LUND UNIVERSITY
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Master in Economic Development and Growth

Measuring the Southern Growth Engine: China, India, and Brazil as Regional and World Economic Powers

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Abstract: The world economy has undergone the transitional period of rebalancing in economic power from the Northern to Southern economies over the past decades, with the shifting becoming even more visible after the phenomenon of the global financial crisis in 2008. This paper examines the role of three large emerging economies, China, India and Brazil, as the new regional and global economic drivers via the transmission channel of international trade. The study employs GVAR framework to capture several external shocks at the world level for 33 individual countries covering the period of 1999Q1-2011Q3. The main findings demonstrate that the positive output shock in the three core emerging economies generally induces a significant and favorable impact on the export and output potentials of both emerging and advanced countries, with the effect being long-lasting even in the long-run. In particular, both China and Brazil act as regional powers and seem to have a vital impact to their neighboring economies as well as extending their global growth driver role to the rest of the world. The results also imply the existence of the decoupling hypothesis of several developing countries from the U.S. and simultaneously an increasing integration with the large emerging economies particularly with China.

Key words: Trade linkage, Economic growth, GVAR model

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Measuring the Southern Growth Engine: China, India, and Brazil as Regional and World Economic Powers*

1. Introduction

The topic of business cycle transmission has always been of interest to policymakers; in particular it has received a considerable attention after the outbreak of the global financial crisis in 2008 when the world trade experienced a synchronized collapse from the crisis originated only from the U.S. economy. The collapse has truly demonstrated the feature of globalized world and that each individual economy is somehow interconnected in the global setting. In addition to this economic linkage, the new economic transition observed over the past two to three decades is the structural shift of economic power from the Northern to the Southern economies, with particular reference to the increased role of China, India and Brazil as the new global economic drivers. In fact, although these three countries are very heterogeneous in terms of size, number of population, and share in world economic output, their impressive growth performance and enormous domestic market certainly creates a favorable prospect for supporting the growth momentum of the global economy, especially during this vulnerable time in the U.S. and Europe.

The three emerging economies have undertaken the economic transformation in recent years, China and India during 1980s, and Brazil during 1990s. By the 21st Century, however, the world had already observed their economic significance, particularly after these countries were explicitly pointed out by the Goldman Sachs investment bank in 2001 as the informal acronym 'BRIC countries' representing the four large and rapidly growing emerging markets namely Brazil, Russia, India and China. In 2010, the three economies –China, India and Brazil— accounts for over 20 percent of the world GDP and the increasing importance of their output, provides potential increased positive spillovers for other countries through several possible channels such as markets for exports, resources for investment, finance for development and technologies for productivities (Nayyar, 2008a; Jha and McCawley, 2011).

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Even though the spillover effect can be transmitted through many ways, this study solely focuses on the trade linkage channel, which has been proven by Forbes and Chinn (2004) and Baxter and Kouparitsas (2004) to be, among all other possible linkages, the most important source for explaining the international business cycle movement. The rationale behind this trade linkage is in fact very simple: an increase in exports in one country automatically corresponds to a rise in imports of another country and vice versa, and since both export and import is ones of the main components in output, a country's national income is thus inevitably affected. This positive transmission through trade is particularly vital for the low- and middle-income economies who are generally known to substantially rely on the export orientation to generate output growth for their economies. Consequently, a significant rise of these large emerging economies –China, India and Brazil— can potentially create a favorable impact on growth and development of not only the small developing countries but also to the soaring advanced countries and the rest of the world.

Although several studies have already examined the systematic spillover from the major industrialized countries, in the midst of the changing landscape in global economic power it is probably even more crucial to understand the degree of linkages occurring from the Southern economies, particularly the ones from China, India and Brazil. This study therefore aims to analyze the economic implication of these three large and rapidly growing countries through the use of the cointegration analysis and global modelling framework, following the pioneer works of Pesaran, Schuermann and Weiner (2004) and Dees, di Mauro, Pesaran and Smith (2007). This framework is known as Global Vector Autoregressive (GVAR) approach; it "combines time series, panel data, and factor analysis techniques permitting to address a wide set of issues" (Cesa-Bianchi et al, 2011). The framework allows the assessment on the extent to which external shocks affect the domestic economy. In particular, the study attempts to answer the hypothesis of "How these core developing countries have been the source of growth in their own region and in the world economy? And what are their prospects?". The GVAR model generally follows two main steps: first, it models each individual country included in the analysis as a small open economy using a country-specific VECM and, secondly, combines all the estimated country-specific models into GVAR utilizing the previously calculated trade weight matrix. This study includes 33 countries covering the period of 1999-2011 which is believed to represent the transitional period of economic power from the North to the Southern's global growth engine. It should also be noted that, in this study, from this point onwards the three core economies refers to the main countries of interest, China, India and Brazil namely.

The main findings from the empirical analysis are found to be correspondent with the existing studies. The result demonstrates that a positive output shock in the three core

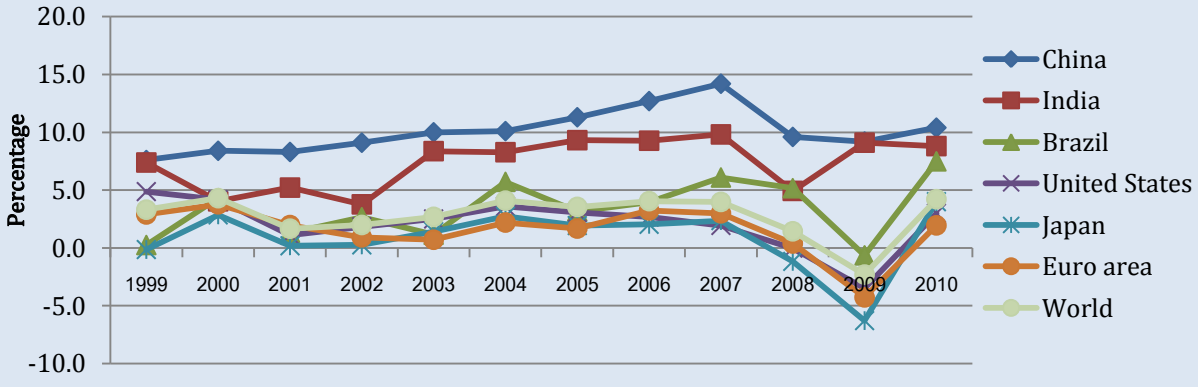
emerging economies generally have a significant and favorable impact on the export and output pattern of other economies for both developing and advanced countries. Additionally, the positive impact from all three countries is also long-lasting over the whole forecasted periods. In particular, both China and Brazil seem to play a vital role to their neighboring economies, acting first as the regional growth power also extending their role of global growth driver to the rest of the world as well.

The rest of the paper is structured as follows: Section 2 explores the stylized facts of the three core countries namely their rising role in the world economy and the changing structure of trade interdependency among the major trading blocs including the current pattern of trade and output. Section 3 reviews the existing literature and explains theoretical framework. Section 4 describes the data and methodology used in the study. Section 5 reports the empirical results and Section 6 concludes the main findings.

2. The stylized facts

The recent decades have been the period of high output and export growth for several Southern economies, particularly for the large emerging countries such as China, India and Brazil. Their GDP growth has been above the world's average of 2.75 percent during 1999-2010 (Figure 1). China, with the most impressive performance among the three, grows with the average of 10.08 percent annually whereas India and Brazil did not lag too far behind: their annual average of GDP growth registers 7.36 and 3.38 percent respectively. In fact, the study by Goldman Sachs projected that the economic size of all 4 BRIC countries (Brazil, Russia, India, and China) together will surpass the GDP share of the current developed G6 economies (US, Japan, UK, Germany, France and Italy) by as soon as 2039 (Wilson and Purushothaman, 2003).

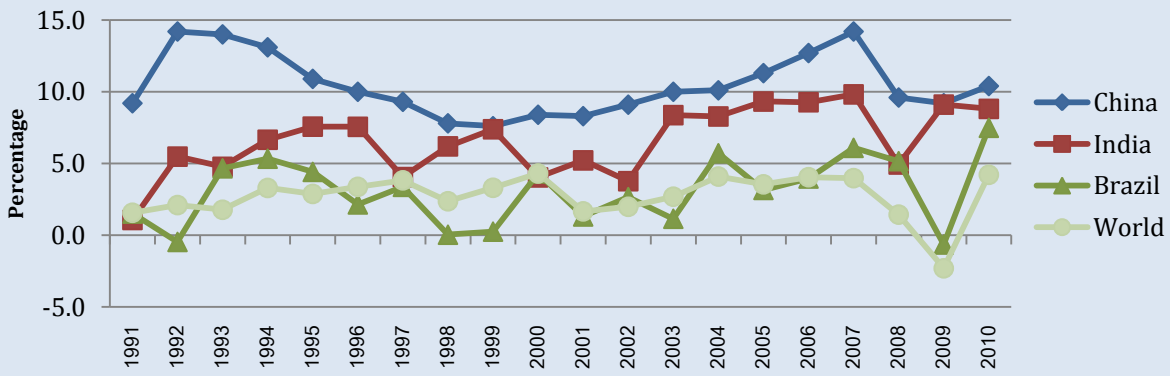
Figure 1: GDP Growth Rate, 1999-2010



Source: World Development Indicator, World Bank (2012)

2.1 The rise of China, India and Brazil

Figure 2: GDP Growth Rate, 1991-2010



Source: World Development Indicator, World Bank (2012)

Prior to their rise, these core emerging economies have undertaken quite substantial economic transformations during 1980s for the cases of China and India, and during 1990s for Brazil. China initially adopted a socialist planned economy system preceding the 1978 reform. The transformation was certainly a state-led process and the main focus was on manufacturing production in order to promote export and attract foreign direct investment. This open-door policy has successfully attracted investors and undoubtedly created a substantial output growth for the Chinese economy ever since.

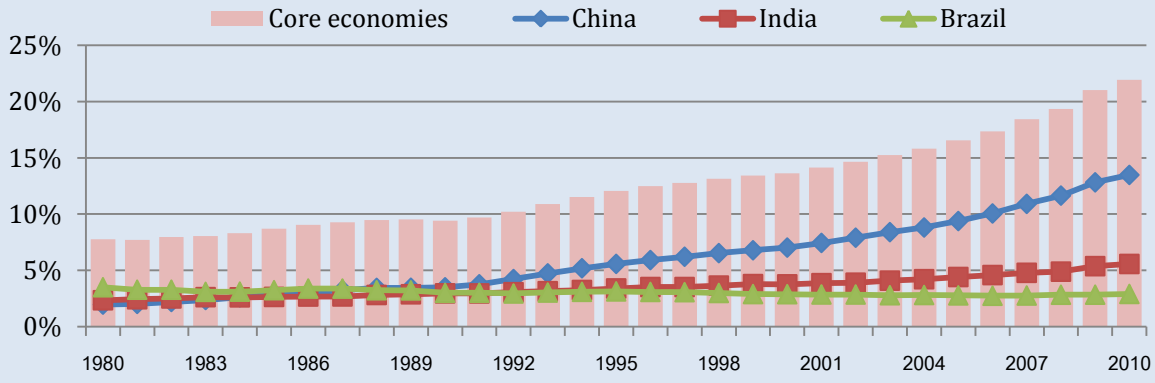
For the case of India, after its independence in 1947 from the Great Britain, it has adopted an inward-orientation strategy with the government obtaining the central role until it encountered the balance of payment crisis in 1991. The crisis required India to become more integrated with the world economy through the process of deregulation and promotion of trade and investment (Kowalski and Dihel, 2009). The economic reform and its openness certainly helped India's growth to accelerate and reduce its poverty problem. However, it should be noted that the growth characteristic of India is rather different from those of other emerging economies. Firstly, India's output growth has been largely led by service sector, particularly in information technology and business processing outsourcing (Kowalski and Dihel, 2009) instead of manufacturing sector like in the case of China and others. Secondly, Indian economy's dependency to trade has always been relatively less than other emerging economies, while two-third of the population largely relies on agriculture as the source of their income (Kowalski and Dihel, 2009). These two points, in fact, could potentially obstruct India's role as an important regional and global economic power through the use of positive international trade spillover.

While China and India were experiencing a period of rapid growth, Brazil was encountering a period of macroeconomic instability during 1980s (Nazmi and Revilla, 2010). Brazilian economy had previously underwent the time of miracle growth as early as in 1964-

1980 but in 1981, however, the economy experienced a collapse in output as a consequence of the second oil crisis in 1979 and the Brazilian's debt crisis during 1981-1982. After the crisis, Brazil established several stabilization programs with the most successful one known as 'Real plan' in 1994. Later on, it was able to stabilize and increase growth for Brazilian output and the impressive growth performance has continued until today.

These three economies, to varying degrees, have performed impressively (Figure 2) and collectively they have transformed the balance of the world economic activity. In terms of their combined economic size in relative to world GDP, their share accounts for over 20 percent in 2010, increasing from less than 8 percent in 1980 (Figure 3). At the same time, the role of advanced G3 economies (the U.S., Europe and Japan), who previously took over the majority of world output, has continuously declined to less than 40 percent of the world GDP in 2010[1] (Figure 4). In addition to their increasing importance, the three core economies have positioned their comparative advantages rather differently in the area of international trade: China is recognized as "the factory of the world" due to its emphasis on manufacturing products, India as "the call center of the world" from its specialization and human capital in information technology and Brazil as "the farmer of the world" from its abundance in natural resources of forest, mineral and metals. This point certainly provides an interesting motivation to further examine the consequence of the rise of these three heterogeneous emerging economies.

Figure 3: Share of Emerging Countries' Output to World's GDP, 1980-2010



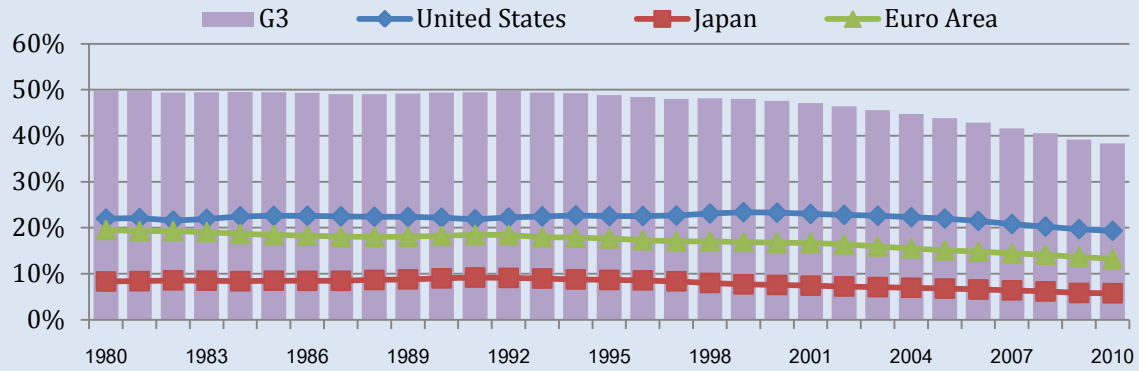
Source: World Development Indicator, World Bank (2012)

In terms of other characteristics, these three economies already account for approximately 40 percent of the total world population in 2010 (Figure 5), and in terms of physical space, they take up roughly 20 percent of the total world's land area (Figure 6). These physical characteristics, their demography in particular, create a promising prospect for them to become the drivers of global consumption thanks to their growing middle class which presents

[1] The share of output used here is calculated using the measure of GDP-PPP (2005 constant price in U.S. dollar) which takes into account the variations in countries' price levels and the purchasing power.

