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Article

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Transmission and impact of stock market shocks on the world economy

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ABSTRACT

In this study, we examine stock market shocks using a Global Vector Autoregressive (GVAR) model encompassing 26 countries from January 1999 to June 2022. Our findings reveal that i) shocks originating from advanced economies (AD) exhibit greater persistence in generating fluctuations compared to shocks from emerging market economies (EME); ii) negative stock market shocks are associated with devaluations of domestic currencies, endogenous responses of monetary policy, and global recession. Our estimates suggest that stock market fluctuations have significant potential to destabilize international markets, with contagion spreading rapidly. Our approach contributes to existing literature by constructing a comprehensive model of the world economy, simulating aggregate shocks, and assessing the relevance of global shocks based on the level of economic development.

1. Introduction

In the current century, two characteristics of market economies stand out: the first is a significant trade and financial interdependence between economies; the second, particularly evident during critical events such as financial crises, is that domestic shocks in major economies can lead to profound fluctuations in the world economy. The challenges that arise involve modeling the interdependences between economies, understanding spillover effects, examining the domestic responses of individual economies, and distinguishing patterns according to the level of economic development.

The aim of this article is to contribute to this research area. We examine the dissemination of stock market shocks from advanced economies and emerging economies in a system of 26 economies. We analyze the transmission channels through which these shocks propagate and examine domestic responses to them.

We employ the GVAR model to address our objectives. This model enables us to construct a system encompassing economies at various levels of development. By using an explicit economic integration variable to connect regions, the GVAR incorporates spillover effects and constructs proxies for the international economy through domestic variables. Thus, the GVAR incorporates features that allow us to capture spillover effects, formulate aggregate shocks, and find heterogeneities in the results.

Given that our sample comprises several economies, an alternative model is the Panel Vector Autoregressive (PVAR). However, the PVAR offers a general response to shocks, lacking the ability to show individual responses. Consequently, heterogeneities in the results would be absent. Another limitation lies in capturing spillover effects. In the GVAR, we construct a Vector Autoregressive with Exogenous Variable (VARX) for each economy. This approach allows economies to react to shocks, generating feedback effects that influence other economies.

While the class of VAR models was an option, VAR models typically focus on a single economy, relying on proxies to represent the world economy. Consequently, these models may mispecify spillover effects. In contrast, GVAR, by constructing the domestic dynamics of each economy, captures spillover effects through feedback mechanisms and interactions between domestic and foreign variables.

The results indicate that negative stock market shocks from AD persistently impact the domestic markets of all economies. The values of domestic stock markets decrease for two years following the shock, marked by capital outflows causing depreciations of domestic currencies and a gradual decline in short-term interest rates. Consequently, the estimates depict episodes of recession, accompanied by a widespread decline in GDP. Although we observe similar fluctuations when shocks originate from EME, they are short-lived, with stock markets showing statistically significant responses for only four months. Thus, we find evidence that shocks from AD lead to meaningful and enduring fluctuations compared to EME shocks.

The literature on stock market shocks, forecasts, and transmission

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channels typically employs Generalized Auto Regressive Conditional Heteroskedasticity (GARCH), GARCH-MIDAS, Vector Autoregressive (VAR), and panel data models (Franses and Dijk, 1996; Soydemir, 2000; Cuadro-Sáez et al., 2009; Song et al., 2022). As mentioned earlier, we opt for the GVAR, which incorporates features facilitating the creation of a rich and coherent scenario, encompassing spillover effects, domestic adjustments, and aggregate analysis in accordance with the researchers' criteria.

One of the articles that inspired our research was Soydemir (2000). In this study, the author employed a VAR with four variables, representing a developed economy (the U.S.) and three EMEs (Brazil, Argentina, and Mexico), to examine stock market movements in both developed and emerging economies. We extend this research by working with a sample of 26 economies, incorporating transmission channels (exchange rate and interest rate) and real sector variables (GDP). In contrast, Soydemir (2000) did not include any channels or real sector variables. Additionally, while Soydemir attributes a significant role to trade in explaining his results, VAR models do not account for trade in their estimates. To address this, we use the GVAR, which incorporates bilateral trade to connect regions.

Pesaran et al. (2004) examined U.S. stock market shocks using a GVAR model encompassing 25 economies over the period from 1979Q1 to 1999Q1. The authors focused their analysis on nine regions: the U.S., the U.K., Germany, France, Italy, Western Europe, Southeast Asia, Japan, and Latin America. We complement this study by i) updating the analysis period from 1999 to 2022, ii) using monthly data instead of quarterly data, iii) individually analyzing the responses of each economy, providing more detailed insights into the reactions to stock market shocks and capturing heterogeneities, iv) testing bilateral financial flows to connect the economies (Pesaran et al. (2004) adopted bilateral trade), and v) evaluating the impact of stock market shocks based on the level of economic development.

Articles on business cycles and fluctuations typically focus on specific countries, regions, or groups of economies (Dees et al., 2007; Gupta and Kabundi, 2010; Bouri et al., 2020; Camacho and Palmieri, 2021). In our study, we investigate shocks from development groups (ADs and EMEs) and depict responses from all regions, providing a comprehensive view of domestic market reactions to these shocks. While Papanyan (2010) concentrated on transmission shocks from the U.S., Europe, and Japan, and Dees et al. (2007) explored the consequences of U.S. shocks on the Eurozone, we advance both studies by increasing the number of shock sources and illustrating domestic adjustments from 19 regions. Our approach and strategy enable us to detect idiosyncratic movements based on the geography of the shock, transmission channels, and the influence of bilateral trade (and financial flow), enhancing our understanding of domestic responses.

We organize the article as follows: Section 2 provides the literature review. Section 3 outlines the GVAR and data. Section 4 presents the econometric results. Finally, Section 5 concludes the article with additional comments.

2. Literature review

Balcilar et al. (2020) analyzed the impact of regional and global stock market shocks on safe-haven assets using a two-factor, regime-based volatility spillover model. An advantage of this study is its incorporation of the domestic dynamics of each economy, providing domestic responses to stock market shocks. The results indicated that stock market shocks promote changes in portfolios and diversification. Furthermore, the authors emphasized the significance of adopting dynamic models, as static models might lead to biased responses.

Chudik and Fratzscher (2011) explored the transmission channels of the 2008 financial crisis in a GVAR. The authors included financial variables such as money market rates, stock markets, the VIX index, and the TED spread. In their GVAR model encompassing 26 economies, their econometric strategy allowed them to assess the importance of liquidity and risk in comprehending the impact of the financial crisis on both advanced and emerging economies. Similar to the findings of Balcilar et al. (2020), the results depicted heterogeneities: for advanced economies, the liquidity channel explained the transmission of the crisis, while for emerging economies, the real side of the economy played a more significant role.

Another GVAR approach to explore the impact of stock market shocks is presented by Dees et al. (2007). The authors studied how a negative U.S. stock market shock affects both the U.S. and the Eurozone. The results indicated responses in credit markets, currency markets, stock markets, and the real sector to this shock. Consequently, Dees et al. (2007) argued that these findings suggest linkages between these economies, a concept the model incorporates by adopting bilateral trade to connect economies. Bilateral trade also aids in constructing the vulnerability between economies, with the foreign variables (as described in Section 3) playing a crucial role.

Building upon these studies, we expand our scope by incorporating several countries to simulate the world economy. We include proxies for both the financial and real sectors to thoroughly investigate the impact of stock market shocks. Similar to Dees et al. (2007), we adopt bilateral trade as a connecting variable. However, we go a step further by testing our main results using bilateral financial flow to link economies.

While Chudik and Fratzscher (2011) and Dees et al. (2007) did not distinguish between the responses of countries based on economic development, we address this aspect by implementing two shocks: one originating from advanced economies and another from emerging economies. This approach enables us to explore how economies respond according to the source of the shock.

Typically, GVAR studies utilize the Generalized Impulse Response Function (GIRF) to examine the impact of local shocks on the system. Dees et al. (2007) highlighted the challenge of identifying shocks in GVAR due to the inclusion of numerous economies and variables. To address this issue, GIRFs do not identify shocks but instead offer transmission channels for them. Chudik and Fratzscher (2011) employed GIRFs in their investigation, and we also adopt GIRFs in our study. However, we enhance our analysis by testing our results using the Structural Generalized Impulse Response Function (SGIRF). SGIRF identifies shocks in one economy, usually the source of the local shock, thereby mitigating the identification challenge associated with GIRFs.

Stock markets are also sensitive to shocks. Lu et al. (2021) demonstrated the impact of oil shocks on domestic stock markets. Harjoto et al. (2021) identified the negative effects of Covid-19 on global stock markets, particularly impacting emerging market economies. Additionally, Caraiani and Calin (2020) investigated the impact of a monetary policy shock on market bubbles in OECD economies using a time-varying Bayesian Vector Autoregressive (BVAR).

One limitation of these studies is their adoption of approaches that treat economies as closed economies. For instance, Caraiani and Calin (2020) employed a BVAR, a method that concentrates on one economy and uses proxies of relevant variables to represent the world economy. The class of VAR models can misrepresent spillover effects because they do not account for the domestic dynamics of individual economies or employ integration variables to link economies. In our study, we portray the responses of 19 regions to stock market shocks, including the reactions of domestic stock markets. In contrast to Dees et al. (2007), who focused on two regions, we depict the responses of all regions.

Wu (2020) and Qiu et al. (2022) conducted analyses on the integration of stock markets. In the former paper, a VAR was employed to advance the study, demonstrating that common global factors are the primary drivers of market integration in Asian economies. In contrast, the latter, unlike all studies discussed in this section, adopted panel data covering the period 1990–2017. Panel data offers advantages, such as the inclusion of several economies and variables (due to the annual time-frequency), the ability to handle samples with a long-time span, and the provision of general responses to shocks. However, akin to criticisms concerning VAR models, panel data does not accurately model

spillover effects. Another concern relates to general responses to shocks. In this case, the results do not indicate heterogeneities. In other words, the authors cannot distinguish whether the response to a shock is attributable to a sizable economy or to several economies.

GVAR offers advantages compared to panel data because it allows us to portray individual responses to shocks. This characteristic was explored by Chudik and Fratzscher (2011), although they focused solely on financial variables without including the real sector. In a similar vein, Dees et al. (2007) concentrated on the U.S. and Eurozone. Our study takes a broader perspective by portraying the responses of all regions, extending the work of Chudik and Fratzscher (2011) by incorporating both financial and real variables. Additionally, we go beyond by testing trade and financial integration variables, and comparing the results of GIRFs and SGIRFs. Moreover, we introduce an innovative approach by constructing shocks based on the level of economic development. This allows us to evaluate spillover effects, financial integration, and individual responses to shocks based on economic development characteristics.

3. Model and data

The GVAR is a set of VARX connected by an economic integration variable, commonly bilateral trade. By utilizing bilateral trade, the GVAR can construct proxies for the external environment, treating each region as a small-open economy (Attílio et al., 2023). It is worth noting that notably industrialized economies, such as the U.S., receive a distinct treatment - a topic we delve into later in the article.

Our presentation is based on Pesaran et al. (2004). Equation (1) presents a VARX (1,1) for a region i in time t. The subscript i varies from 0 to N+1 and t from 1 to T. The vector x_{it} represents the domestic variables of region i; x^*_{it} is the vector of foreign variables of the region i, the proxies for the external environment; a_{i0} is the constant of region i; a_{i1} is the trend term; ε_{it} is the vector of idiosyncratic shocks.

$$x_{it} = a_{i0} + a_{i1}t + \Phi_i x_{i,t-1} + \Lambda_{i0}x^*_{it} + \Lambda_{i1}x^*_{i,t-1} + \varepsilon_{it}. \tag{1}$$

To calculate the foreign variables, we use w_{ij}, which represents the bilateral trade between regions i and j (as shown in Equation (2)). The bilateral trade data (sum of exports and imports) were obtained from Mohaddes and Raissi (2020). Consequently, each VARX includes its corresponding foreign variables, weighted by bilateral trade.

$$x^*_{it} = \sum_{j=0}^{N} w_{ij}x_{jt}. \tag{2}$$

Equation (2) illustrates the economic integration between the regions of the system. Particularly, we use Equation (2) to build three proxies for the world economy: foreign stock market, foreign interest rate, and foreign GDP. Equation (3) displays the vectors of domestic and foreign variables to region i:

$$\begin{aligned} x_{it} &= (q_{it}, y_{it}, e_{it}, r_{it})' \\ x^*_{it} &= (q^*_{it}, y^*_{it}, r^*_{it})'. \end{aligned} \tag{3}$$

In Equation (3), q_{it} is the stock market, y_{it} is GDP, e_{it} is the exchange rate, and r_{it} is the short-term interest rate. The second vector of Equation (3) represents foreign variables (world economy). The exchange rate is the ratio of the domestic currency to the U.S. dollar; therefore, when regarding the U.S., the exchange rate only enters the foreign variable vector. This denotes another particularity concerning the U.S.; it would be incorrect to treat the U.S. as a small open economy, so we take a parsimony approach by including foreign variables in its vector. Equation (4) illustrates the treatment for the U.S.:

$$\begin{aligned} x_{it} &= (q_{it}, y_{it}, r_{it})' \\ x^*_{it} &= (e^*_{it})'. \end{aligned} \tag{4}$$

This adaptation for the U.S. is a commonly applied practice in GVAR studies (see Pesaran et al., 2004; Dees et al., 2007). In addition to representing the international economy, foreign variables also contribute to the long-term stabilization of the model. While the GVAR considers the short-term impact of domestic variables on foreign variables, it aligns with the attributes of small open economies where domestic variables exhibit no long-term influence on foreign variables. However, omitting the long-term effects of domestic variables entirely is a strong proposition for internationally relevant economies, such as the U.S. (Attílio et al., 2023).

