The Impact of China's Slowdown on the Asia-Pacific Region*: an application of the GVAR model

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Abstract

Export-oriented development strategy brought the Asia and Pacific region economic success through rapid growth, making it the fastest growing region in the world. In recent years, despite waning demand from the crisis-hit advanced economies, Asian exports remained an outlier on the upside thanks to the accelerating demand from China that boosted intra-regional trade in Asia. While its Asian trading partners benefit from growing exports to China, their deepening linkages with China have made them increasingly vulnerable to the risk of a China slowdown. In this paper, we examined the impact of a negative Chinese GDP shock on Asian economies employing the Global Vector Autoregressive (GVAR) Modeling methodology developed by Pesaran, Schuermann and Weiner (2004), and Dees, di-Mauro, Pesaran, and Smith (2007). We found that the Chinese slowdown severely impacts the commodity exporters such as Australia while countries on the Asian production cycle such as Singapore and Malaysia are also affected adversely. We also found that a negative shock to the real GDP of China would not only reduce the price of crude oil, as some previous studies have shown, but also metals and agricultural prices.

JEL Classification: C33, F44, F47, O53

Keywords: China, GVAR, Trade linkage, Asia, Sovereign risk analysis, Empirical macroeconomics, International business cycles

1. Introduction

Global economic integration has dramatically expanded over the past two decades. Global trade surged to $36 trillion in 2012 from $6 trillion in 1990. Led by China, Asia & Pacific countries'[1] trade levels rose 18 times over this period, which is faster than any other regional country groups. The export-oriented development strategy brought the Asia & Pacific region economic success through rapid growth, making it the fastest growing region and the world's growth engine. On the other hand, increased integration and dependence on exports intensified the region's vulnerability to external shocks.

Since 2008, due to the anemic growth in the United States and the recession in the Eurozone, the advanced economies' demand for Asia & Pacific exports has been waning. Nevertheless, thanks to surging Chinese demand, the rest of Asia & Pacific countries' ("Asia" henceforth) exports remained an outlier on the upside. The Asian exports to China doubled over the last five years and China became the largest market for Asia after surpassing Japan in 2005 and the US in 2007. As China became the central point of the Asian supply chain, its demand has been supporting the region's production of goods ranging from raw materials to electronic components.[2] Despite the recent acceleration in the US economy, the advanced economies' overall growth expectations remain subdued; therefore, China's continuing role supporting the East Asian economies remains critical. However, China's economy is slowing down from the rapid growth rates exceeding 10 percent over the past several decades. The real GDP growth in 2013 was a steady 7.7 percent but further slowdown is expected going forward, and some projections show growth rates dropping to about 6 percent by the end of the decade.

Against this background, we aim to examine and quantify the impact of a negative Chinese GDP shock on Asian economies using the Global Vector Autoregressive (GVAR) model developed by Pesaran, Schuermann and Weiner (2004), and Dees, di-Mauro, Pesaran, and Smith (2007). Through GVAR, we examine how and to what extent the Chinese economic growth affects Asian countries. The transmission mechanism of this slowdown may be diversified; in this paper we examine the shocks to the real economy based on trade linkages. For simplicity, the original GVAR model assumes a fixed trade weight for the sample period. However, considering the recent rapid expansion of Chinese trade volume, both in exports and imports, we find that the "fixed weight" assumption is not optimal. Thus, following Cesa-Bianchi, Pesaran, Rebucci, and Xu (2011; henceforth CPRX), we construct a model with time-varying trade relations. After estimating the GVAR model, we calculate

[1] The Asia and Pacific countries in this paper are defined by the ten largest countries in the Asia Pacific Region in terms of GDP: ASEAN-4 (Indonesia, Malaysia, the Philippines and Thailand), Australia, China, India, Japan, Korea and New Zealand.

[2] China's "export powerhouse" role undeniably contributed to other regions' growth particularly those of the commodity exporters in Latin America and Africa; however, this paper will only focus on China's linkages to Asia.

a set of generalized impulse response functions (henceforth GIRFs) for 1985, 1995, 2005, and 2011 with different trade weights and investigate the changes of the shock propagation mechanism from China to the Asian countries.[3]

Surprisingly few published studies quantify the impact of a negative Chinese real GDP shock on Asian economies. Furthermore, to the best of our knowledge, we are the first study to employ the GVAR methodology to analyze the impact. To the best of our knowledge, Han and Ng (2011) is the only study that analyzed Asia's economies using the GVAR methodology; however, its focus was on evaluating macroeconomic forecasts for the original ASEAN economies.

Our results confirm that the impact of a negative shock to Chinese real GDP on the Asian countries has significantly increased under the recent trade structures of 2005 or 2011 compared to the earlier trade structures of 1985 or 1995. This confirms the common understanding of Asia's increased dependency on China. The GIRFs are significantly negative for almost all Asian countries with the exception of India, Korea and the Philippines. All remaining Asian countries are negatively impacted by a real GDP shock to Chinese economies at the 68% interval, with the negative impact to the Euro area significant even at the 95% confidence interval. China's slowdown also curbs its demand for commodities, and we investigated whether this translates into commodity price drops. Our GIRFs show that a negative shock to the real GDP of China not only reduce crude oil prices, as some previous studies have shown, but also metals and agricultural prices. Our sign-restricted results show that a potential slow-down in China might benefit Korea in the long run. For comparison, we ran our model to test the impact of the US real GDP, and found that the impact was mostly visible in countries that showed a more muted response to a Chinese shock, such as India, Indonesia, and the Philippines.

The rest of the paper is organized as follows. In Section 2, we analyze the historical transition of the Chinese trade volume using trade data. In Section 3, we explain the GVAR model with time varying trade weights, following past studies, and we specify the model and generate an estimate. In Section 4, we calculate the GIRFs, and investigate the effect of a Chinese economic shock on the Asian countries by comparing the shapes of the GIRFs with various trade weight matrixes. Section 5 summarizes our conclusions.

2. China's trade volume and the transition of trade share

China's membership of the World Trade Organization in 2001 dramatically altered the outlook for global trade and became a turning point for the country's economic development. In Figure 1, we see

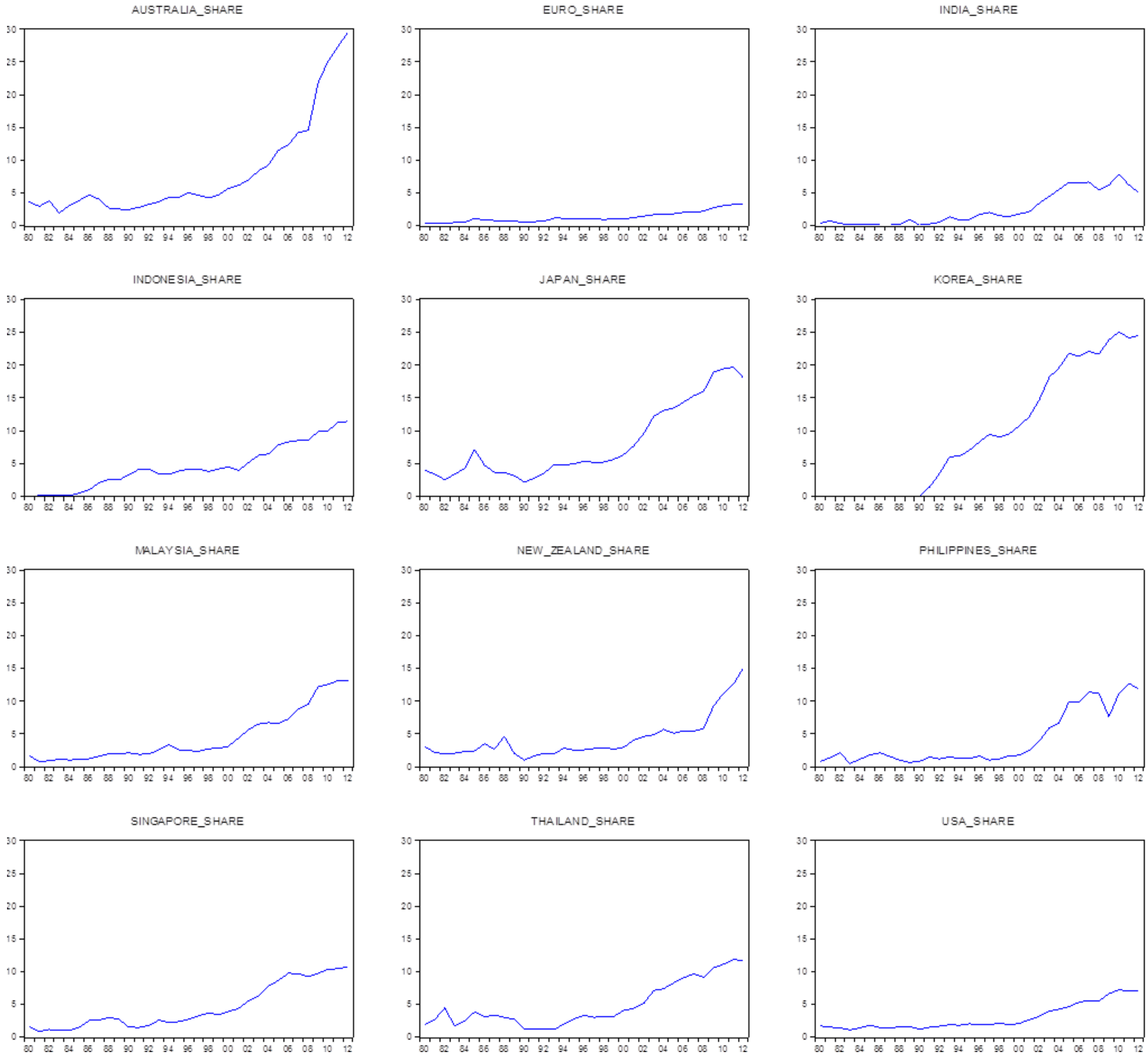
[3] The focus of CPRX was to investigate the effect of the Chinese economy on the Latin American countries.

how the share of exports of Asian countries to China evolved over the past several decades. We observe a significant jump since 2001: particularly, exports of Australia, Japan and Korea to China have expanded more than three-fold. Likewise, the Asian countries' imports from China have been rising considerably in recent years (see Figure 2). In particular, Australia, Japan, Korea, Malaysia and the Philippines saw the largest rise in their imports from China.

China's share of world trade rose from about 4 percent in 2000 to around 12 percent last year. Figure 3 shows the evolution of trade shares of each country in 1985, 1995, 2005, and 2011. While the United States, Japan and Eurozone countries have seen decline in their share of trade in the global economy, China's trade share rose in recent years. China is now the largest trading nation in the world after surpassing the US, and is the largest trading partner for 35 countries across the globe. In our sample of nine Asian countries, China is the largest trading partner of seven countries (Australia, India, Japan, Korea, Malaysia, New Zealand and Thailand); the second largest of Indonesia and third largest of the Philippines. Under these circumstances, if the Chinese economy runs into a recession, we believe that it will transmit to the Asian countries and the rest of the world.

In the next section, we explain the GVAR methodology and analyze China's economic impact using the GIRFs with time-varying trade weights.

Figure 1: The share of exports to China in US, Eurozone, Japan, and Asian countries' Total Trade (yearly; percentage; 1980-2012)



Source: IMF Direction of Trade Statics

Figure 2: The share of imports from China in US, Eurozone, Japan, and Asian countries' Total Trade (yearly; percentage; 1980-2012)