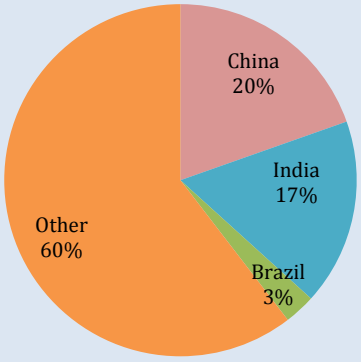
potential purchasing power and prospective large investment flows, particularly from China (Jha and McCawley, 2011), which support the long-term momentum of the global economy. Furthermore, given the slow and prolonged recovery in the North, the primary source of demand for the global economy is unlikely to arise from the industrialized countries; the role of global growth driver, instead, has begun and will continue to fall into the Southern economies' shoes (Jha and McCawley, 2011).

Figure 4: Share of Advanced Countries' Output to World's GDP, 1980-2010



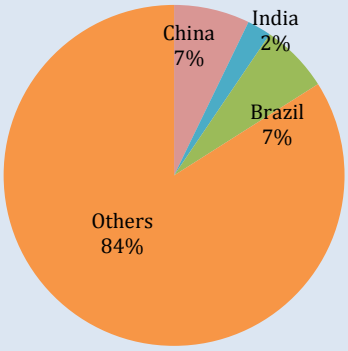
Source: World Development Indicator, World Bank (2012)

Figure 5: Share of Population, 2010



Source: World Development Indicator, World Bank (2012)

Figure 6: Share of Land Area, 2010



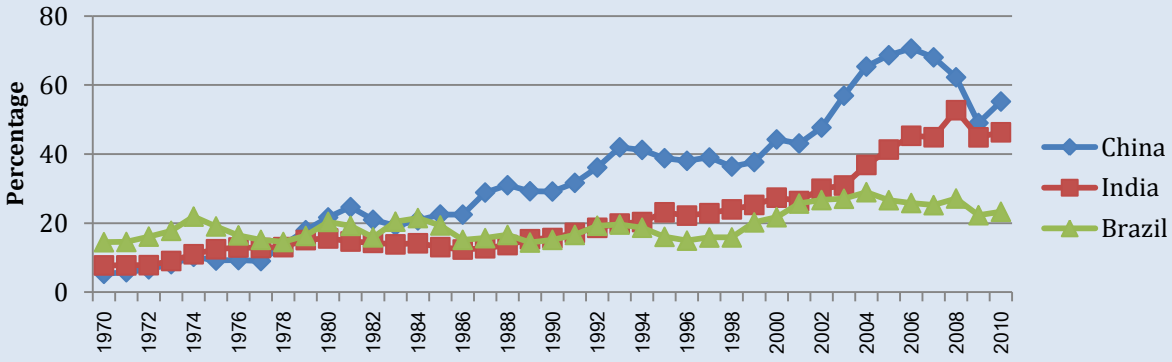
Source: World Development Indicator, World Bank (2012)

2.2 The changing structure of trade interdependency

"Trade linkage is an important feature of economic integration between countries" (Çakir and Kabundi, 2011), in fact several empirical studies has proven that trade transmission provides the most important source for international business cycle movements (Forbes and Chinn, 2004 and Baxter and Kouparitsas, 2004). According to the summary statistics of international trade, China, India and Brazil have certainly continuously integrated with the global economy: figure 7 demonstrates the evolution of the openness to trade of the three core

economies showing an increase from an insignificant share to roughly 50 percent for the case of China and India, whereas Brazil's trade accounts for approximately 20 percent of its GDP. Moreover, the share of their trade all together in relative to the total world trade has grown considerably from only 4.77 percent in 1999 to 13.06 percent in 2010, particularly the share of China has risen by more than threefold over the 10-year period (Table 1).

Figure 7: Foreign Trade to GDP (Percent), 1970-2010



Source: World Development Indicator, World Bank (2012)

Table 1: Share of Total Trade in the World Market (percent) , 1999-2010

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China	3.1	3.7	4.1	4.8	5.6	6.2	6.7	7.2	7.7	7.9	8.8	9.8
India	0.7	0.7	0.7	0.8	0.9	0.9	1.1	1.2	1.4	1.4	1.7	1.9
Brazil	0.9	0.9	1.0	0.9	0.8	0.9	0.9	1.0	1.0	1.2	1.2	1.3
Total	4.77	5.31	5.79	6.46	7.30	8.05	8.81	9.45	10.13	10.48	11.65	13.06

Source: Author's calculation using DOTS database from IMF (2012)

The trade weight matrix[2] shown in Table 2 provides a good indicator of the 21st Century's changing structure in trade interdependency among the major trading blocs[3] namely China, India, Brazil, G3, Asia, Latin American Countries (LAC) and the rest of the world (ROW). This trade matrix indicates the degree of trade linkage between the two economies as it captures the importance of country j for country i in terms of trade dependence. As mentioned by Dees et al. (2007), this dependence is a particularly essential element for the study and especially vital for the assessment whose emphasis is placed on the future momentum of the emerging economies with rapidly evolving trade relationship. The main insight obtained from the calculated trade weight here is that all three core economies have increased their role in the trading basket of all other countries: over the past decade (the average over the period 1999-2001 in comparison with that of 2008-2010), the average increases in trade share are 0.95, 1.36

[2] The detail of trade weight matrix can be referred to section 4.2.1.1: the construction of trade weight in the data and methodology section.
[3] The detail of the countries included in trading blocs can be referred to table 5 in section 4: data and methodology.

and 11.08 percent for Brazil, India and China respectively. This rising importance of the core economies particularly applies to the neighboring countries, i.e. China and India expand their role in Asia's trade while Brazil in LAC's one. Furthermore, these core economies are also more integrated with the trade of advanced G3 countries. Most importantly, the performance of China has been incredibly impressive; it has become the key trading partners for all G3 economies, taking almost one fifth of the total trade in each country. From the average trade share of 2008-2010, Chinese trade accounts for 25.36, 16.94 and 14.62 percent of Japan, U.S. and Euro area's total trade respectively.

In addition to the expansion towards the global economy trade flows, commercial exchange among these core countries has also experienced an increasing trend. Their intra-commercial exchange is in fact the main contributing factor for their predominant role as traders. The interdependency degree of India and Brazil in Chinese trade has increased by 2.14 and 2.08 percent during 1999-2010, while the integration between India and Brazil, even if still comparatively insignificant, are continuously improving over time. Both India and Brazil appear to substantially trade more with China: China has in fact proven to expand its export and import in these countries by 11.60 and 13.60 percent respectively during 1999-2010. These findings certainly indicate the rising role of the three core economies in the global economic setting and motivate further investigation for assessing their role – and that of China in particular—as the new global growth driver.

Table 2: Trade shares for major trading blocs in 1999-2010

(a) Average Trade Weight for 1999-2001										
Country	**USA**	**Euro Area**	**Japan**	**China**	**India**	**Brazil**	**Asia**	**LAC**	**ROW**	**Total Wij**
USA	0	0.1553	0.1243	0.0734	0.0088	0.0180	0.1157	0.1527	0.3518	1
Euro Area	0.2080	0	0.0666	0.0608	0.0151	0.0214	0.0888	0.0262	0.5130	1
Japan	0.3188	0.1319	0	0.1278	0.0074	0.0081	0.2399	0.0184	0.1478	1
China	0.2287	0.1636	0.2504	0	0.0090	0.0089	0.2054	0.0181	0.1160	1
India	0.2042	0.2462	0.0652	0.0387	0	0.0076	0.1441	0.0163	0.2777	1
Brazil	0.3032	0.2498	0.0586	0.0270	0.0091	0	0.0485	0.1898	0.1142	1
Asia	0.2987	0.1496	0.2542	0.0960	0.0189	0.0074	0	0.0157	0.1595	1
LAC	0.7293	0.0839	0.0339	0.0198	0.0032	0.0443	0.0332	0	0.0525	1
ROW	0.4087	0.3956	0.0670	0.0305	0.0092	0.0073	0.0673	0.0144	0	1
(b) Average Trade Weight for 2002-2004										
Country	**USA**	**Euro Area**	**Japan**	**China**	**India**	**Brazil**	**Asia**	**LAC**	**ROW**	**Total Wij**
USA	0	0.1558	0.1026	0.1132	0.0110	0.0183	0.1085	0.1518	0.3388	1
Euro Area	0.1867	0	0.0585	0.0883	0.0172	0.0193	0.0888	0.0249	0.5162	1
Japan	0.2618	0.1271	0	0.1925	0.0068	0.0073	0.2417	0.0160	0.1468	1
China	0.2180	0.1668	0.2232	0	0.0145	0.0137	0.2304	0.0223	0.1111	1
India	0.1939	0.2334	0.0499	0.0823	0	0.0101	0.1726	0.0152	0.2426	1
Brazil	0.3220	0.2280	0.0455	0.0599	0.0106	0	0.0582	0.1546	0.1212	1
Asia	0.2527	0.1493	0.2353	0.1642	0.0234	0.0083	0	0.0148	0.1520	1
LAC	0.6832	0.0897	0.0382	0.0464	0.0053	0.0436	0.0424	0	0.0514	1
ROW	0.3690	0.4147	0.0639	0.0497	0.0112	0.0078	0.0691	0.0146	0	1

Table 2: Trade shares for major trading blocs in 1999-2010 (Continued)

(c) Average Trade Weight for 2005-2007										
Country	**USA**	**Euro Area**	**Japan**	**China**	**India**	**Brazil**	**Asia**	**LAC**	**ROW**	**Total Wij**
USA	0	0.1528	0.0866	0.1489	0.0196	0.0144	0.0974	0.1505	0.3299	1
Euro Area	0.1654	0	0.0494	0.1183	0.0214	0.0221	0.0879	0.0306	0.5050	1
Japan	0.2227	0.1159	0	0.2230	0.0088	0.0090	0.2350	0.0235	0.1621	1
China	0.2172	0.1740	0.1752	0	0.0181	0.0230	0.2395	0.0274	0.1256	1
India	0.2399	0.2305	0.0422	0.0932	0	0.0143	0.0713	0.1841	0.1245	1
Brazil	0.1608	0.2058	0.0393	0.1283	0.0127	0	0.1722	0.0200	0.2609	1
Asia	0.2080	0.1442	0.2021	0.2201	0.0105	0.0331	0	0.0194	0.1626	1
LAC	0.5972	0.1037	0.0450	0.0781	0.0582	0.0079	0.0526	0	0.0574	1
ROW	0.3274	0.4071	0.0656	0.0765	0.0092	0.0183	0.0786	0.0172	0	1
(d) Average Trade Weight for 2008-2010										
Country	**USA**	**Euro Area**	**Japan**	**China**	**India**	**Brazil**	**Asia**	**LAC**	**ROW**	**Total Wij**
USA	0	0.1511	0.0718	0.1694	0.0228	0.0177	0.0921	0.1581	0.3170	1
Euro Area	0.1460	0	0.0435	0.1462	0.0258	0.0267	0.0864	0.0327	0.4927	1
Japan	0.1777	0.1045	0	0.2536	0.0132	0.0120	0.2429	0.0245	0.1717	1
China	0.1974	0.1778	0.1535	0	0.0297	0.0304	0.2319	0.0344	0.1450	1
India	0.1671	0.2226	0.0472	0.1629	0	0.0230	0.0807	0.1763	0.1201	1
Brazil	0.1318	0.1931	0.0372	0.1547	0.0172	0	0.1809	0.0172	0.2679	1
Asia	0.1712	0.1345	0.1898	0.2495	0.0152	0.0439	0	0.0224	0.1737	1
LAC	0.5443	0.1043	0.0417	0.1141	0.0639	0.0089	0.0570	0	0.0656	1
ROW	0.2891	0.3890	0.0653	0.1102	0.0110	0.0268	0.0889	0.0197	0	1

Source: Author's own calculation using DOTS database from IMF (2012)

2.3 The integrated world economy

In addition to the increasing role as the world traders reflected in trade weight matrix, another basic measurement of correlations in output, export and import among China, India and Brazil are proven to be highly synchronized. China's output is shown to be highly correlated with both India and Brazil with the correlation coefficients of 0.93 and 0.91 respectively, whereas India-Brazil output tie reaches 0.80. A similar conclusion can also be drawn from another two variables of export and import in all three core countries (Table 3). In fact, a high degree of synchronization in business cycle movement should be recognized as a world phenomenon: all coefficients observed in table 4 register a value higher than 0.59 which indicates a statistically high correlation.

However, it should be noticed that the simple analysis through the use of correlation analysis suffers some limitations such as its assumption basing solely on the linear relationship and the possibility of spurious or accidental associations between the chosen variables. Conclusions on China, India and Brazil as rising emerging economies based on solely correlation analysis are therefore premature and should not yet be drawn until a more extensive examination is conducted.

Table 3: Simple correlation coefficients among the three core economies

Correlation	Real output	Real export	Real import
China-India	0.934083	0.911973	0.981250
China- Brazil	0.907386	0.884448	0.869861
India- Brazil	0.806239	0.870216	0.799578

Source: Author's own calculation

Table 4: Simple correlation coefficients of real GDP, export and import between the three core economies and other major trading blocs

(a) Correlation coefficients among major trading blocs' real output						
	Asia	**LAC**	**USA**	**Euro Area**	**Japan**	**ROW**
China	0.932947	0.501569	0.826862	0.856359	0.840763	0.944791
India	0.966455	0.306460	0.921603	0.920045	0.834163	0.925946
Brazil	0.759295	0.700657	0.594489	0.637047	0.764673	0.766793
(b) Correlation coefficients among major trading blocs' real export						
	Asia	**LAC**	**USA**	**Euro Area**	**Japan**	**ROW**
China	0.940754	0.895685	0.883101	0.917632	0.923412	0.969695
India	0.941399	0.843616	0.887201	0.945885	0.924518	0.95242
Brazil	0.886964	0.923615	0.959816	0.794411	0.812574	0.807675
(c) Correlation coefficients among major trading blocs' real import						
	Asia	**LAC**	**USA**	**Euro Area**	**Japan**	**ROW**
China	0.984043	0.962334	0.915542	0.964477	0.987071	0.969695
India	0.965507	0.912375	0.887519	0.976139	0.9757	0.95242
Brazil	0.824292	0.888972	0.687864	0.743886	0.82647	0.807675

Source: Author's own calculation

3. Theory

3.1 Previous research

In the globalized world, the implementation of effective macroeconomic policy requires both the consideration of domestic market conditions and interdependencies across countries. In fact, there are several channels of inter-market transmission, Nayyar (2008a) and Jha and McCawley (2011) have identified the main four ones. These channels are, namely, (1) international trade for exports and import, (2) investment, (3) aid and finances for development and (4) technologies for productivity enhancement. Among the four, trade linkage is the most important determinant of the business cycle of a country: Frankel and Rose (1997 and 1998) and Inklaar et al. (2005) demonstrate that countries with high degree of trade interdependency tend to have similar business cycles. The view on synchronized business cycles has been supported by various economists: Forbes and Chinn (2004), to mention a relevant paper, utilize the factor model to examine the cross-country linkages among five advanced economies and several emerging markets. Their study suggests that trade linkage provides a vital shock transmission and certainly determines the synchronization of business cycle, reaching the same conclusions.