Regarding our data sources, we obtain the stock market index and inflation index – which we use to deflate some series – from the Organization for Economic Cooperation and Development (OECD). Exchange rates were sourced from the International Financial Statistics (IFS)/International Monetary Fund (IMF), and GDP and short-term interest rates were collected from the Federal Reserve Bank of St. Louis (FRED). Our data set comprises 26 countries, covering the period from January 1999 to June 2022.

For seasonal adjustment, we use the X-11 method on the real stock markets, real exchange rates, and GDP. Deflation of the stock market was performed using the domestic Consumer Price Index (CPI), 2015 = 100. Given that the exchange rate represents the ratio of the domestic currency per U.S. dollar, we employ the CPI of the domestic country and that of the U.S. to deflate the time series. All variables, except interest rates, were logarithmized.

We create the Eurozone by aggregating eight economies (Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, and Spain) based on the average GDP in PPP from 2014 to 2016. Consequently, our system includes 19 regions (18 countries and the Eurozone). Table A in the appendices presents the countries and regions of the model.

To derive the GVAR, we create two new vectors: $z_{it} = (x_{it}, x^*_{it})'$ and $x_t = (x'_{0t}, x'_{1t}, x'_{2t}, x'_{3t}, \ldots, x'_{Nt})'$; the first contains domestic and foreign variables, while the second is a domestic global vector in which each term denotes all domestic variables for each region. With these vectors, we write the identity: $z_{it} = W_i x_t$. The matrix W_i has the shares of bilateral trade between the regions of the system. We insert these terms into Equation (1) as follows:

$$Gx_t = a_0 + a_1 t + Hx_{t-1} + \varepsilon_t,$$

$$\text{where: } a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ a_{20} \\ \ldots \\ a_{N0} \end{pmatrix}, a_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ a_{21} \\ \ldots \\ a_{N1} \end{pmatrix}, \varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ \varepsilon_{1t} \\ \varepsilon_{2t} \\ \ldots \\ \varepsilon_{Nt} \end{pmatrix}, G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ A_2 W_2 \\ \ldots \\ A_N W_N \end{pmatrix}, H = \begin{pmatrix} B_0 W_0 \\ B_1 W_1 \\ B_2 W_2 \\ \ldots \\ B_N W_N \end{pmatrix},$$

$$A_i = [I_{k_i}, -\Lambda_{i0}], \text{and } B_i = [\Phi_i, \Lambda_{i1}]. \tag{5}$$

We multiply Equation (5) by the inverse of matrix G, which is generally a non-singular matrix. This representation generates Equation (6):

$$x_t = G^{-1}a_0 + G^{-1}a_1 t + G^{-1}Hx_{t-1} + G^{-1}\varepsilon_t. \tag{6}$$

Equation (6) represents the basic form of the GVAR. Additional derivations, including Equation (7) (when time series are

nonstationary), are described by Pesaran et al. (2004). However, for this article, we use the model in the error correction form. In the appendices, Tables B, C and D present the unit root tests for domestic and foreign variables, the order of each VARX, and the number of cointegrating relationships. The results indicate the presence of unit roots in most of the time series, but we also detect cointegrating relationships.[1]

Following Dees et al. (2007), we employ the Weighted Symmetric (WS) test. The results indicate that the variables are nonstationary in levels, but they become stationary in differences. The next step involves evaluating cointegrating relationships, and Table C demonstrates the existence of long-term relationships between the variables. Consequently, we adopt the GVAR in the error correction form, as outlined by Pesaran et al. (2004).

$$\Delta x_{it} = a_{i0} + a_{i1}t + \Pi_i v_{i,t-1} + \Lambda_{i0}\Delta x_{it}^{*} + \psi_{i0}\Delta d_t + \varepsilon_{it},$$

$$\text{where } \Pi_i = (A_i - B_i, -\psi_{i0} - \psi_{i1}), v_{it-1} = \begin{pmatrix} z_{i,t-1} \\ d_{t-1} \end{pmatrix}, \text{and } d_t \text{ is a global vector.} \tag{7}$$

Section 4 presents the econometric results of the dynamic analysis using the GIRF and the Generalized Forecast Error Variance Decomposition (GFEVD). The GIRF illustrates how a shock spreads and impacts the regions of the system, while the GFEVD provides information about the extent to which a specific fluctuation of a given variable occurred due to other variables.

Kim (2013) argued that GIRFs can lead to misleading inferences since they are based on extreme inferences. A notable limitation of GIRFs is their inability to identify shocks. To address this, Khan (2020) and Attílio (2023) employed the SGIRF to reinforce their results. SGIRF allows for the identification of shocks in one economy. Consequently, we present the responses of both GIRFs and SGIRFs in our results.

In the empirical section, we analyze two shocks: one originating from advanced economies and another from emerging market economies. We simulate a global shock using Australia, Canada, the Eurozone, Japan, Korea, Norway, New Zealand, Sweden, Switzerland, the U.K., and the U. S. (AD shock). For the emerging group, a shock is simulated using Brazil, Chile, China, India, Indonesia, Mexico, South Africa, and Turkey (EME shock). Consequently, an AD shock (or EME shock) represents shocks in all domestic stock markets of the economies in this group. The GIRF and SGIRF present the responses of all economies to these global shocks based on economic development.

4. Results

4.1. AD and EME shocks

Figs. 1-4 illustrate the domestic responses of all economies to a negative shock in the stock markets of advanced economies. In the first part of this subsection, we simulate a shock on advanced economies, and similarly, we adopt the same with emerging economies in the second part. This approach enables us to examine how economies react to shocks based on the level of economic development. The values in the GIRF are presented in percentages, with the dashed lines representing a 90% confidence interval obtained by bootstrap. The solution of the GVAR was based on the average bilateral trade in 2014–16.

In Fig. 1, we observe that the AD shock induces fluctuations in all stock markets, with all responses being statistically significant and presenting negative values. In general, domestic stock markets exhibit variations between 1 and 2%.

Fig. 2 explores how movements in the domestic stock market impact GDP. Two observations can be made: these fluctuations have a negative effect on GDP, and GDP responses are transitory in some economies. In all Latin American countries (BRA, CHL, and MEX), GDP experiences a fall over two years. However, the same response is not observed in Asian economies. GDP did not fall in China and India (Chinese GDP increased in the first months), while the GDP of Indonesia and Japan declined. Additionally, we did not detect any persistent differences between advanced and emerging economies. In short, the estimates illustrate that negative stock market shocks are related to a global recession, leading to a decrease in GDP.

Figs. 3 and 4 help in understanding the transmission of the shock, focusing on two financial channels: exchange rates and interest rates. Based on the estimates for domestic currencies, we observe events known as “flight to quality”, where capital flows to safer havens, resulting in the depreciation of the domestic currency. However, no distinct pattern for this process emerged when comparing advanced and emerging economies, as both experienced depreciations. Additionally, some currencies, such as those of Australia, India, and South Africa, appreciated.

Examining credit markets in Fig. 4, we observe that most react negatively to the shock. While one might anticipate positive interest rate values due to potential contractionary monetary policies implemented by central banks to curb the outflow of capital, as observed in Bhattarai et al. (2020), our estimates did not confirm this response.

From this, we can draw the following preliminary conclusions: the negative shock from AD stock market generates persistent and significant effects in all economies, manifested in declines in both domestic stock markets and interest rates, as well as episodes of “flight to quality”. In this context, our results align with the findings of Aguiar and Gopinath (2007), who demonstrated that the business cycle of emerging economies is influenced by developed economies. Importantly, our estimates underscore the enduring influence of advanced economies on the business cycle of emerging economies, which contradicts the findings of Kose et al. (2012) and Abiad et al. (2015). These studies argued that developing economies have become more resistant to external shocks. Figs. 1-4 highlight that AD shocks are a prominent source of fluctuations in emerging markets.

Following the same structure as before, the second part of this subsection portrays a negative shock on the aggregate EME stock market. Figs. 5-8 display the domestic responses of all economies. The most apparent difference from the previous figures is the transitory nature of the EME shock. For example, in Fig. 5, the negative shock takes around four to five months to lose statistical significance. In many economies, this shock was not able to produce statistically significant responses. This limited impact is reflected in other markets with moderate domestic responses. Once again, we detected the same tendency: EME shocks are transitory and short-lived. Even in one of the most sensitive markets, the exchange rate showed only short-lived episodes of “flight to quality."

In short, the estimates in Figs. 1-8 suggest that advanced economies exert a meaningful and persistent influence on domestic fluctuations, leading to enduring effects on stock, exchange, credit markets, and GDP. Conversely, when we investigate a shock originating from emerging economies, it has only short-lived effects. Using a GVAR to study the spread of the 2008 financial crisis, Chudik and Fratzscher (2011) concluded that both advanced and emerging economies were negatively influenced by the unfolding of this event. In this case, our results show a similar scenario in which shocks from advanced economies cause strong fluctuations in all economies.

The fluctuations depicted in Figs. 1-8 suggest that stock market shocks trigger movements in the currency and credit markets. One hypothesis is that these shocks impact exchange rates, leading to the depreciation of domestic currencies. Subsequently, central banks react. Given the negative nature of the shock and the impending recession, monetary authorities accommodate the negative stock market shock.

[1] The cointegration test indicated that five economies (Canada, Chile, Norway, New Zealand, and Sweden) do not have cointegrating relationships. Despite the absence of cointegrating vectors for these economies, their inclusion did not compromise the stability of the model. Consequently, we decided to retain these economies to ensure a representative portrayal of the world economy.

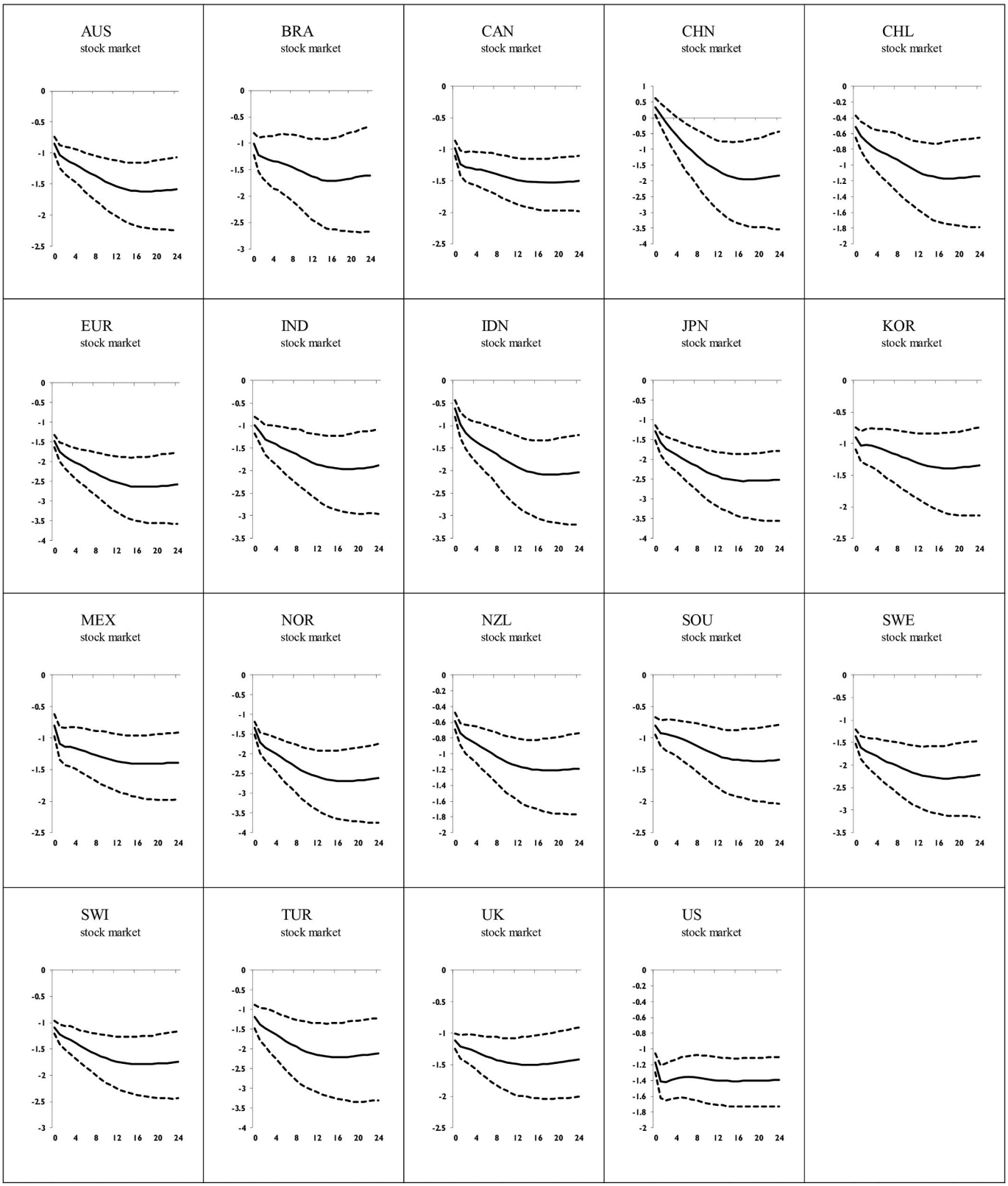

Fig. 1. GIRF of a negative shock on the stock market of AD and domestic responses of domestic stock markets.

Finally, the stock market shock corresponds to declines in GDP (we use SGIRFs in Section 4.2 to identify stock market shocks and reinforce this hypothesis).