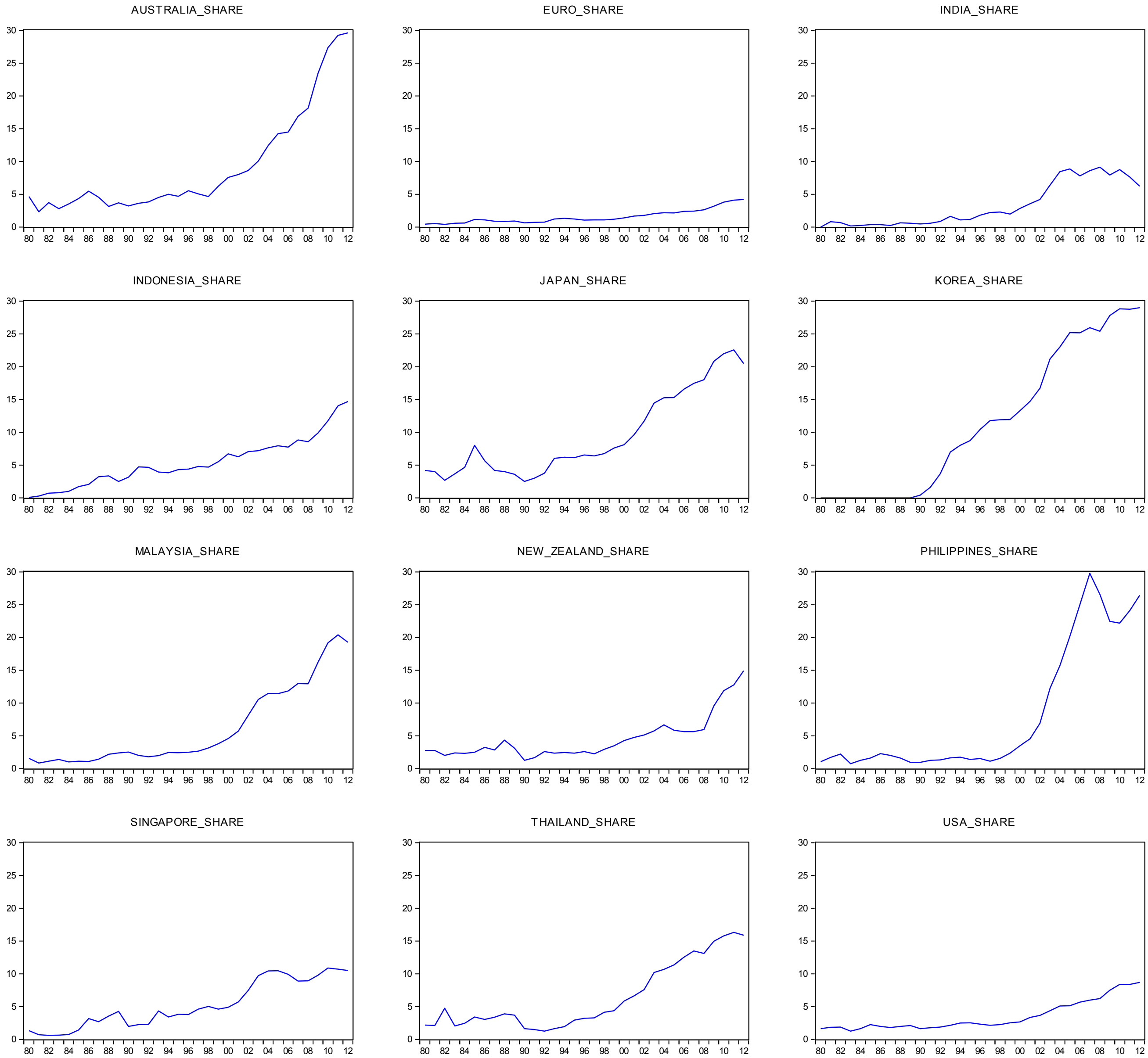


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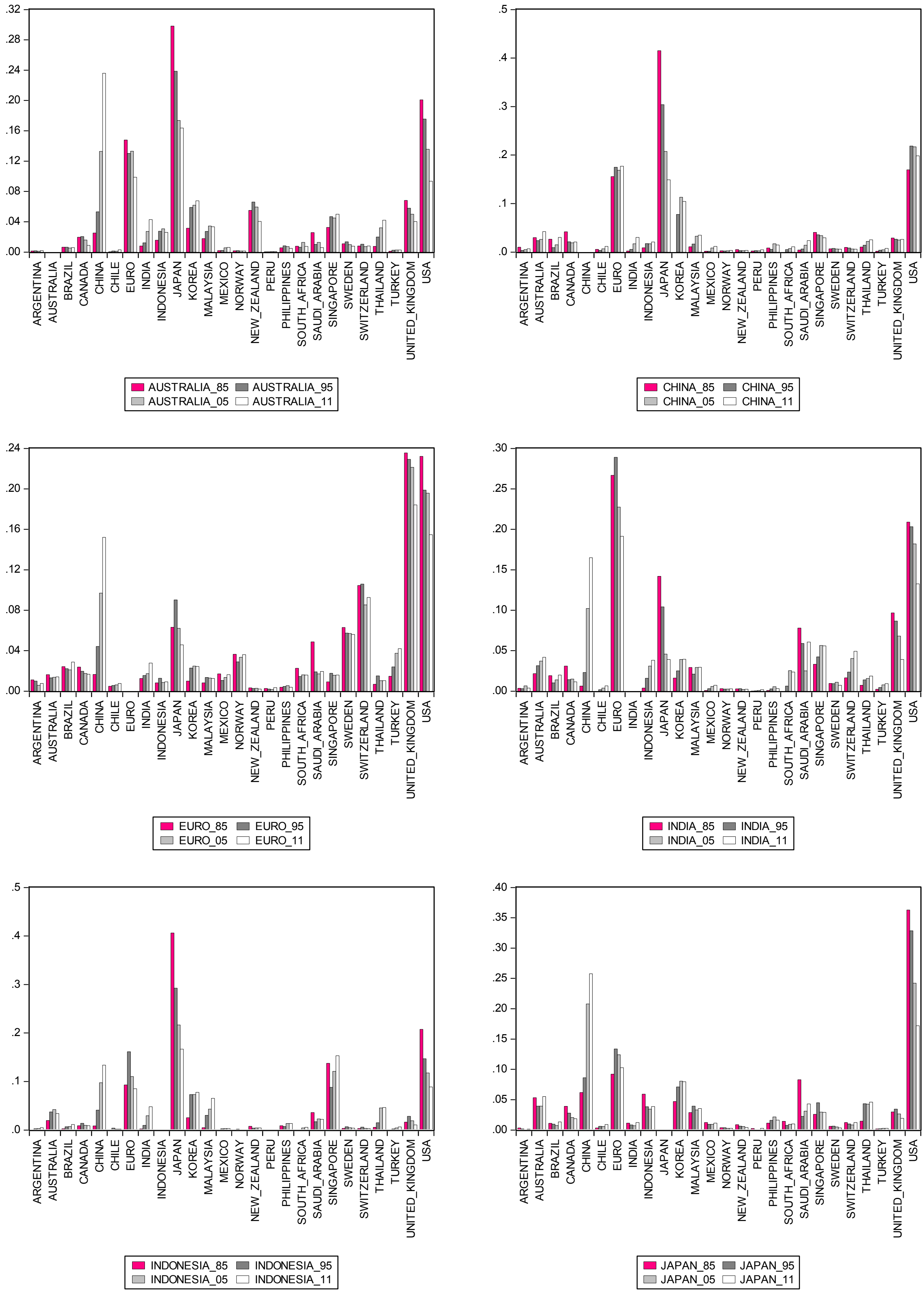
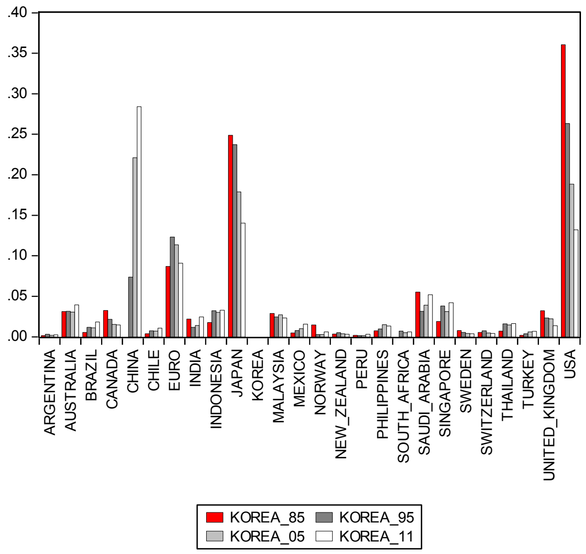
Figure 3: Trade weight in US, Eurozone, Japan, and other Asian countries

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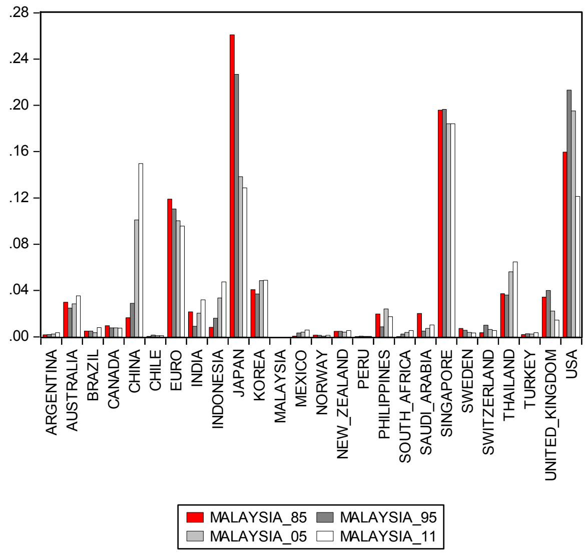
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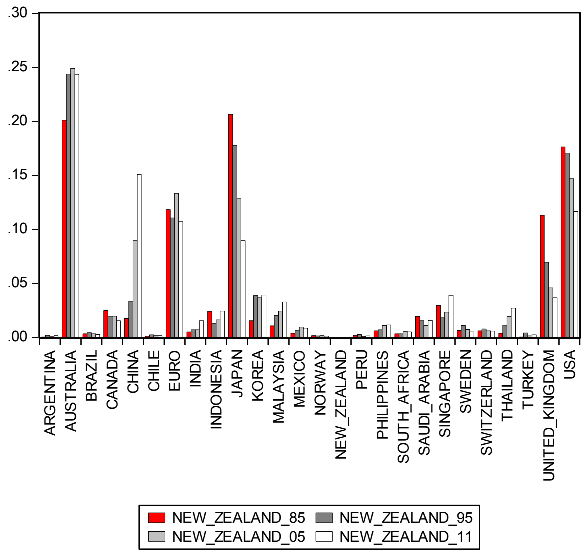
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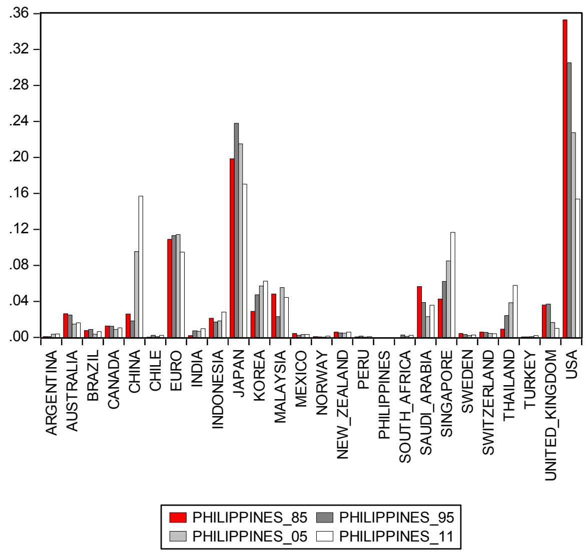
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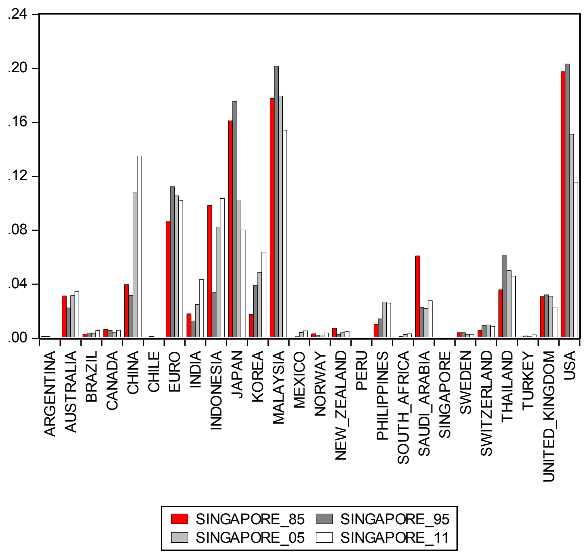
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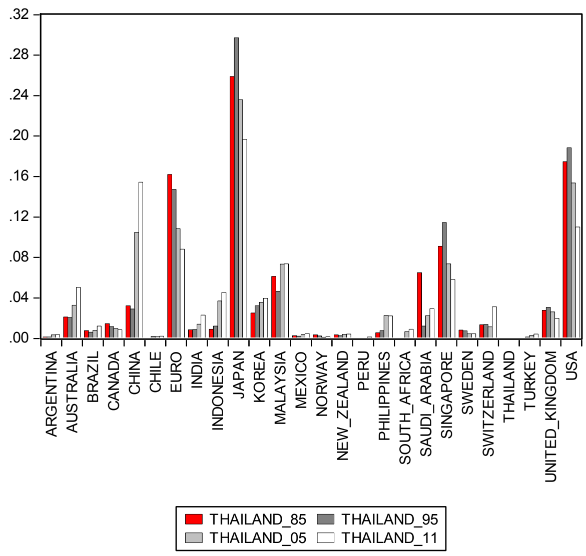
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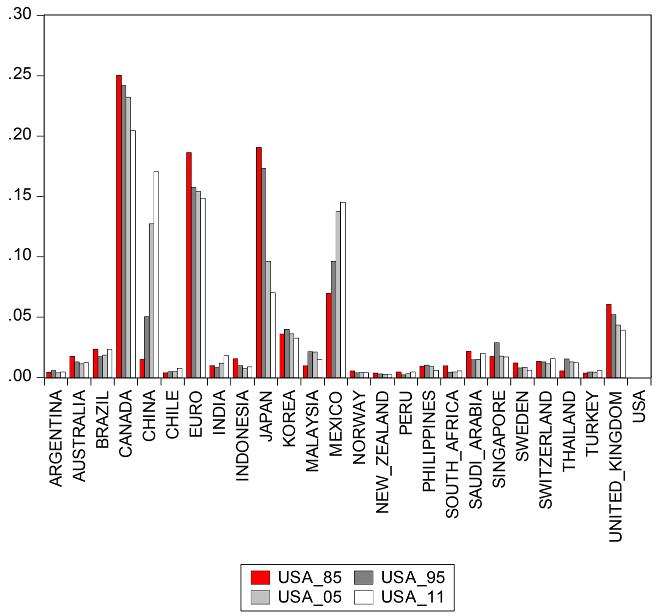


Source: IMF Direction of Trade Statics

3. The GVAR model

3.1 Structure of the GVAR model

Our main objective is to investigate how the emerging Chinese economy impacted the recent global economy. We plan to give an answer to questions such as: "What was the turning point for China to become an economically powerful country?" "How has this affected the rest of the world?" or "How has the magnitude change?"

As we reviewed in Section 2, China's trade linkages have drastically changed shortly after China joined the WTO in December 2001. Thus, we expect that the magnitudes of shock propagations from China to the global economy before and after the year 2001 are quite different. In order to quantify this change we use a novel time-series technique: the global vector autoregressive (henceforth GVAR) model, which was originated by Pesaran, Schuermann, and Weiner (2004, henceforth PSW), Dees, di Mauro, Pesaran, and Smith (2007a), and Dees, Holly, Pesaran, and Smith (2007b). [4]

The standard VAR of country i is a stand-alone model in the sense that it specifies the inter-temporal as well as inter-variable relation among a set of country i's macroeconomic variables, $\mathbf{x}_{it}$. For instance, when the monetary policy effects are examined, the $\mathbf{x}_{it}$ often includes such variables as the GDP, inflation rate, equity prices, exchange rate, as well as the interest rate and monetary base. In the standard VAR model, these variables are all assumed to be endogenously determined in the domestic economy.

Often the price of crude oil is included in the model, but the treatment of this variable differs between countries. For the US, we assume that the oil price is determined domestically; therefore it is included in $\mathbf{x}_{it}$. However, for a small-open economy like the UK or Japan, we assume that the oil price is exogenously determined, and it is included as a part of global variables, $\mathbf{d}_{it}$. If we add $\mathbf{d}_{it}$, the model is extended to a VAR with exogenous variables, or VARX.

The GVAR model consists of a set of county-by-country VAR models that includes a set of "country-specific foreign variables" $\mathbf{x}_{it}$*, which is constructed by taking the weighted average across all the countries j of the corresponding variable. Since the foreign variables are assumed to be weakly exogenous, and they are denoted as "star" variables below, the model is called VARX*. In this paper, following CPRX, we have estimated 26 country-specific VARX* models. Since the GDP of these 26 countries adds up to approximately 90% of the world GDP, we claim that the model

[4] Due to its modeling flexibility, the GVAR model is applied to various fields such as macroeconomics (Dees, di Mauro, Pesaran, and Smith, 2007), industrial sectors (Hiebert and Vansteenkiste, 2010), bond markets (Favero, 2012), and real estate markets (Vansteenkiste, 2007).

covers the world economy.[5]

Without loss of generality, the VARX*(p, q) of country i, which includes one lag (that is, p =1) of $\mathbf{x}_{it}$ and one lag (q =1) of $\mathbf{x}_{it}$* and $\mathbf{d}_{it}$, is represented as follows:

$$\mathbf{x}_{it} = \mathbf{a}_{io} + \mathbf{a}_{i1}t + \mathbf{\Phi}_i \mathbf{x}_{i,t-1} + \Lambda_{i0}\mathbf{x}_{it}^* + \Lambda_{i1}\mathbf{x}_{i,t-1}^* + \Upsilon_{i0}\mathbf{d}_{it} + \Upsilon_{i1}\mathbf{d}_{i,t-1} + \mathbf{u}_{it} \quad (1)$$

where $\mathbf{a}$, Φ, Λ, and Υ are the coefficients. A vector of country-specific shocks, $\mathbf{u}_{it}$, is assumed to be distributed serially uncorrelated with zero mean and a nonsingular covariance matrix, i.e. $\mathbf{u}_{it} \sim i.i.d\ (0, \Sigma_{ii})$. Needless to say, we can generalize it to have more lags as well as different lag lengths for different variables. Also, if the variables in the VARX* are the I(1) processes and are co-integrated, then the VARX* model can be transformed into a vector error correction model with exogenous variables, or VECMX*. This makes us impose any long-run relations that might exist in the economy, which increases the efficiency of parameter estimation. We will examine these possibilities in the next subsection.

The dataset used by CPRX is as follows. The domestic variable, $\mathbf{x}_{it}$, includes the real GDP y_{it}, the inflation rate π_{it}, the real exchange rate $e_{it} - p_{it}$, the real quality prices q_{it}, the short-term interest rate ρ_{it}^S, and the long-term interest rate ρ_{it}^L. However, q_{it}, ρ_{it}^S, and ρ_{it}^L, are included when they are available. As for the global variables, $\mathbf{d}_{it}$, the oil price index p_t^o is included in order to capture the influences from international commodity market.[6]

In order to appropriately measure the effect of China's emergence in the global economy, we have extended their dataset in two important dimensions: (1) the end of the sample period is extended from 2011Q3 to 2013Q1; and (2) two other commodity prices, i.e. the metals price index p_t^m and the agriculture price index p_t^a, are added to $\mathbf{d}_{it}$. By extending the sample period, we investigate the up-to-date impact of the Chinese economy on the world. Also, since China is the dominant purchaser of metals and agricultural products, we can model the multiple channels of impact propagation through the international commodity markets.

A set of "country-specific foreign variables" $\mathbf{x}_{it}$*, which is constructed by taking the weighted average across all the countries j of the corresponding variable as follows:

$$\mathbf{x}_{it}^* = \sum_{j=0}^{25} \omega_{ij}(t) \cdot \mathbf{x}_{jt} \quad (2)$$

where a sequence of time-varying weights satisfies $\omega_{ii}(t) = 0$ and $\sum_{j=0}^{N} \omega_{ij}(t) = 1$ for i = 0, ..., 25.

[5] Since one of the economies is the Euro area, which consists of eight countries (Germany, France, Italy, Spain, Netherlands, Belgium, Austria, and Finland), the total number of countries is 33.

[6] Though the candidates of global variables $\mathbf{d}_{it}$ are the same for all the sample countries, we may select different combinations. Thus we add country index "i" to its subscript.

Since this weight represents the closeness of the economic activities between the countries, the ideal weights should properly reflect this magnitude. In the literature of GVAR, either one of two candidates is often used. One is the trade weight, which is constructed by using the bi-directional trade flow data. The other is the financial weight, which represents the flow of funds between the countries.

Although the financial relation is drawing more attention when we analyze the shock propagations in a recent global economy, we use the trade weight in this paper because the quality of data used for constructing the trade weight is more reliable than that of financial weight, and these data are available from the 1980s. For more discussion, see CPRX (2011).

When we estimate the country-specific VARX*, $\mathbf{x}_{it}$* is constructed directly from the data. However, for dynamic analysis such as calculating the impulse response functions, the value of $\mathbf{x}_{it}$* is calculated internally from the forecasted values of {$\mathbf{x}_{jt}$*} for $i \neq j$, which are obtained by solving the system of Equation (1) and Equation (2). This is why the GVAR model can describe the interactions of variables not only within a country but also between countries.