The supports on the idea behind the international business cycle synchronization and trade linkages (Baldwin, 2009; Freund, 2009; and Bems et al., 2010) become even stronger after the phenomenon of the trade collapse as a consequence of the global financial crisis in 2008. The linkage through trade coupled with the sharp contraction in final demand creating vulnerability in world trade, world output and its growth prospect. Several studies have examined the consequence of a negative shock on output, export and import: Forbes (2002), Ma and Cheng (2005) and Abiad et al., (2010) all conclude that the transmission through a contraction in final demand for international trade plays an important role during the global downturn known as "contagious effect". As the world economy becomes highly integrated, a sudden change, either a favorable or destructive one, in a small or a large country, creates the possibility to turn the event into a global phenomenon. The assessment of an individual country's vulnerability to external shock certainly provides crucial insights but using a global modeling approach, which incorporates all relevant variables influencing the performance of the economy, provides more well-rounded considerations. The first pioneer work employing GVAR framework is the study by Pesaran, Schuermann and Weiner (2004). It offers the first attempt to solve the puzzle by laying the ground for the global modeling framework known as Global Vector Autoregressive (GVAR) model, linking a large number of individual countries together with their international trade tie and allowing the evaluation on these economies to be conducted simultaneously. The aforementioned paper examines in fact a consequence of several possible shocks, such as a negative shock to the U.S. equity prices and to equity markets in South East Asia, and a positive shock to German output. However, the main focus of the paper is more emphasized on the theoretical arguments and methodology rather than the empirical finding section.

Another pioneer study on GVAR modeling is the study by Dees, di Mauro, Pesaran and Smith (2007). It also examines "the transmission mechanism of shock at the world level" (Dees et al., 2007), and is intended to extend the previous study by Pesaran et al. (2004) in several dimensions. The study includes 26 economies with 8 Euro Area countries being combined into a single economy, covering the period of 1979-2003. The study focuses on the implications of external changes, particularly the shock from the U.S. economy, on Euro area economy at both short and long-run horizons. As expected, one of the key findings suggests that financial shocks from the U.S. economy creates a significant impact towards Euro Area; the effect from financial shock affects however the behavior of output in a more synchronized manner than the one from real economy, such as a distress in real output and inflation. The result also reveals a significant consequence of the second effect: the persistence of shock over time due to a spillover reaction from other economies which are in turn as well adversely affected from the first round of shock.

In addition, the study also contributes to the theoretical foundation: it presents how GVAR approach can be derived from a global unobserved common factor model, providing a rather solid theoretical ground to the model if compared to its empirical success in goodness of fit. Even though the authors demonstrate that GVAR is very effective in solving the puzzle of business cycle co-movements, it mainly focuses on the aspects of advanced economies while the changing landscape of global economic setting certainly creates a strong incentive for policymakers to also examine in deep the impact of a shock from several growing developing and emerging economies.

On the other hand, Çakir and Kabundi (2011) explore trade linkages from four large emerging economies –namely, Brazil, Russia, India and China (BRIC) – on a small open South African economy during the period of 1995-2009. The main findings of the study indicate that BRIC countries, through international trade, have both individually and as a bloc played, with different degrees, an important role to the performance of South African economy. Individually, among the four examined countries, an export shock from India creates the highest positive spillover to South African import, whereas a shock to Brazilian import explains the highest variation in South African export. As a bloc, an export shock from BRIC countries plays a more important role to the South African economic performance than that of import. In addition, by using variance decomposition analysis, the result shows that "exchange rate is the main channel of transmission of trade shocks" (Çakir and Kabundi, 2011) as reflected in its highest fraction of forecasted error variance. In sum, the growth of BRIC economies creates a positive spillover to South Africa through international trade channel. Although this study did place emphasis on one emerging country, South Africa, still it is necessary for policymakers to understand the overall picture in developing world in order to implement effective macroeconomic policies in a coordinated manner.

In short, all previous studies have shown that not only financial and real linkages exist, but also that they apply for both the cases of advanced and developing economies. Extending these findings, this study deepen the examination of transmission mechanism from the previous existing literature in several dimensions: firstly it extends the period and sample countries of investigation, secondly, it presents the main findings from a current perspective of transitional periods in which developing countries rapidly increase their role in global economy at one side and advanced economies are in the midst of vulnerability at another.

3.2 Theoretical framework: Economic growth and trade theory

The relationship between economic growth and international trade is extensively examined in the new endogenous growth theory. Among the important theories in endogenous

school, Lucas (1988) elaborates a neoclassical theory of growth and international trade using three different models that point out the important features of comparative advantages: physical capital accumulation, human capital accumulation through schooling and through learning by doing. It is suggested that the rate of economic growth in each country differs depending on its comparative advantage. Another pioneer literature on this topic is the work of Grossman and Helpman (1991) which demonstrates that international trade promotes economic growth as it induces the development of knowledge and technology. These factors in turn lead to a specialization in production and, coupling with economies of scale, cost of production is reduced. Innovation and new varieties are then introduced to the market at a faster rate, promoting growth and development.

In addition, the topic of economic growth and international trade are also widely discussed in terms of their relationship direction or causality effect and, in fact, no consensus on the direction has been reached. Additionally, most international trade studies have distinguished the typology of foreign trade and focused on either the perspective of export or import. In the existing literature concerning export, there are in fact four main strands. First, the argument is based on the idea that exporting activities promote growth known as export-led growth. There are two main explanations on how export leads to an economic growth of a country. Firstly, an increase in export generates higher national income for a country and positive spillover is further enlarged by a multiplier effect. Secondly, an expansion in export induces an improvement in the country's specialization which in turn implies a higher productivity in the production process and leads to a more efficient reallocation of resources ultimately resulting in higher output growth. There is an extensive literature supporting the idea of export-led growth, Balassa (1978) and Ram (1985), for example, suggest that exports play an important role in generating economic growth using regression of output growth on several export variables. Other studies include the study of Song and Chen (1995), Amirkhalkhali and Dar (1995), Yaghmaian and Ghorashi(1995), Burney (1996), Fosu (1996) on numbers of least developing countries (LDCs), and Mc Nab and Moore (1998) on the case of developing countries. The counter argument however suggests that, if export-led growth hypothesis holds, theoretically real exchange rate appreciation should be correspondingly found during periods of economic growth (Yang, 2008) but this phenomenon in several cases is not found

The second argument is that of growth-led export: for instance, Lancaster (1980) and Krugman (1984) propose that output growth enhances the level of labor skills and technology – factors responsible for the construction of a comparative advantage– and as a result promotes and facilitates higher exports. Meanwhile, the third strand of literature concludes two-way

causality such as Helpman and Krugman (1985) and Bhagwati (1988). And lastly, the fourth strand of literature found that there is no systematic relationship between growth and trade. With reference to the aspect of policy implication, the direction of the relationship can help the relevant authority designing appropriate policies which emphasize on export promotion in the case of export-led growth, whereas those promoting economic development and growth would be the proper answer for a setting where the growth-led export applies.

4. Data and Methodology

4.1 Data

In this study, the estimation of GVAR model includes 33 individual countries from both advanced and emerging world (Table 5). The selection of the chosen countries follows the two main aspects of consideration. Firstly, the concern on the representativeness of the data since the share of the chosen economies on the world output accounts for approximately as high as 90 percent. Secondly the countries are chosen basing on data availability which consequently forces the exclusion of certain economies. The period of investigation covers 1999Q1-2011Q4 and the choice to start at the beginning of the 21st Century is intentional since this time marks the reallocation of global economic power from the Northern towards Southern countries. Moreover, the variables are selected basing on the reviewed theoretical foundation and, given that the main purpose of the study is to model the extent to which the chosen Southern economies drive economic growth through the channel of trade, it employs real outputs, real exports and real imports as the main variables. Here export and import are modelled jointly since GVAR framework allows to do so, differing from the majority of methods used in international trade studies that permit the incorporation of only one variable or another. Despite of its importance, this point usually remains "overlooked in the existing literature" (Bussiere et al., 2009). This aspect is rather crucial for our considerations because of "the strong import content of exports": in most countries, in fact, there is quite a strong correlation between export and import and that's why they should be taken into account simultaneously (Bussiere et al., 2009). Additionally, the model also incorporates real exchange rate and inflation variables as they help remove the presence of money illusion effect and refine the positive effect captured on real trade and output growth from the three core economies. Moreover, oil price is included in the model as the common global factor affecting the production side. The details of the variables included are reported in table 6.

Table 5: Countries and regions including in GVAR model

Core economies	***G3 economies***	***LAC economies***
China	U.S.	Mexico
India	Euro area	Argentina
Brazil	Japan	Chile
		Peru
Euro area	***Asian economies***	***Rest of the world (ROW)***
Germany	Korea	Canada
France	Indonesia	Australia
Italy	Thailand	New Zealand
Spain	Philippines	Sweden
Netherlands	Malaysia	Switzerland
Belgium	Singapore	Norway
Austria		South Africa
Finland		Turkey
		Saudi Arabia
		United Kingdom

The main source of the data used in this study is International Financial Statistics (IFS) and Direction of Trade Statistics (DOTS) database from the International Monetary Fund (IMF) while other sources are the Organisation for Economic Co-operation and Development (OECD), the World Bank, the European Central Bank (ECB), the Inter-American Development Bank (IADB) and U.S. Energy Information Administration (EIA). The frequency of the data employed here is quarterly which is believed to allow a clearer demonstration of growth and trade effect in relative to annual data frequency whose aggregation effect leads to a loss of important insights. Also, the data is seasonally adjusted and also converted into real term using consumer price index (CPI), export price index and import price index since real term eliminates the money illusion effect and allows the actual effect to be observed. For the purpose of economic interpretation, all data except inflation are included in the model in logarithmic term. In addition, the study utilizes the statistical program provided by Smith and Galesi (2011) called 'GVAR toolbox version 1.1' which was released in July 2011 and sponsored by the European Central Bank. The GVAR toolbox coupled with Microsoft Excel and MatLab is used to perform GVAR modeling in this paper. It is available and can be downloaded from the following site: *http://www-cfap.jbs.cam.ac.uk/research/gvartoolbox/index.html***.**

Table 6: Variables included in GVAR model

Variables	Descriptions	Details of data used
Y_{it}	Log (Real output)	Logarithmic of quarterly GDP (seasonally adjusted) deflated by CPI, expressed in terms of U.S. dollar
EX_{it}	Log (Real export)	Logarithmic of quarterly export (seasonally adjusted) deflated by export price index, expressed in terms of U.S. dollar
IM_{it}	Log (Real import)	Logarithmic of quarterly import (seasonally adjusted) deflated by import price index, expressed in terms of U.S. dollar
Π_{it}	Inflation rate	The percentage change in consumer price index (CPI)
RER_{it}	Log (Real exchange rate)	Logarithmic of nominal exchange rate against U.S. dollar deflated by CPI
P^{oil}_t	Log (Spot oil price)	Logarithmic of spot price for crude oil (Brent) in U.S. dollar per barrel

In order to fulfill the main purpose of the study, several economies are included in the model both (1) as an individual country and (2) combined in regions. In fact, these classifications allow more meaningful and relevant conclusions to be made regarding the effect of the positive regional and global spillover. The details of the two different models performed in this study are shown in table 7: model (1) and model (2).

Table 7: Two models examined

Model (1): Individual model (17 economies)	Model (2): Regional model (6 economies)
1. China 2. India 3. Brazil 4. U.S. 5. Euro area 6. Japan 7. Korea 8. Indonesia 9. Thailand 10. Philippines 11. Malaysia 12. Singapore 13. Mexico 14. Argentina 15. Chile 16. Peru 17. Rest of the world (ROW)	1. China 2. India 3. Brazil 4. U.S. 5. Euro area 6. Japan 7. 6 Asian economies 8. 4 Latin American countries (LAC) 9. 10 Rest of the world (ROW)

It should be noted that in the model (2) which merges some countries into a region, the regional variables are created for all endogenous (domestic) variables. These regional variables are generated as the weighted average of the variables from an individual country included in that region. The weight employed here is based on the information obtained from the Purchasing Power Parity's adjusted GDP (PPP-GDP) and, specifically, the study uses the average PPP-GDP weight during the period of 2008-2010 believed to truly reflect the current importance of a single economy in the global economic platform. The intuition behind the weight is to capture a country's output share contributing to its own regional GDP and, once the GDP of all countries in the region are added up and divided by that regional GDP, it should aggregate into a unity value. An important point to be clarified is that these PPP-GDP weights are not the same as the trade weight used in the construction of foreign variables which can be consulted in details in the methodology section.

4.2 Methodology

The study examines the transmission mechanism using GVAR modelling framework, a tool presenting a number of advantages if compared to the traditional standard VAR model which is able to handle only a relatively small number of variables (Çakir and Kabundi 2011).

Moreover, VAR model is usually exercised in time series studies while the introduction of GVAR approach allows the aspect of multi-country or panel data to be exploited. In addition to these advantages, GVAR presents other two fundamental merits, in particular for the international trade modelling:

1) The model allows the interaction of a large number of countries to be included in the model systematically (Bussiere et al., 2009). This is very important particularly for the highly integrated world economy. Simultaneously, the model is able to capture both the impact of the slowdown in Northern economies (U.S. growth and EU debt crisis) and the rising role of emerging economies (Asia).
2) Export and import can be jointly estimated in the same estimation (Bussiere et al., 2009) particularly in the current international trade setting where outsourcing, offshoring, and vertical integration as supply chain network of intermediate goods accounts for a larger and larger share in international trade. This transition of trade feature certainly has an important implication on the transmission of shocks across markets.

The estimation of GVAR model consists of two main procedures: first, it individually models a country as a small open economy by estimating a country-specific VECM and, secondly, combines and links all estimated country-specific models into GVAR using the trade linkage matrix, therefore making the model able to simultaneously generate an impulse response function for the shock at the world level.

4.2.1 Estimating country-specific model

In a country-specific model (VARX*), the variables included are (1) domestic variables (X_{it}) which are endogenously determined in the country and (2) foreign variables (X^*_{it}) which ideally should be exogenously determined. Under the framework of GVAR, the foreign variables however are required to satisfy only weakly exogeneity condition. Here in this study, the variables included in each country-specific model for all economies except the U.S. are namely:

$$X_{it} = (Y_{it}, EX_{it}, IM_{it}, \Pi_{it}, RER_{it}) \text{ and } X^*_{it} = (Y^*_{it}, \Pi^*_{it}, P^{oil}_t)$$

Meanwhile, the U.S. economy is included in the model as the reference country because of its significant role in the global economy, and in turn, the variables included in the U.S. model slightly differ from those of other countries. These variables included are namely:

$$X_{U.S.t} = (Y_{U.S.t}, EX_{U.S.t}, IM_{U.S.t}, \Pi_{U.S.t}, P^{oil}_t) \text{ and } X^*_{it} = (Y^*_{U.S.t}, \Pi^*_{U.S.t}, RER^*_{U.S.t},)$$

It should be noted that in the U.S. case, real exchange rate is included as an exogenous variable because of the assumption that the value of U.S. dollar is determined by other economies.

Instead, oil price is included in the model as an endogenous variable given the predominant role of the U.S. economy. In short, the differences between a country-specific and the U.S. model are the variable of real exchange rate is included as endogenous while price of oil is incorporated as exogenous variable in a country-specific model and vice versa for the U.S. model.