These figures also indicate heterogeneities in the results. One of the main differences between the shocks is the responses of the Chinese economy. Regarding the AD shock, the stock market and interest rates decrease, GDP increases, and the domestic currency appreciates. In the case of the EME shock, the stock market decreases, and the domestic currency depreciates (the other variables are not statistically significant). In this sense, China shows a distinct pattern of responses to these

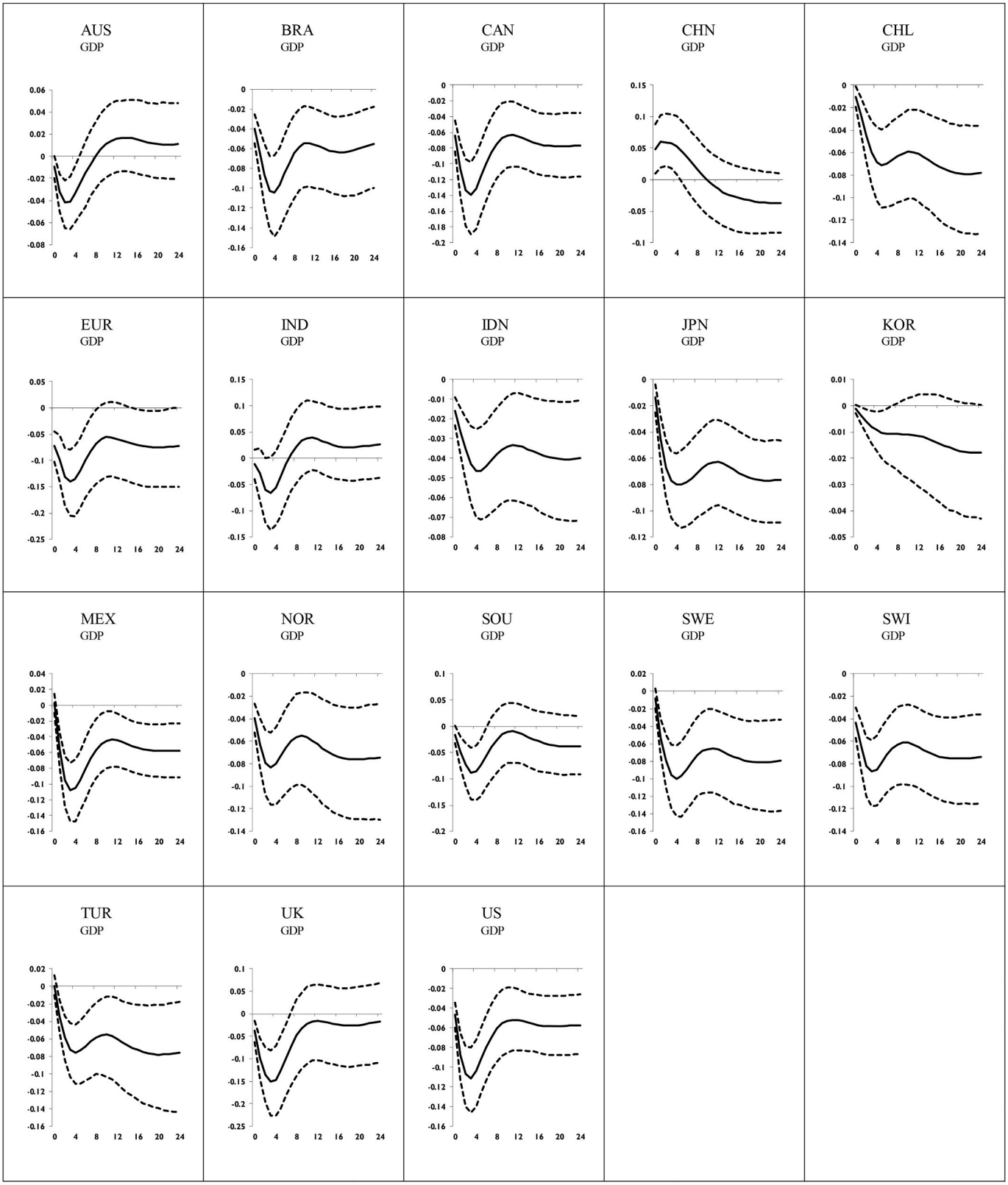

Fig. 2. GIRF of a negative shock on the stock market of AD and domestic responses of the GDP.

two shocks compared to the other economies.

We offer the following explanation for these distinct responses of the Chinese economy. Perhaps the negative external shock increases uncertainty in the Chinese economy, provoking stress reactions in the financial markets, such as declining values in stocks. The Chinese central bank reacted by decreasing interest rates, a move that could prevent a potential economic recession. As the cost of capital decreases, companies can borrow capital and invest in new plans and projects, thereby increasing production. This economic boom in China may attract external capital, resulting in the appreciation of the domestic currency.

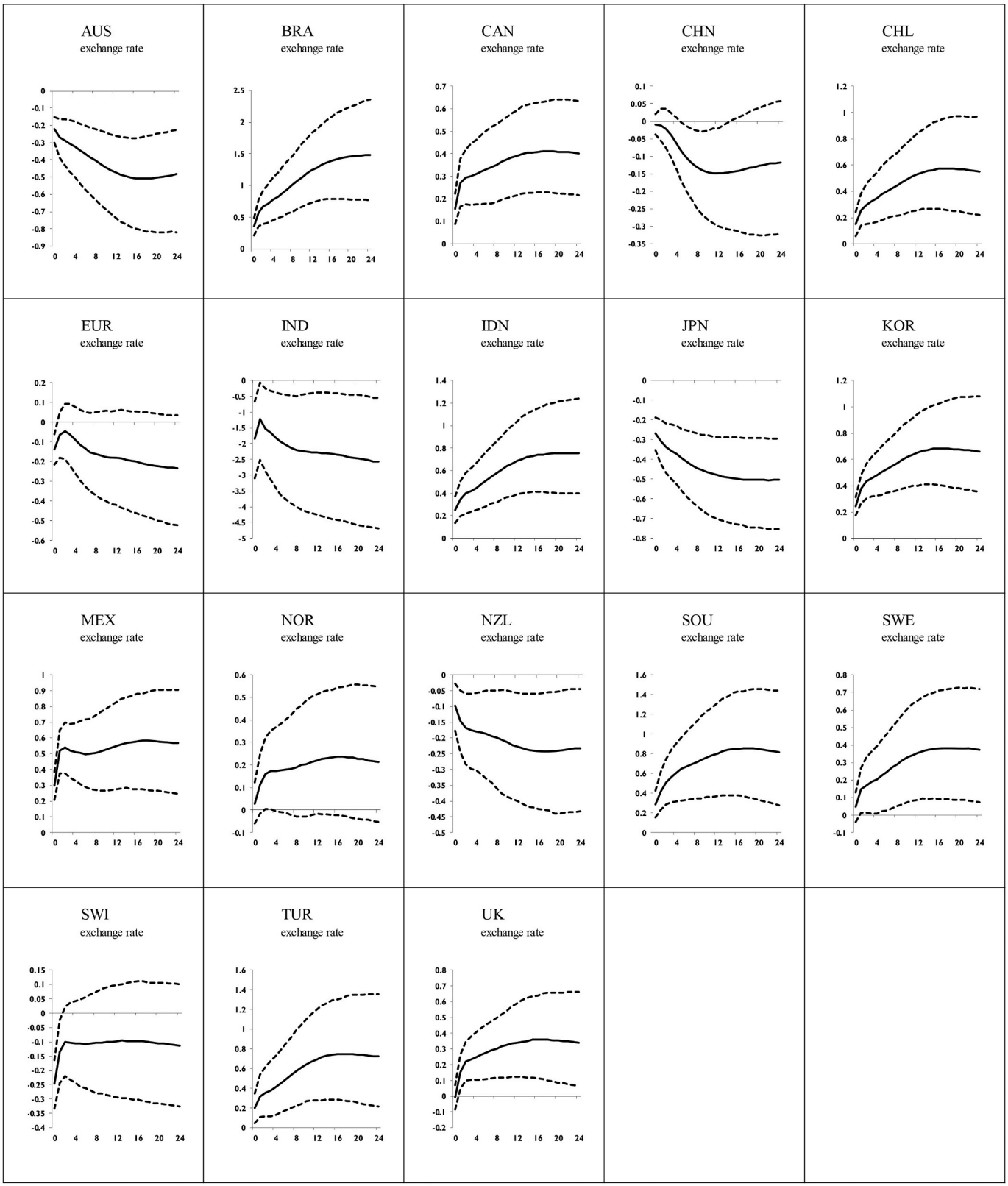

Fig. 3. GIRF of a negative shock on the stock market of AD and domestic responses of the exchange rates.

An implicit assumption in this rationale is that the Chinese central bank manages to avert a potential recession stemming from an external negative shock.

Regarding the negative stock market impact from the EME, it's important to note that the Chinese stock market is included in this shock. Thus, to a certain degree, this constitutes a domestic negative shock on the stock market. This market loses value, leading to an outflow of capital. Subsequently, the domestic currency experiences depreciation. Because the response of the stock market loses statistical significance in the first year, we can suppose that these effects are short-lived, which

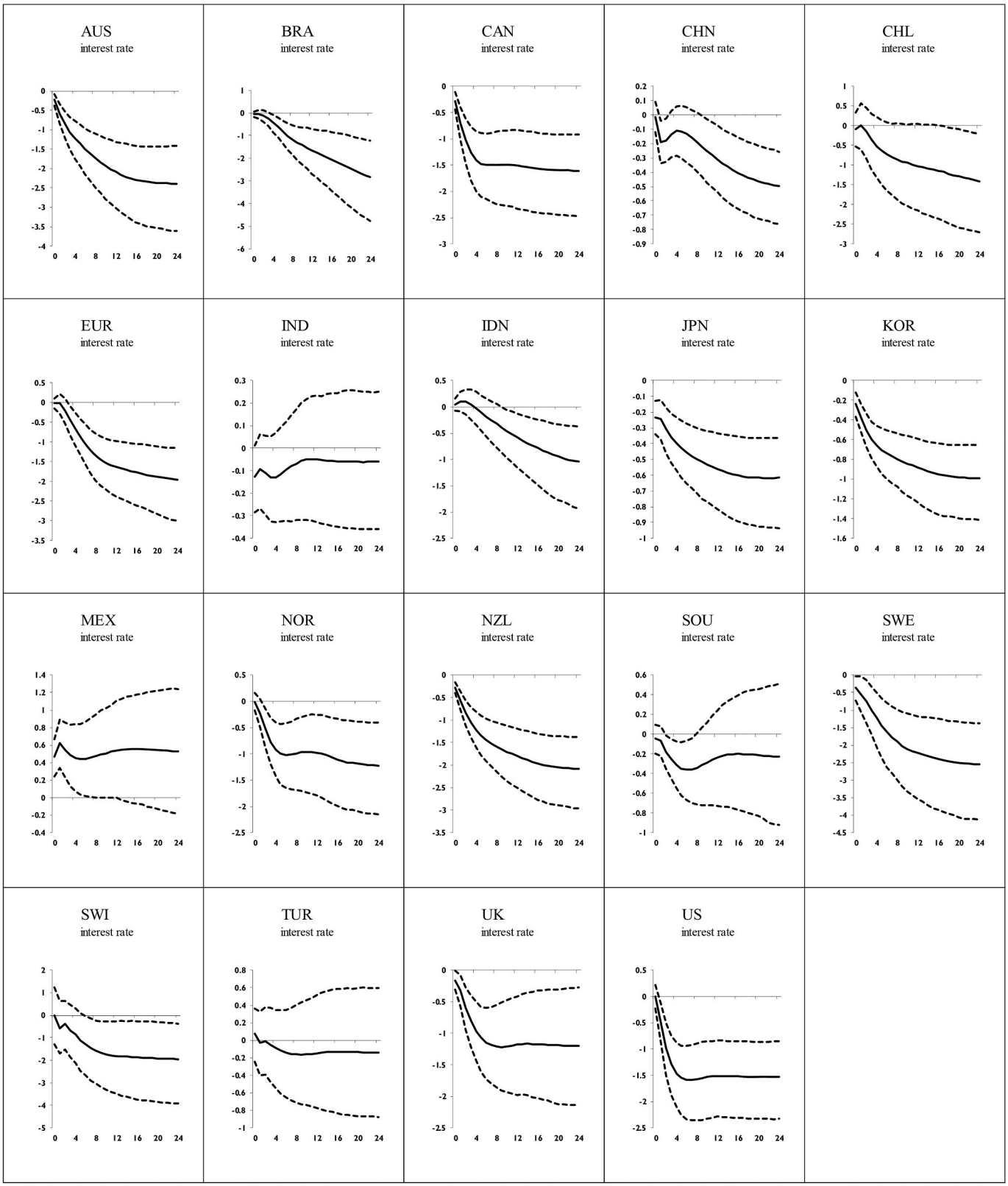

Fig. 4. GIRF of a negative shock on the stock market of AD and domestic responses of the interest rates.

explains the lack of response in GDP. Naturally, these are suppositions. For a formal evaluation of the responses of the Chinese economy, we should identify its shock, which is not the goal of our investigation.