Since Equation (1) includes the contemporaneous values, $\mathbf{x}_{it}$* and $\mathbf{d}_{it}$, on its right hand side, these variables must be weakly exogenous in order to estimate the parameters consistently. In the following paragraph, we list a set of restrictions that we assume. These assumptions are formally tested in the next subsection.

First, we assume that both y_{it}^{*} and π_{it}^{*} are weakly exogenous, and are included in $\mathbf{x}_{it}$* for all the sample economies. Next, the "US-specific foreign" real exchange rate is assumed to be weakly exogenous and included in the US model, because the value of the US dollar is determined outside the US economy. However, for the rest of the economies, the "country-specific foreign" exchange rate is excluded.[7]

For the rest of variables, we split our 26 economies into two types, and list a different set of assumptions. The first type is the large-open economy. We classify the US as this type, and assign "0" as its country index. For this type, we assume that: 1) the international commodity prices are determined in its economy; and 2) the condition of the foreign financial markets does not affect its economy (See CPRX, Dees, di Mauro, Pesaran, and Smith (2007) for similar treatment). Thus in the US model, three commodity prices, i.e. p_t^o, p_t^m and p_t^a, are included in $\mathbf{x}_{0t}$, and three foreign financial conditions, i.e. q_{0t}^{*}, ρ_{0t}^{*S} and ρ_{0t}^{*L}, are excluded from $\mathbf{x}_{0t}$*. This means that, for the US, the global variable $\mathbf{d}_{0t}$ is null.

7 As a result, the "US-specific own" real exchange rate is excluded from the US model, but the corresponding variable is included in the model of other economies.

The second type is the small-open economy. The rest of the sample economies, indexed as i = 1, ..., 25, are in this category. For these economies, we assume that both the international commodity markets and the foreign financial markets influence their economies. Thus for economy i, three commodity prices are included in $\mathbf{d}_{it}$, and three foreign financial variables are included in $\mathbf{x}_{it}$*.

3.2 Estimation and testing

We begin by investigating the order of integration of each variable. For this, following CPRX and others, we use the weighted symmetric Dickey-Fuller tests (henceforth the WS test). The Akaike information criterion (AIC) is used for selecting the optimal lag length. The test results are reported in Table 1 (for domestic variables) and Table 2 (for foreign variables). The results indicate that most of the variables in levels contain a unit root, but are stationary after a first differencing. Therefore, we examine the possibility of co-integrating relations among variables in the below.

However, before examining the co-integration, we estimate the country-specific VARX*(p,q) models country-by-country. In order to reduce the total number of parameters, we restrict the maximum lag length of foreign and global variables, q, to one. Further, we restrict the maximum lag lengths of domestic variables, p, to two. Given these restrictions, we search for the optimal lag lengths by using the AIC. The results are shown in the two columns of "p" and "q", labeled "Computer Selected" in Table 4.

A word of caution should be mentioned at this point. Notice that the right-hand side of Equation (1) contains the instantaneous foreign variables, $\mathbf{x}_{it}$*. Thus, when we stack all the VARX* models, it becomes a large system of simultaneous equations. Under these circumstances, estimating the country-specific VARX* one-by-one, not all at the same time, is justified if $\mathbf{x}_{it}$* are weakly exogenous. This point is formally tested below as an item of diagnostic checking.

Since most of the variables are the I(1) processes, we further test whether the variables are co-integrated by the Johansen's trace test.[8] Table 3 summarizes the results. Overall, test results suggest the existence of co-integrating relations. Although we do not pursuit the economic implications of them, we impose them in order to enhance the efficiency of estimation. Thus our analysis below uses the VECMX* models.

Lastly, we make some refinements. If we have correctly estimated the VECMX*, and the entire system is stable, then any shock in a co-integrating relation should disappear within a

[8] Pesaran, Shin, and Smith (2000) and others have recommended using the trace test rather than the maximum eigenvalue test, since the latter test is generally less robust to the presence of skewness and excess kurtosis in the errors than the former test. See Cheung and Lai (1993).

reasonable amount of time. On the other hand, if the models are over-parameterized, the system may be unstable. For inspecting the risk of over-parameterization, we use the persistence profiles (henceforth PPs), proposed by Pesaran and Shin (1996). We have adjusted both the number of co-integration ranks and the lag lengths by referring the shape of the PPs. The adjusted number of co-integration ranks and lags are reported in the right-hand side of Table 4.

Figure 4 displays the bootstrap median of the PPs of the effect of system wide shocks to the cointegrating relations. Panel (a) of Figure 4 reports all the PPs with a set of computer selected lag lengths and the cointegration ranks. Since the responses of PPs exhibit explosive behavior, we have reduced the number of parameters one-by-one through trail and error. Panel (b) is calculated with the modified system. Unlike Panel (a), one-half of the adjustment is achieved within one quarter to one year for most of the countries in Panel (b). Thus we conclude that the modified system is stable.

Lastly, we have conducted a series of diagnostic checking. Notice that the right-hand side of Equation (1) contains the instantaneous foreign variables, $\mathbf{x}_{it}$*. Thus, when we stack all the VARX* models, it becomes a large system of simultaneous equations. Under this circumstances, estimating the country-specific VARX* one-by-one, not all at the same time, is justified if $\mathbf{x}_{it}$* are weakly exogenous. Up to now, we have estimated the models by assuming the weak exogeneity. This assumption is formally tested, and results are reported in Table 5. At five percent significance level, we have rejected 10 times out of 203 tests. Since this size is close enough to the level of significance, we consider these rejection cases due to the sampling variation.

We have also examined the parameter stability (Table 6), the structural breaks (Table 7), and the correlation of error terms (Table 8). Neither of the tests has detected any noticeable problem.

Throughout these operations, we have completed estimating a reasonable GVAR model. Using this model, we will conduct a series of policy evaluations in the next section.

Table 1: Unit Root Test Statistics for Domestic Variables (Weighted Symmetric Dickey-Fuller test)

Domestic Variables	Critical Value	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	INDIA	INDONESIA	JAPAN	KOREA	MALAYSIA	MEXICO
y (with trend)	-3.24	-1.78	-2.97	-2.31	-2.58	-2.40	-2.32	-0.98	-1.45	-1.85	-0.68	-0.83	-1.64	-1.89
y (no trend)	-2.55	0.20	1.97	1.69	1.14	0.32	0.95	1.06	1.34	2.92 *	1.29	0.82	1.74	1.60
Dy	-2.55	-5.41 *	-6.12 *	-6.64 *	-5.27 *	-3.75 *	-4.60 *	-4.48 *	-7.67 *	-7.34 *	-5.22 *	-5.36 *	-5.94 *	-5.96 *
DDy	-2.55	-7.72 *	-9.52 *	-8.21 *	-8.11 *	-12.27 *	-9.67 *	-9.18 *	-8.91 *	-8.60 *	-8.96 *	-8.09 *	-8.89 *	-9.81 *
Dp (with trend)	-3.24	-3.84 *	-3.82 *	-2.83	-2.52	-3.06	-4.99 *	-2.01	-6.23 *	-6.11 *	-3.28 *	-2.95	-6.13 *	-3.94 *
Dp (no trend)	-2.55	-2.69 *	-2.53	-2.51	-1.27	-3.09 *	-2.02	-0.69	-6.08 *	-6.06 *	-1.22	-2.16	-5.72 *	-2.87 *
DDp	-2.55	-13.00 *	-10.36 *	-6.63 *	-8.08 *	-7.54 *	-7.42 *	-7.03 *	-9.65 *	-7.46 *	-8.22 *	-7.28 *	-9.10 *	-6.06 *
DDDp	-2.55	-15.71 *	-10.85 *	-9.34 *	-11.38 *	-9.56 *	-11.73 *	-10.04 *	-10.82 *	-9.15 *	-11.79 *	-9.16 *	-12.17 *	-15.66 *
eq (with trend)	-3.24	-3.52 *	-3.60 *	-	-2.96	-	-2.28	-2.10	-3.57 *	-	-1.85	-2.87	-3.17	-
eq (no trend)	-2.55	-3.04 *	-0.82	-	-0.78	-	-0.29	-0.98	-1.10	-	-1.73	-1.50	-1.81	-
Deq	-2.55	-6.80 *	-6.18 *	-	-6.57 *	-	-5.34 *	-7.30 *	-7.16 *	-	-7.28 *	-6.09 *	-6.45 *	-
DDeq	-2.55	-8.64 *	-9.32 *	-	-9.28 *	-	-7.89 *	-10.55 *	-9.55 *	-	-8.03 *	-7.91 *	-10.42 *	-
ep (with trend)	-3.24	-2.39	-2.19	-1.61	-1.73	-0.69	-2.17	-2.39	0.19	-1.68	-2.05	-2.92	-2.15	-3.93 *
ep (no trend)	-2.55	-2.06	0.78	0.08	1.45	-0.44	-0.66	0.26	1.92	-1.80	-0.30	-0.55	0.12	-0.10
Dep	-2.55	-7.58 *	-4.70 *	-7.54 *	-7.86 *	-7.26 *	-7.37 *	-7.34 *	-5.12 *	-8.39 *	-5.53 *	-6.03 *	-7.52 *	-7.35 *
DDep	-2.55	-9.82 *	-8.95 *	-9.01 *	-9.11 *	-11.35 *	-9.35 *	-8.34 *	-8.75 *	-9.57 *	-7.93 *	-8.64 *	-9.48 *	-10.80 *
r (with trend)	-3.24	-2.81	-3.47 *	-2.92	-4.26 *	-1.72	-4.60 *	-3.26 *	-3.55 *	-4.23 *	-3.14	-2.72	-2.31	-2.12
r (no trend)	-2.55	-2.33	-1.93	-2.71 *	-1.25	-1.59	-1.16	-1.24	-3.50 *	-4.03 *	-1.82	-0.94	-2.23	-1.82
Dr	-2.55	-16.71 *	-5.03 *	-9.67 *	-6.16 *	-6.41 *	-7.09 *	-4.34 *	-6.91 *	-6.76 *	-5.19 *	-8.16 *	-6.21 *	-6.57 *
DDr	-2.55	-13.61 *	-11.56 *	-11.96 *	-9.74 *	-8.31 *	-8.93 *	-8.62 *	-10.15 *	-12.67 *	-5.60 *	-9.87 *	-8.97 *	-11.49 *
lr (with trend)	-3.24	-	-2.36	-	-3.75 *	-	-	-3.14	-	-	-2.53	-2.56	-	-
lr (no trend)	-2.55	-	-0.97	-	-1.04	-	-	-0.90	-	-	-0.68	-0.07	-	-
Dlr	-2.55	-	-5.93 *	-	-5.98 *	-	-	-5.43 *	-	-	-5.77 *	-7.10 *	-	-
DDlr	-2.55	-	-8.26 *	-	-9.07 *	-	-	-7.97 *	-	-	-8.45 *	-9.69 *	-	-

Domestic Variables	Critical Value	NORWAY	NEW_ZEALAND	PERU	PHILIPPINES	SOUTH_AFRICA	SAUDI_ARABIA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UNITED_KINGDOM	USA
y (with trend)	-3.24	-1.18	-0.32	-1.56	-2.11	-1.62	-0.03	-1.49	-3.12	-2.81	-0.99	-2.96	-2.17	-1.69
y (no trend)	-2.55	0.09	1.21	0.42	1.30	1.18	1.41	1.32	0.88	1.64	2.08	1.76	-0.64	1.26
Dy	-2.55	-3.51 *	-4.89 *	-7.82 *	-6.48 *	-5.27 *	-3.10 *	-5.96 *	-4.77 *	-5.64 *	-6.81 *	-7.92 *	-3.19 *	-4.88 *
DDy	-2.55	-9.31 *	-8.16 *	-9.33 *	-11.51 *	-8.28 *	-17.97 *	-8.71 *	-8.79 *	-8.57 *	-8.61 *	-9.85 *	-13.15 *	-8.17 *
Dp (with trend)	-3.24	-3.18	-4.02 *	-3.51 *	-5.42 *	-4.58 *	-3.77 *	-3.66 *	-3.80 *	-5.29 *	-3.15	-2.37	-2.23	-1.39
Dp (no trend)	-2.55	-2.02	-2.59 *	-3.24 *	-4.48 *	-2.85 *	-3.41 *	-3.63 *	-2.09	-3.64 *	-2.55	-1.47	-1.05	-0.07
DDp	-2.55	-8.41 *	-7.95 *	-8.41 *	-7.20 *	-8.85 *	-9.16 *	-8.70 *	-7.19 *	-8.13 *	-8.68 *	-8.25 *	-8.52 *	-10.14 *
DDDp	-2.55	-10.76 *	-10.18 *	-10.68 *	-9.37 *	-9.60 *	-10.01 *	-10.94 *	-9.49 *	-10.95 *	-10.16 *	-11.00 *	-8.39 *	-11.96 *
eq (with trend)	-3.24	-2.08	-3.59 *	-	-1.84	-4.59 *	-	-4.00 *	-2.85	-2.14	-2.23	-	-1.85	-1.85
eq (no trend)	-2.55	-1.79	-0.78	-	-1.45	-0.38	-	-1.69	-0.24	-0.51	-1.86	-	-0.68	-0.48
Deq	-2.55	-6.54 *	-8.39 *	-	-4.80 *	-8.81 *	-	-7.94 *	-7.25 *	-6.97 *	-5.38 *	-	-7.68 *	-6.78 *
DDeq	-2.55	-13.74 *	-8.35 *	-	-13.77 *	-7.96 *	-	-10.75 *	-13.19 *	-8.74 *	-9.09 *	-	-8.40 *	-9.38 *
ep (with trend)	-3.24	-2.69	-2.89	-1.70	-2.45	-2.49	-1.76	-1.36	-2.54	-2.48	-2.24	-0.93	-3.16	-
ep (no trend)	-2.55	0.38	-0.16	0.47	0.01	-0.83	-0.57	2.05	-0.61	0.37	0.34	0.23	0.20	-
Dep	-2.55	-7.89 *	-7.33 *	-9.02 *	-6.33 *	-5.08 *	-3.04 *	-6.86 *	-7.37 *	-8.43 *	-5.73 *	-6.18 *	-6.12 *	-
DDep	-2.55	-9.95 *	-9.21 *	-9.15 *	-7.97 *	-16.17 *	-11.52 *	-8.89 *	-9.21 *	-8.50 *	-9.51 *	-10.52 *	-9.72 *	-
r (with trend)	-3.24	-3.08	-3.28 *	-3.55 *	-3.46 *	-2.84	-	-3.24 *	-2.45	-2.27	-3.78 *	-1.49	-3.62 *	-3.95 *
r (no trend)	-2.55	-1.59	-1.89	-3.29 *	-2.22	-2.64 *	-	-1.39	-1.45	-2.07	-2.19	-1.55	-1.18	-1.59
Dr	-2.55	-8.79 *	-8.58 *	-4.68 *	-6.73 *	-6.23 *	-	-4.81 *	-8.33 *	-5.19 *	-6.60 *	-9.55 *	-6.97 *	-3.94 *
DDr	-2.55	-9.00 *	-9.90 *	-9.42 *	-10.26 *	-8.60 *	-	-8.60 *	-11.08 *	-8.90 *	-8.25 *	-9.56 *	-9.25 *	-7.68 *
lr (with trend)	-3.24	-1.45	-2.19	-	-	-0.57	-	-	-2.30	-2.07	-	-	-3.21	-4.19 *
lr (no trend)	-2.55	-0.76	-0.60	-	-	-1.00	-	-	-0.53	-1.23	-	-	-0.11	-1.24
Dlr	-2.55	-8.12 *	-7.91 *	-	-	-8.83 *	-	-	-7.23 *	-6.29 *	-	-	-8.55 *	-6.12 *
DDlr	-2.55	-8.66 *	-9.72 *	-	-	-8.81 *	-	-	-8.46 *	-8.21 *	-	-	-9.09 *	-8.25 *

Note: The WS statics (Park and Fuller, 1995) for all level variables are based on regressions including a linear trend, except for the interest rate variables. The WS statistics for variables in first and second differences are based on regressions including an intercept and no linear trend. The 95% critical value of the WS statistics for regressions with trend is -3.24, and for regression s without trade -2.55

Table 2: Unit Root Test Statistics for Foreign Variables (Weighted Symmetric Dickey-Fuller test)