4.2.2 The construction of trade weight

In the pioneer work by Dees et al. (2007), it is pointed out that the most important feature of GVAR framework is "the systematic inclusion of the country-specific foreign variables in the individual country models in order to deal with the common factor dependencies that exist in the world economy" (Dees et al., 2007). In fact, the systematic inclusion refers to each country's trade weight which indicates their degree of trade integration between the two economies, and it is calculated as follows:

$$W_{ij} = \frac{\text{Export from country i to j + Import of country i to j}}{\text{Total trade of country i}} = \frac{\text{Total trade of country i with j}}{\text{Total trade of country i}}$$

As can be seen from the above formula, W_{ij} captures the importance of country j on country i in terms of their trade relation. Table 2 shown in section 2.2 presents the evolution of average trade shares for the major trading blocs over the whole period of the study (1999-2010) to demonstrate the stylized facts of international trade. However, in the model estimation, the average annual trade weight is utilized in the construction of foreign variables included in the country-specific models. In fact, foreign variables are systematically linked in the GVAR system using the average trade weight during the last five years of the study, specifically from the year 2006-2010, in order the capture the most current trade integration among the selected economies. The data on annual bilateral trade is obtained from the IMF's Direction of Trade Statistics (DOTS) database.

4.2.3 Unit root test

Prior to the estimation of cointegration in country-specific variables, the stationary properties of each variable in each country are examined. In fact, the common characteristic of most economic and financial time series is that they exhibit trending behavior or non-stationary, violating the cointegration model's assumption and possibly produce misleading results. In order to reassure the stationary property, the study employs both the traditional Augmented Dickey-Fuller (ADF) test and the Weighted Symmetric Augmented Dickey-Fuller (WS-ADF) test – a method which are able to solve the problem arising from a small sample size. Both stationary tests are performed in level, first difference and second difference of the variables. The appropriate lag structure is chosen basing on the information criteria to

eliminate the autocorrelation problem in the error terms. The problem of dynamic misspecification leads to inconsistent estimators whereas too many lags could also cause the problem of losing degrees of freedom and obtaining large standard errors (inefficient estimators). In particular, both Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are used to determine the lag structure. It should be noted that BIC is superior to AIC especially in case of a small sample case since BIC penalizes more heavily larger model orders, implying that it gives an exact number of lags needed.

Since the stationarity property of variables is not the focus of this study, the results from unit root tests are briefly presented in this section: the unit root tests basing on ADF and WS-ADF tests are shown in table 8 and 9. As anticipated, most of the selected variables are unit root, i.e. real outputs, real exports and real imports, real exchange rate and inflation are not stationary in their level but are white noise in their first difference: I(1). This result on stationary allows a further examination of cointegrating long-run relationship.

Table 8: Unit root tests for the domestic variables using ADF test

Domestic Variables	**Asia**	**Brazil**	**China**	**Euro Area**	**India**	**Japan**	**LAC**	**ROW**	**USA**
lnrgdp (with trend)	-3.04	-1.67	-2.67	-2.30	-2.96	-2.25	-2.16	-2.89	-1.88
lnrgdp (no trend)	-0.66	-0.09	-0.66	-1.05	-0.65	0.37	-2.09	-0.79	-1.17
Dlnrgdp	-4.23	-5.20	-4.46	-4.92	-3.23	-3.29	-4.08	-4.48	-3.60
DDlnrgdp	-6.92	-5.94	-6.19	-6.40	-5.64	-10.96	-6.78	-5.66	-4.44
lnrexp (with trend)	-3.32	-2.22	-2.29	-1.85	-3.04	-3.06	-2.69	-2.91	-2.48
lnrexp (no trend)	-0.12	-0.31	-1.14	-1.00	-0.07	-2.33	-1.64	-1.34	-1.03
Dlnrexp	-4.24	-4.74	-4.27	-2.33	-5.70	-3.49	-4.09	-4.36	-4.40
DDlnrexp	-5.54	-7.88	-5.89	-7.67	-6.68	-5.27	-6.36	-5.78	-7.30
lnrimp (with trend)	-3.64	-2.52	-2.53	-2.78	-2.38	-3.70	-2.81	-3.06	-2.33
lnrimp (no trend)	-0.45	-1.13	-0.40	-0.99	-0.76	-0.65	-1.27	-0.91	-1.57
Dlnrimp	-3.09	-4.43	-4.61	-4.81	-5.02	-4.72	-4.08	-4.46	-4.89
DDlnrimp	-6.58	-6.03	-5.46	-6.17	-7.27	-5.96	-6.20	-6.23	-5.44
lnrer (with trend)	-2.99	-1.86	-2.84	-2.50	-2.75	-2.13	-2.72	-3.07	
lnrer (no trend)	-0.24	0.11	-0.08	-0.83	0.26	-0.37	-2.56	-0.39	
Dlnrer	-4.83	-5.93	-5.37	-4.90	-3.65	-2.93	-4.96	-5.28	
DDlnrer	-7.64	-6.65	-6.59	-6.49	-5.34	-11.88	-5.80	-6.00	
inf (with trend)	-3.97	-3.95	-4.30	-2.99	-1.73	-2.13	-5.61	-0.67	-2.14
inf (no trend)	-4.03	-1.43	-4.34	-2.80	-0.98	-2.14	-5.37	-1.85	-2.03
Dinf	-4.98	-2.98	-4.67	-5.90	-2.42	-5.44	-5.56	-3.29	-3.46
DDinf	-6.12	-6.96	-5.14	-5.35	-8.84	-5.69	-5.68	-6.35	-7.75

Note: The critical value at 5% significant level is -2.89 and -3.45 when including a trend component.

Table 9: Unit root tests for the domestic variables using WS-ADF Test

Domestic Variables	Asia	Brazil	China	Euro Area	India	Japan	LAC	ROW	USA
lnrgdp (with trend)	-3.22	-1.16	-2.26	-2.18	-2.69	-2.38	-2.39	-2.77	-1.64
lnrgdp (no trend)	-0.38	-0.72	-1.01	-1.16	-0.60	-0.12	-2.35	-1.06	0.44
Dlnrgdp	-4.43	-5.52	-4.71	-5.05	-3.42	-3.31	-4.30	-4.73	-3.53
DDlnrgdp	-7.22	-6.36	-6.63	-7.07	-5.87	-10.68	-7.15	-6.07	-4.58
lnrexp (with trend)	-3.50	-1.78	-2.40	-2.14	-3.17	-3.30	-2.96	-3.07	-2.66
lnrexp (no trend)	-0.06	-0.76	-1.24	-0.62	0.40	-1.91	-1.52	-1.36	-1.12
Dlnrexp	-4.51	-4.95	-4.52	-2.60	-5.97	-3.73	-4.30	-4.61	-4.65
DDlnrexp	-5.83	-8.19	-6.30	-8.18	-7.08	-5.41	-6.65	-6.21	-7.43
lnrimp (with trend)	-3.88	-2.42	-2.49	-3.02	-2.53	-3.93	-2.97	-3.16	-2.54
lnrimp (no trend)	0.14	-1.46	-0.38	-0.60	-0.25	-0.05	-1.38	-1.08	-0.89
Dlnrimp	-3.14	-4.71	-4.86	-5.07	-5.28	-4.95	-4.33	-4.71	-5.05
DDlnrimp	-7.03	-6.48	-5.84	-6.61	-7.74	-6.48	-6.56	-6.59	-5.85
lnrer (with trend)	-2.82	-1.48	-1.97	-2.12	-2.26	-2.14	-2.99	-2.92	
lnrer (no trend)	-0.22	-0.27	-0.61	-0.99	0.08	-0.88	-2.80	-0.35	
Dlnrer	-5.08	-6.19	-5.55	-4.98	-3.85	-2.97	-5.14	-5.53	
DDlnrer	-7.95	-7.05	-6.90	-7.17	-5.74	-11.64	-6.17	-6.39	
inf (with trend)	-2.56	-3.52	-4.55	-2.63	-1.67	-2.46	-5.21	-1.04	-2.28
inf (no trend)	-2.22	-1.77	-4.59	-2.65	-1.35	-2.43	-4.59	-0.22	-2.29
Dinf	-2.09	-3.23	-5.02	-6.21	-2.38	-5.88	-5.60	-3.49	-3.58
DDinf	-4.49	-7.34	-5.55	-5.68	-8.51	-6.77	-6.14	-6.80	-8.30

Note: The critical value at 5% significant level is -2.55 and -3.24 when including a trend component.

4.2.4 Cointegration test

While there is still no consensus concerning the short-run relationship among macroeconomic variables, researchers generally agree upon the long-run ones (Bussiere et al., 2009). "Theories of long-run relations look at equilibrium conditions between the observed variables which hold over a certain period of time" (Bussiere et al., 2009). Among the variables of interest in this study, there are several possible existing long-run relationships as demonstrated in table 10.

Table 10: Possible Theoretical Long-run Relationship

Theories	
Purchasing power parity	$RER_{it} \sim I(0)$
Output convergence	$Y_{it} - Y^*_{it} \sim I(0)$
Stationarity of real trade balance	$EX_{it} - IM_{it} \sim I(0)$
Trade equation Export Import	 $EX_{it} - \alpha_i RER_{it} - \beta_i Y^*_{it} \sim I(0)$ $IM_{it} - \gamma_i RER_{it} - \delta_i Y_{it} \sim I(0)$

Source: Bussiere et al. (2009)

In order to identify the number of existing relationships, the rank of cointegration is then determined after the stationary test. In this study, the standard Johansen reduced rank procedure (Johansen, 1992 and 1995) is performed for each individual country basing both on

the specification of a country-specific model (VARX*) and on the appropriate lag structure of domestic and foreign variables. Since there are eight variables included in each country-specific model, statistically there can be at most seven cointegrating relationships among these variables. Table 11 reports both the lag structure chosen for domestic and foreign variables and the number of cointegrating relationships contained in each country.

Table 11: VARX* orders and cointegrating relationship in the country-specific models for the major trading blocs

Economies	Lag of domestic variables (p)	Lag of foreign variables (q)	No. of cointegrating relations
Asia	2	1	3
Brazil	1	1	2
China	2	1	2
Euro Area	2	1	3
India	2	1	2
Japan	1	1	2
LAC	2	1	2
ROW	1	1	2
USA	2	1	4

4.2.5 Weak exogeneity test

The exogeneity property of foreign (X^*_{it}) and global variables is the key assumption underlying GVAR model as the estimation of country specific model is based on this weak exogeneity assumption. Consequently, it is necessary that the selected foreign variables follow this requirement. The test of exogeneity employed here is based on Johansen (1992) and Harbo et al. (1998) which assess the joint significance of the estimated error-correcting terms for the country-specific foreign variables. The test of weak exogeneity examines the following equation for each l^{th} element of X^*_{it} in each individual country i model:

$$\Delta X^*_{it} = \mu_{il} + \sum_{j=1}^{r_i} \gamma_{ij,l}\, ECM^j_{i,t-1} + \sum_{k=1}^{p_i} \theta_{ik,l} \Delta X_{i,t-k} + \sum_{m=1}^{q_i} \delta_{im,l} \Delta X^*_{i,t-m} + \varepsilon_{it,l}$$

Note that $ECM^j_{i,t-1}$ for j=1, 2, …, r_i refers to the estimated error-correcting term corresponding to r_i cointegrations or to the rank for country i determined in country-specific model using Johansen's reduced-rank procedure. $\Delta X_{i,t-k}$ for k=1, 2, …,p_i is the difference of domestic variables of country i for p lag orders whereas ΔX^*_{it} for m=1, 2, …,q_i is the difference of foreign and global variables of country i for q lag orders.

The testing result for weak exogeneity is shown in details in table 12 which reports the results on joint significance test (F-Statistics) that $\gamma_{ij,l} = 0$ for each j=1, 2, …, r_i. It can be seen

from table 12 that all variables included as foreign or global variables cannot be rejected of their weak exogeneity assumption thereby the key assumption of the GVAR model is satisfied.

Table 12: Test for weak exogeneity at the 5% significance level

Country	F-test	Critical values	Real output	Oil price	Inflation
Asia	F(3,31)	2.9113	0.7697	0.1888	0.9311
Brazil	F(2,37)	3.2519	0.1369	0.0477	0.3675
China	F(2,32)	3.2945	0.1044	0.0633	2.2163
Euro Area	F(3,31)	2.9113	1.0870	0.0310	3.3309
India	F(2,32)	3.2945	1.8887	0.0148	1.6456
Japan	F(2,37)	3.2519	0.4706	0.0255	0.7334
LAC	F(2,32)	3.2945	0.6559	1.4783	0.3740
ROW	F(2,37)	3.2519	0.3615	0.0040	2.0510
			Real output	**RER**	**Inflation**
USA	F(4,30)	2.6896	0.2471	0.3290	0.7073

5. Empirical findings

In this study, the GVAR model (1) contains in total 17×8 = 136 variables for 17 economies, each of them having 8 variables and consequently there are as many possible simulations –the effect of a shock initiated in one variable on all other variables in the GVAR system –that can be assessed. In order to fulfill the objective of this study in evaluating the increasing importance of the three large emerging economies –China, India and Brazil, only certain simulations are chosen to be presented in this part of the empirical findings.

In this section, two main results of the generalized impulse response function (GIRF) and the generalized forecast error variance decomposition (GFEVD) are presented. First, GIRF demonstrates a reaction of a variable over time in response to a one unit (one standard error) change in the shock variable. Secondly, GFEVD shows the fraction of the variance explained by enabling the understanding of the true influence and dominant cause of change. These two measurements help examine "the dynamic properties of the global model and to assess the time profile of the effects of shocks" (Dees et al., 2007). It is important to note that the GVAR framework offers in this regard a vital advantage over the traditional Vector Autoregressive (VAR) model: in this case, in fact, both GIRF and GFEVD are invariant to the ordering of the variables. This merit is a particularly important property when dealing with a large macroeconomic system (Çakir and Kabundi, 2011). This paper reports a positive output shock originated in all three core economies and additionally presents the same findings from the advanced economies. The implication of a positive output shock reveals the role of domestic and foreign demand: the extent to which an increase in domestic demand in a given country affects its trading partners' export and growth. The study initially follows the recommended time

horizons of 40 quarters, which is believed to be consistent with the convergence properties (Smith and Galesi, 2011). The impulse response function is however very sensitive and volatile to any additional external changes and therefore the chosen time horizons for the economic interpretation should be limited to only 24 quarters or 6 years ahead.

Before looking into the empirical findings, it should firstly be noted that in figure 8-17 the thick line indicates the median point estimates as a consequence of one standard deviation shock, while the dotted line represents the bootstrapped mean values of GIRFs with the confidence interval of 90 percent. With respect to time horizon, short-term here refers to the impact of shock occurred within one year whereas long-run refers to the effect after 3 years from shock origination. Additionally, the paper reports the average impact of shock measured as the arithmetic average for the whole 24 quarters.

5.1 A shock to Chinese output

Figure 8-9 (8a to 9i) demonstrates the GIRFs of a positive shock to Chinese output: a positive shock to Chinese national income, in fact, corresponds to approximately an increase of 4.61 percent in its GDP. A noticeable reaction to this favorable shock is an average rise of Chinese import by 6.30 percent in the short-run (within one year) and by 7.76 percent, even higher in the longer-run (after three years). These results certainly reflect the strong final demand from China as a global consumer as its income grows.

As anticipated, the positive shock to Chinese output also helps promote exports in other economies, particularly for the Asian ones (figure 8g) such as Indonesia and Singapore. One positive standard deviation shock in GDP of China improves the exports of Asian region as a whole by 2.28 percent at the impact and this positive spillover continues to increase to 3.84 and reaches the highest magnitude of 5.15 percent in the third quarter after the shock is initiated. This finding definitely confirms the idea of China being the regional growth driver for Asia. However, the interpretation that China generates final demand should be cautiously undertaken as China is actually known to take the role of the assembly hubs for the Asian supply chain network; a large increase in exports from Asian countries from an increase in Chinese GDP might be the contribution of an increase in exports of intermediates rather than final goods. This is, in fact, one of the limitations in this study because the data employed does not distinguish the types of goods traded but only the aggregate value of export and import.