Another heterogeneity concerns the responses of the domestic currencies. In Fig. 3, eleven currencies depreciate (Brazil, Canada, Chile, Indonesia, Korea, Mexico, Norway, South Africa, Sweden, Turkey, and the U.K.) to the shock, while seven currencies (Australia, China, the Eurozone, India, Japan, New Zealand, and Switzerland) appreciate. These estimates highlight the importance of domestic factors, such as institutional arrangements and vulnerability to shocks, in

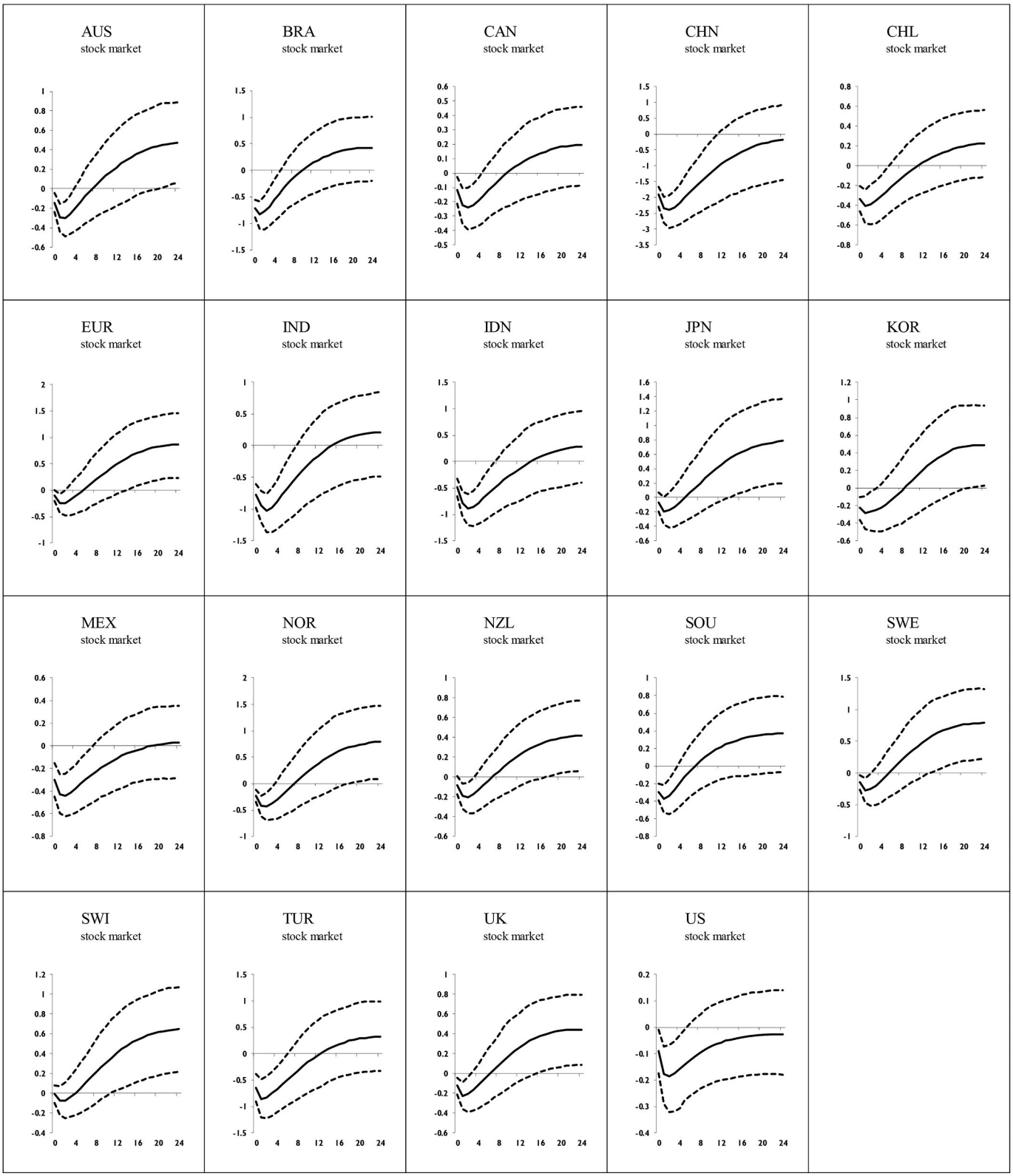

Fig. 5. GIRF of a negative shock on the stock market of EME and domestic responses of the stock markets.

comprehending these different responses to the same shock.

One possible explanation for these divergent responses in the exchange rates is the reaction of domestic currencies to the outflow and inflow of capital. We can suppose that declining interest rates, by reducing the cost of capital, could assist the economy in recovering from the negative shock on the stock market. For example, among the currencies that appreciate after the shock, in four economies, the GDP does not decrease one year after the shock (the estimates are not statistically significant). Perhaps these economies received external capital, contributing to the appreciation of domestic currencies.

On the other hand, in 9 out of the 11 countries that experienced depreciation in their currencies, the GDP fell for the entire two years of

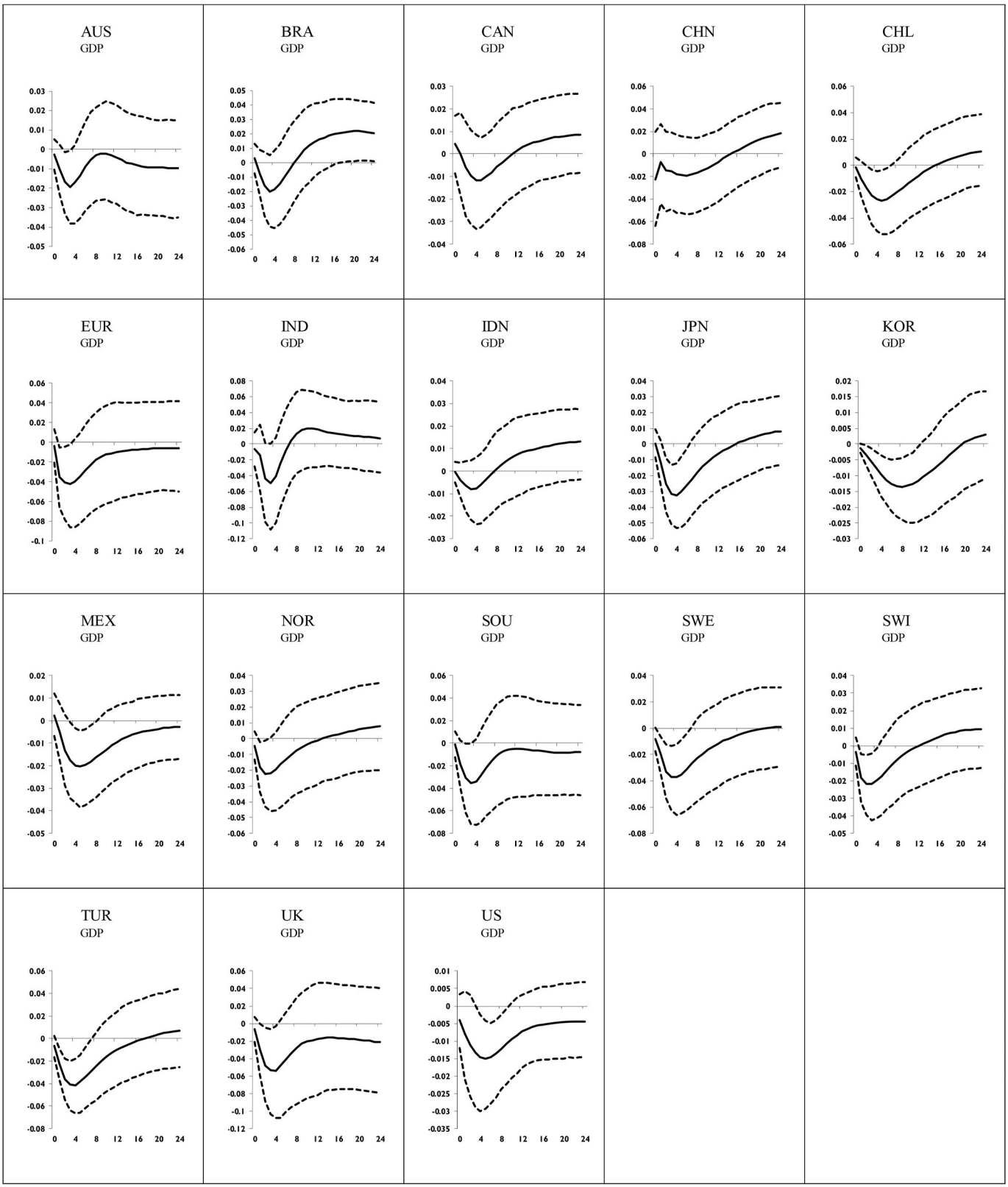

Fig. 6. GIRF of a negative shock on the stock market of EME and domestic responses of the GDP.

the shock. In this sense, because these economies are more vulnerable to the shock, their financial markets reacted by experiencing capital outflow, which pressured the domestic currency to depreciate. Of course, our model does not allow us to confirm these predictions. They are only attempts to explain the heterogeneities (later, we employ a tool that facilitates a more formal analysis of these comments, the SGIRFs).

Table 1 provides additional evidence supporting the importance of ADs in explaining fluctuations in domestic stock markets. It presents the variance decomposition of domestic stock markets in AD and EME stock market fluctuations. For example, after the U.S. stock market

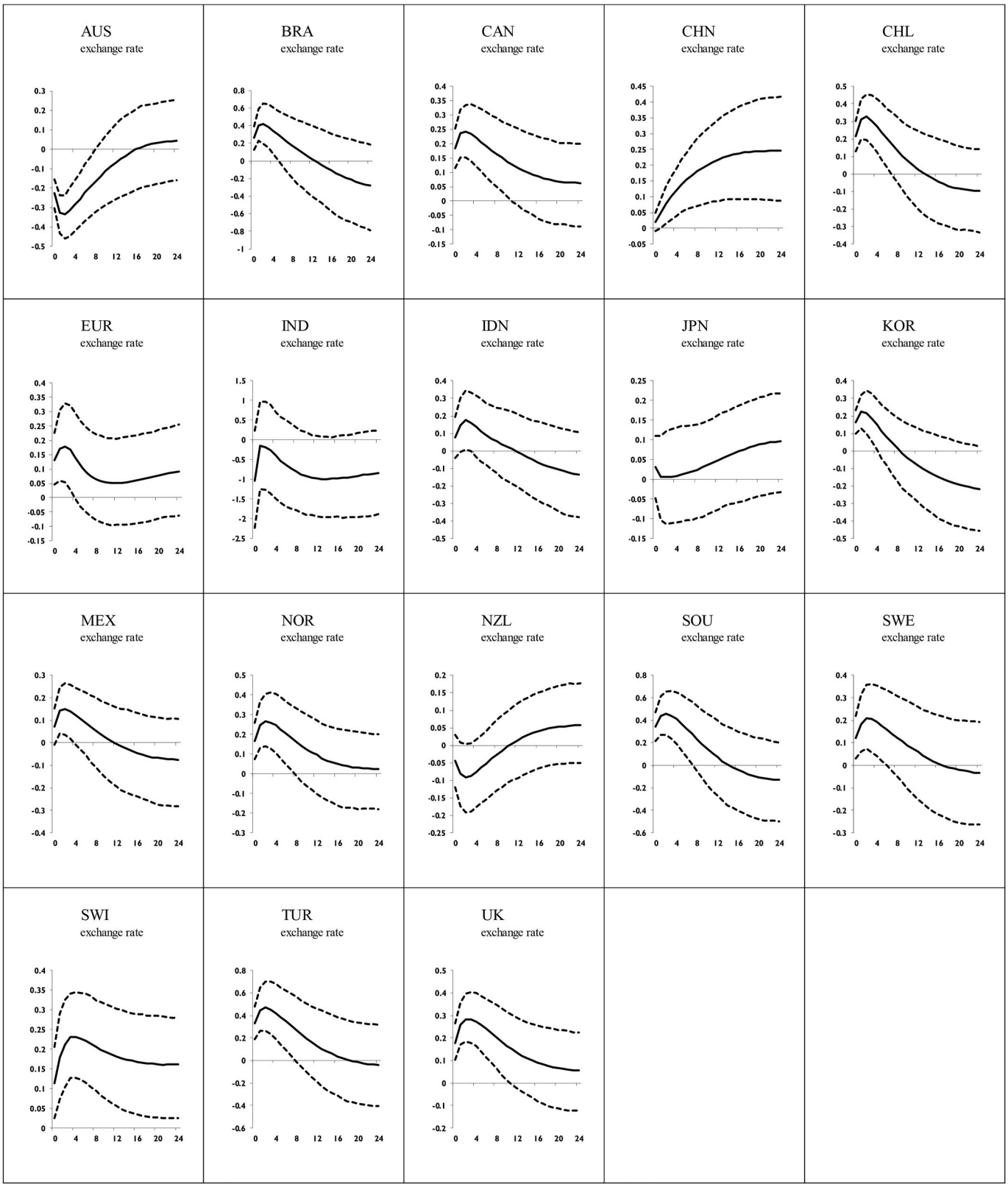

Fig. 7. GIRF of a negative shock on the stock market of EME and domestic responses of the exchange rates.

experiences a negative shock, about one-fifth of its fluctuation can be attributed to the stock markets of emerging economies, while the majority of its variation comes from advanced economies. We normalized the values in each row to a sum of 100%, with four ADs at the top of the table and four EMEs at the bottom.