Foreign Variables	Critical Value	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	INDIA	INDONESIA	JAPAN	KOREA	MALAYSIA	MEXICO
ys (with trend)	-3.24	-1.38	-1.42	-0.37	-2.86	-2.98	-0.62	-0.98	-1.60	-1.81	-0.93	-0.52	-2.60	-3.66 *
ys (no trend)	-2.55	1.85	0.76	2.02	1.52	1.77	1.96	1.48	1.74	2.39	1.63	1.85	2.05	1.66
Dys	-2.55	-5.25 *	-4.76 *	-5.17 *	-5.42 *	-5.78 *	-4.68 *	-5.22 *	-5.34 *	-6.75 *	-5.25 *	-3.82 *	-6.58 *	-5.56 *
DDy	-2.55	-9.13 *	-7.31 *	-7.69 *	-7.86 *	-8.10 *	-7.51 *	-8.17 *	-8.19 *	-8.08 *	-8.09 *	-11.04 *	-8.17 *	-7.89 *
Dps (with trend)	-3.24	-3.02	-3.19	-3.55 *	-1.93	-3.56 *	-2.88	-3.51 *	-3.19	-2.88	-3.49 *	-3.12	-3.12	-3.27 *
Dps (no trend)	-2.55	-2.69 *	-1.55	-2.55	-0.36	-2.00	-2.30	-1.98	-1.48	-2.20	-2.12	-2.32	-2.32	-1.06
DDps	-2.55	-6.25 *	-7.30 *	-12.28 *	-9.38 *	-7.21 *	-8.41 *	-10.00 *	-7.65 *	-7.19 *	-7.39 *	-7.25 *	-7.46 *	-8.04 *
DDDp	-2.55	-14.61 *	-10.35 *	-10.73 *	-11.43 *	-9.99 *	-9.19 *	-9.49 *	-9.85 *	-10.53 *	-10.34 *	-9.91 *	-10.81 *	-10.85 *
eqs (with trend)	-3.24	-2.19	-2.41	-2.61	-1.95	-2.69	-2.60	-2.24	-2.26	-2.37	-2.48	-2.23	-2.59	-1.96
eqs (no trend)	-2.55	-0.47	-0.98	-0.91	-0.50	-0.88	-1.06	-0.51	-0.68	-0.97	-0.67	-0.74	-0.95	-0.52
Deqs	-2.55	-7.30 *	-7.48 *	-7.80 *	-6.93 *	-7.43 *	-7.41 *	-7.35 *	-7.43 *	-7.53 *	-7.52 *	-7.35 *	-7.50 *	-6.91 *
DDeq	-2.55	-8.89 *	-9.03 *	-9.16 *	-9.29 *	-9.02 *	-9.28 *	-8.92 *	-8.92 *	-8.91 *	-9.22 *	-10.48 *	-8.71 *	-9.31 *
eps (with trend)	-3.24	-1.79	-3.16	-1.94	-2.58	-2.12	-3.35 *	-2.67	-1.69	-1.59	-1.87	-2.77	-2.00	-2.34
eps (no trend)	-2.55	-0.68	0.06	-0.41	-0.27	-0.82	-1.75	0.69	-0.11	1.32	0.32	1.27	-0.11	-2.26
Deps	-2.55	-3.94 *	-5.62 *	-8.50 *	-4.36 *	-4.23 *	-4.69 *	-8.17 *	-7.98 *	-9.32 *	-4.82 *	-8.38 *	-7.51 *	-4.22 *
DDep	-2.55	-8.80 *	-8.62 *	-13.04 *	-8.40 *	-15.29 *	-13.99 *	-9.36 *	-9.53 *	-8.73 *	-12.98 *	-13.05 *	-8.49 *	-14.12 *
rs (with trend)	-3.24	-2.85	-3.27 *	-3.26 *	-3.88 *	-2.95	-2.55	-2.26	-2.46	-3.08	-2.92	-2.90	-3.66 *	-3.76 *
rs (no trend)	-2.55	-2.63 *	-1.42	-1.48	-1.33	-1.65	-2.08	-1.39	-1.17	-1.66	-1.21	-1.27	-1.70	-1.51
Drs	-2.55	-10.68 *	-5.45 *	-15.11 *	-4.05 *	-6.12 *	-11.31 *	-11.07 *	-7.28 *	-4.87 *	-6.56 *	-6.19 *	-4.72 *	-5.65 *
DDr	-2.55	-11.52 *	-9.20 *	-12.82 *	-10.44 *	-11.09 *	-11.38 *	-11.16 *	-11.73 *	-9.35 *	-10.44 *	-10.43 *	-9.05 *	-10.34 *
lrs (with trend)	-3.24	-2.91	-3.79 *	-3.04	-4.17 *	-3.38 *	-2.98	-3.98 *	-2.98	-3.60 *	-3.35 *	-3.45 *	-2.92	-4.08 *
lrs (no trend)	-2.55	-0.69	-0.33	-0.70	-0.88	-0.91	-0.60	-0.43	-0.52	-0.58	-0.59	-0.69	-0.47	-0.84
Dlrs	-2.55	-5.84 *	-5.85 *	-5.79 *	-6.01 *	-5.42 *	-5.84 *	-6.00 *	-5.91 *	-5.46 *	-5.92 *	-5.56 *	-5.64 *	-5.83 *
DDlr	-2.55	-8.60 *	-9.11 *	-8.65 *	-8.36 *	-9.06 *	-8.78 *	-8.72 *	-8.71 *	-8.81 *	-8.57 *	-8.83 *	-8.67 *	-8.45 *

Foreign Variables	Critical Value	NORWAY	NEW_ZEALAND	PERU	PHILIPPINES	SOUTH_AFRICA	SAUDI_ARABIA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UNITED_KINGDOM	USA
ys (with trend)	-3.24	-2.95	-1.96	-1.20	-1.93	-1.67	-1.85	-2.51	-2.42	-2.54	-2.42	-2.23	-3.54 *	-1.27
ys (no trend)	-2.55	0.73	2.13	1.92	2.17	0.51	0.76	1.71	0.86	1.31	1.82	1.65	1.30	1.22
Dys	-2.55	-4.94 *	-5.26 *	-5.16 *	-6.91 *	-4.64 *	-5.32 *	-5.86 *	-5.19 *	-5.36 *	-6.16 *	-5.41 *	-5.29 *	-4.81 *
DDy	-2.55	-7.59 *	-7.77 *	-7.46 *	-8.55 *	-7.33 *	-7.67 *	-8.11 *	-7.75 *	-7.70 *	-8.29 *	-7.69 *	-7.58 *	-7.98 *
Dps (with trend)	-3.24	-2.18	-2.81	-3.06	-2.98	-3.18	-3.06	-3.89 *	-2.67	-2.21	-3.11	-2.81	-2.17	-2.86
Dps (no trend)	-2.55	-0.65	-1.00	-2.47	-1.94	-1.62	-1.98	-2.88 *	-0.64	-0.56	-1.73	-1.66	-0.55	-1.18
DDps	-2.55	-7.12 *	-7.64 *	-9.64 *	-6.99 *	-6.66 *	-7.67 *	-8.06 *	-7.12 *	-7.53 *	-7.28 *	-7.06 *	-7.94 *	-10.03 *
DDDp	-2.55	-9.14 *	-10.37 *	-8.95 *	-10.12 *	-9.46 *	-9.85 *	-11.51 *	-9.69 *	-10.03 *	-10.59 *	-9.98 *	-10.25 *	-9.81 *
eqs (with trend)	-3.24	-2.51	-2.66	-2.05	-2.24	-2.15	-2.31	-2.69	-2.05	-2.08	-2.53	-2.10	-2.22	-3.12
eqs (no trend)	-2.55	-0.81	-0.84	-0.58	-0.97	-0.89	-0.88	-0.82	-0.94	-0.89	-0.82	-0.78	-0.77	-0.84
Deqs	-2.55	-7.46 *	-7.37 *	-7.36 *	-7.39 *	-7.57 *	-7.54 *	-7.65 *	-7.23 *	-7.30 *	-7.43 *	-7.29 *	-7.38 *	-7.66 *
DDeq	-2.55	-8.85 *	-9.06 *	-7.99 *	-9.00 *	-8.98 *	-8.87 *	-10.11 *	-8.67 *	-10.52 *	-10.27 *	-8.86 *	-10.27 *	-9.11 *
eps (with trend)	-3.24	-2.52	-2.82	-2.36	-2.14	-2.82	-3.40 *	-2.18	-2.57	-2.61	-2.42	-2.70	-2.13	-1.78
eps (no trend)	-2.55	0.17	0.39	-0.82	0.15	-1.89	-3.31 *	-0.27	0.42	0.26	-0.86	-0.74	0.49	1.50
Deps	-2.55	-7.58 *	-5.31 *	-4.51 *	-4.69 *	-4.68 *	-3.89 *	-4.73 *	-7.42 *	-7.41 *	-4.81 *	-8.01 *	-7.21 *	-7.66 *
DDep	-2.55	-9.33 *	-9.45 *	-13.81 *	-15.15 *	-8.13 *	-15.34 *	-12.98 *	-9.00 *	-8.55 *	-13.55 *	-8.98 *	-8.45 *	-9.30 *
rs (with trend)	-3.24	-2.79	-3.39 *	-2.77	-2.78	-2.62	-2.49	-3.46 *	-2.56	-2.56	-2.68	-2.43	-2.47	-1.70
rs (no trend)	-2.55	-1.12	-1.51	-2.18	-1.24	-1.37	-1.45	-1.56	-0.99	-1.06	-1.37	-1.27	-1.02	-1.14
Drs	-2.55	-5.35 *	-4.62 *	-12.18 *	-7.40 *	-6.47 *	-9.40 *	-5.24 *	-6.05 *	-5.75 *	-5.97 *	-9.47 *	-6.32 *	-12.04 *
DDr	-2.55	-9.14 *	-8.92 *	-10.99 *	-10.75 *	-10.51 *	-9.61 *	-7.81 *	-9.93 *	-10.16 *	-10.25 *	-10.18 *	-10.38 *	-11.77 *
lrs (with trend)	-3.24	-2.87	-2.85	-3.96 *	-3.07	-2.93	-2.99	-2.89	-2.66	-2.64	-2.76	-2.70	-2.63	-3.37 *
lrs (no trend)	-2.55	-0.43	-0.60	-0.67	-0.52	-0.58	-0.47	-0.50	-0.60	-0.72	-0.53	-0.71	-0.70	-0.67
Dlrs	-2.55	-6.10 *	-5.84 *	-5.82 *	-5.77 *	-5.73 *	-5.65 *	-5.86 *	-5.83 *	-5.70 *	-5.57 *	-5.80 *	-5.84 *	-5.20 *
DDlr	-2.55	-8.79 *	-8.75 *	-8.68 *	-8.68 *	-8.86 *	-8.69 *	-8.70 *	-8.53 *	-8.27 *	-8.67 *	-8.67 *	-8.35 *	-8.98 *

Note: The WS statics (Park and Fuller, 1995) for all level variables are based on regressions including a linear trend, except for the interest rate variables. The WS statistics for variables in first and second differences are based on regressions including an intercept and no linear trend. The 95% critical value of the WS statistics for regressions with trend is -3.24, and for regression s without trade -2.55

Table 3: Co-integration Rank Statistics (Upper Panel: Trace Statistics, Lower Panel: 5% Significance Level)

Country	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	INDIA	INDONESIA	JAPAN	KOREA	MALAYSIA	MEXICO
# endogenous variables	5	6	4	6	4	5	6	5	4	6	6	5	4
# foreign (star) variables	8	8	8	8	8	8	8	8	8	8	8	8	8
r=0	205.80	389.15	176.31	292.09	179.06	278.99	311.46	230.81	215.81	331.97	374.54	218.15	179.62
r=1	129.39	271.04	86.15	205.43	103.97	168.59	208.45	145.47	123.49	207.82	274.67	142.32	102.16
r=2	71.52	175.17	40.35	135.48	47.31	104.03	136.52	88.99	65.89	143.22	188.20	85.12	42.95
r=3	37.45	108.55	17.23	86.92	17.27	47.24	83.73	45.98	20.25	94.14	106.12	38.71	12.92
r=4	17.58	60.41		53.26		17.37	45.88	22.26		52.38	58.34	14.63	
r=5		19.20		23.48			17.06			22.83	27.99		
r=6													
r=7													

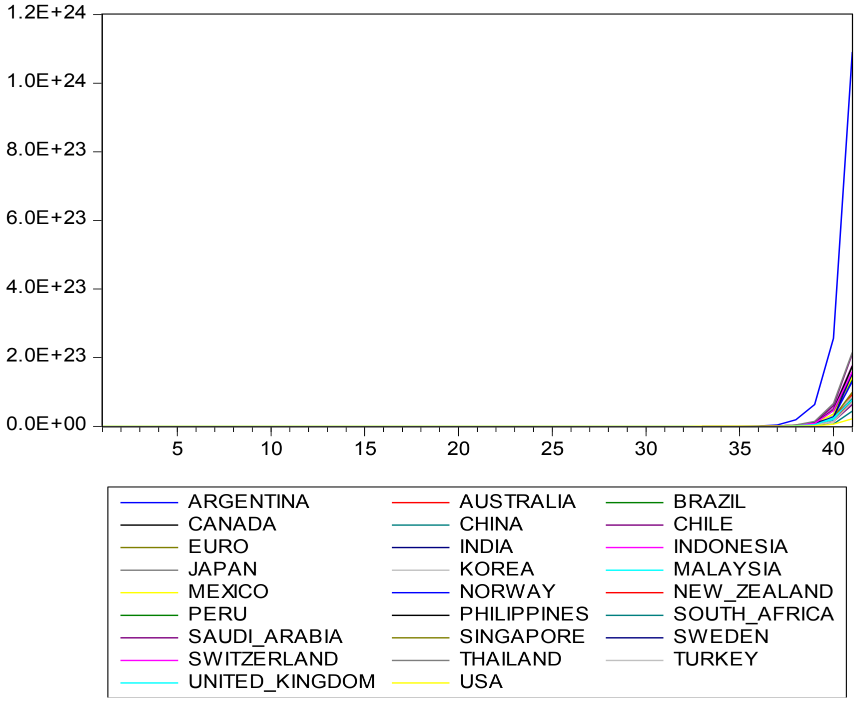
Country	NORWAY	NEW_ZEALAND	PERU	PHILIPPINES	SOUTH_AFRICA	SAUDI_ARABIA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UNITED_KINGDOM	USA
# endogenous variables	6	6	4	5	6	3	5	6	6	5	4	6	8
# foreign (star) variables	8	8	8	8	8	8	8	8	8	8	8	8	3
r=0	329.00	277.75	227.59	265.30	285.35	156.64	242.05	270.36	304.20	295.29	176.71	303.96	340.81
r=1	228.95	180.59	127.74	159.66	202.42	76.75	153.47	197.58	209.50	184.17	110.50	195.22	245.20
r=2	146.50	106.77	69.83	86.76	130.80	28.43	105.03	128.23	145.57	108.33	57.99	129.01	166.36
r=3	94.02	64.15	29.07	45.07	85.91		58.52	75.17	90.23	59.34	19.99	71.31	116.81
r=4	48.77	33.69		16.66	51.03		16.03	45.62	46.96	24.60		40.20	74.94
r=5	19.52	11.13			23.19			20.80	20.02			15.70	45.65
r=6													25.93
r=7													12.50

Country	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	INDIA	INDONESIA	JAPAN	KOREA	MALAYSIA	MEXICO
# endogenous variables	5	6	4	6	4	5	6	5	4	6	6	5	4
# foreign (star) variables	8	8	8	8	8	8	8	8	8	8	8	8	8
r=0	178.46	223.88	136.94	223.88	136.94	178.46	223.88	178.46	136.94	223.88	223.88	178.46	136.94
r=1	136.94	178.46	99.12	178.46	99.12	136.94	178.46	136.94	99.12	178.46	178.46	136.94	99.12
r=2	99.12	136.94	64.91	136.94	64.91	99.12	136.94	99.12	64.91	136.94	136.94	99.12	64.91
r=3	64.91	99.12	33.87	99.12	33.87	64.91	99.12	64.91	33.87	99.12	99.12	64.91	33.87
r=4	33.87	64.91		64.91		33.87	64.91	33.87		64.91	64.91	33.87	
r=5		33.87		33.87			33.87			33.87	33.87		
r=6													
r=7													

Country	NORWAY	NEW_ZEALAND	PERU	PHILIPPINES	SOUTH_AFRICA	SAUDI_ARABIA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UNITED_KINGDOM	USA
# endogenous variables	6	6	4	5	6	3	5	6	6	5	4	6	8
# foreign (star) variables	8	8	8	8	8	8	8	8	8	8	8	8	3
r=0	223.88	223.88	136.94	178.46	223.88	99.12	178.46	223.88	223.88	178.46	136.94	223.88	240.05
r=1	178.46	178.46	99.12	136.94	178.46	64.91	136.94	178.46	178.46	136.94	99.12	178.46	197.07
r=2	136.94	136.94	64.91	99.12	136.94	33.87	99.12	136.94	136.94	99.12	64.91	136.94	158.01
r=3	99.12	99.12	33.87	64.91	99.12		64.91	99.12	99.12	64.91	33.87	99.12	122.96
r=4	64.91	64.91		33.87	64.91		33.87	64.91	64.91	33.87		64.91	91.81
r=5	33.87	33.87			33.87			33.87	33.87			33.87	64.54
r=6													
r=7													

