed to stay at its current level of 0.02 percent until the end of the forecasting horizon. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix. The darker shade represents 50% confidence interval, and the lighter shade represents 95% confidence interval.

In comparison, Latin American emerging economies respond to this shock by a reduction in their growth rate from 2.8 percent to 2 percent in three quarters, but the recovery process is expected to be very weak, with a continuing deceleration to about 1.3 percent at the end of the forecasting period. Hence, while the magnitude of the response by the Latin American economies is similar to the shock of a Eurozone recession, the difference lies in the persistent deterioration in the growth performance that does not recover from the shock of a slowdown in China.

The results illustrate that both regions of emerging economies are vulnerable to a shock from Chinese hard-landing, but in contrast to the popular view that Asian countries are more tied to China's growth prospects, our results suggest that Latin American countries are at least as much exposed to these risks. The latter might reflect the commodity-driven growth regime present in the majority of the large and fast-growing Latin American countries, and that the recent commodity boom has largely been driven by the rising demand of China. Besides, China has diversified links with emerging Asia than with Latin America, and the nature of trade linkages are much more based on intra-industry trade in manufactures. This is another reason for the more diffused effects of the shocks from China on emerging

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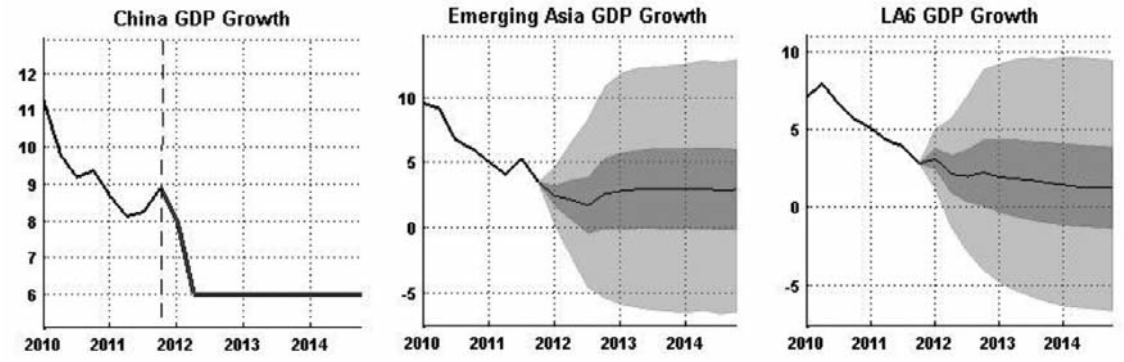
Asia. In comparison, inter-industry trade linkages – primary commodities in exchange for manufacture – with Latin America leads to higher dynamic spillover effects from Chinese growth to Latin American growth performance.

Figure 6 – Simulation of a slowdown in China's growth



Source: This figure shows the conditional forecasts of the emerging Asia's and emerging Latin America's growth in response to the slowdown in China's growth sharply in the fourth quarter of 2011from 8.8 percent to 6 percent in the second quarter of 2012, and the endogenous response of other variables. The model is estimated by a mean-adjusted Bayesian VAR, the prior specifications are provided in Table 1, and other model options involving tightness parameters are listed in Appendix. The darker shade represents 50% confidence interval, and the lighter shade represents 95% confidence interval.

5. Conclusion

This paper analyzed the impact of external shocks on emerging economies by using a mean-adjusted BVAR model. Drawing on the impulse response functions and conditional forecasts, the paper assessed the response of emerging economies' growth to a multiplicity of shocks including external demand shocks and global financial conditions, and examined the robustness of emerging economies' growth to deteriorating external conditions. In particular, conditional forecasting analyses focused on two scenarios: The impact of a worsening Eurozone recession on growth in China, emerging Asia and Latin America, and that of a slowdown in China's growth on emerging Asia and Latin America.