As for the favorable spillover to the other large emerging countries, Chinese growth in output generates as well a significant rise in exports of both India and Brazil (figure 8b and 8c): on average, they gain 3.57 and 3.94 percent respectively from a positive shock in Chinese GDP. Looking closely to the data, India obtains higher benefits in the short-run (an average increase of 4.15 percent) while Brazil is able to exploit the favorable effect to a comparable level in the

long-run (an average increase of 4.14 percent). More importantly, the effect from the growth in output seems to be quite long lasting: the impact remains positive and significant over the whole period of consideration (24 quarters).

From the perspective of advanced countries, G3 economies are the least fortunate in obtaining the benefit from the rise of China. Even though they experience a positive spillover in term of export performance, the favorable effects are found to be less significant in comparison to other countries. On average, the positive GDP shock increases export of the U.S., Euro area and Japan by 1.75, 2.26 and 3.21 percent respectively. Among these three economies, Japan is able to obtain the highest benefit and the probable explanations are China-Japan close proximity both in terms of geographical distance and strong trade tie.

With regard to the effect on economic growth (figure 9; 9a to 9i), a positive shock in GDP also creates a positive and long-lasting impact to all other economies despite variations in the magnitude. One standard deviation shock corresponds to an average increase of 2.58 and 4.9 percent in GDP of India and Brazil, and the positive spillover creates the highest degree of positive growth for both countries in the second quarter after the shock. It should be noticed that even though the relationship between China and India presents the advantage in terms of geographical proximity in comparison with the case of China-Brazil, the results show in both cases of export and economic growth that the positive spillover from China to India is still weaker than that to Brazil. This finding is, in fact, in line with the finding of Cesa-Bianchi et al. (2011) whose result found on Brazil also indicates that the positive impact obtained from China's growth is significantly high.

In terms of regional growth spillover, Asian region takes the advantage of China's growth: on average, one standard deviation growth in Chinese GDP leads to 2.57 percent growth in output growth of Asia region as a whole. The benefit is highest in the second quarter after the positive shock: a growth in Chinese output creates 3.83 percent for Asian region. This finding, in fact, solves the 'mystery' found on the spillover towards export –whether the export to China concentrates only on intermediate goods or also on high value added products– and it reassures the conclusion that Chinese growth derives from its true final demand as a result of its economic expansion and not from its re-exporting activities. Surprisingly, a positive growth in Chinese output is also able to significantly create positive spillover to the growth of Latin American economies: at the highest impact, one positive standard deviation shock creates 4.0 percent output growth for the region. This finding corresponds to the result reported in the study by Cesa-Bianchi et al. (2011), indicating that a positive shock to Chinese output has increasingly benefited the economy of LAC since 1990s. In short, the finding reflects the importance of Chinese economy even for the non-neighboring countries.

As for the impact on the advanced countries, the spillover effects are relatively much less impressive. In particular, a positive growth of China is not able to generate much output growth in the U.S.: one positive standard deviation shock in Chinese output only corresponds to an average rise of 0.51 percent in U.S. GDP. Furthermore, the study by Cesa-Bianchi et al. (2011) provides additional insights relating to the increased influence of Chinese economy: with a more recent trade weight (that of 2009) employed in their GVAR model, in fact, a favorable shock to Chinese GDP yields a more significant positive outcome to both industrialized and emerging countries, particularly in the long-run. The long-run impact for the U.S., for example, is proven to increase by 50 percent when applying the trade weight of year 2009 over 1995, demonstrating the acceleration of China's integration to the world economy at the beginning of 1990s.

More importantly, the implication behind the Chinese beneficial spillover should also be counter-factually considered. In the event at which China were to experience a period of decelerated growth, the impact would surely be felt in other countries, particularly in its neighbors. In fact, Cova et al. (2010) suggest that Chinese growth would have been 2.60 percent lower than its actual growth in 2009 if the Chinese extensive fiscal stimulus package were not implemented. Certainly, this further implies that both Asian and LAC economies, who benefit largely from the Chinese positive spillover, would have been slower in their recovery process after the global financial crisis.

Figure 8: Generalized Impulse Response Function (GIRF) for a positive shock in China's real GDP on real export of other economies

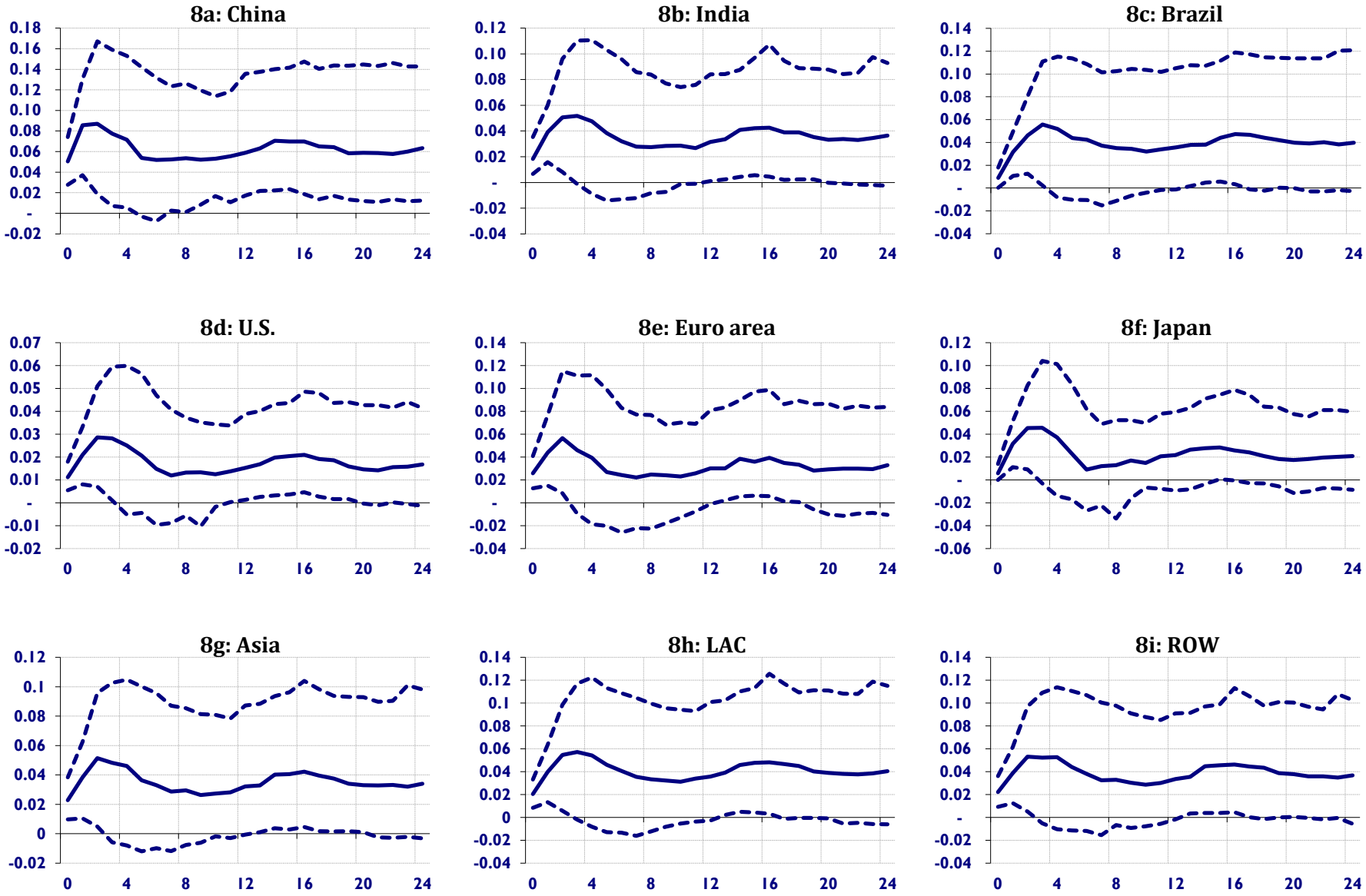
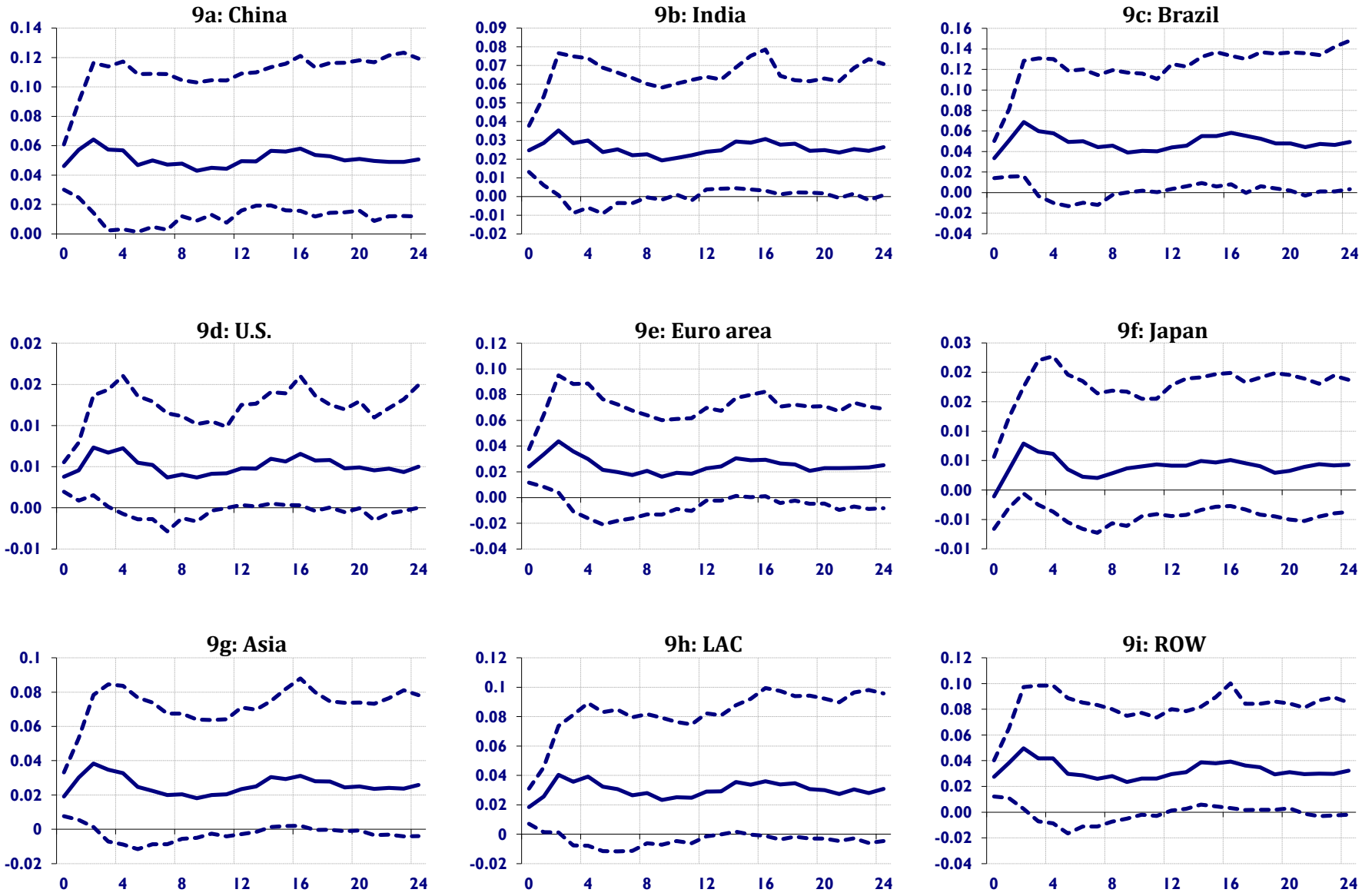


Figure 9: Generalized Impulse Response Function (GIRF) for a positive shock in China's real GDP on real output of other economies



5.2 A shock to Indian output

The GIRFs of a positive shock to India's GDP are shown in figure 10-11 (10a to 11i). A positive shock to India's output in fact corresponds to an increase of its GDP by 2.19 percent. This positive impact on India's income leads to a small increase in its import: an increase of 1.04 in the short-run and only 0.50 percent in the long-run. This implies that India holds a lower ability, in comparison with China, to generate demand for other economies' products. In fact, this result is in line with what is found in the impulse response for other economies' exports: an increase in India's national income, as anticipated, does not significantly generate a significant rise in exports of other economies, even for the Asian neighboring countries. In the short-run, the average impact on Asia's export is as trivial as 0.44 percent and the highest impact found is only 0.59 percent during the fourth quarter after the impact. This small positive impact is also shown to be temporary and dies out over time. The result implies that through the linkage of trade, India is still not a reliable source of growth for its region.

In the same way, India's positive output growth does not create a significant and favorable spillover to the exports of the other two large emerging economies and the small positive effect is short-lived. This result is also corresponding to what is found for the advanced economies: among G3 countries, the export of U.S. benefits the most from India's income growth; still this positive spillover is rather insignificant and found to be temporary. As a matter of fact, it can be concluded that the trade linkages between India and other economies, given India's economic size, are relatively low, creating the doubt of its role in being a global growth driver.

The same conclusion also applies for the impact on other economies' output growth (figure 11: 11a to 11i): the positive GDP shock in India can only generate an average of 0.38 and 0.13 output growth for China and Brazil respectively. Looking at the results in details, this small positive effect is observed only in the short-term. As for the role of growth driver for the region, it is still questionable whether the rise of India can provide sufficient growth spillover to its neighboring economies through the channel of international trade and thus the role of core regional driver should at this point remain in China's shoes. Correspondingly, India's output growth also does not create any benefits to the advance G3 economies.

Despite the estimated results showing trivial impact of India, the interpretation should however not lead to the conclusion that the growth of India is insignificant to the global economy. The most plausible explanation why in this study India plays a less influential role is its economic characteristic which specializes in service sector rather than manufacturing and consequently the measurement of trade linkages might not be able to capture the reality while

an additional examination of other channels such as financial linkage could provide better insights.

5.3 A shock to Brazilian output

Another important rising influential economy examined in this study is Brazil; its impressive impact obtained from the empirical findings is in fact beyond the author's expectation. Figure 12-13 (12a to 13i) demonstrate the effect of the Brazilian positive output shock on the export and output growth of other economies. One positive standard deviation shock to Brazil's national income corresponds to approximately an increase of 4.50 percent in its GDP. This positive shock immediately translates into a rise of Brazil's demand for import: an average increase of 7.93 percent is observed for the whole period of 24 quarters. Looking closely, import rises by 7.22 percent in the short-run whereas in the long-run its expansion is even more impressive (an average increase of 8.13 percent).

As a potential regional growth driver, the positive effect is promising for Latin American countries: it is found that a positive shock to GDP of Brazil creates an export improvement of 3.82 percent on average for the region as a whole. In the short-run, the magnitude of spillover for export is 4.29 percent and this positive spillover remains strong and in place for LAC even after three years with the impressive long-run average of 3.8 percent. Individually, Mexico and Peru are the countries who are able to capture the highest benefits from the rise of Brazil: they experience, on average, a 4.69 and 4.04 percent improvement in export on average as a consequence of a positive shock in Brazil's GDP. The finding certainly supports Brazil as a successful regional driver.