We apply the same strategy discussed above to the countries in Table 1. In all economies, AD stock markets dominate as the principal source of domestic fluctuations. One difference is that the impact of EMEs' stock markets on the domestic fluctuation of EMEs is greater than the fluctuations from ADs. For example, in the U.K., the Eurozone, and

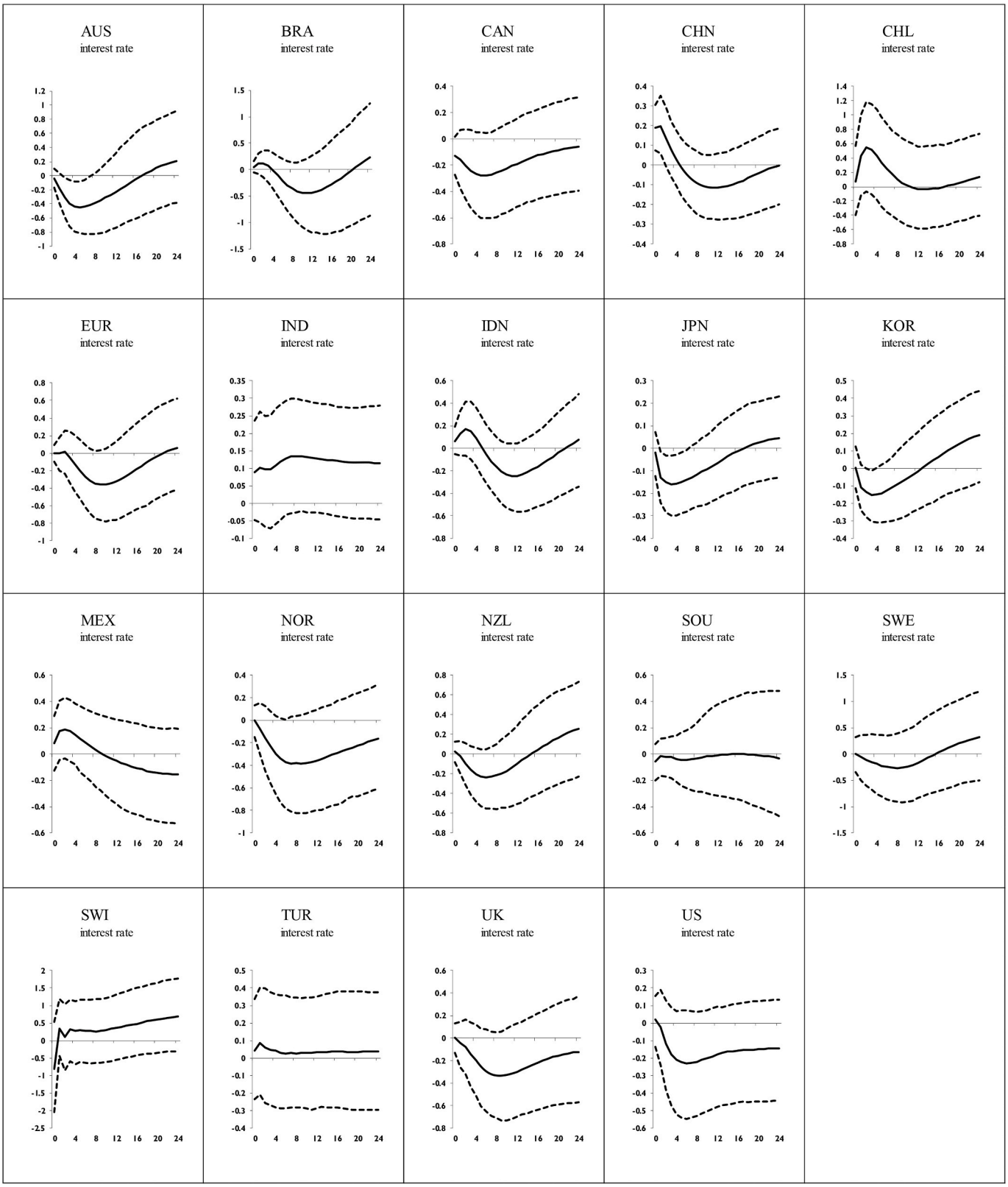

Fig. 8. GIRF of a negative shock on the stock market of EME and domestic responses of the interest rates.

Table 1
GFEVD of domestic stock markets to EME and AD.

	EME	AD		EME	AD		EME	AD		EME	AD
US			UK			EUR			JPN		
1	20.38	79.62	1	10.23	89.77	1	4.73	95.27	1	8.77	91.23
4	20.51	79.49	4	8.93	91.07	4	4.12	95.88	4	7.80	92.20
8	20.04	79.96	8	8.74	91.26	8	4.53	95.47	8	8.46	91.54
12	19.73	80.27	12	9.61	90.39	12	6.13	93.87	12	10.19	89.81
24	19.71	80.29	24	13.44	86.56	24	11.68	88.32	24	15.83	84.17
	EME	AD		EME	AD		EME	AD		EME	AD
CHN			BRA			IND			SOU		
1	23.09	76.91	1	32.46	67.54	1	25.61	74.39	1	22.07	77.93
4	22.61	77.39	4	31.88	68.12	4	23.28	76.72	4	19.27	80.73
8	21.46	78.54	8	31.84	68.16	8	21.68	78.32	8	18.07	81.93
12	18.14	81.86	12	31.94	68.06	12	21.45	78.55	12	18.32	81.68
24	10.86	89.14	24	33.32	66.68	24	23.85	76.15	24	21.11	78.89

Japan, EMEs account for a maximum of 16% of domestic fluctuation (with period 24 in Japan being the highest value). On the other hand, we have 32% in Brazil, 25% in India, and 22% in South Africa, although the prevalence of ADs is still present. Table 1 reinforces the estimates presented in Figs. 1-8, wherein shocks stemming from ADs are more influential in domestic fluctuations.

4.2. SGIRFs

As discussed in Section 3, GIRFs can generate misleading inferences due to extreme identification. Another limitation of GIRFs is that, by not identifying shocks, they do not offer guidance to understand how a shock affects the system of economies. We address this limitation by employing the SGIRF, which identifies shocks. Thus, SGIRF provides an economic rationale for the transmission of a shock. In our case, we construct an SGIRF under the economic rationale that a shock to the stock market causes changes in capital flow and expectations. These movements affect exchange rates, altering the relative value of domestic currencies. Because central banks and the financial market react to these fluctuations, interest rates change. Subsequently, these fluctuations affect the real sector (production). In short, SGIRF helps us understand how stock market shocks affect financial markets and production by ordering the model. According to this description, we order the model as: q, e, r, y.

Compared to Figs. 1-8, which used the GIRF, Figs. 9-12 adopt the SGIRF. While the results from Figs. 1-8 portrayed the consequences of a shock on the stock markets, Figs. 9-12 also present the impact of this shock. However, the addition in Figs. 9-12 is that we now know how the stock market shock affects financial and real sectors. In other words, SGIRF contributes to the comprehension of the transmission channels of stock market shocks and the fluctuations in macroeconomic variables. We can also affirm that SGIRF helps connect the effect of shocks on the international economy since this shock causes changes in exchange rates, which is a variable that captures the interaction between domestic and external economies. Due to space, we present the responses of the stock markets and GDP (the responses of interest and exchange rates are available upon request). Figs. 9 and 10 present the SGIRF of an AD shock, and Figs. 11 and 12 the SGIRF of an EME shock.

Figs. 9 and 10 are very similar to Figs. 1 and 2. The main difference in Fig. 9 (compared to Fig. 1) is that the Chinese stock market does not fall in response to the shock. In Fig. 10, the response of the Chinese GDP falls at the end of the shock, while in Fig. 2, its response was statistically nonsignificant. Besides these observations, the general picture is similar between Figs. 1–2 and Figs. 9 and 10.

Regarding the EME shock, Fig. 11 shows a distinction from Fig. 5: now the EME shock is persistent in most economies, contrary to Fig. 5, where the shock loses statistical significance over time. However, we can still notice a difference between the AD and EME shocks and the reactions of the stock markets. In Fig. 9, only the Chinese stock market response loses statistical significance; in Fig. 11, the stock markets of the Eurozone, Japan, New Zealand, Sweden, Switzerland, and the U.K. lose statistical significance. Thus, the persistence of the AD shock on the stock markets is higher than the persistence of the EME shocks. Consequently, one of our main conclusions does not change by using the SGIRF. Considering Fig. 12, the estimates show that an EME shock can provoke a global recession. Similarly to Fig. 11, the persistence of this shock is higher than the persistence in Fig. 6.

In short, the results using the GIRFs and SGIRFs maintain the main findings. The main difference is that the SGIRF increased the persistence of the EME shock. For the AD shock, we did not observe a meaningful difference.

4.3. Robustness check

Until now, we used bilateral trade to connect economies and construct the world economy. In this sense, we employed a real variable (trade openness, or the sum of exports and imports) to build the transmission channels of stock market shocks. However, the stock market is a financial variable. Perhaps a better approximation of its transmission channels is to use bilateral financial flow. We incorporate these observations by using the sum of inward and outward direct investment positions between economies in the years 2019–2021 from the Coordinated Direct Investment Survey (CDIS) of the IMF. We change bilateral trade to bilateral financial flow. Figs. 13 and 14 present a negative AD stock market shock and the responses of the stock markets and GDP, and Figs. 15 and 16 present the same responses for a negative EME shock.

Fig. 13 shows that an AD stock market shock triggers a global decline in domestic stock markets. In contrast to the GIRFs and SGIRFs that used bilateral trade, even the Chinese stock market declines in response to the shock. One noteworthy observation is the duration (persistence) of the shock. The responses of all economies are statistically significant for two years.

In contrast, Fig. 15 shows that the EME shock causes declines in domestic stock markets, but the persistence is lower than in the AD shock; in Australia, Chile, Japan, New Zealand, Sweden, the U.K., and the U.S., the shock is not statistically significant. Besides, in the Eurozone, the response of its stock market is positive. Consequently, once again, we confirm our conclusion that AD stock market shocks are more pervasive and persistent than EME shocks.

Another piece of evidence supporting this conclusion is that the AD shock causes fluctuations in GDP in all economies (Fig. 14). Regarding the EME shock, 12 economies (Fig. 16) do not show statistically significant responses. Hence, our main results do not change because of bilateral trade or financial flow.

One last check is the existence of structural breaks in the time series.

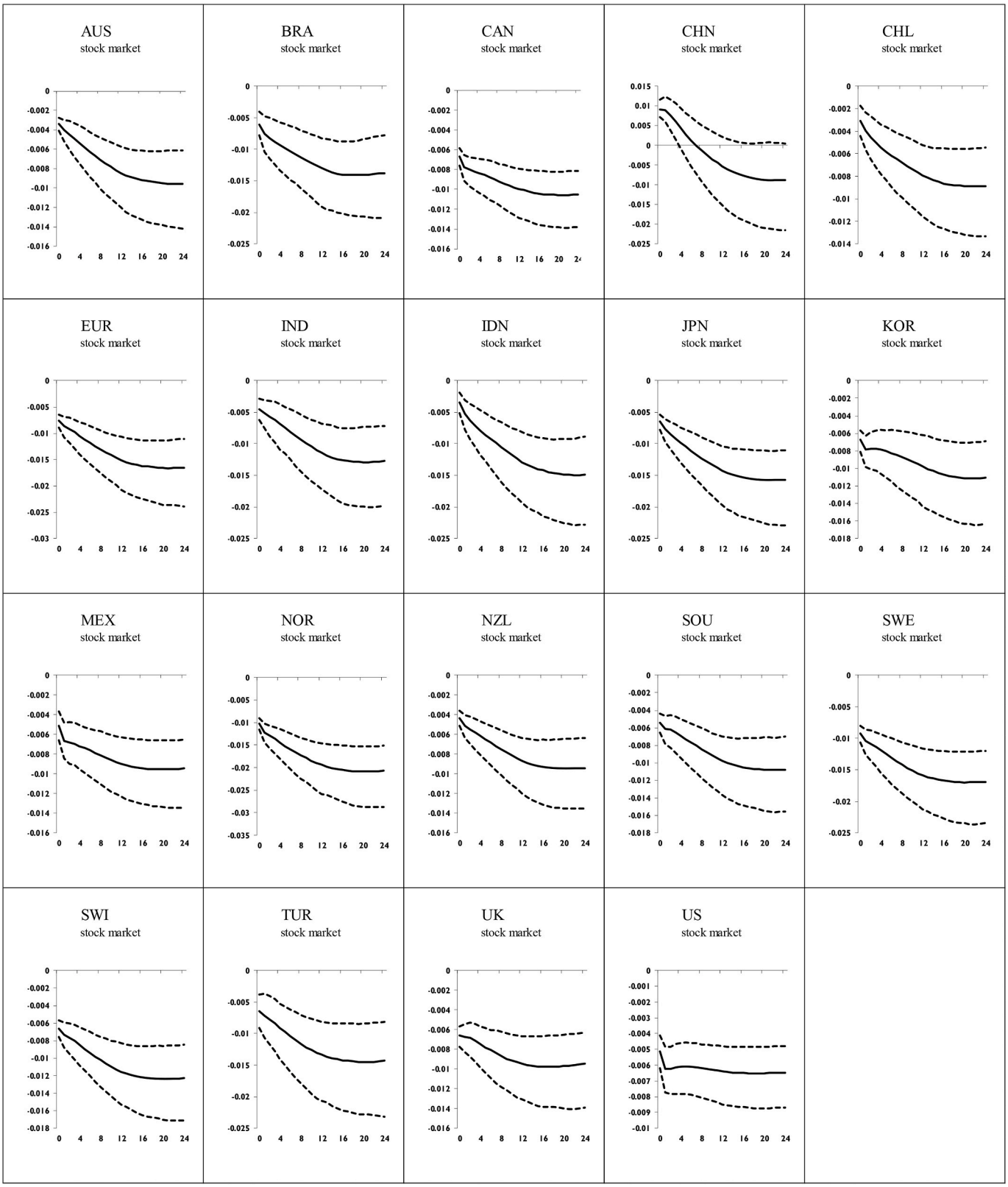

Fig. 9. SGIRF of a negative AD stock market shock and responses of stock markets.