The central result is that while the shocks from Eurozone growth account for a small percentage of the forecast error variance relative to those from the U.S. growth, their impact on emerging economies could be rather severe. According to scenario analyses conducted in this paper, the size of the spillover from a worsening Eurozone recession to China and other emerging economies depends on the response of the U.S. growth to Eurozone recession. If the U.S. economy experiences a quick recovery from the deepening recession in Euro area economies, the initial impact of the Eurozone shock on emerging economies will be muted, but the subsequent quarters will have a depressed phase of growth in China and emerging Asia, while Latin American economies will recover almost completely. On the other hand, if the U.S. experiences a stagnation as the Eurozone recession deepens, the initial negative impact on emerging economies will be much severe, and the subsequent effect will be more negative for emerging Asia and Latin America. The consequent effect

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on China is expected to be smaller as a result of the depressed commodity prices acting as a positive supply shock.

This result indicates that a severe external demand shock may create a sharp deterioration in the growth performance of emerging economies, which have not entirely decoupled from advanced economies. It also implies that while China has a large impact on business cycle fluctuations in emerging economies of Asia and Latin America, it does not have the capacity to replace the growth impetus from previously industrialized economies yet. However, this does not mean that increased integration among emerging economies through enhanced South-South trade and financial linkages fails to provide an alternative growth regime delinked from advanced economies. In fact, we may be in the early phases of such a transformation after the global financial crisis, and the few data points covering four years in the post-crisis period may not be able to capture the emergence of a self-sustaining growth process in emerging economies.

Another result of the forecasting analyses is that a slowdown in China's growth creates a significant and persistent slowdown in emerging economies of Asia and Latin America. Those in Latin America are predicted to experience a more severe slowdown, which contradicts the popular view that Asian economies are more likely to suffer from a contraction in Chinese growth. The results in this paper imply that the emerging Latin American countries growth is more vulnerable to a slowing down in China and this might be related to the fact that these economies are much less diversified and the recent growth phase has been closely associated to the commodity boom driven largely by China. This underlines the need to diversify towards manufactured goods production in order to reduce the region's vulnerability to external demand shocks. The more diversified productive structure of emerging Asian economies provides a more diffused transmission of shocks from China, and constitutes a better environment to pursue further regional integration in order to reduce the region's reliance on exports to advanced countries.

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Appendix

Data sources

United States real GDP growth rate: Datastream.

Eurozone real GDP growth rate: Datastream.

U.S. three-month Treasury bill rate: Datastream.

VIX: Chicago Board Options Exchange.

China real GDP growth rate: For the period 1993-1999 from Abeysinghe and Rajaguru (2004), and the rest from Datastream.

Emerging Asia real GDP growth rate: weighted average real GDP growth of eight Asian economies including Hong Kong, South Korea, Malaysia, Thailand, Indonesia, Taiwan, Singapore, and Philippines, where weights used were the World Development Indicators nominal GDP figures in U.S. dollars. All real GDP data for these countries were taken from Datastream, except for three countries: for Malaysia and Philippines, GDP volume data from International Financial Statistics of the IMF were used, and for Indonesia, real GDP data was obtained from the OECD database Main Economic Indicators.

Emerging Latin American (LA6) GDP growth rate: weighted average real GDP growth of six Latin American economies including Argentina, Brazil, Chile, Columbia, Mexico, and Peru, where weights used were the World Development Indicators nominal GDP figures in U.S. dollars. The real GDP data for Argentina, Chile, Mexico, and Peru were taken from Datastream, and those for Brazil and Columbia were taken from the GDP volume data from International Financial Statistics of the IMF.

Model and Prior Options

Options	*Choice*	*Comment*
Lag length	2	Lag length of the VAR
Constant	meanadj	Determines the parametrization of the deterministic term in the VAR. Options: 'none' (no constant), 'standard' (the usual form), 'meanadj' (deterministic part is unconditional mean).
Overall tightness	0.5	Prior hyperparameter as in the original Minnesota prior.
Cross-variable tightness	1	Prior hyperparameter as in the original Minnesota prior.
Lag decay	1	Prior hyperparameter as in the original Minnesota prior.
Exogenity tightness	0.001	Prior hyperparameter. Domain: [0,1]. If =1, exogenous variables are treated just like the endogenous.