In terms of the spillover to China and India's exports, Brazilian output growth generates a significant rise in demand for foreign goods by 4.29 and 2.99 percent, on average, respectively. Initially, China's and India's exports rise by 5.55 and 3.66 percent and this positive effect persist even in the long-run with slightly lower magnitudes of 4.23 and 2.92 percent. It should be noted that the higher elasticity between China and Brazil applies two-way, i.e. both positive spillover from China towards Brazil and vice versa. This is due to the higher integration between the two in terms of trade particularly over the recent decades. Cesa-Bianchi et al. (2011), in fact, suggest that the growing linkage between China and Brazil exists not only in terms of a direct trade linkage but also via an indirect one transmitted through their traditional trading partners, particularly the U.S. and Euro area who hold high trade integration with both China and Brazil.

As opposed to China, a positive output growth in Brazil translates to a significant rise of export for the U.S.: the result shows that the exports of the U.S. rise consecutively for 0.51, 1.43, and 2.26, in response to the positive GDP shock, and reach the highest 2.51 percent in the third quarter after the shock is initiated. The plausible explanation for this higher impact, in relative

to China, is the geographical distance between Brazil and the U.S. which facilitates and promotes their trade tie.

In comparison to China, Brazil's impact on other countries' exports is generally smaller while the country is actually able to overcome India's positive effects. Furthermore, the favorable impact from both China and Brazil are found to be long-lasting as the outcomes remain positive over the forecasted horizons. For instance, the impact from Brazil's growth in G3 market as a whole is relatively high: the greatest impact reaches 3.25 percent in the third quarter after the impact whereas the positive effect from China is even more substantial as it is able to promote as high as 4.10 percent increase in export during the second quarter after the shock.

In addition to the positive spillover on exports, the impact of Brazilian output growth can be further extended to other countries' GDP growth as shown in figure 5.6 (5.6a to 5.6i). The results indicate that there is a positive spillover effect from Brazil's output growth to the other two emerging economies: for instance, a unit increase in Brazil's GDP generates an average increase of Chinese output by 2.63 over the 24 quarters, of which the highest impact of 4.09 percent occurs at the second quarter after the shock and the favorable impact remains persistently positive even in the long-run. A positive impact is also observed for India: on average, there is an increase of 1.62 percent in GDP and the highest impact of 2.82 percent occurs during the second quarter after the impact.

In terms of its role as a regional growth driver, Brazil is also able to perform impressively since its growth generates a significant and permanent increase in its neighboring countries' output. LAC economies, in fact, experience an improvement in GDP as a region by 1.11, 1.79 and the highest degree of 2.97 percent consecutively after the positive shock is originated. At the same time, the long-run average (an increase of 2.04 percent in GDP) persists and remains close to the impact in short-run (an increase of 2.26 percent in GDP). Looking at the result from an individual country, another large important emerging country in the region, Mexico, receives a very high growth spillover (an average of 2.48 percent increase in its GDP) from output growth in Brazil, this positive impact occurs almost immediately and the gain in the short-run is substantial (an increase of 3.19 percent).

In contrast to the findings above, the spillover from Brazil does not lend a hand to the growth generation in the advanced economies. Both in the U.S. and Japan, an increase in Brazil's GDP does not lead to an increase in output of the two countries neither in the short- nor in the long-run.

Similar to the reaction of exports, the Brazilian spillover towards output, on average, is still at a lower degree for all markets in comparison with that of China. However, its

performance is very much promising and it is able to surpass India, at least in terms of the spillover through international trade channels.

5.4 A shock to U.S. output

Even though the main objective of the study is to evaluate the role of rising emerging economies, it is also important to examine the impact from the perspective of advanced countries, particularly from the U.S., as the investigation provides a natural benchmark and additionally presents the supporting argument on the growing importance of emerging markets.

Figure 14-15 (14a to 15i) display the GIRFs of a positive shock to the GDP of the U.S.: an increase in its national income, in fact, corresponds to approximately a rise of 0.20 percent in GDP. Even with this positive effect, an increase income is proven not to translate much to a higher import demand: the demand for import in fact slightly increases only by 0.16, 0.29 and 0.36 immediately and during the first and second quarter after the impact. Additionally, a positive effect on import begins to vanish afterwards. This finding surprisingly reflects a low degree of positive spillover from the U.S. economy. It is, in fact, corresponding to what is found in Cesa-Bianchi et al. (2011): by using the recent trade weight (2009), the U.S. impact on both industrialized and developing countries falls drastically, and the positive impact on the U.S. economy itself reduces by roughly 50 percent if compared with the 1995 trade weight.

In line with the impulse response function found in U.S. import, a positive growth in U.S. output creates rather insignificant and temporary effect on the majority of the countries. In particular, one positive standard deviation in U.S. GDP does not significantly generate higher exports for China, India, and Brazil as demonstrated in figure 14 (14a to 14c). While there is no significant effect on China, the positive effect on the export of India lasts only until the third quarter after the impact, and the effect on Brazil disappears right after the first quarter following the shock. Similarly, the positive spillover is also small for other developing economies: Asia's export increases by 0.21 percent at the impact before vanishing whereas the impact on LAC exports is slightly higher with a rise of 0.27 and 0.05 percent and disappears after the first quarter following the positive shock. Again, the empirics are consistent with the study by Cesa-Bianchi et al. (2011): in using the new trade weight (2009), the short-run impact drops considerably while the long-run impact reduces by 50 percent in relative to the 1995 trade weight. Correspondingly, the effect of the positive shock on the output of other economies is generally insignificant and exists only temporarily.

Even though this interpretation seems counter-intuitive in the light of the common perception that the U.S. is the most influential economy in the world, it is somewhat

corresponding to several literature (Bussiere et al., 2009; Kose and Prasad, 2010; Cesa-Bianchi et al., 2011) which proves the existence of the decoupling hypothesis. For instance, Cesa-Bianchi et al. (2011) found the evidence supporting decoupling: several developing countries become more autonomous in terms of their economic growth.

The important implication behind this finding can be referred to the event of the great recession originated from the U.S. economy in 2008. Even though the negative impact was sudden and severe, countries in both Asia and Latin America were able to gain their momentum much faster than what many economists had anticipated. This is the consequence of the decoupling from the U.S. and simultaneously higher integration with China. From a counter-factual point of view, the adverse impact would have been much stronger if the recession were to happen during 1990s when the U.S. economy played a much more central role (Cesa-Bianchi et al., 2011).

Figure 10: Generalized Impulse Response Function (GIRF) for a positive shock in India's real GDP on real export of other economies

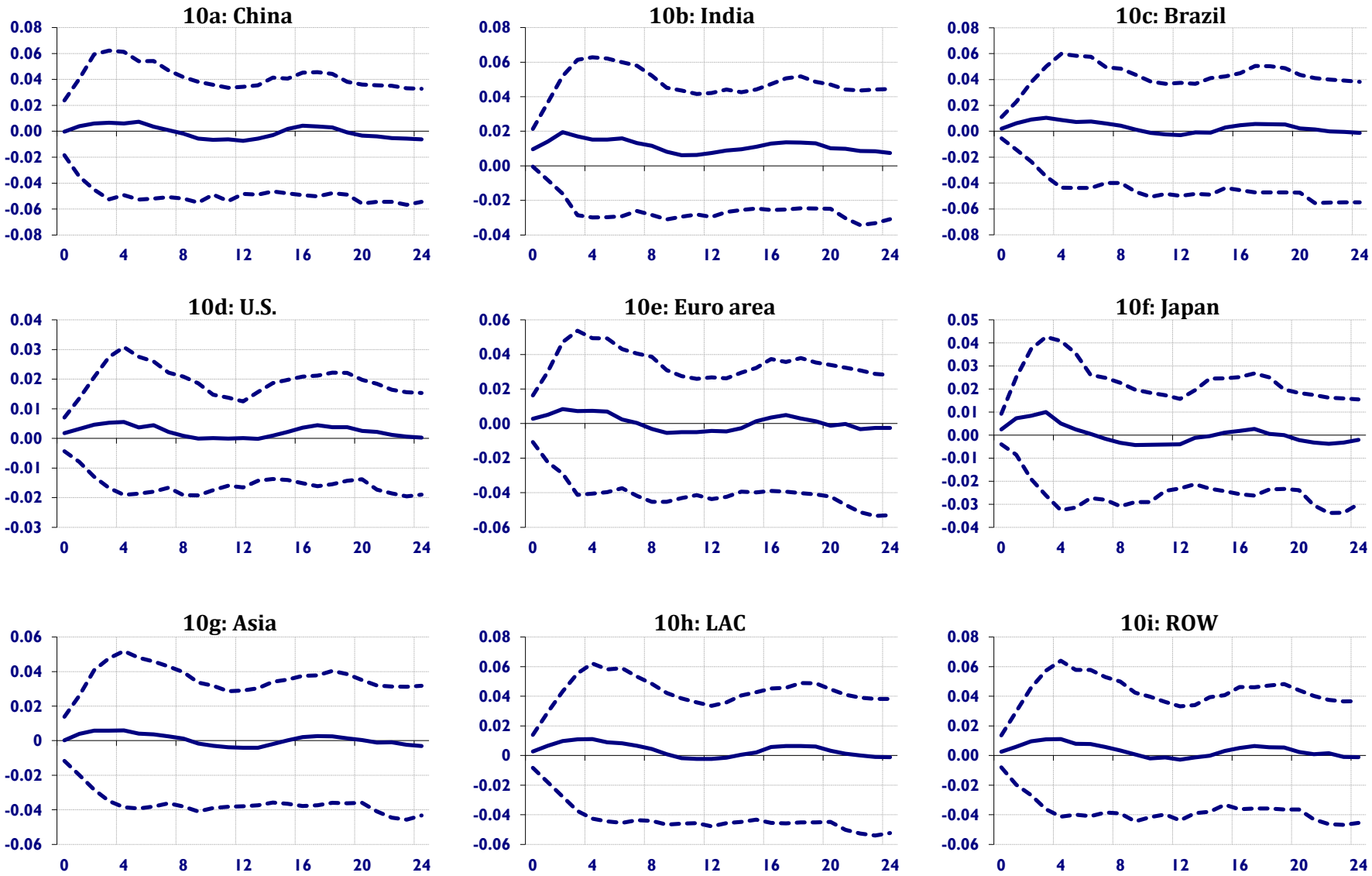


Figure 11: Generalized Impulse Response Function (GIRF) for a positive shock in India's real GDP on real output of other economies

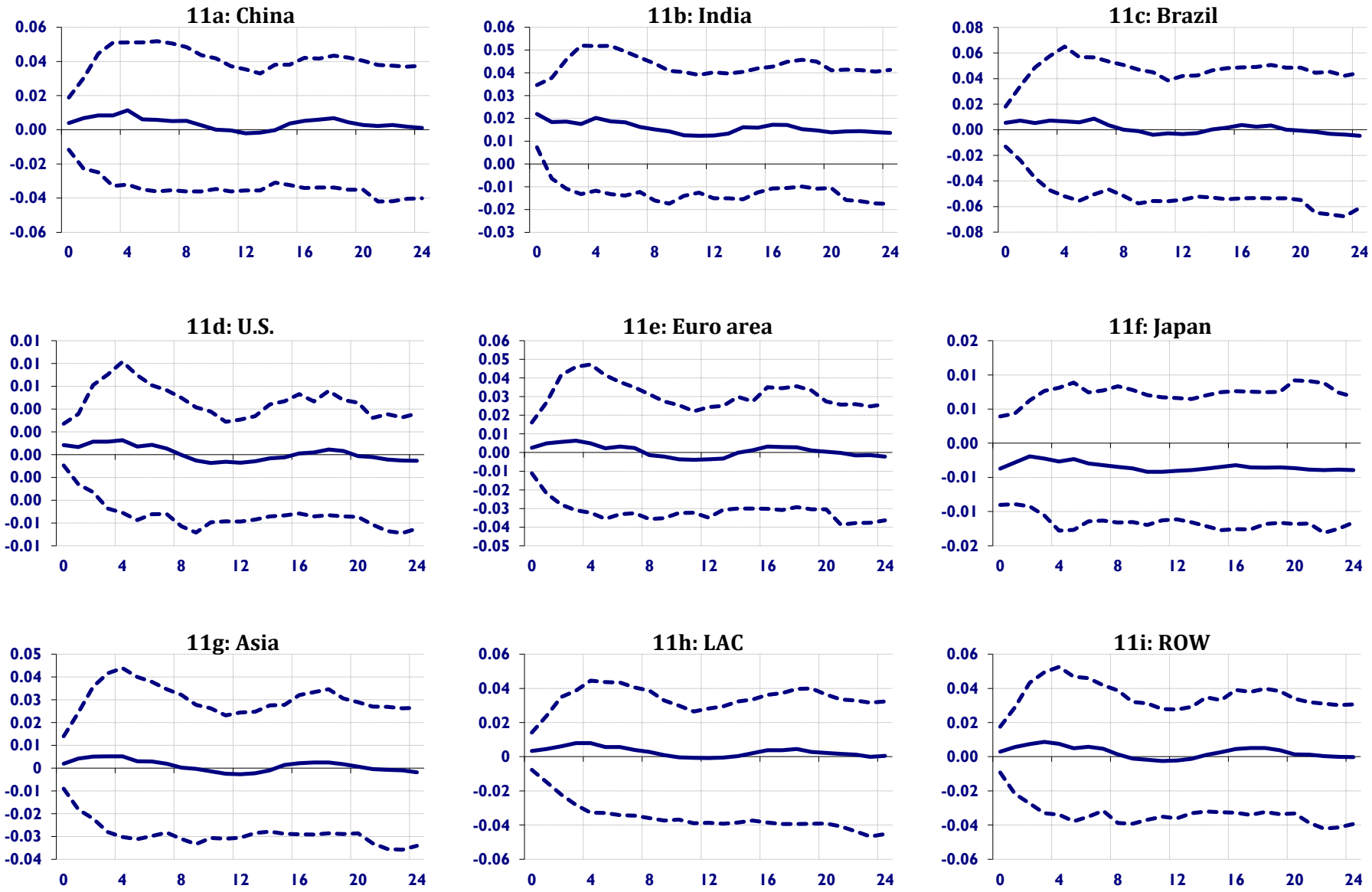


Figure 12: Generalized Impulse Response Function (GIRF) for a positive shock in Brazil's real GDP on real export of other economies