Figure 4: Persistence Profiles

(a) Persistence Profiles by computer selecting lags and co-integrating relations



(b) Persistence Profiles by modified lags and co-integrating relations

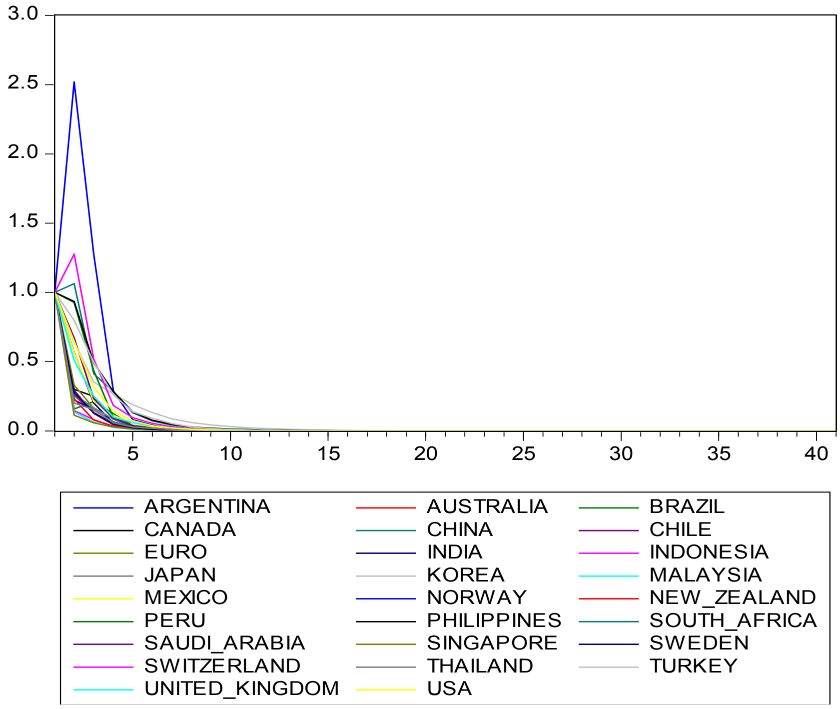


Table 4: Co-integration Ranks and Lag Orders of VARX*

	Computer Selected			After Modified		
	p	q	co-int rank	p	q	co-int rank
ARGENTINA	2	1	1	1	1	1
AUSTRALIA	1	1	4	1	1	2
BRAZIL	2	1	1	1	1	1
CANADA	2	1	2	2	1	1
CHINA	1	1	2	1	1	1
CHILE	2	1	3	1	1	2
EURO	2	1	2	2	1	1
INDIA	2	1	2	1	1	1
INDONESIA	2	1	3	1	1	1
JAPAN	2	1	3	2	1	1
KOREA	2	1	4	2	1	1
MALAYSIA	1	1	2	1	1	1
MEXICO	2	1	2	1	1	2
NORWAY	2	1	3	1	1	2
NEW ZEALAND	2	1	2	1	1	2
PERU	2	1	3	1	1	1
PHILIPPINES	2	1	2	2	1	1
SOUTH AFRICA	2	1	2	2	1	1
SAUDI ARABIA	2	1	2	2	1	1
SINGAPORE	2	1	3	1	1	1
SWEDEN	2	1	2	1	1	1
SWITZERLAND	1	1	3	2	1	2
THAILAND	1	1	3	2	1	1
TURKEY	2	1	2	2	1	2
UNITED KINGDOM	2	1	2	2	1	1
USA	2	1	3	2	1	2

Table 5: Weak Exogeneity Test

Country	F test	5% crit	ys	Dps	eqs	eps	rs	lrs	poil	pmetal	pagri
ARGENTINA	F(1,118)	3.92	2.98	0.00	1.15		0.01	0.12	0.38	0.12	1.71
AUSTRALIA	F(2,116)	3.07	0.72	0.06	0.72		0.19	0.20	0.44	0.83	0.08
BRAZIL	F(1,119)	3.92	0.30	0.44	0.09		1.64	0.32	1.21	0.76	0.01
CANADA	F(1,111)	3.93	0.10	2.33	0.45		3.33	0.96	1.33	1.22	0.50
CHINA	F(1,119)	3.92	0.99	0.08	0.01		1.58	1.53	2.80	0.07	0.72
CHILE	F(2,112)	3.08	1.18	2.43	1.56		1.92	0.11	0.01	0.44	2.24
EURO	F(1,111)	3.93	0.97	1.12	0.22		0.12	0.05	0.17	0.34	0.32
INDIA	F(1,118)	3.92	0.26	0.24	0.04		0.20	0.06	4.30 *	0.19	0.28
INDONESIA	F(1,115)	3.92	0.01	0.54	0.14		0.01	3.27	0.01	0.25	0.01
JAPAN	F(1,111)	3.93	0.14	4.16 *	0.30		6.36 *	4.85 *	2.12	0.02	0.00
KOREA	F(1,111)	3.93	2.49	0.85	0.16		0.35	0.22	0.00	0.10	2.19
MALAYSIA	F(1,113)	3.93	0.88	0.26	0.17		2.10	0.16	1.36	0.61	0.02
MEXICO	F(2,118)	3.07	0.74	2.10	1.50		1.26	0.79	0.83	0.92	1.22
NORWAY	F(2,110)	3.08	1.19	1.90	0.75		0.12	2.33	4.99 *	1.40	0.23
NEW ZEALAND	F(2,110)	3.08	0.82	2.59	1.52		0.66	0.01	3.58 *	1.84	0.28
PERU	F(1,115)	3.92	0.56	0.53	0.82		0.21	0.00	4.47 *	0.10	2.11
PHILIPPINES	F(1,113)	3.93	0.70	0.81	5.37 *		0.15	0.00	2.45	2.79	2.28
SOUTH AFRICA	F(1,111)	3.93	1.85	0.01	0.97		1.22	0.63	0.00	1.81	2.93
SAUDI ARABIA	F(1,120)	3.92	1.11	0.14	0.11		0.01	2.60	3.56	0.04	0.92
SINGAPORE	F(1,118)	3.92	0.09	1.31	0.00		0.39	1.87	0.83	0.00	1.34
SWEDEN	F(1,111)	3.93	0.99	4.97 *	0.17		0.12	0.38	1.70	0.69	0.04
SWITZERLAND	F(2,116)	3.07	1.81	5.78 *	1.06		1.66	0.56	1.28	0.54	1.31
THAILAND	F(1,118)	3.92	1.15	0.31	0.08		0.03	0.06	0.79	0.07	0.26
TURKEY	F(2,114)	3.08	1.14	1.96	0.42		1.68	0.30	1.19	0.10	0.22
UNITED KINGDOM	F(1,117)	3.92	1.09	1.62	0.01		1.32	0.84	0.66	0.01	0.00
USA	F(2,111)	3.08	1.12	0.59		2.25					

Note: * denotes significance at 5 percent significance level.

Table 6: Parameter Stability Test

Variables	y	Dp	eq	ep	r	lr	poil	pmetal	pagri	Total	Rejection Rate
PK sup	7	8	1	3	3	3	0	0	0	25	18.38
PK msq	5	4	0	2	2	2	0	0	0	15	11.03
Nyblom	5	4	3	3	3	5	0	1	1	25	18.38
Robust Nyblom	5	4	2	6	2	4	0	0	0	23	16.91
QLR	7	14	9	10	16	6	0	0	1	63	46.32
Robust QLR	2	7	4	6	4	5	0	0	0	28	20.59
MW	6	7	4	6	4	5	0	0	1	33	24.26
Robust MW	3	6	6	7	1	5	0	0	0	28	20.59
APW	7	15	9	10	15	7	0	0	1	64	47.06
Robust APW	3	7	5	7	2	5	0	0	0	29	21.32

Note: The test statistics PK sup and PK msq are based on the cumulative sum of OLS residuals, Nyblom is the Nyblom test for time-varying parameters and QLR, MW APW are the sequential Wald statistics for a single break a an unknown change point. Statistics with the prefix 'robust' denote the heteroskedasticity-robust version of tests. All tests are implemented at the 5% significance level.

Table 7: Break Dates Computed with the QLR at 5% significance level

Variables	y	Dp	eq	ep	r	lr	poil	pmetal	pagri
ARGENTINA	1990Q2	1989Q3	1989Q3	1989Q2	1989Q3	-	-	-	-
AUSTRALIA	1988Q1	1990Q4	1988Q4	2001Q3	1988Q1	1988Q2	-	-	-
BRAZIL	1990Q1	1989Q3	-	1990Q3	1989Q3	-	-	-	-
CANADA	1987Q4	1991Q1	1987Q4	2000Q3	1987Q4	1990Q1	-	-	-
CHINA	2003Q2	1988Q3	-	1995Q2	1990Q1	-	-	-	-
CHILE	1996Q3	1987Q4	1987Q4	1988Q4	1987Q4	-	-	-	-
EURO	1987Q4	1997Q1	1999Q2	1999Q3	1988Q3	1989Q1	-	-	-
INDIA	1996Q2	1997Q3	1992Q2	2004Q3	2000Q4	-	-	-	-
INDONESIA	1998Q1	1997Q4	-	1997Q2	1997Q1	-	-	-	-
JAPAN	1991Q1	1988Q4	1992Q4	1995Q2	1987Q4	-	-	-	-
KOREA	1989Q3	1987Q4	1997Q1	1998Q1	1997Q3	1989Q2	-	-	-
MALAYSIA	1998Q1	2004Q3	1987Q4	1997Q2	1998Q2	-	-	-	-
MEXICO	1988Q1	1988Q1	-	1989Q3	1988Q1	-	-	-	-
NORWAY	1987Q4	1999Q3	1989Q4	2003Q3	1998Q4	1990Q3	-	-	-
NEW ZEALAND	1987Q4	1987Q4	1992Q4	1999Q2	1987Q4	1987Q4	-	-	-
PERU	1990Q1	1990Q1	-	1989Q4	1989Q4	-	-	-	-
PHILIPPINES	1987Q4	1991Q2	1988Q1	1987Q4	1987Q4	-	-	-	-
SOUTH AFRICA	1988Q3	1996Q1	1987Q4	1989Q1	1996Q2	1988Q2	-	-	-
SAUDI ARABIA	1990Q1	1997Q3	-	1997Q3	-	-	-	-	-
SINGAPORE	1994Q1	1989Q4	1991Q3	1995Q1	1995Q3	-	-	-	-
SWEDEN	1987Q4	1993Q2	1988Q4	1999Q4	1988Q2	1988Q1	-	-	-
SWITZERLAND	1992Q3	1987Q4	1987Q4	1992Q4	1988Q4	2001Q2	-	-	-
THAILAND	2004Q4	2002Q3	1990Q3	1998Q2	1994Q4	-	-	-	-
TURKEY	2000Q2	1994Q2	-	2000Q2	1994Q2	-	-	-	-
UNITED KINGDOM	1988Q1	1991Q1	1993Q1	1988Q4	1987Q4	1987Q4	-	-	-
USA	1999Q4	2000Q2	1998Q2	-	1987Q4	1988Q1	2001Q4	2000Q4	2003Q3

Table 8: Contemporaneous Effects of Foreign Variables on Domestic Counterparts by Countries

		y	Dp	eq	ep	r	lr
ARGENTINA	Coefficient	0.65	-0.29	1.25	-	1.75	-
	t-Ratio	2.69	-0.12	2.83	-	0.74	-
AUSTRALIA	Coefficient	0.14	0.71	0.77	-	0.47	0.90
	t-Ratio	1.22	3.21	5.81	-	3.98	5.95
BRAZIL	Coefficient	0.33	3.08	-	-	0.57	-
	t-Ratio	1.61	1.28	-	-	0.14	-
CANADA	Coefficient	0.46	0.65	0.90	-	0.51	1.02
	t-Ratio	4.75	6.25	15.41	-	2.94	14.97
CHINA	Coefficient	0.49	0.44	-	-	0.01	-
	t-Ratio	1.84	1.27	-	-	0.38	-
CHILE	Coefficient	0.57	0.12	0.51	-	0.13	-
	t-Ratio	1.72	1.51	4.30	-	2.11	-
EURO	Coefficient	0.26	0.15	1.09	-	0.07	0.68
	t-Ratio	2.76	3.07	21.79	-	2.88	9.22
INDIA	Coefficient	0.10	0.23	0.70	-	-0.01	-
	t-Ratio	0.53	0.79	5.07	-	-0.13	-
INDONESIA	Coefficient	0.77	0.31	-	-	1.06	-
	t-Ratio	2.11	0.50	-	-	1.24	-
JAPAN	Coefficient	0.08	0.13	0.69	-	-0.05	0.53
	t-Ratio	0.47	1.66	7.10	-	-1.11	6.10
KOREA	Coefficient	0.21	0.55	0.91	-	-0.23	0.27
	t-Ratio	1.23	2.03	4.75	-	-1.64	0.85
MALAYSIA	Coefficient	1.13	0.53	1.20	-	0.01	-
	t-Ratio	3.61	3.60	7.46	-	0.09	-
MEXICO	Coefficient	0.18	-0.13	-	-	0.35	-
	t-Ratio	1.19	-0.21	-	-	0.79	-
NORWAY	Coefficient	0.50	0.86	0.74	-	0.19	0.72
	t-Ratio	3.13	4.28	6.57	-	1.00	5.02
NEW ZEALAND	Coefficient	0.34	0.42	1.12	-	0.73	0.36
	t-Ratio	1.56	2.24	9.87	-	2.06	1.70
PERU	Coefficient	0.42	-0.97	-	-	-2.42	-
	t-Ratio	1.05	-0.41	-	-	-1.89	-
PHILIPPINES	Coefficient	0.18	-0.56	1.00	-	0.43	-
	t-Ratio	0.82	-1.30	5.34	-	1.67	-
SOUTH AFRICA	Coefficient	0.09	0.02	0.87	-	0.02	0.48
	t-Ratio	0.88	0.10	6.07	-	0.32	2.18
SAUDI ARABIA	Coefficient	0.39	-0.13	-	-	-	-
	t-Ratio	1.46	-0.74	-	-	-	-
SINGAPORE	Coefficient	1.01	0.57	1.27	-	0.25	-
	t-Ratio	3.97	3.79	11.46	-	1.85	-
SWEDEN	Coefficient	1.06	1.31	1.19	-	0.45	0.98
	t-Ratio	3.45	8.54	16.22	-	2.51	6.16
SWITZERLAND	Coefficient	0.51	0.37	0.92	-	0.21	0.50
	t-Ratio	4.30	2.93	16.66	-	2.64	6.71
THAILAND	Coefficient	0.59	0.44	0.86	-	0.47	-
	t-Ratio	1.17	1.77	7.10	-	1.59	-
TURKEY	Coefficient	1.07	4.32	-	-	1.09	-
	t-Ratio	2.78	3.57	-	-	1.57	-
UNITED KINGDOM	Coefficient	0.55	0.63	0.84	-	0.23	0.75
	t-Ratio	4.15	4.73	12.96	-	1.90	6.17
USA	Coefficient	0.29	0.34	-	-	-	-
	t-Ratio	1.96	3.54	-	-	-	-

Note: t-Ratio is White's heteroskedastity robust standard t-statistic.