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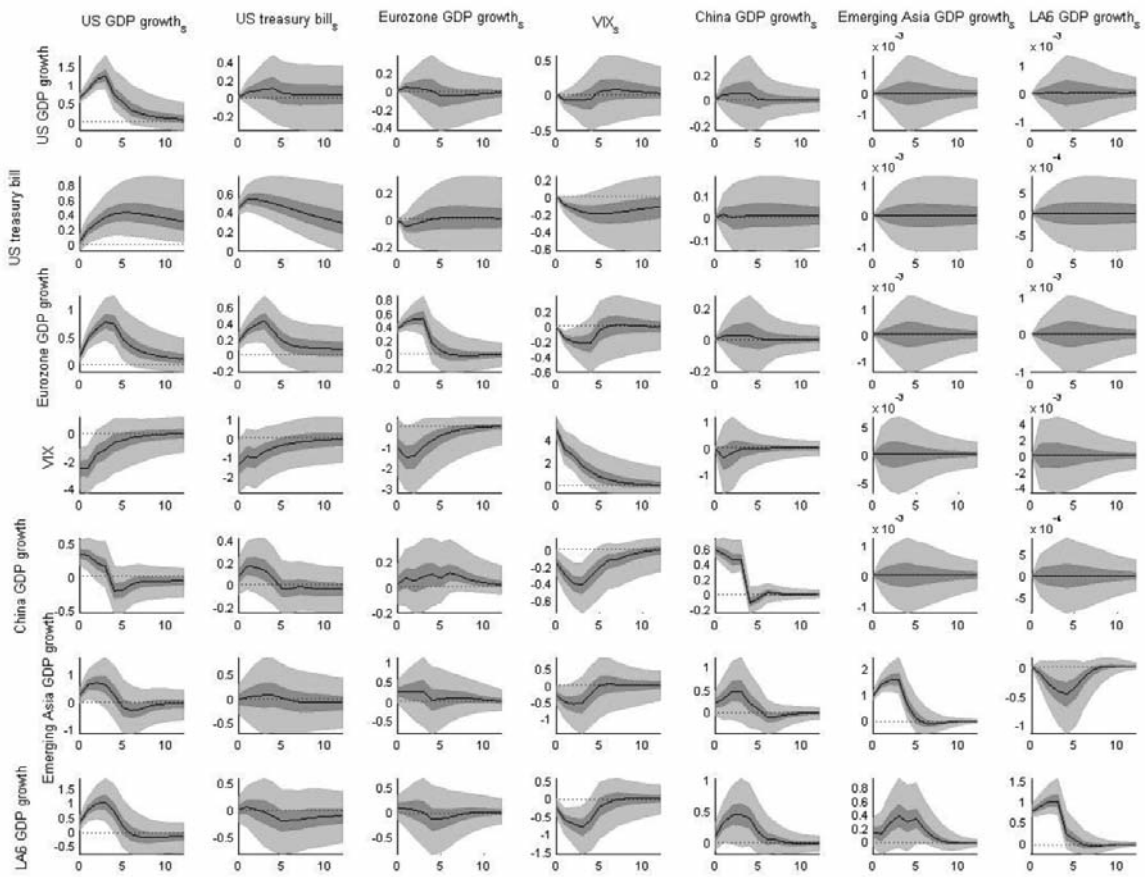
Figure A1 – Impulse response functions of the Bayesian VAR with informative priors (in percent; shown over 12-quarter horizon)



Source: Author's calculations.