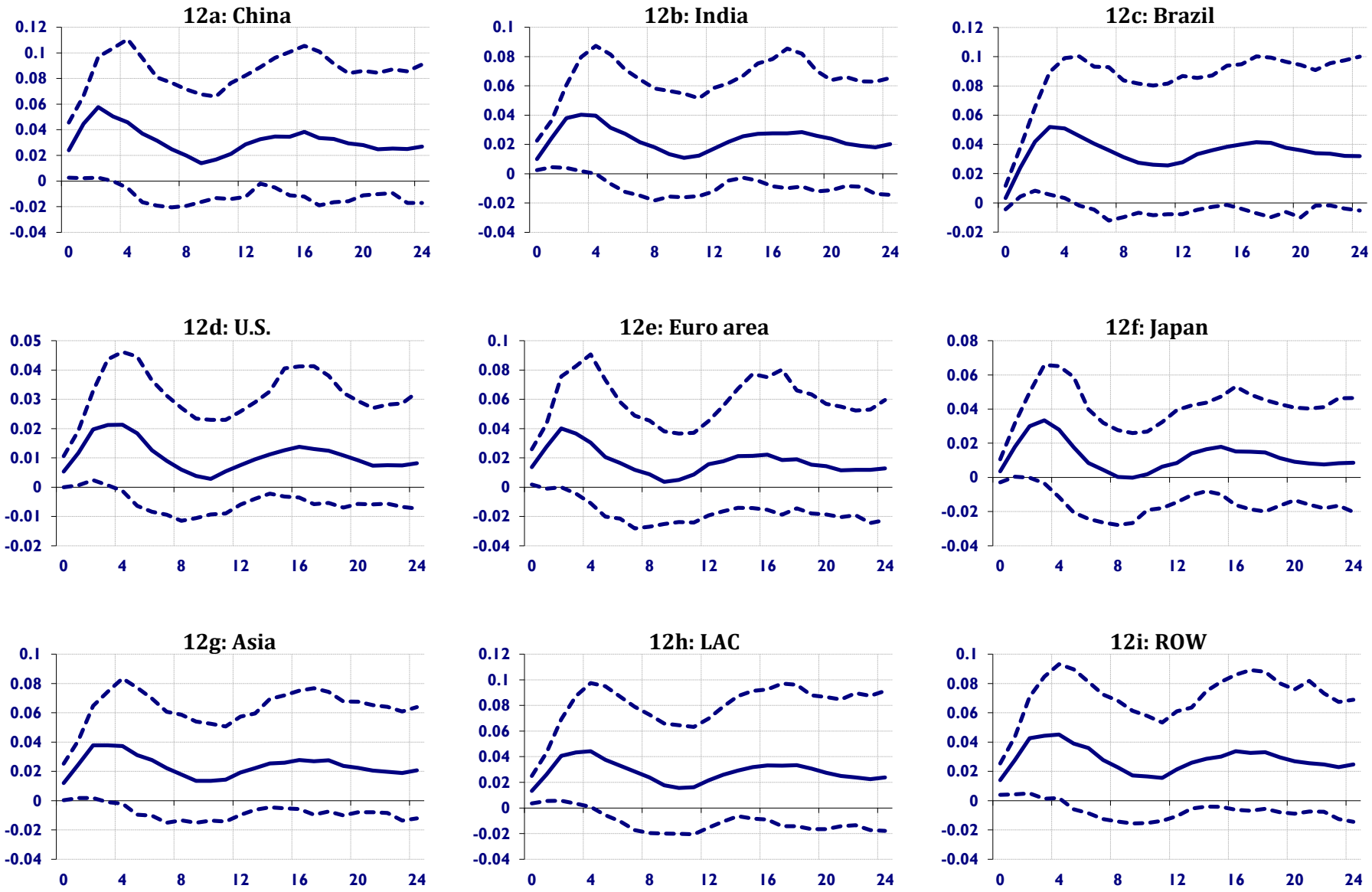


Figure 13: Generalized Impulse Response Function (GIRF) for a positive shock in Brazil's real GDP on real output of other economies

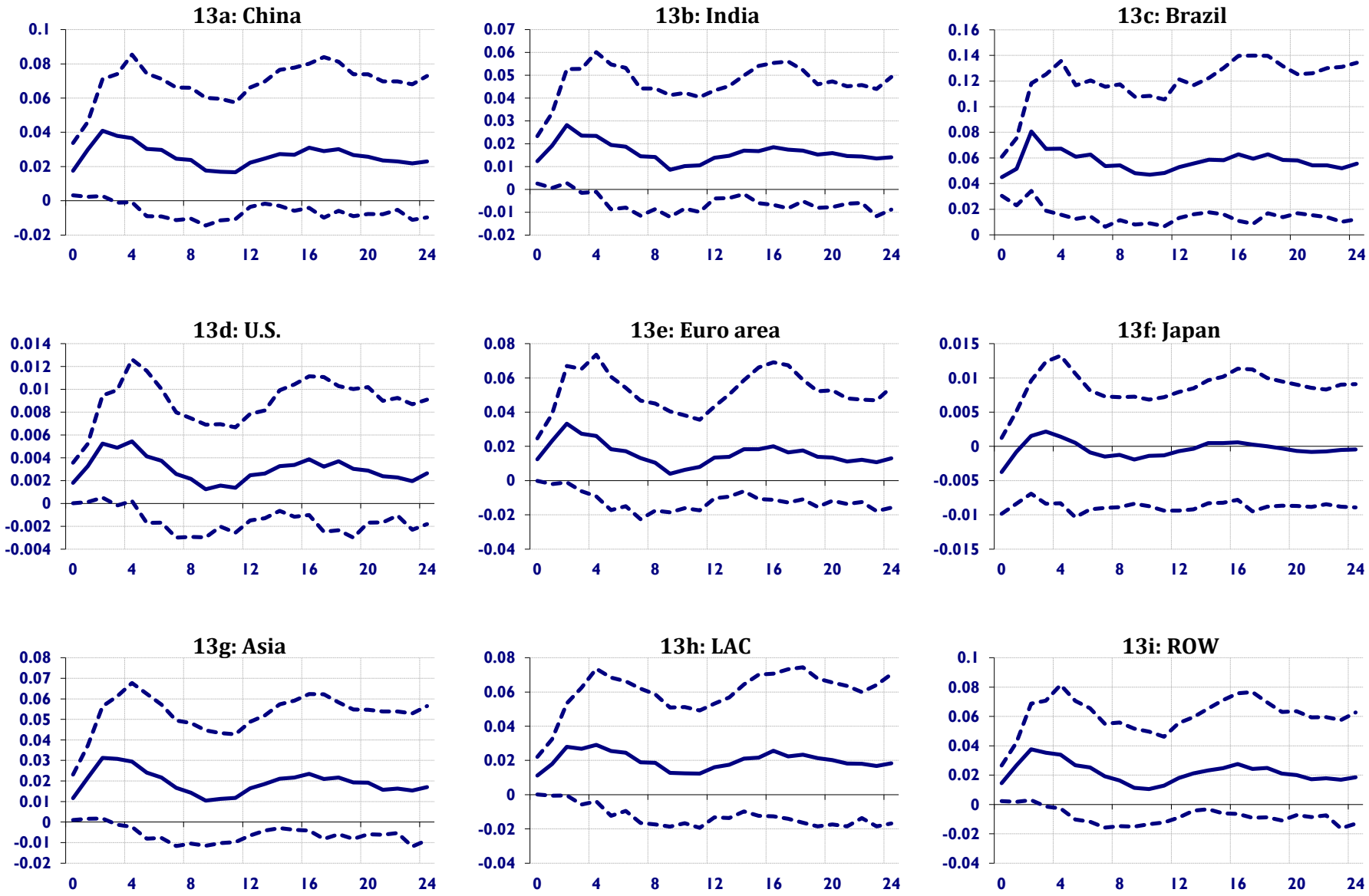


Figure 14: Generalized Impulse Response Function (GIRF) for a positive shock in the U.S.'s real GDP on real export of other economies

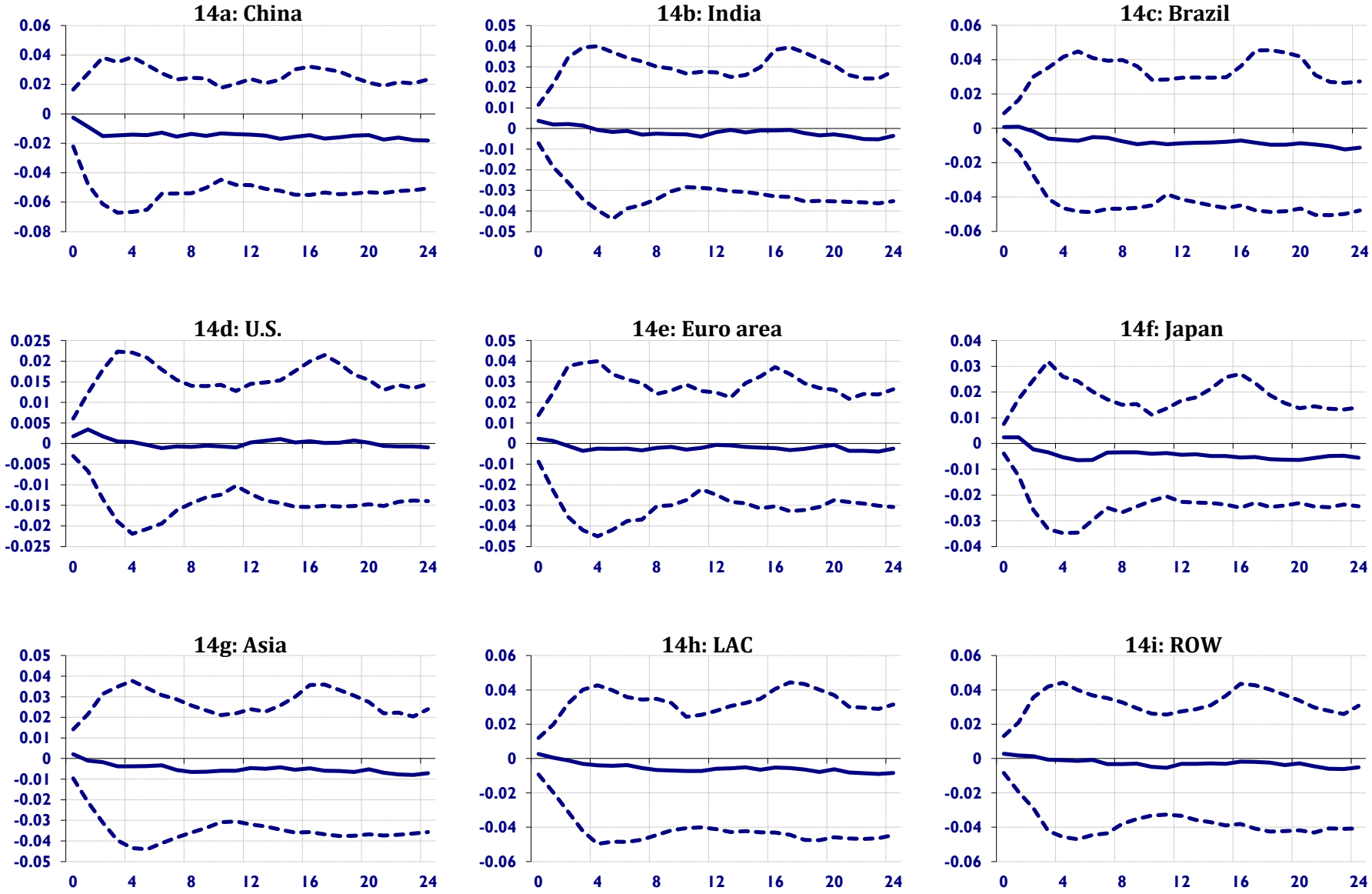


Figure 15: Generalized Impulse Response Function (GIRF) for a positive shock in the U.S.'s real GDP on real out of other economies

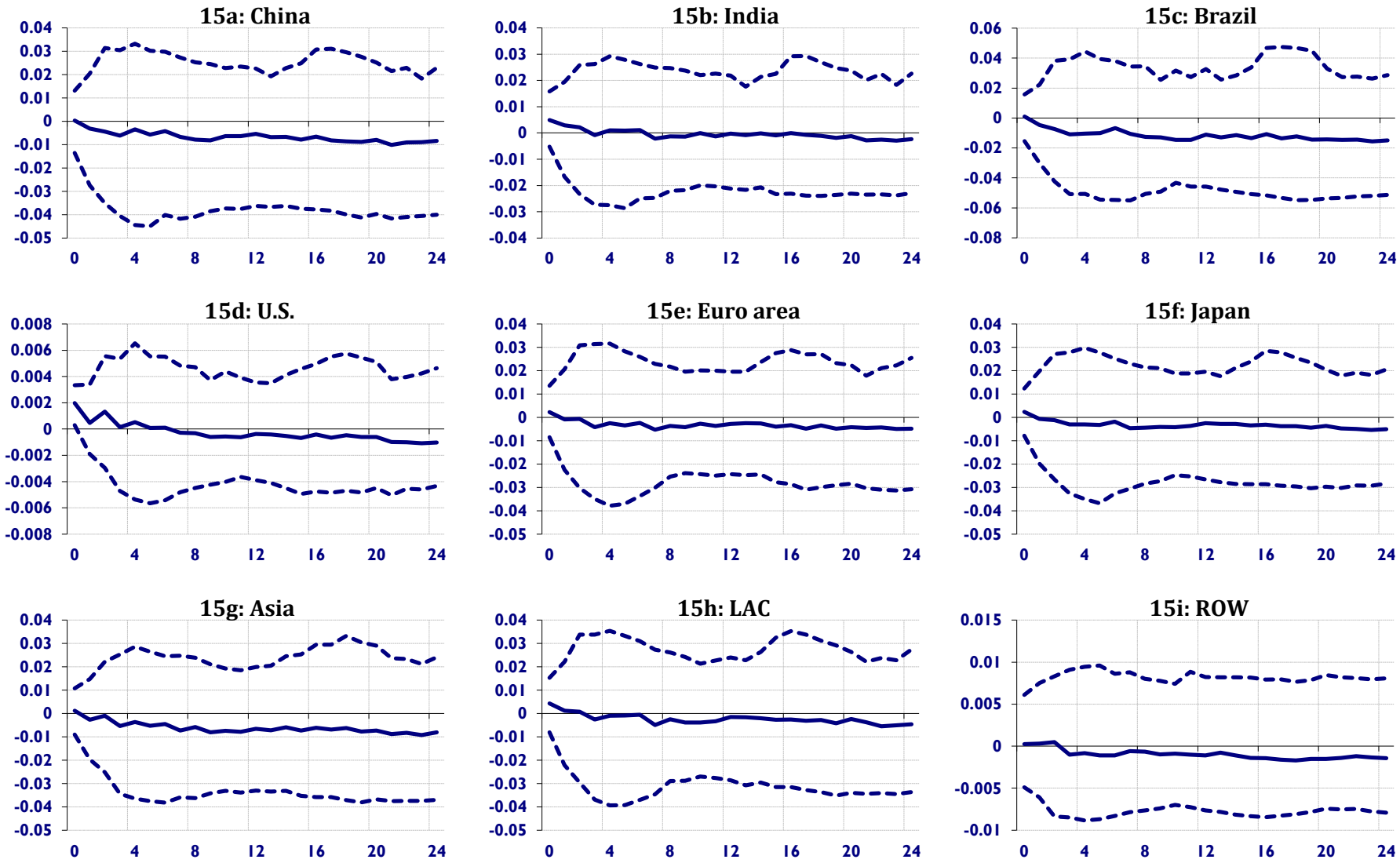


Figure 16: Generalized Impulse Response Function (GIRF) for a positive shock in Euro area's real GDP on real export of other economies