Table 9: Average Pair-wise Cross-section Correlations of Variables using in GVAR model and Associated Model's Residuals

	Real GDP				Inflation				Equity Price		
	Levels	First Differences	VECMX Residuals		Levels	First Differences	VECMX Residuals		Levels	First Differences	VECMX Residuals
ARGENTINA	0.90	0.08	-0.01	ARGENTINA	0.27	0.05	0.02	ARGENTINA	0.47	0.22	-0.01
AUSTRALIA	0.97	0.15	0.04	AUSTRALIA	0.34	0.08	0.00	AUSTRALIA	0.79	0.52	0.03
BRAZIL	0.96	0.16	0.02	BRAZIL	0.23	0.02	-0.05	BRAZIL	-	-	-
CANADA	0.97	0.21	0.01	CANADA	0.42	0.14	0.01	CANADA	0.73	0.55	0.05
CHINA	0.97	0.09	-0.01	CHINA	0.06	0.07	-0.01	CHINA	-	-	-
CHILE	0.96	0.15	0.05	CHILE	0.40	0.05	0.00	CHILE	0.77	0.30	0.06
EURO	0.96	0.27	0.02	EURO	0.46	0.16	0.02	EURO	0.77	0.57	-0.11
INDIA	0.97	0.00	-0.02	INDIA	0.17	0.04	0.01	INDIA	0.77	0.33	0.01
INDONESIA	0.96	0.10	0.01	INDONESIA	0.03	0.05	0.02	INDONESIA	-	-	-
JAPAN	0.90	0.16	-0.01	JAPAN	0.43	0.10	0.00	JAPAN	0.32	0.44	-0.11
KOREA	0.96	0.12	0.03	KOREA	0.37	0.07	0.01	KOREA	0.71	0.36	-0.01
MALAYSIA	0.97	0.21	0.04	MALAYSIA	0.28	0.12	0.02	MALAYSIA	0.62	0.40	0.05
MEXICO	0.96	0.17	0.08	MEXICO	0.21	0.01	0.02	MEXICO	-	-	-
NORWAY	0.96	0.20	0.00	NORWAY	0.38	0.08	0.02	NORWAY	0.42	0.41	0.00
NEW ZEALAND	0.96	0.13	0.04	NEW ZEALAND	0.34	0.07	0.02	NEW ZEALAND	0.80	0.49	0.05
PERU	0.87	0.07	0.02	PERU	0.24	-0.04	-0.03	PERU	-	-	-
PHILIPPINES	0.95	0.08	0.02	PHILIPPINES	0.22	0.04	0.01	PHILIPPINES	0.71	0.36	0.03
SOUTH AFRICA	0.94	0.19	0.05	SOUTH AFRICA	0.34	0.07	0.04	SOUTH AFRICA	0.78	0.48	0.07
SAUDI ARABIA	0.91	0.02	-0.01	SAUDI ARABIA	0.01	-0.01	0.03	SAUDI ARABIA	-	-	-
SINGAPORE	0.97	0.20	0.01	SINGAPORE	0.24	0.05	0.01	SINGAPORE	0.74	0.53	0.01
SWEDEN	0.97	0.20	0.00	SWEDEN	0.47	0.11	0.01	SWEDEN	0.77	0.51	-0.01
SWITZERLAND	0.97	0.21	-0.01	SWITZERLAND	0.40	0.11	0.03	SWITZERLAND	0.78	0.53	0.01
THAILAND	0.95	0.15	0.02	THAILAND	0.31	0.07	0.01	THAILAND	0.64	0.39	0.05
TURKEY	0.97	0.14	0.00	TURKEY	0.17	0.00	-0.01	TURKEY	-	-	-
UNITED KINGDOM	0.96	0.20	0.01	UNITED KINGDOM	0.45	0.11	0.01	UNITED KINGDOM	0.77	0.56	-0.03
USA	0.97	0.23	-0.01	USA	0.42	0.19	0.02	USA	0.77	0.54	0.00

	Real Exchange Rate				Short-term Interest Rate				Long-term Interest Rate		
	Levels	First Differences	VECMX Residuals		Levels	First Differences	VECMX Residuals		Levels	First Differences	VECMX Residuals
ARGENTINA	0.42	0.09	0.06	ARGENTINA	0.44	0.03	-0.02	ARGENTINA	-	-	-
AUSTRALIA	0.84	0.37	0.22	AUSTRALIA	0.59	0.13	0.02	AUSTRALIA	0.87	0.39	0.02
BRAZIL	0.80	0.20	0.14	BRAZIL	0.40	0.01	-0.07	BRAZIL	-	-	-
CANADA	0.81	0.32	0.16	CANADA	0.64	0.18	0.09	CANADA	0.89	0.37	-0.02
CHINA	0.48	0.10	-0.03	CHINA	0.54	0.07	0.02	CHINA	-	-	-
CHILE	0.76	0.29	0.15	CHILE	0.61	0.02	-0.03	CHILE	-	-	-
EURO	0.82	0.36	0.28	EURO	0.66	0.18	0.05	EURO	0.88	0.45	-0.07
INDIA	0.61	0.26	0.16	INDIA	0.30	0.10	0.04	INDIA	-	-	-
INDONESIA	0.35	0.22	0.11	INDONESIA	0.23	0.08	0.04	INDONESIA	-	-	-
JAPAN	0.70	0.16	0.12	JAPAN	0.60	0.05	0.01	JAPAN	0.84	0.28	-0.04
KOREA	0.80	0.29	0.15	KOREA	0.60	0.07	0.04	KOREA	0.79	0.06	-0.04
MALAYSIA	0.76	0.30	0.19	MALAYSIA	0.47	0.07	0.04	MALAYSIA	-	-	-
MEXICO	0.75	0.11	-0.02	MEXICO	0.49	0.03	0.04	MEXICO	-	-	-
NORWAY	0.82	0.39	0.26	NORWAY	0.60	0.05	-0.01	NORWAY	0.86	0.31	0.00
NEW ZEALAND	0.82	0.37	0.24	NEW ZEALAND	0.56	0.06	0.01	NEW ZEALAND	0.80	0.19	0.03
PERU	0.73	0.05	0.05	PERU	0.43	0.04	0.05	PERU	-	-	-
PHILIPPINES	0.82	0.18	0.13	PHILIPPINES	0.61	0.09	0.03	PHILIPPINES	-	-	-
SOUTH AFRICA	0.76	0.32	0.20	SOUTH AFRICA	0.48	0.11	0.03	SOUTH AFRICA	0.62	0.20	0.00
SAUDI ARABIA	0.65	0.09	0.04	SAUDI ARABIA	-	-	-	SAUDI ARABIA	-	-	-
SINGAPORE	0.83	0.38	0.24	SINGAPORE	0.56	0.09	0.02	SINGAPORE	-	-	-
SWEDEN	0.79	0.36	0.24	SWEDEN	0.68	0.10	0.02	SWEDEN	0.90	0.39	0.02
SWITZERLAND	0.81	0.31	0.26	SWITZERLAND	0.51	0.09	-0.03	SWITZERLAND	0.79	0.38	0.00
THAILAND	0.82	0.30	0.20	THAILAND	0.60	0.12	0.04	THAILAND	-	-	-
TURKEY	0.81	0.19	0.10	TURKEY	0.27	0.05	0.01	TURKEY	-	-	-
UNITED KINGDOM	0.78	0.33	0.20	UNITED KINGDOM	0.66	0.15	0.04	UNITED KINGDOM	0.89	0.40	-0.03
USA	-	-	-	USA	0.59	0.11	0.05	USA	0.86	0.41	-0.03

Note: VECMX refer to residuals from country specific VECMX models with foreign variables. The number of co-integration relations and lag orders in the countries specific VECMX models are given Table 4 at after modified.

4. China's economic growth and its transmission to the United States, the Euro area, and the Asian countries

In this section, we estimate the GIRFs using the GVAR model results. The concept of GIRFs was proposed by Koop et al. (1996) and has been applied to VAR analysis by Pesaran and Shin (1998). GIRFs are different from the standard IRFs proposed by Sims (1980), which assumes orthogonal shocks. The standard IRFs are calculated using the Cholesky decomposition of covariance matrix of reduced-form errors. Thus, if we calculate the IRFs using different orders of variables, the shape of IRFs will be different. If a VAR contains two or three variables, we might be able to use the standard IRFs by assuming a relation between the variables inferred from economic theory. However, the same approach is not useful for the GVAR model since it contains a large number of variables. This means that we cannot list a set of variables with a reasonable order that reflects economic theory. Therefore, instead of using the standard IRFs proposed by Sims (1980), we use the GIRFs, which produce shock response profiles that are not different for different orders of variables.

We will investigate how a negative real GDP shock in China transmits to the Asian countries as well as major developed economies based on the trade weights of 1985, 1995, 2005, and 2011. By eye-balling the trade weight matrices of 1985 and 1995, we do not observe any big variations. On the other hand, as explained in Section 2, as the trade linkages strengthen, we see a significant shift in the trade weight matrices of 2005 and 2011 from those of 1985 and 1995. Our focus is on seeing how the change of trade relations affects the propagation of shock.

First, we will examine the impact of a one percent drop in China's real GDP on the developed nations of the United States, the Eurozone, and Japan. For all three countries, the impact of a negative shock on Chinese GDP is increasingly negative impact as we use more recent trade weights. Although the GIRFs have a negative shape when using the trade weight matrices of 1985 and 1995, and these lines are near zero. Therefore, it may imply that a negative Chinese shock would have minimal or nonexistent effect on these economies in 1985 and 1995. We notice that the Eurozone has the most pronounced impact compared to the US and Japan, both in the short-term as well as the long term. The US and Japan exhibit similar responses both qualititvely and quantitatively. We will test the significance of the negative impact in the next section.

Figure 5: GIRFs for one percent decline in China's GDP (the US, Euro area, and Japan)

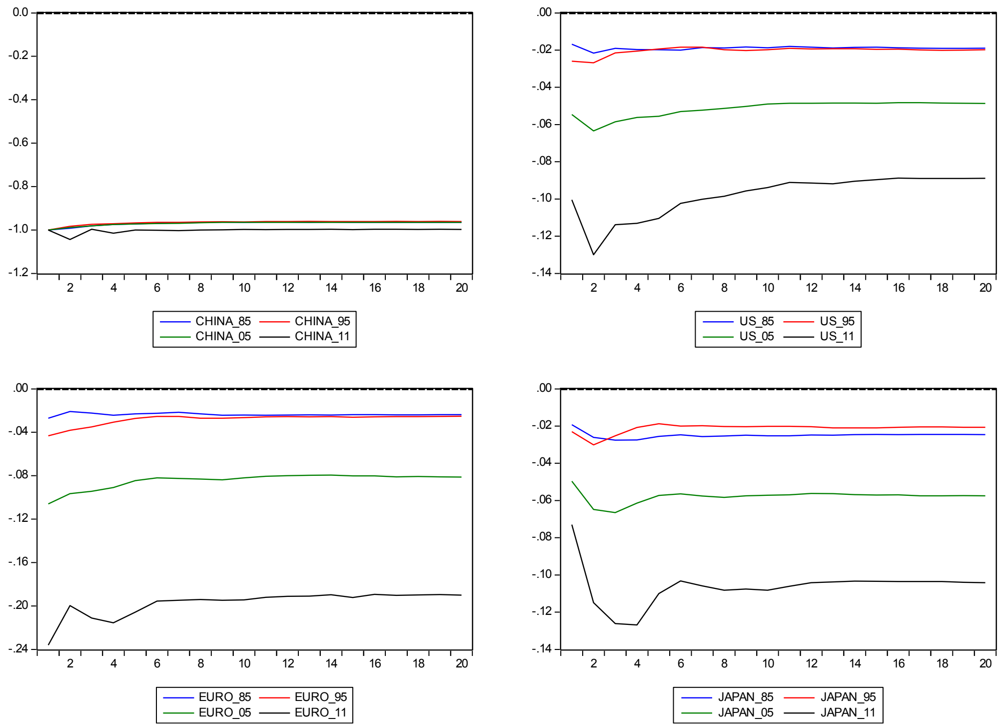
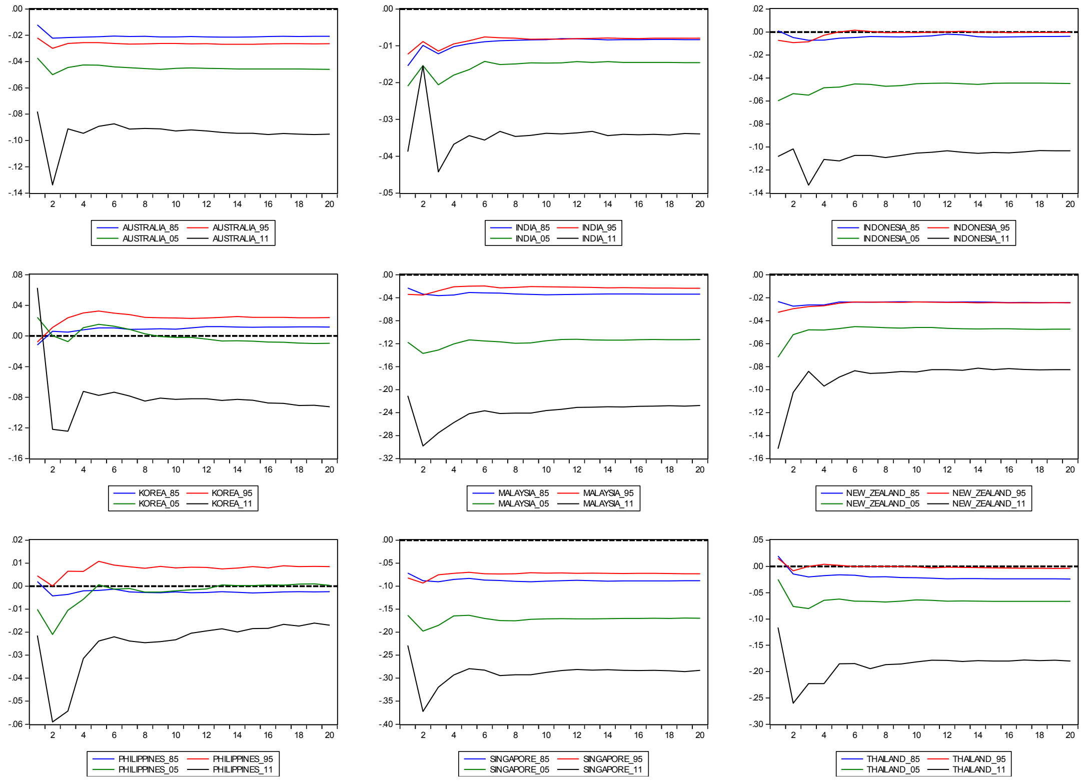


Figure 6 shows the GIRFs for a one percent decline in China's growth on our set of Asian countries. As in the developed countries' case, the impact of a negative shock has become progressively negative on the Asian economies using more recent trade weight structures. Interestingly, for Korea and the Philippines, the impact of a negative Chinese shock was positive under the earlier structures of 1985 and 1995 for the former, and 1985 for the latter. Thailand and Indonesia had a nearly non-existent impact with earlier trade weights. Under more recent trade structures, every country experiences a negative shock; however, the level and extent of the shocks differ greatly. Malaysia, Thailand and Singapore are by far the most negatively impacted countries both in the short term as well as the long term. They are followed by Australia, Indonesia, Korea and New Zealand, among which New Zealand seeing the largest short-term, and Australia the largest long-term impact under the most recent trade structure. The impact of negative Chinese real GDP shock is less marked for India and the Philippines with the Philippines seeing the least long-term negative impact by a one percent negative GDP shock in China.

Figure 6: GIRFs for one percent decline in China's GDP (Asian countries)



In Figure 7, we display the GIRFs for a one percent decline in China's GDP on commodity price indices. China's increasingly commodity-intensive growth path manifests itself in the increasingly negative impact of Chinese negative growth shock on commodity prices. Similar to the GIRFs observed above, the impact of Chinese negative GDP shock is considerably more visible under the 2011 trade matrix structure. China is the world's largest consumer of industrial metals and the second-largest consumer of oil. The graph below shows that the short-term negative impact of a Chinese GDP shock on oil prices is more pronounced than the impact on metal prices, but the GIRFs exhibit very similar long-term paths. China's impact on agricultural prices rose significantly under the 2011 trade structure, although the impact on prices in both short-term and long-term is much more muted compared to the impact on oil and metal prices.

Figure 7: GIRFs for one percent decline in China's GDP (commodity prices)

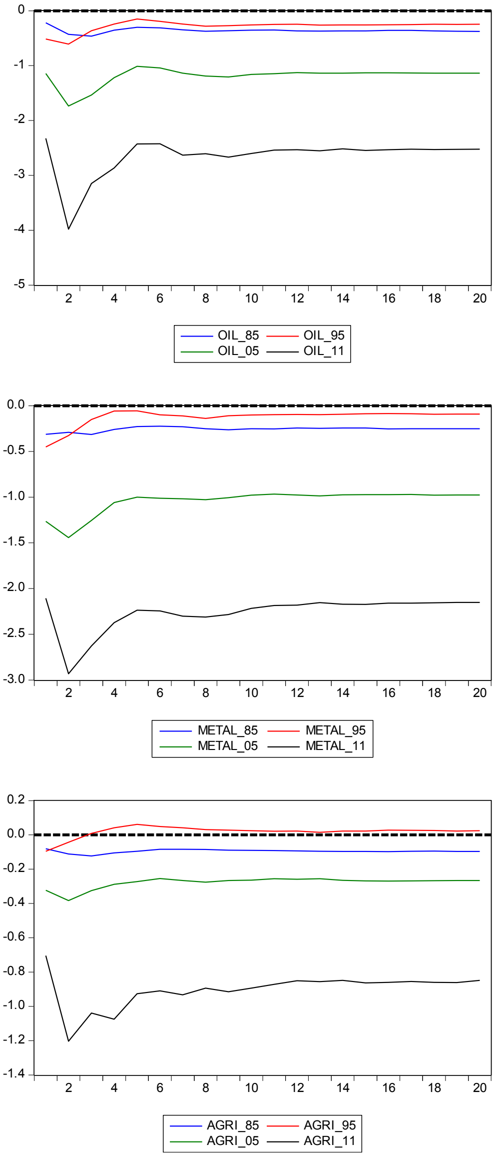


Figure 8a and Figure 8b shows the GIRFs for one standard deviation decline in China's real GDP with a 68% and 95% confidence interval, using a bootstrapping method. The figures show that the GIRFs of Malaysia, Singapore, the Eurozone, Japan, and Australia under the trade weight matrix of 2005 are significant at a 68% confidence interval. When we use the trade weight matrix of 2011, the GIRFs of more countries, Malaysia, Singapore, Thailand, the USA, the Eurozone, Japan, Australia, and New Zealand are significant in almost periods. We also note that oil, metal and agricultural price indices are all significant under the most recent trade structure. Furthermore, when we look at Figure 8a and 8b, we see that a one percent drop in China's GDP is significant during the entire period in the Euro area at 95% confidence interval using the trade weight matrix of 2011.