According to Dees et al. (2007), GVAR alleviates this problem, in part, because foreign variables enter all VARX. In this sense, a structural break in region *i* does not mean that the other countries present the same structural break. Dees et al. (2007) used impulse response functions with confidence bands calculated by bootstrap to improve the reliability of their results, avoiding point estimates analysis. We followed the same strategy: we constructed GIRFs and SGIRFs using confidence intervals by bootstrap with 1000 replications. Additionally, because our period covers two major global episodes, the financial crisis of 2008 and Covid-19, we regressed the model without including these periods. The

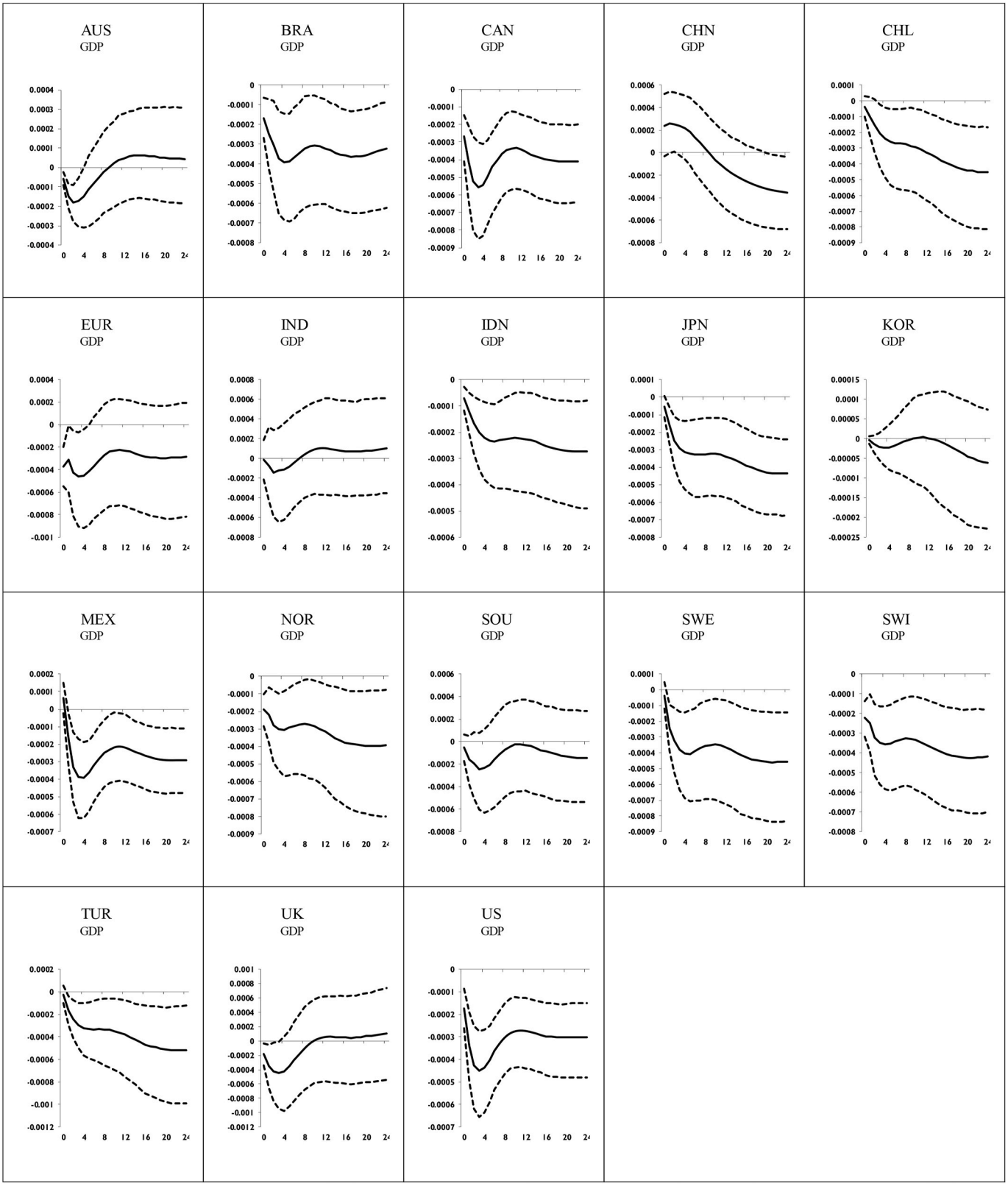

Fig. 10. SGIRF of a negative AD stock market shock and responses of GDP.

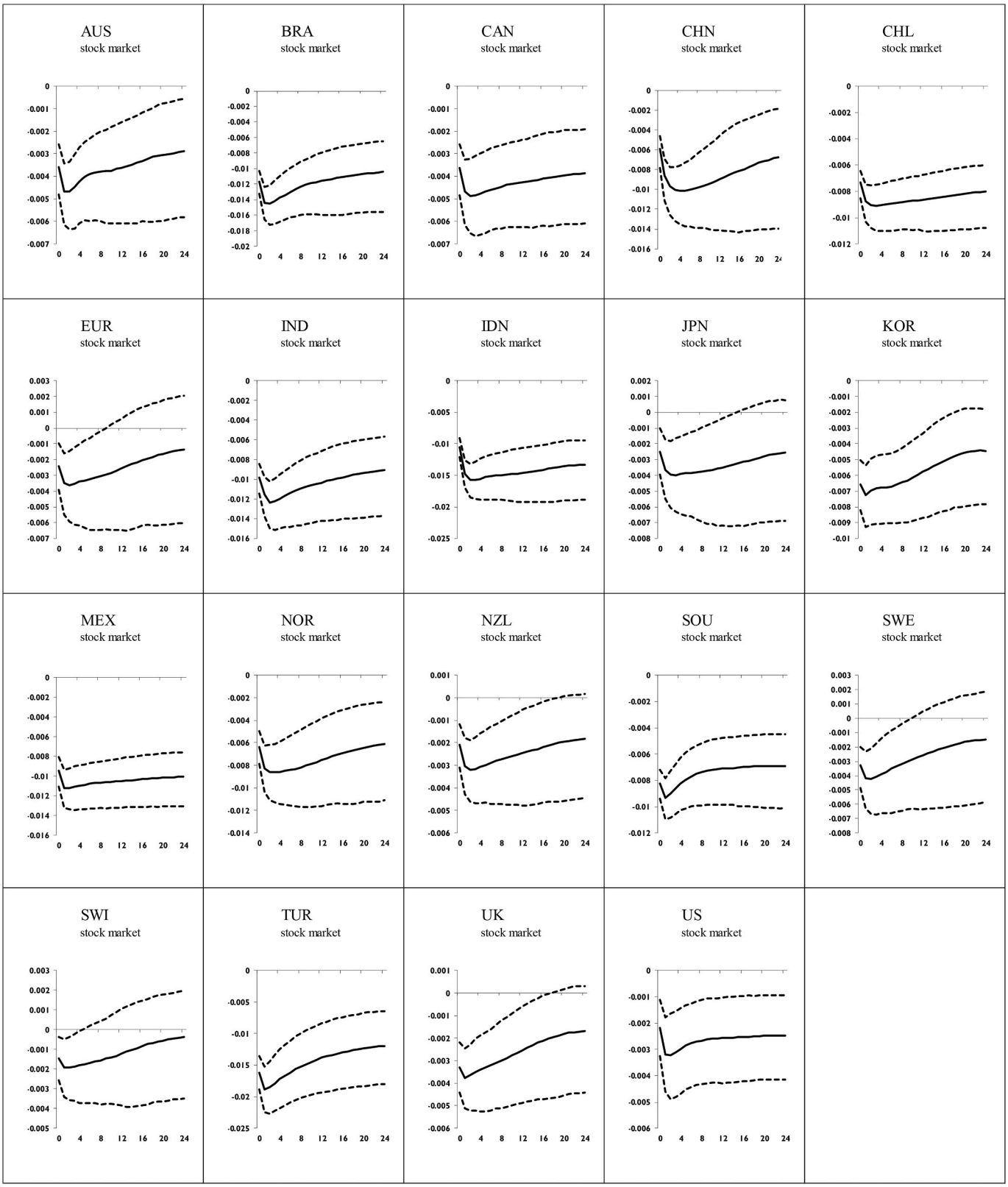

Fig. 11. SGIRF of a negative EME stock market shock and responses of stock markets.

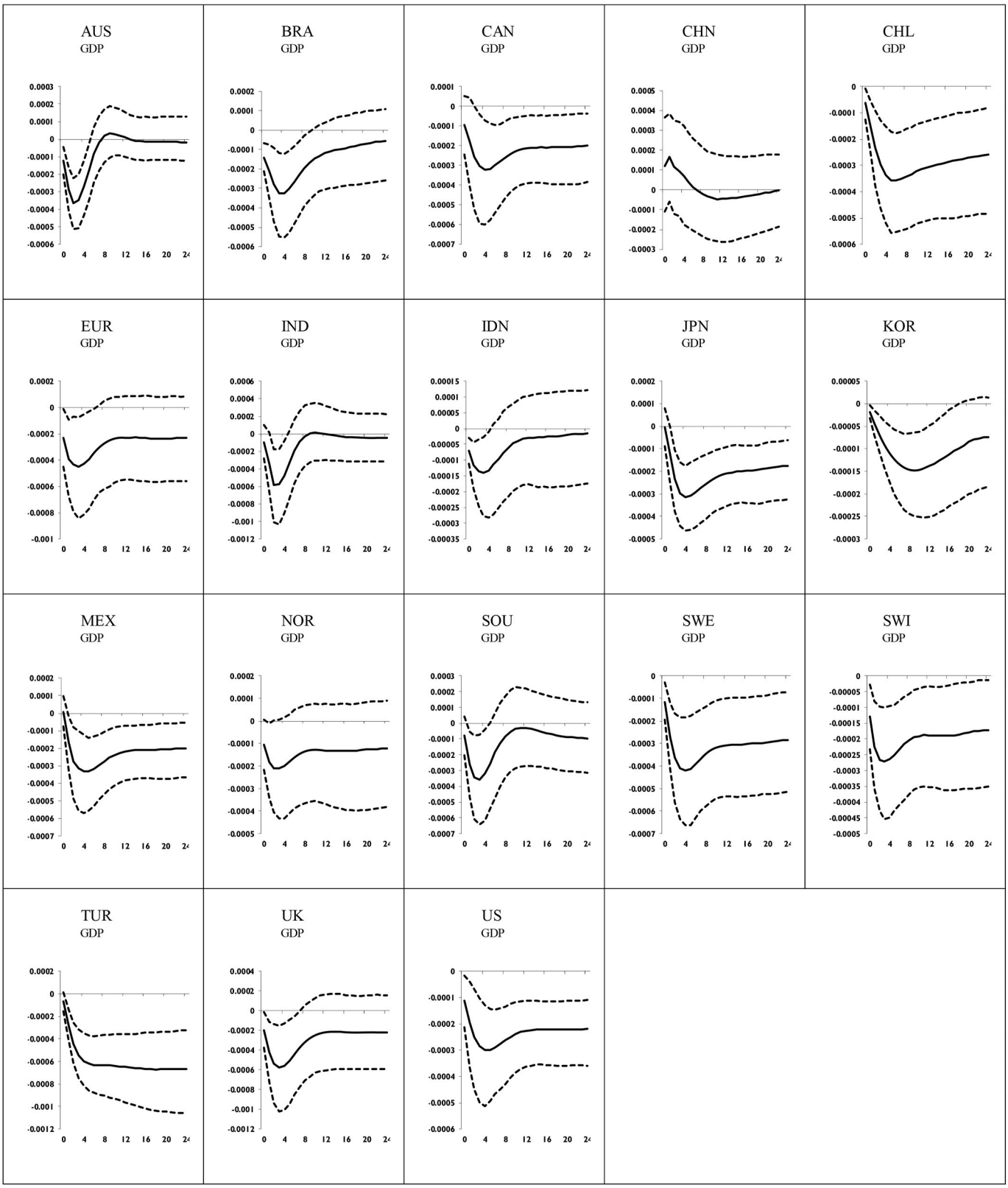

Fig. 12. SGIRF of a negative EME stock market shock and responses of GDP.

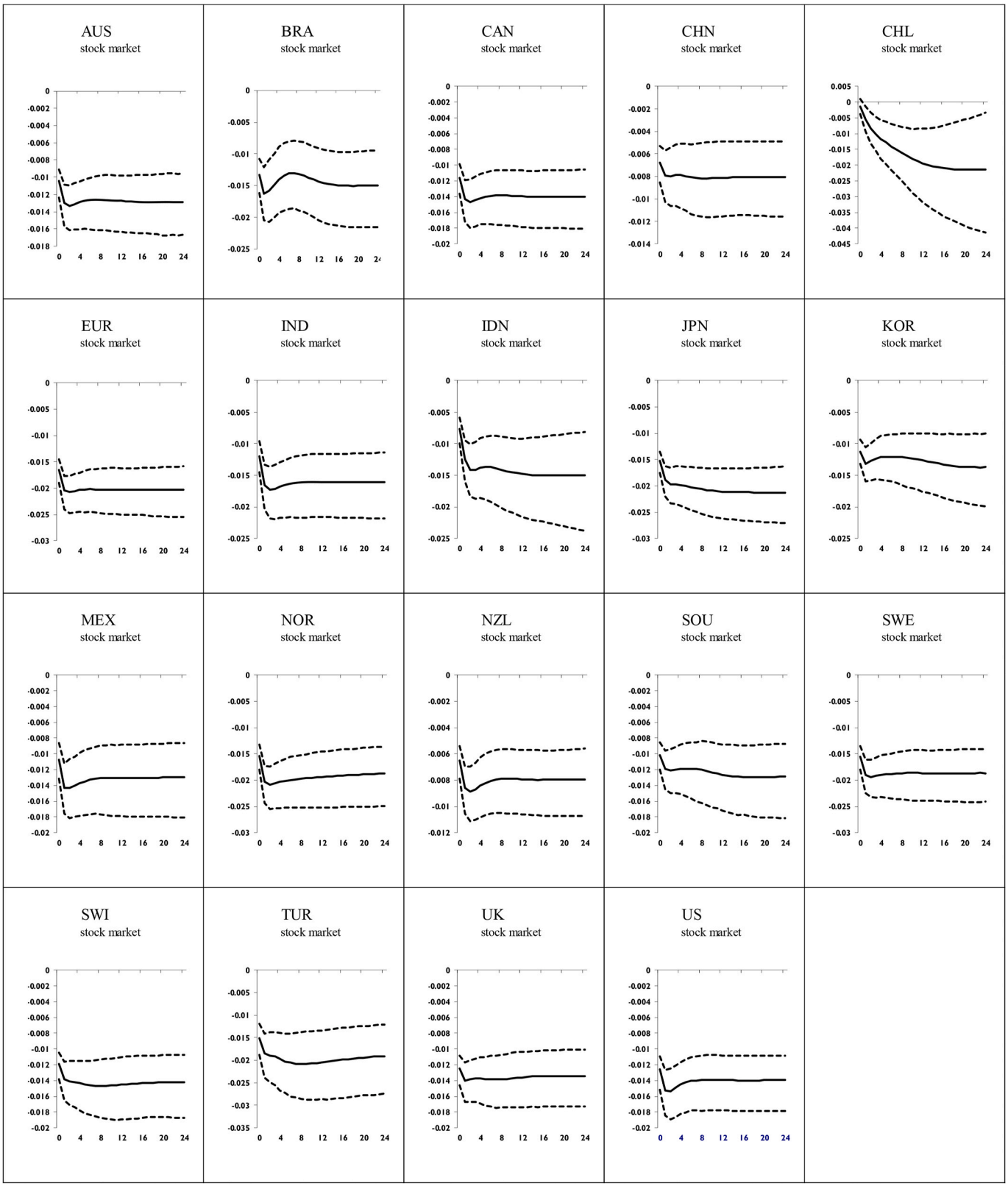

Fig. 13. GIRF of a negative AD stock market shock and responses of stock markets (financial flow).