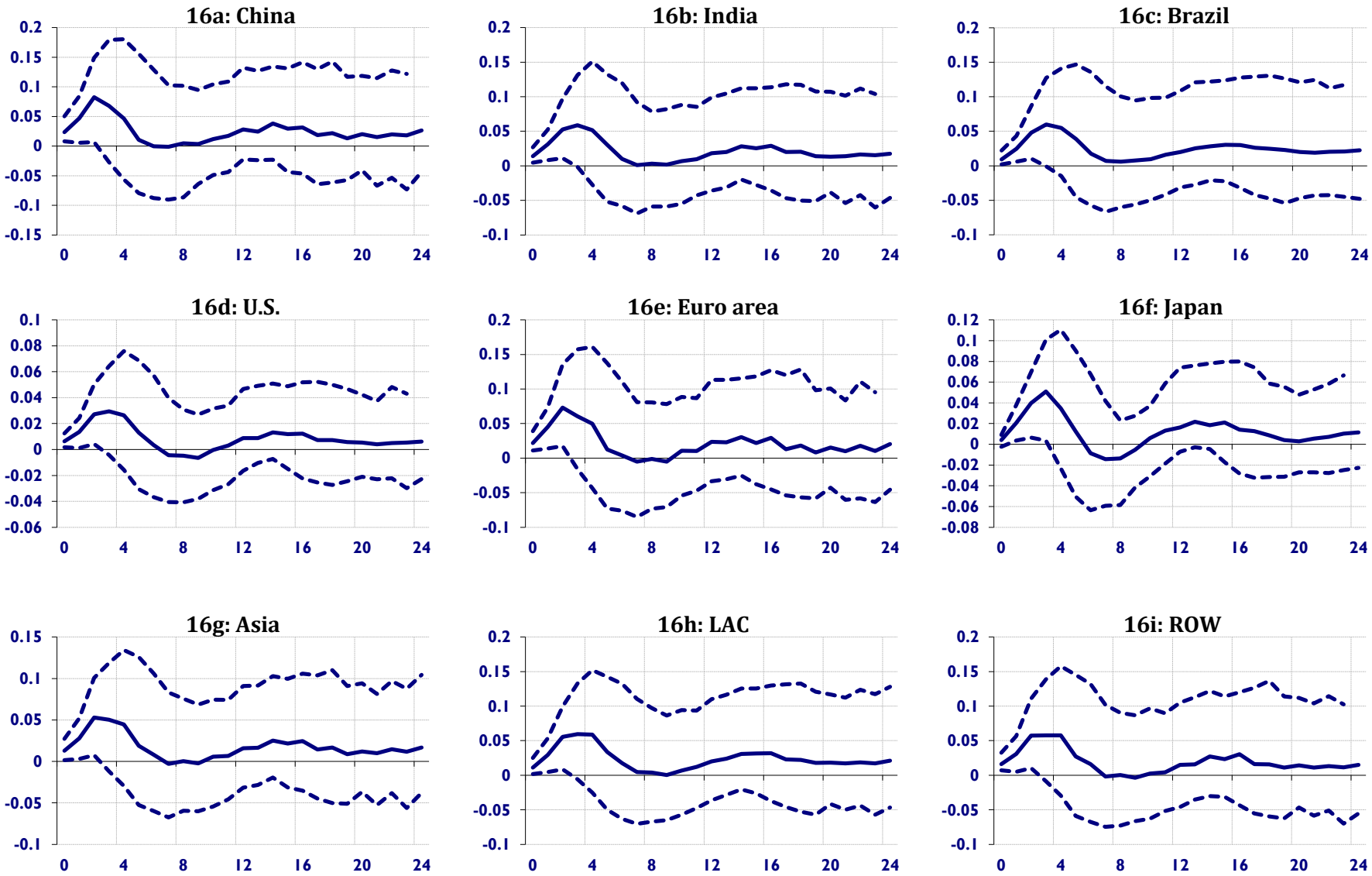
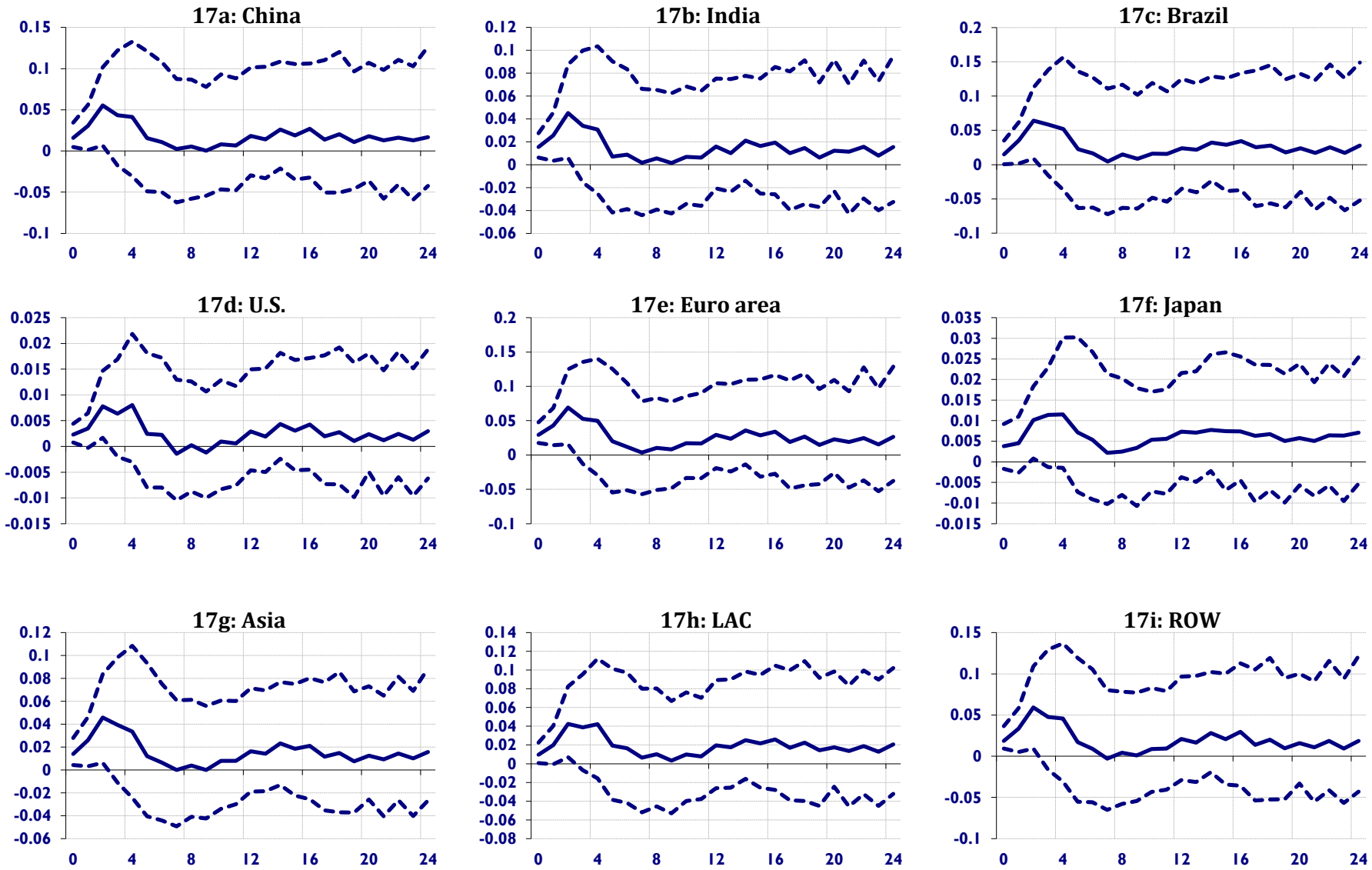


Figure 17: Generalized Impulse Response Function (GIRF) for a positive shock in Euro area's real GDP on real output of other economies



5.5 A shock to Euro area output

The soaring situation in Euro area raises a concern for the momentum of global economy since it might imply that the source of important final demand could potentially be dampened. Therefore, the assessment of Euro area's impact on the world economy certainly provides a useful insight on how other economies should direct their adjustment. Figure 16 (16a to 16i) demonstrates the impact of the positive shock in Euro area's output. A positive shock to the Euro area's output results in a small increase in its import with the average rise of 2.57 percent over the forecasted horizons.

In terms of the positive spillover effect on others, the results show that other economies benefit a rather small and temporary favorable impact from the Euro area's output growth (figure 17; 17a-17i). In particular, among the three emerging economies, the positive effect from Euro area seems to distribute rather equally: on average, the spillover from output growth generates a rise of 2.48, 2.44 and 2.09 percent in the exports of China, Brazil and India respectively. However, it should be noted that these favorable effects diminish and mostly disappear within the sixth quarter after the shock originated. Correspondingly, the time profile for the reaction of output as a consequence of a positive shock in Euro area's GDP indicates the same direction as the impulse response of export: initial periods characterized by positive spillover which diminishes and disappears over time.

5.6 Generalized variance decomposition

In order to confirm the main findings, GFEVDs are also presented to display the contribution of the variance explained by each variable included for the selected emerging economies, in fact, this offers a further explanation of the dominant influence deriving from the shock. The variance decompositions reported are the average value over the 24-quarter horizons. According to table 13, the estimated fraction of variance decomposition shows that a positive GDP shocks originating from China, India and Brazil explain high variation in both exports and imports of LAC region. This indeed confirms the main findings that a positive shock to output leads to a positive spillover via the trade linkage channels. In particular, a positive Brazilian output shock, as anticipated, explains the highest fraction in both export and import of LAC, implying that Brazil has been assuming the role of regional power in Latin America. From the lower fraction in real output observed in the variance decomposition, the current type of foreign trade among LAC seems to not generate a proportional increase in national income (low income elasticity), i.e. the types of goods traded is still relatively low value added. This point is

however beyond the scope of this study but it should definitely be further examined to obtain a more comprehensive conclusion.

In addition, the variance decomposition for Asian economies is also reported in table 14. The results found here are in line with what is found for the case of LAC region. For Asia, a positive output shock from the three core emerging economies explains a relatively high fraction in both export and import, particularly for the latter. Furthermore, it is also observed that a positive shock in output explains a high variation in Asia's real output, this indicates that there exists a high positive spillover. The possible explanation is that the positive shock favors Asia's output growth and, in turn, generates income and higher demand for import in these countries. In the case of China, the positive growth spillover explains a high degree of 0.99 percent of variation in output and 0.90 percent of variation in import, whereas India's shock is able to explain even higher variation of 2.00 percent in output, and 0.80 percent in import. It should be noticed that only 0.43 percent of the variation in export is explained by Indian output growth. This offers an additional explanation that the importance of India through trade linkage remains relatively weak in comparison to the other two core emerging economies.

Table 13: GFEVDs of LAC explained by the GDP shocks from the selected economies

Shock originating Countries	LAC variables				
	Real output	Real export	Real import	Real exchange rate	Inflation rate
China	0.0015	0.0325	0.0183	0.0009	0.0112
India	0.0021	0.0311	0.0170	0.0020	0.0101
Brazil	0.0040	0.0532	0.0381	0.0088	0.0045

Source: Author's own calculation

Table 14: GFEVDs of Asia explained by the GDP shocks from the selected economies

Shock originating Countries	Asia variables				
	Real output	Real export	Real import	Real exchange rate	Inflation rate
China	0.0099	0.0057	0.0090	0.0086	0.0080
India	0.0200	0.0043	0.0080	0.0171	0.0047
Brazil	0.0098	0.0061	0.0053	0.0125	0.0074

Source: Author's own calculation

6. Conclusion

This study evaluates the role of three large emerging economies, China, India and Brazil, as the new regional and global economic drivers utilizing the channel of international trade linkage which in many studies is found to be the most important channel of growth spillover. After the economic transformation of these three core economies during 1980s and 1990s, they have proven to perform quite impressively in terms of their output growth and poverty reduction and thanks to their enormous economic sizes they are likely to become ones of the

most influential economies. In fact, after the phenomenon of the global financial crisis in 2008, the world economy has accelerated the transitional period of rebalancing in economic power from the Northern to Southern economies, transition which appears quite steady since the advanced economies remain still rather weak in their recovery process.

The study employs GVAR framework to capture several external shocks at the world level. This modeling framework is proven to be superior to the VAR as it is specifically designed to deal with large numbers of interaction between countries and is not sensitive to the choice of variable orderings when considering the impulse response function. Generally, GVAR follows two main steps: firstly, individually models a country as a small open economy by estimating a country-specific VECM and, secondly, combines and links all estimated country-specific models into the GVAR system using the trade weight matrix. The study offers an additional contribution to a small number of the existing literature in several respects. First, it extends both the sample countries and time frame included in the model. The paper includes the data from 33 individual countries and later combines them into several regions. The quarterly data from the period of 1999Q1-2011Q3 is chosen since it is believed to be the appropriate frequency and transitional period of global economic landscape from the North to Southern growth engine. To my knowledge, the study therefore reports the most up-to-date situation of the world economy. Secondly, the GVAR framework, differing from the majority of international trade studies, allows both export and import –which reflect the linkages from the real side of the economy– to be modelled jointly. Most importantly, the focus of this paper is on the assessment of the possibility for all three large and rapidly growing countries, China, India and Brazil, to act as both their regional and global growth power. To my knowledge, the emphasis on these three economies together is put for the first time, with particular regard to the modelling of their positive shock at the world level.

The results obtained are based on the generalized impulse response functions and the generalized forecast error variance decompositions. The main findings are found to be in line with the existing studies: they demonstrate that the positive output shock in the three core emerging economies generally induces a significant and favorable impact on the export and output potentials of both emerging and advanced countries. Additionally, the positive impact from all three countries is also long-lasting over the whole period of forecasting.

In particular, both China and Brazil seem to play a vital role to their neighboring economies, acting as regional powers as well as extending their global growth driver role to the rest of the world. For China, its positive output shock generates a significant increase and long-lasting demand for import, demonstrating that the country, as its income grows, acts as global

consumer. Correspondingly, a rise in demand for Chinese imports translate to an expansion in exports from its trading partners, particularly Asian economies, as well as its growing LAC partners including Brazil. Meanwhile, G3 economies were only able to obtain a relatively small benefit from China's growth.

For the case of Brazil, the favorable shock on its GDP is shown to be more impressive than expected confirming the country as the regional growth driver for Latin America. The positive shock immediately translates to a rise of Brazil's demand for import, particularly towards the products traded from its neighboring LAC and the positive spillover remains strong even after three years. As opposed to China, a positive output growth in Brazil translates to a significant rise of export from the U.S. owing to their geographical proximity which facilitates and promotes stronger trade tie in relative to China.

It should be noted that the income elasticity between China and Brazil is high and applies two-way (both positive spillover from China towards Brazil and vice versa). This is due to the growing integration between the two in terms of trade, particularly over the recent decades. In fact, this growing linkage between China and Brazil exists not only in terms of a direct trade linkage but also via an indirect one transmitted through their traditional trading partners, particularly the U.S. and Euro area who hold high trade integration with both China and Brazil.

On the other hand, for the case of India, the transmission via trade linkage is trivial. This should not however lead to the conclusion that the growth of the country is irrelevant to the global economy since further examination taking into account other channels of linkages should be examined. As for the advanced countries, the U.S. and Euro area, their role in supporting the long-term global economic growth remain rather important. However, it is noticeable that the magnitudes of their favorable impacts are smaller if compared to those of the three core emerging countries and the positive effects persist only temporarily or for a short time.

The most important finding which can be derived from this study is the proof of the existence of the decoupling hypothesis from the U.S. economy. In particular, it is found that China helps alleviate the adverse shock of the global financial crisis in 2008. Several countries in both Asia and Latin America in fact were able to gain their momentum much faster than what many economists had anticipated owing to their high degree of trade integration with China whose economy remains strong thanks to the extensive and enormous support from the fiscal stimulus package. However, it should be kept in mind that, despite the rapid economic growth of China, India and Brazil, these countries are still subject to a volatile economic condition and

there exist several relevant development issues to be solved in order for them to surpass the advanced countries and truly become the growth engine for the global economy.

It should be noticed that the study presents some limitations. First, the impulse response functions are generally known to be quite sensitive to time and changes, therefore the reliable time profile of each reaction should be limited to a rather short-term. In addition, several further examinations such as other linkages and further classification on the types of goods traded should further be conducted in order to fully capture the rise of these emerging economies.

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