Figure 8a Bootstrapped GIRFs for a One Standard Deviation decrease in China GDP's with confidence interval 68% and 95% (ASEAN region plus commodity)

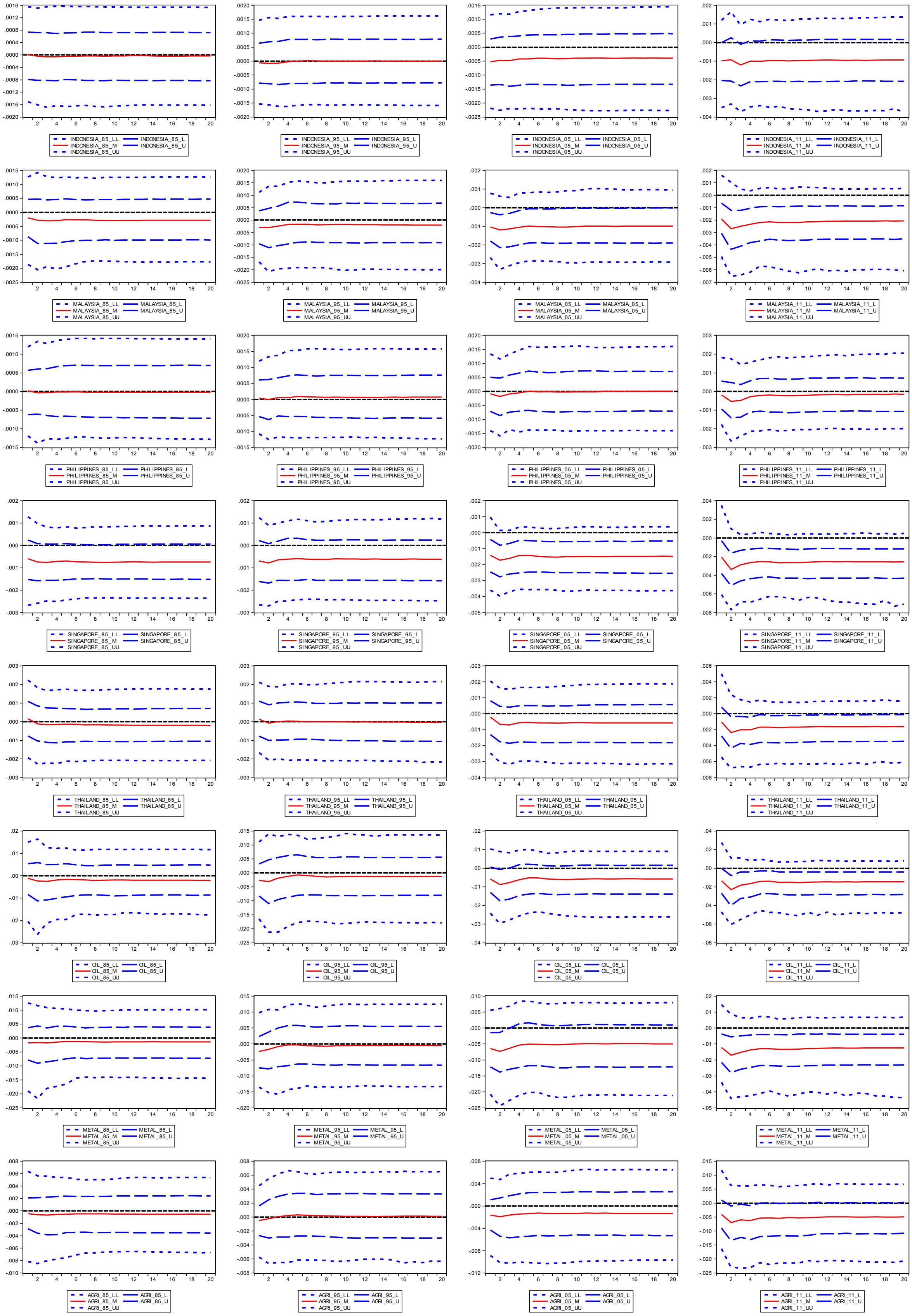
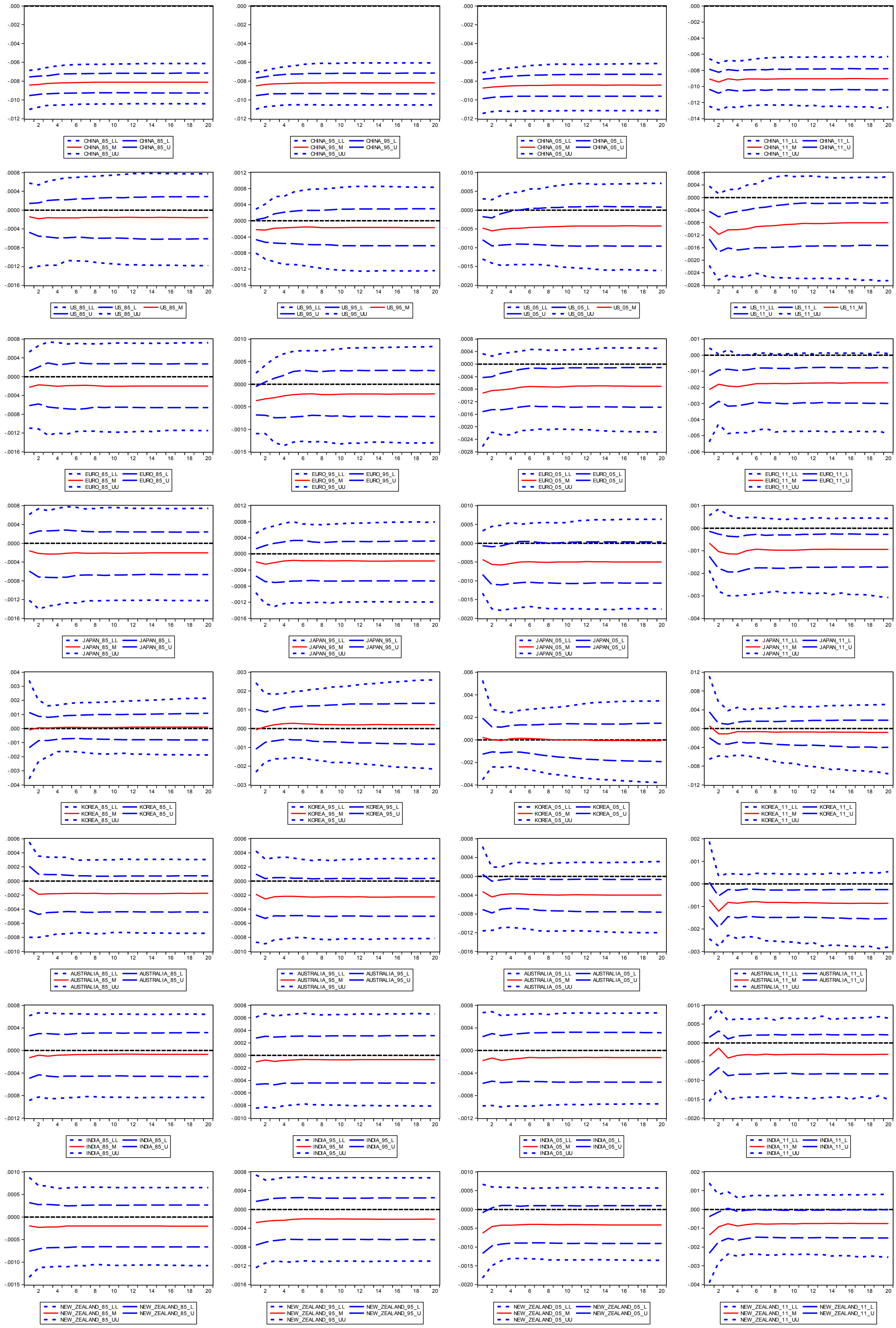


Figure 8b Bootstrapped GIRFs for a One Standard Deviation decrease in China's GDP with confidence interval 68% and 95% (Asian-Pacific except ASEAN region)



4.2 The Chinese impact with sign-restrictions

In the previous sub-section, we investigated the effect of China's economic slow-down on the rest of the world with a primary focus on the Asian countries. We have confirmed that, as China's trade linkages with other countries deepened, the negative impact of a Chinese economic shock became much larger in magnitude. By comparing the response shape of GIRFs over four different years, i.e. 1985, 1995, 2005, and 2011, we have demonstrated how the impact has evolved over the last three decades.

The calculation of the GIRFs does not require us to impose any specific restrictions, such as recursive ordering of the variables in the VAR, or zero coefficient restrictions on the instantaneous coefficient matrix like the structural VAR. This is a great advantage for the GVAR, since it is generally quite difficult to order the variables in recursive fashion.

Since we are interested in the effect of a potential contraction in Chinese demand from the rest of the world, we should choose a set of responses which match our interest. We have implemented this by using the sign-restriction technique proposed by Uhlig (2005). Thus, we assume the following scenario:

1. Chinese GDP declines by 1% at time 0.
2. At time 1 (one quarter after the shock), both the oil price and metals prices drop.

In table 10, we summarize the sign-restrictions which we imposed on the simulated impulse responses. Figure 9, Figure 10, and Figure 11 report the distribution of GIRFs with above sign-restrictions.

Most of the GIRFs in Figures 9, 10, and 11 are consistent with the previous results. However, we obtained more nuanced results for the following cases. For India and Indonesia, the responses are significant at 68% with the sign restrictions. For Korea, the median response is slightly positive in the long run. This might reflect the fact that Korea and China complement each other in the international trade. Thus, a potential slow-down in China might benefit Korea in the long run. Concerning commodity prices, we have imposed restrictions on the oil and metals prices as we reported in Table 10. On the other hand, even though we do not impose any restriction on the agricultural prices, the response is now significant at 68%.

Overall, although we need more investigation as well as careful treatment of the implication of restrictions reported in Table 10. These new findings suggest the additional information provided by sign-restrictions.

Table 10: Signs and the timings of the sign-restrictions

	0	1	2
Chinese GDP	<0	-	-
Oil price	-	<0	-
Metal Price	-	<0	-

Figure 9: GIRFs for a one percent decline in China GDP (Eurozone, Japan and China, with sign-restrictions)

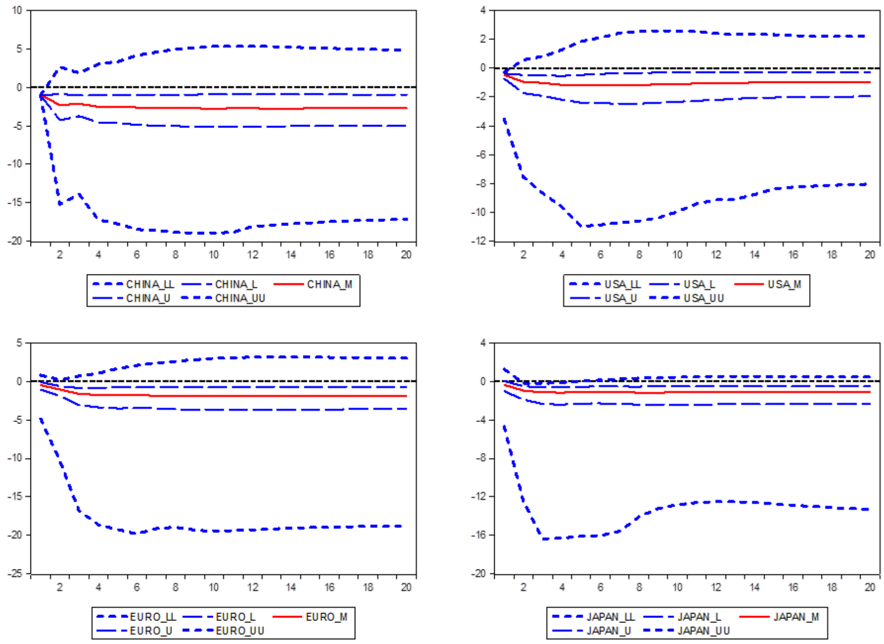


Figure 10: GIRFs for a one percent decline in China's GDP (Asian countries-with sign-restrictions)

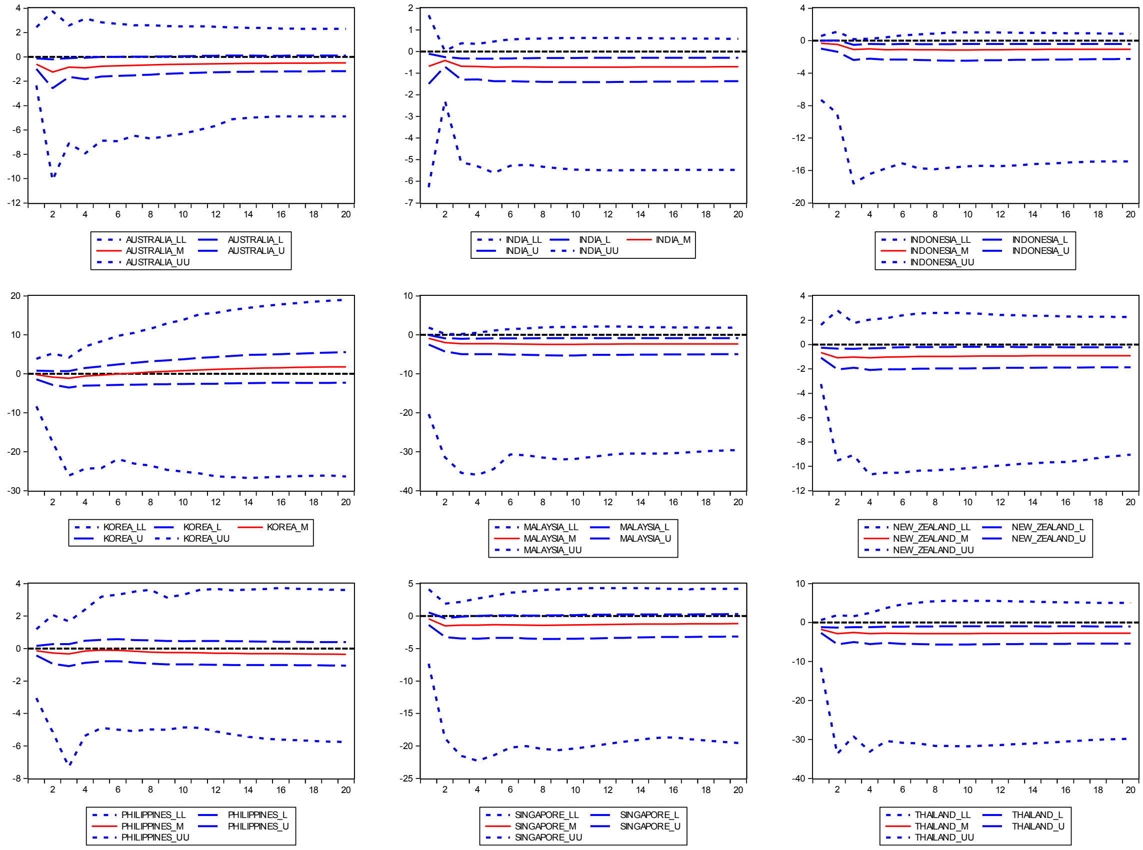
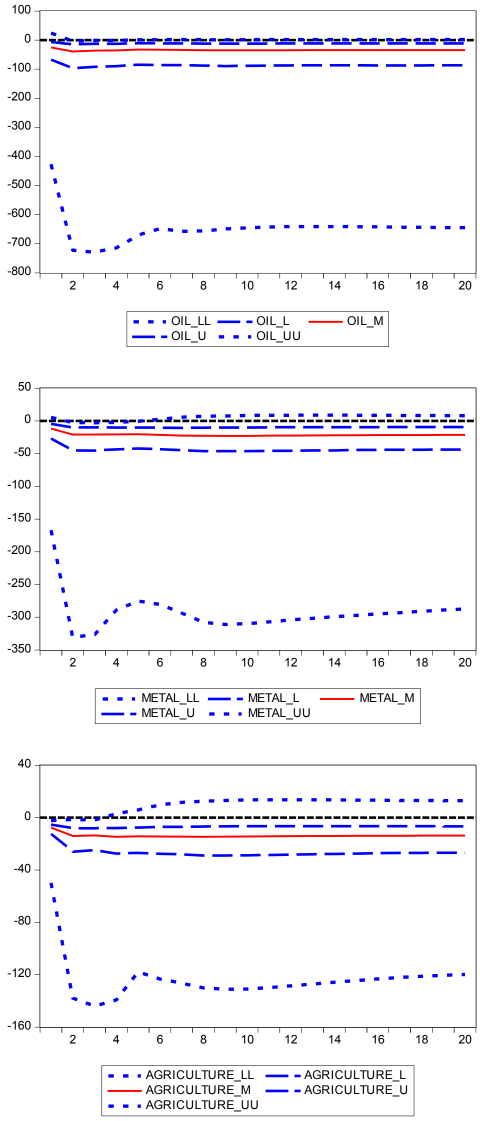


Figure 11: GIRFs for minus one percent in China GDP to commodity price with sign-restrictions



4.3 The US impact

For comparison with the impact of a China's real GDP shock, analyzed in the previous section, we will now investigate the impact of a one percent drop in US real GDP on other countries. First, we review the GIRFs of China, the Eurozone, and Japan in Figure 12. We note that although the impact is negative, the level and shape does not change across different trade matrices, which was the case for China given its growing presence in the world.