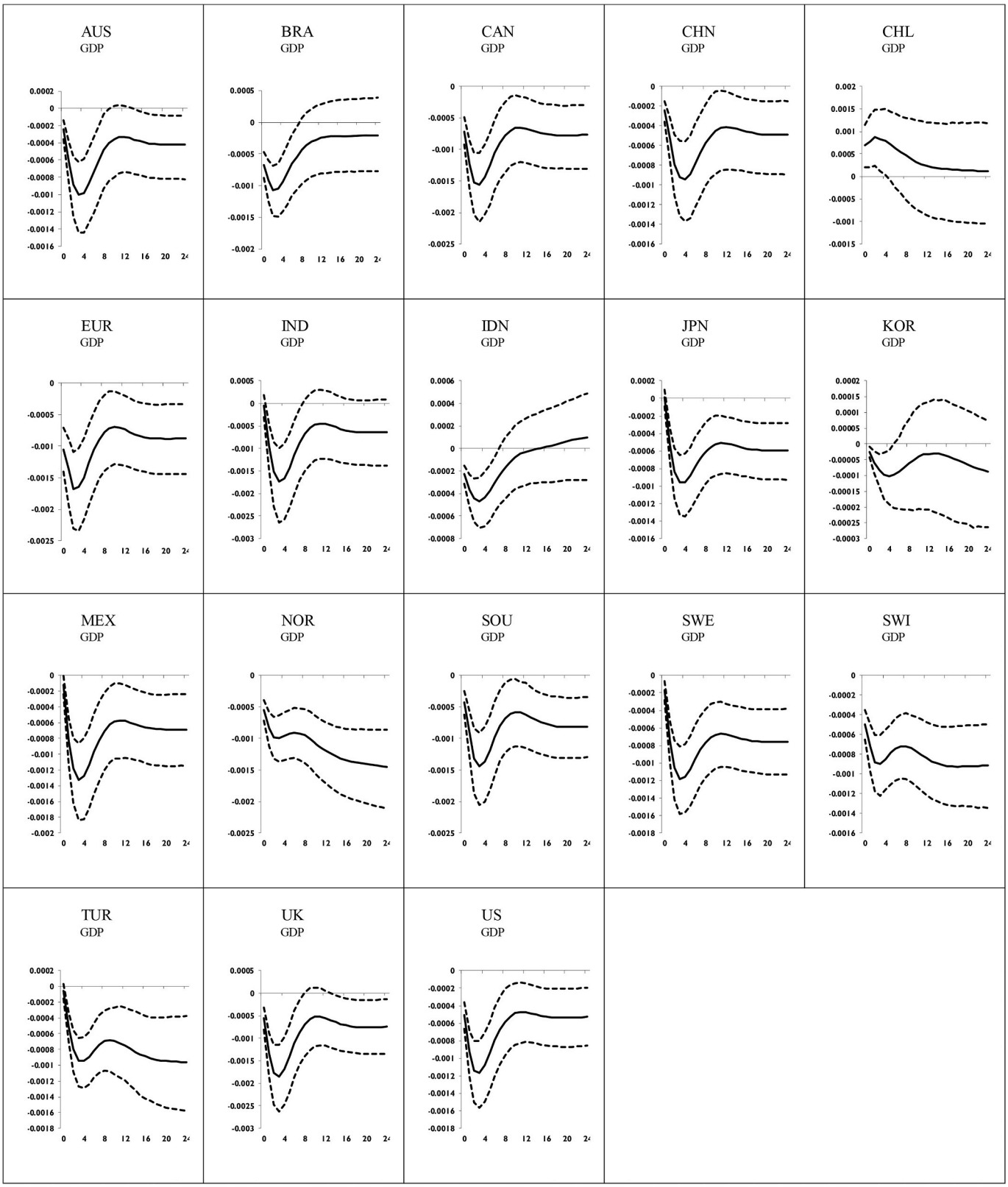

Fig. 14. GIRF of a negative AD stock market shock and responses of GDP (financial flow).

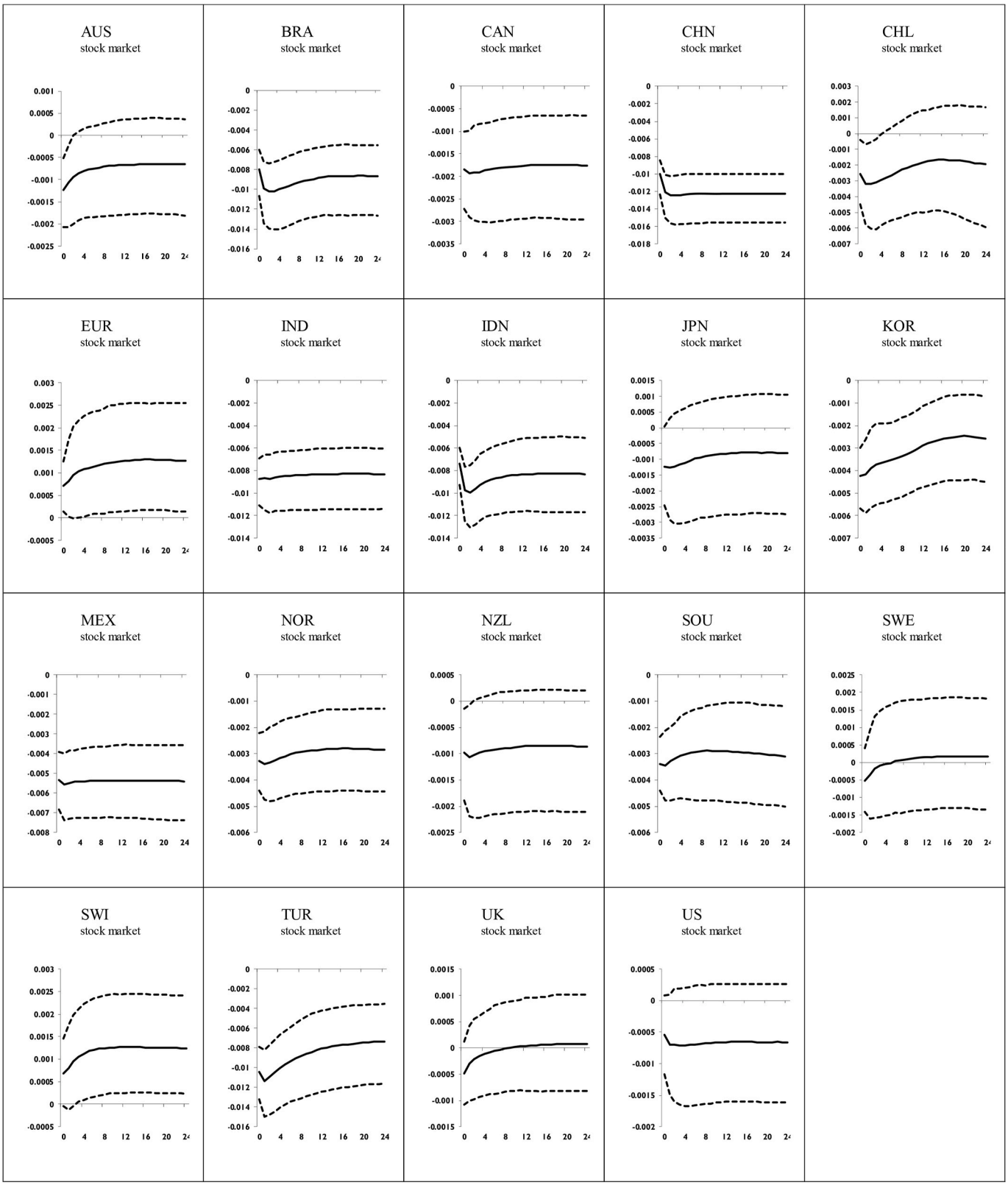

Fig. 15. GIRF of a negative EME stock market shock and responses of stock markets (financial flow).

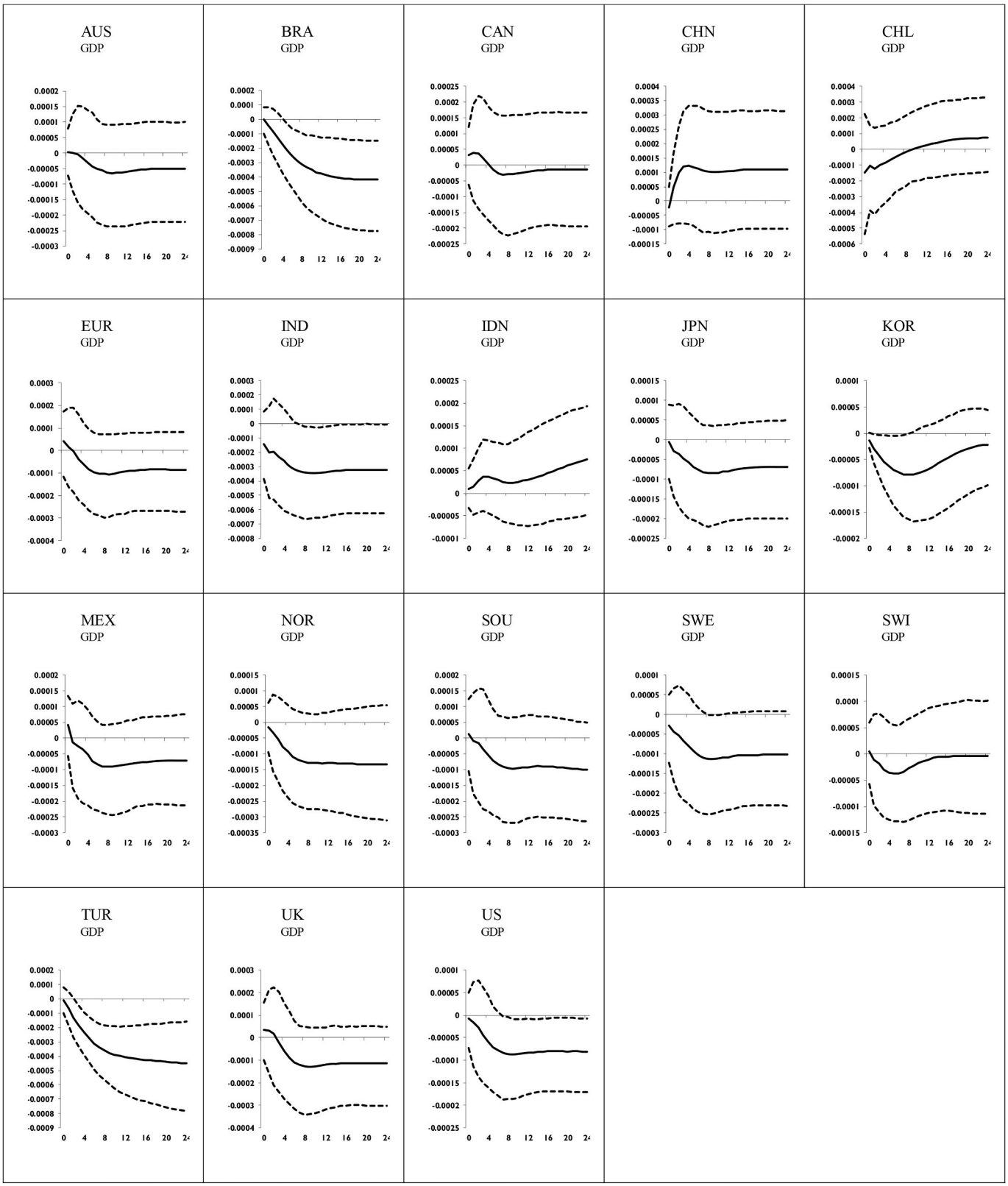

Fig. 16. GIRF of a negative EME stock market shock and responses of GDP (financial flow).

main results did not change (results are available upon request).