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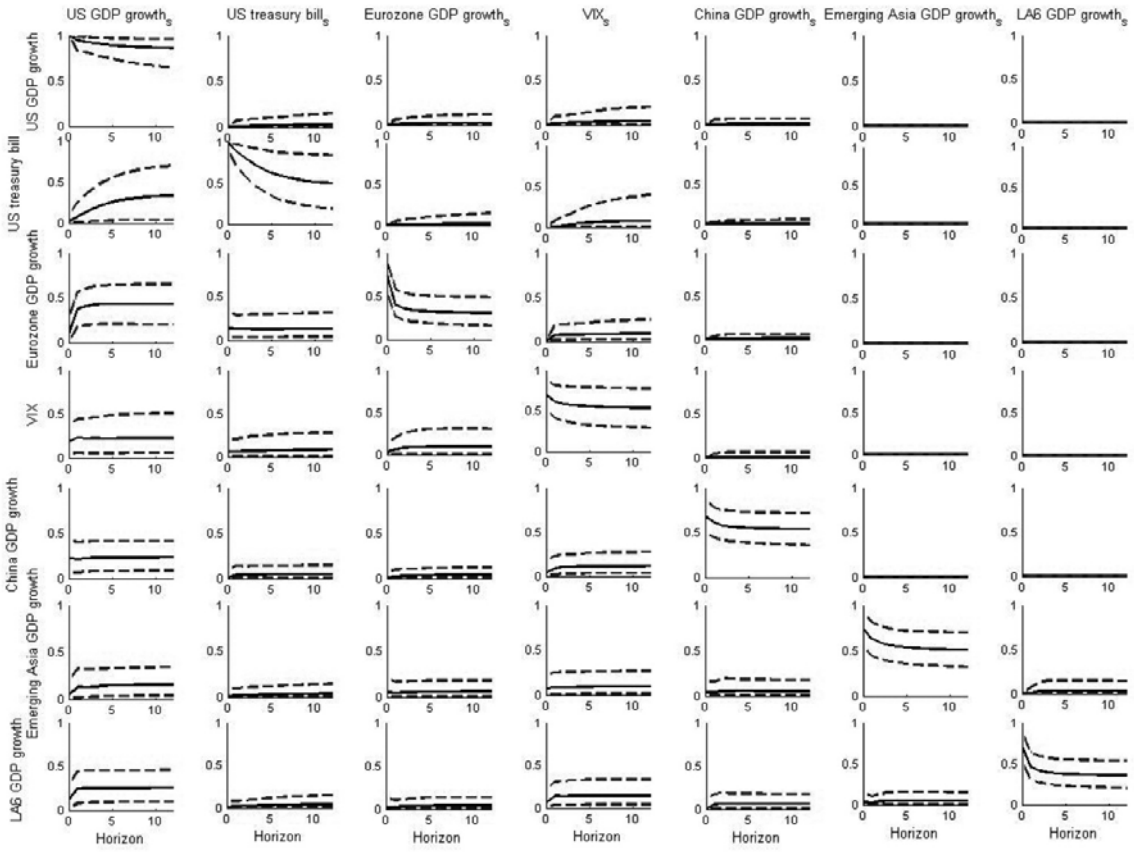
Figure A2 – Variance decomposition of the Bayesian VAR with informative priors (shown over 12-quarter horizon)



Source: Author's calculations.

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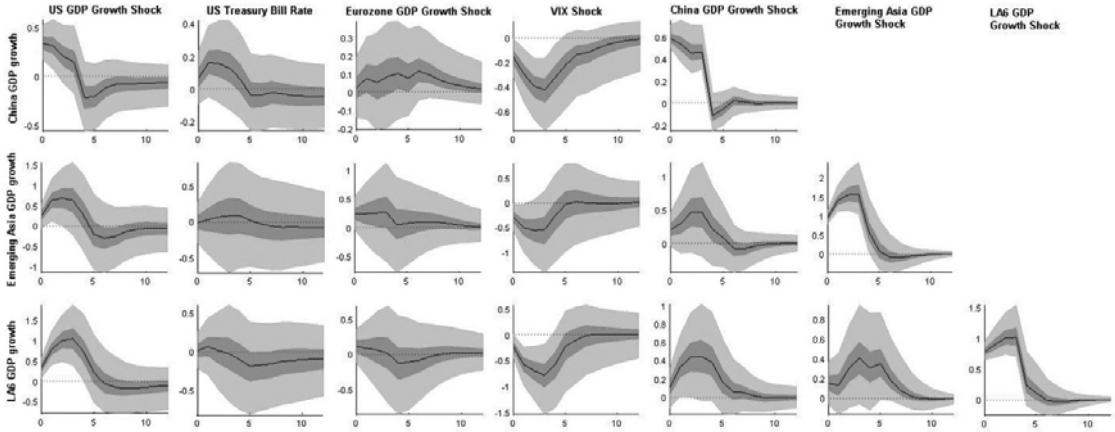
Figure 2 – Alternative (without grids)



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