Figure 13 shows that US real GDP has a negative impact on Asian countries, mainly those that showed a more muted response to a Chinese shock, such as India, Indonesia, and the

Philippines. This confirms China's expanding presence in the region, and the shape of GIRFs show the US impact is a lot less than China's.

In figure 15a and 15b, we calculated 68% and 95% confidence intervals using a bootstrapping method. The Eurozone, Malaysia, and Singapore are statistically significant with 95% confidence interval when using trade weight matrix in 1985, 1995 and 2005, but among the rest of the countries some show a borderline statistical significance while others are not statistically significant. This confirms that the impact of a shock to China's economy has larger and more widespread impact on the Asian economies than a shock to the US economy.

Figure 12: GIRFs a for one percent decline in US GDP (Euro area, Japan and China)

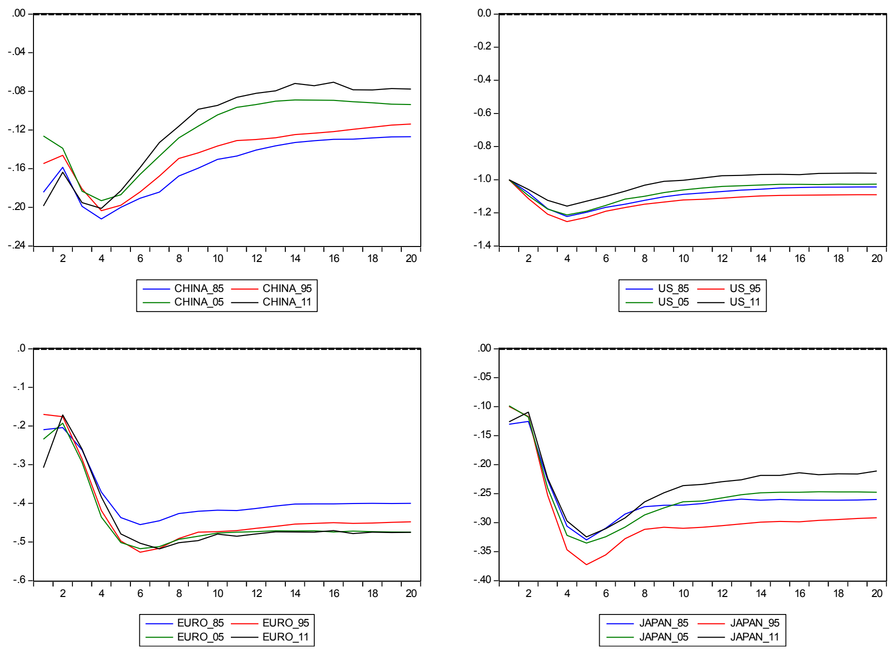


Figure 13: GIRFs for a one percent decline in US GDP (Asian Pacific)

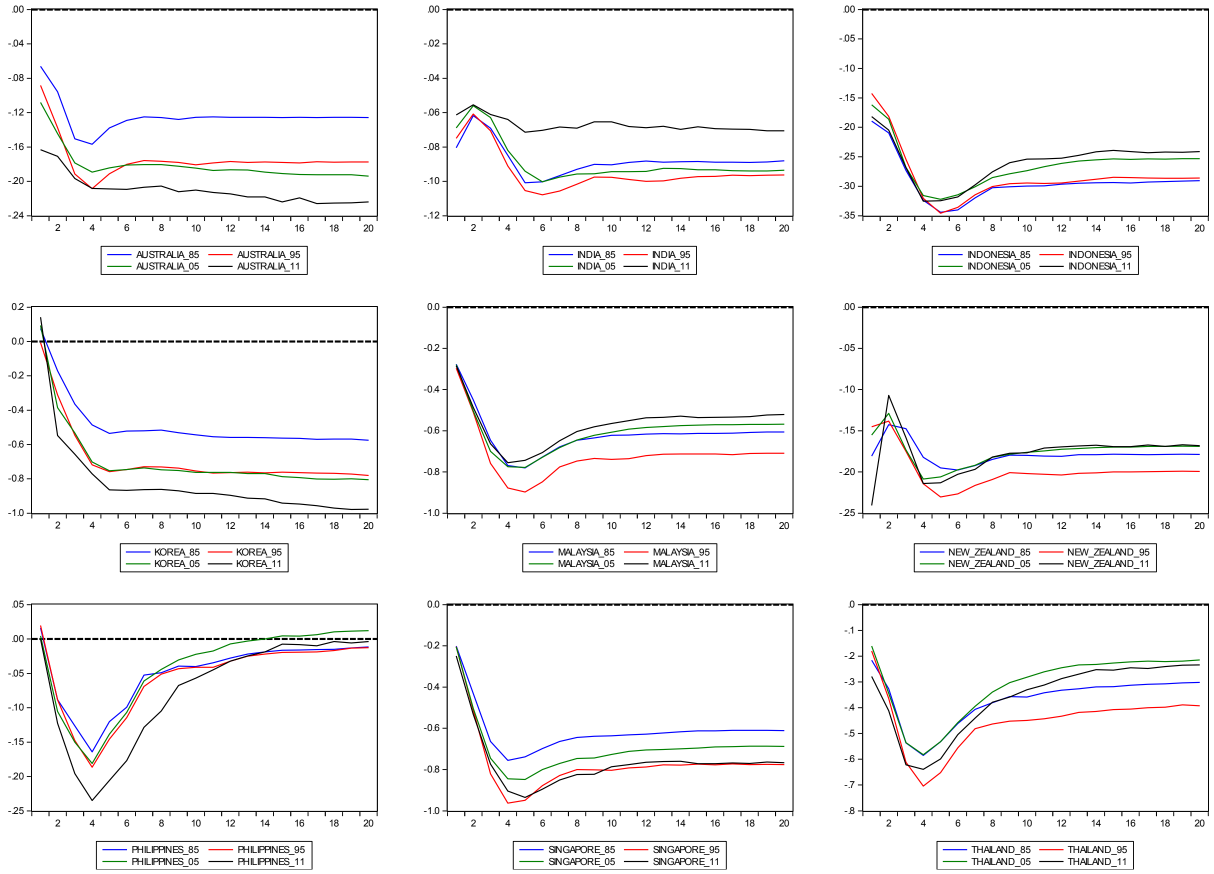


Figure 14: GIRFs for a one percent decline in US GDP (commodity prices)

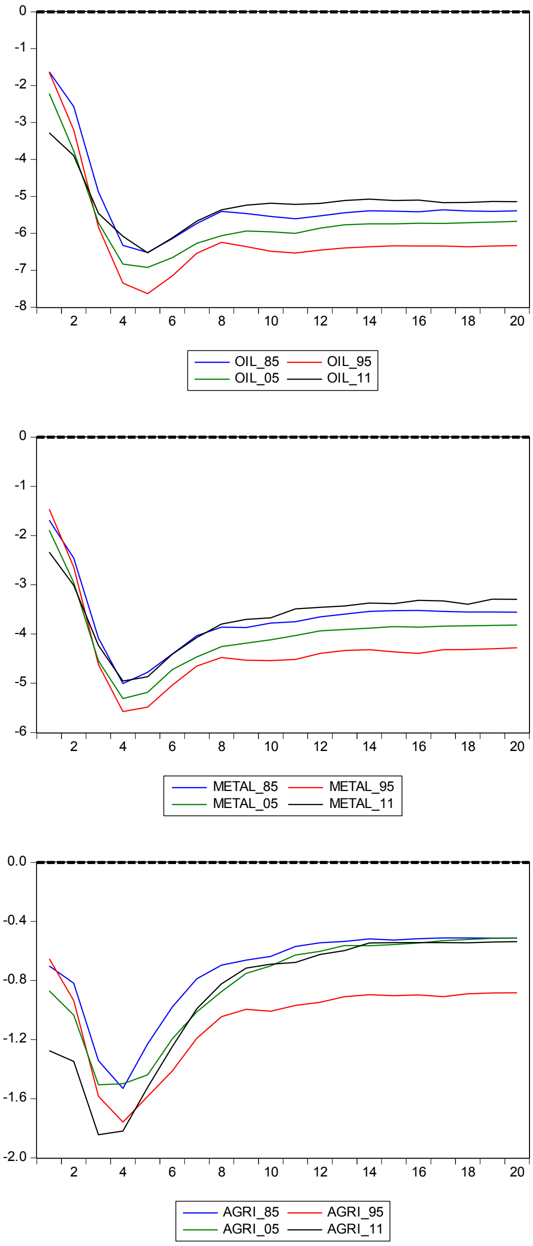


Figure 15a: Bootstrapped GIRFs for One Standard Deviation decrease in US GDP with confidence intervals of 68% and 95% (ASEAN region plus commodities)

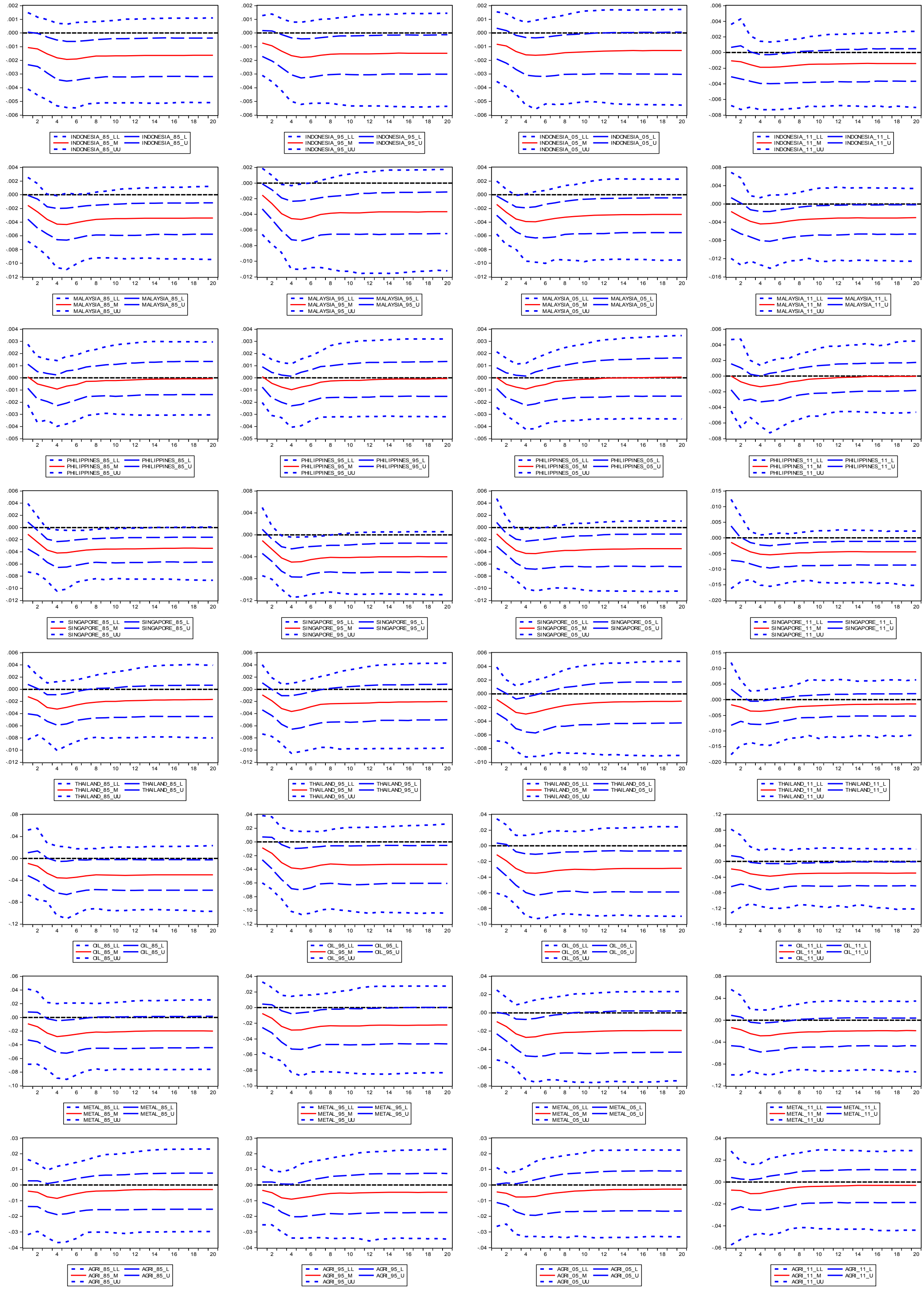


Figure 15b: Bootstrapped GIRFs for One Standard Deviation decrease in US GDP at confidence intervals of 68% and 95% (Asia except the ASEAN region)

5. Conclusion and remarks

In this paper, following CPRX, we estimated a GVAR model using a time-varying trade weight matrix. China's economy has been growing and its presence in the global economy is expanding through trade relations. We analyzed how and to what extent the Chinese economic fluctuations affect the global economy -- Asia and the Pacific region in particular. After estimating the GVAR model, we calculated the GIRFs with different trade weight matrice of 1985, 1995, 2005, and 2011 in order to compare the size and timing of the shock propagations. We also calculated the 68% and 95% confidence interval using the bootstrapping method and tested whether the estimated impacts are statistically significant.

As the Chinese economy has grown, the country's trade structure has changed. Unlike under the earlier trade structures of 1985 or 1995, a negative shock in the Chinese real GDP has a significant impact on the surrounding countries under the more recent trade structures of 2005 or 2011. When we evaluate the impact using the trade weights of 2011, the calculated GIRFs are almost significantly negative for the Asian and Pacific countries like Singapore and Malaysia at 95% confidence interval.

A shock to the Chinese real GDP also has an impact on the international prices of not only the crude oil market but also the metals and agricultural markets. This means that China has become the factory of the world by expanding its linkages through trade relations. This deepening of linkages has increased the degree of influence of the Chinese economy.

With regard to future research, we consider improvement of the trade weight matrix as the key. In this paper, following CPRX, we used the trade weight matrix representing the linkages to countries. However, capital inflows and outflows significantly affect economies. Since the measurement of closeness of countries is key for the GVAR model, we should also consider using foreign direct investment data. If we can capture the financial linkages between countries, we can analyze monetary easing and the impact of hot money flowing in to developing countries.

Appendix 1: Data

We obtained the data files which cover for the period between 1979Q1 and 2011Q2 from the Center for Financial Analysis & Policy, University of Cambridge[A1]. We have added the recent data for the period between 2011Q2 and 2013Q1 mainly based on Appendix B in Smith and Gales (2011). We use the World Bank's commodity price data downloaded from the following website[A2] . We replace oil price, adding metal index and agriculture index. The more detailed information about adding data is available form authors upon requests.

[A1] http://www-cfap.jbs.cam.ac.uk/research/gvartoolbox/download.html

[A2] http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21574907~menuPK:7859231~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html

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