5. Conclusion

We contribute to the literature by providing a general analysis encompassing EMEs and ADs in a system connected by bilateral trade (and financial flow). GVAR permits us to compare shocks from different regions and the domestic responses of all economies. However, our approach does not address idiosyncratic domestic factors, which are crucial for understanding specific responses. To this end, a case study is a recommendable next step in our investigation. The challenge is to model the international economy while explicitly incorporating trade/financial flow. We propose that a modified GVAR focused on one country could address these considerations.

Finally, our results evidence the economic interdependence and integration between economies, showing how financial episodes can spread throughout the system, causing persistent fluctuations in domestic markets. Although exchange rates absorb part of the shock, they do not completely shield the country. Therefore, we assert that our paper highlights how external financial shocks can produce fluctuations in EMEs and ADs, drawing the attention of policymakers to tools and structural reforms that can improve the resilience of economies.

Declarations

The authors report there are no competing interests to declare.This research did not receive any specific grants from public, commercial, or non-profit agencies.The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Appendices.

Table A
Countries and regions

AUS	Austria	NOR	Norway	EUR	
BRA	Brazil	NZL	New Zealand	(AUT)	Austria
CAN	Canada	SOU	South Africa	(BEL)	Belgium
CHN	China	SWE	Sweden	(FIN)	Finland
CHL	Chile	SWI	Switzerland	(FRA)	France
IND	India	TUR	Turkey	(GER)	Germany
IDN	Indonesia	UK	United Kingdom	(ITA)	Italy
JPN	Japan	US	United States	(NTH)	Netherland
KOR	South Korean	EUR	Eurozone	(SPA)	Spain
MEX	Mexico				

Note: The last column shows the aggregation of the Eurozone. In brackets are the countries that makeup part of it.

Table B
Unit Root Test for Domestic Variables at 5% of statistical significance

	Critical Value	AUS	BRA	CAN	CHN	CHL	EUR	IND	IDN	JPN	KOR
q (with trend)	−3.24	−2.67	−1.57	−3.69	−3.89	−1.43	−2.65	−2.90	−2.16	−2.25	−3.26
q (no trend)	−2.55	−0.54	0.78	−0.89	−2.51	0.99	−2.28	0.28	0.16	−1.88	−0.83
Dq	−2.55	−7.07	−7.95	−7.27	−5.89	−7.79	−10.71	−6.77	−6.97	−9.61	−7.34
y (with trend)	−3.24	−5.76	−4.27	−4.58	−3.98	−4.37	−4.05	−5.04	−1.35	−4.19	−2.35
y (no trend)	−2.55	−5.54	−4.27	−4.24	−3.99	−4.38	−3.80	−4.82	−1.14	−4.20	−2.38
Dy	−2.55	−9.51	−9.92	−8.36	−14.90	−6.43	−12.27	−14.04	−9.29	−6.55	−4.72
e (with trend)	−3.24	−1.84	−1.85	−1.47	−1.56	−1.83	−1.84	0.17	−1.44	−1.71	−2.64
e (no trend)	−2.55	−1.24	−1.77	−0.02	0.07	−1.56	−1.25	−1.18	0.15	−1.89	−1.00
De	−2.55	−11.35	−8.67	−10.47	−5.73	−9.91	−10.34	−2.16	−8.91	−9.38	−6.96
r (with trend)	−3.24	−2.46	−3.37	−2.73	−2.66	−3.25	−2.52	−1.37	−3.34	−2.21	−2.89
r (no trend)	−2.55	−1.92	−2.38	−2.09	−2.25	−2.88	−1.42	−0.83	−0.45	−2.23	−0.38
Dr	−2.55	−3.74	−4.49	−6.34	−11.52	−6.33	−4.88	−12.52	−6.42	−10.32	−9.38

		MEX	NOR	NZL	SOU	SWE	SWI	TUR	UK	US
q (with trend)	−3.24	−0.79	−2.77	−1.78	−1.95	−2.94	−2.57	−1.04	−2.50	−2.81
q (no trend)	−2.55	1.03	0.34	−0.46	0.95	−0.86	−1.72	2.12	−1.99	−0.88
Dq	−2.55	−8.13	−10.13	−6.94	−7.95	−7.35	−7.53	−6.93	−9.01	−10.92
y (with trend)	−3.24	−3.95	−3.56		−5.15	−3.65	−3.36	−3.48	−5.01	−4.33
y (no trend)	−2.55	−3.78	−3.58		−5.05	−3.56	−3.37	−3.48	−4.77	−4.16
Dy	−2.55	−9.67	−11.31		−8.60	−9.19	−11.54	−5.82	−10.27	−7.78
e (with trend)	−3.24	−1.96	−1.77	−2.47	−2.50	−2.24	−1.88	−0.93	−2.19	
e (no trend)	−2.55	−1.55	−1.48	−1.70	−2.26	−2.09	−0.74	−0.97	−1.68	
De	−2.55	−11.92	−10.38	−10.26	−10.44	−7.31	−11.43	−11.79	−10.13	
r (with trend)	−3.24	−0.45	−2.83	−2.14	−2.97	−1.79	−2.33	−1.57	−2.39	−2.06
r (no trend)	−2.55	0.22	−1.49	−1.87	−1.26	−1.48	−1.29	−0.56	−1.55	−1.93
Dr	−2.55	−4.69	−7.62	−6.19	−6.59	−7.24	−18.32	−11.68	−4.58	−5.05

Table C
Unit Root Test for Foreign Variables at 5% of stastistical significance

	Critical Value	AUS	BRA	CAN	CHN	CHL	EUR	IND	IDN	JPN	KOR
q* (with trend)	−3.24	−3.86	−3.73	−3.58	−3.27	−3.75	−3.62	−3.65	−3.69	−3.86	−3.86
q* (no trend)	−2.55	−0.98	−0.86	−0.77	−0.69	−0.71	−0.34	−0.66	−0.97	−0.78	−0.86
Dq*	−2.55	−8.97	−7.44	−10.49	−7.94	−7.43	−7.56	−7.47	−7.31	−9.22	−9.04
y* (with trend)	−3.24	−5.08	−3.40	−5.16	−4.77	−4.13	−3.52	−3.34	−4.16	−4.60	−5.17
y* (no trend)	−2.55	−4.83	−3.32	−4.98	−4.62	−4.06	−3.47	−3.30	−4.10	−4.52	−5.10
Dy*	−2.55	−7.45	−8.35	−8.09	−8.07	−9.25	−7.33	−6.92	−8.72	−9.08	−8.30
e* (with trend)	−3.24	0.34	−0.12	−0.61	−0.13	−0.14	−0.34	−1.45	0.86	−0.39	0.22
e* (no trend)	−2.55	−1.05	−1.09	−0.85	−1.15	−0.96	−0.94	−0.43	−1.08	−0.62	−1.06
De*	−2.55	−4.11	−5.75	−7.61	−6.33	−6.54	−7.22	−10.24	−1.85	−7.45	−4.23
r* (with trend)	−3.24	−2.57	−2.38	−2.10	−2.45	−2.37	−2.11	−2.59	−2.71	−2.41	−2.29
r* (no trend)	−2.55	−1.17	−1.34	−1.82	−1.49	−1.31	−1.13	−1.23	−1.36	−1.33	−1.26
Dr*	−2.55	−6.75	−5.80	−4.83	−5.41	−5.72	−6.56	−5.61	−6.15	−6.21	−6.53

		MEX	NOR	NZL	SOU	SWE	SWI	TUR	UK	US
q* (with trend)	−3.24	−3.56	−3.08	−3.74	−3.59	−2.83	−3.14	−3.21	−3.16	−3.01
q* (no trend)	−2.55	−0.86	−1.47	−0.90	−0.99	−1.25	−1.32	−1.37	−1.21	−0.48
Dq*	−2.55	−10.41	−7.93	−7.38	−7.44	−7.99	−7.91	−7.71	−7.78	−7.39
y* (with trend)	−3.24	−5.03	−4.41	−3.99	−3.47	−3.98	−4.40	−4.52	−4.12	−3.56
y* (no trend)	−2.55	−4.85	−4.19	−3.91	−3.36	−3.81	−4.16	−4.30	−3.93	−3.45
Dy*	−2.55	−7.32	−8.03	−9.12	−6.90	−9.43	−8.30	−7.66	−8.70	−7.18
e* (with trend)	−3.24	−0.25	−1.84	−0.24	0.30	−1.58	−0.56	−0.85	−1.23	−0.92
e* (no trend)	−2.55	−0.89	−1.30	−0.98	−1.13	−1.24	−1.23	−1.22	−1.16	−0.60
De*	−2.55	−6.61	−7.64	−6.46	−3.44	−9.81	−6.48	−7.54	−9.25	−9.03
r* (with trend)	−3.24	−2.16	−2.55	−2.80	−2.72	−2.92	−2.88	−2.64	−2.65	−2.70
r* (no trend)	−2.55	−1.87	−1.51	−1.48	−1.34	−1.46	−1.49	−1.38	−1.41	−1.23
Dr*	−2.55	−4.87	−4.41	−5.11	−5.59	−4.57	−4.57	−4.99	−4.96	−3.63

Table D
VARX order and number of cointegrating relationships

	VARX (p,q)		Cointegrating relationships
	p	q	
AUS	2	1	1
BRA	2	2	1
CAN	2	2	0
CHN	2	2	3
CHL	2	2	0
EUR	2	2	1
IND	2	2	1
IDN	2	2	1
JPN	2	2	1
KOR	2	2	1
MEX	2	2	1
NOR	2	2	0
NZL	2	1	0
SOU	2	2	2
SWE	2	2	0
SWI	2	2	1
TUR	2	2	1
UK	2	2	1
US	2	2	1

References

Abiad, A., Bluedorn, J., Guajardo, J., Topalova, P., 2015. The rising resilience of emerging market and developing economies. World Dev. 72, 1–26.

Aguiar, M., Gopinath, G., 2007. Emerging market business cycles: the cycle is the trend. J. Polit. Econ. 115, 69–102.

Attílio, L.A., 2023. Impact of oil and agricultural shocks on the financial markets of emerging market economies. Int. Econ. J. 37, 270–293.

Attílio, L.A., Faria, J.R., Rodrigues, M., 2023. Does monetary policy impact CO2 Emissions? A GVAR analysis. Energy Econ. 119, 106559.

Balcilar, M., Demirer, R., Gupta, R., Wohar, M.E., 2020. The effect of global and regional stock market shocks on safe haven assets. Struct. Change Econ. Dynam. 54, 297–308.

Bhattarai, S., Chatterjee, A., Park, W., 2020. Global spillover effects of US uncertainty. J. Monetary Econ. 114, 71–89.

Bouri, E., Demirer, R., Gupta, R., Sun, X., 2020. The predictability of stock market volatility in emerging economies: relative roles of local, regional, and global business cycles. J. Forecast. 39, 957–965.

Camacho, M., Palmieri, G., 2021. Evaluating the OECD's main economic indicators at anticipating recessions. J. Forecast. 40, 80–93.

Caraiani, P., Călin, A.C., 2020. The impact of monetary policy shocks on stock market bubbles: international evidence. Finance Res. Lett. 34, 101268.

Chudik, Alexander, Fratzscher, M., 2011. Identifying the global transmission of the 2007-2009 financial crisis in a GVAR model. Eur. Econ. Rev. 55, 325–339.

Cuadro-Sáez, L., Fratzscher, M., Thimann, C., 2009. The transmission of emerging market shocks to global equity markets. J. Empir. Finance 16, 2–17.

Dees, Stephane, Mauro, F., Pesaran, M., Smith, V., 2007. Exploring the international linkages of the Euro area: a global VAR analysis. J. Appl. Econom. 22, 1–38.

Franses, P., Dijk, D., 1996. 'Forecasting stock market volatility using (non-linear) Garch Models. J. Forecast. 15, 229–235.

Gupta, R., Kabundi, A., 2010. Forecasting macroeconomic variables in a small open economy: a comparison between small- and large-scale models. J. Forecast. 29, 168–185.
Harjoto, M.A., Rossi, F., Paglia, J.K., 2021. COVID-19: stock market reactions to the shock and the stimulus. Appl. Econ. Lett. 28, 795–801.
Khan, N.S., 2020. Revisiting the effects of NAFTA. Econ. Anal. Pol. 68, 1–16.
Kim, H., 2013. Generalized impulse response analysis: general or extreme? EconoQuantum 10, 136–141.
Kose, M., Otrok, C., Prasad, E., 2012. Global business cycles: convergence or decoupling? Int. Econ. Rev. 53, 511–538.
Lu, X., Ma, F., Wang, J., Zhu, B., 2021. Oil shocks and stock market volatility: new evidence. Energy Econ. 103, 105567.
Mohaddes, Kamiar, Raissi, M., 2020. Compilation, Revision and Updating of the Global VAR (GVAR) Database, 1979Q2-2016Q4. University of Cambridge: Faculty of Economics (mimeo).
Papanyan, S., 2010. The transmission of shocks between Europe, Japan and the United States. J. Forecast. 29, 54–70.
Pesaran, M. Hashem, Schuermann, T., Weiner, S., 2004. Modeling regional interdependencies using a global error-correcting macroeconometric model. J. Bus. Econ. Stat. 22, 129–162.
Qiu, Y., Ren, Y., Xie, T., 2022. Global factors and stock market integration. Int. Rev. Econ. Finance 80, 526–551.
Song, Y., Tang, X., Wang, H., Ma, Z., 2022. Volatility forecasting for stock market incorporating macroeconomic variables based on GARCH-MIDAS and deep learning models. J. Forecast. 1–9.
Soydemir, G., 2000. International transmission mechanism of stock market movements: evidence from emerging equity markets. J. Forecast. 19, 149–176.
Wu, F., 2020. Stock market integration in East and Southeast Asia: the role of global factors. Int. Rev. Financ. Anal. 67, 101416.