# Intra-regional trade in intermediate goods and macroeconomic interdependence in East Asia [*]

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First version: December 2017

This version: June 2018

**Abstract**: Over the last few decades there has emerged quite a unique and interesting trade structure in East Asia, in which countries in the region trade intermediate goods heavily with themselves while trade more final goods with the rest of the world. This paper discusses the facts about this trade structure in detail and empirically investigates how it is related to the macroeconomic interdependence in East Asia using a VAR model and data of nine major countries in the region. Our main findings are as follows. First, a positive USA output shock raises exports, imports and GDP in most of the East Asian countries, and USA output shocks explain a larger fraction of output in an East Asian country where exports are more concentrated in intermediate goods. Second, an export shock of an East Asian country that raises its exports also raises its imports, and the contribution of export shocks in the variance of imports is increasing in the share of intermediate goods in imports of the country. Third, compared to output shocks from Japan, those from China appear to be more influential to the East Asian economies.

**JEL Classification Codes**: F41, E32.

**Keywords**: trade in intermediate goods, international macroeconomic interdependence, international production and trade network, East Asia, VAR.

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# 1. Introduction

Intra-regional trade in East Asia has been increasing steadily over the last few decades, and in recent years it has accounted for about half of the region's total trade. An outstanding feature of this intra-regional trade is the overwhelming share of trade in intermediate goods. Intermediate goods are produced and traded between several blocs inside the region such as Japan, China, the NIEs, and the ASEAN countries. On the other hand, in extra-regional trade final goods are more important than intermediate goods. These facts suggest quite a unique and interesting trade structure in East Asia, that is, countries in the region trade intermediate goods heavily with themselves while trade more final goods with the rest of the world.

How would this trade structure affect the international transmission of macroeconomic shocks in East Asia, or more generally, the way countries in the region are interdependent? In a previous study (Vu 2016), I address this question and seek for an answer to it by building a three-country theoretical model which incorporates the trade structure in East Asia. I find that, because intermediate goods are used as inputs in the production of final goods, in the presence of intra-regional trade in intermediate goods there emerges a linkage in the production side between East Asian countries, which substantially affects the responses of exports and imports as well as other macroeconomic variables of these countries. For example, when production of final goods of a country *A* in East Asia increases due to some external shock, say an increase in demand in the USA, country *A*'s imports of intermediate goods from another country *B* in East Asia will increase, and if these intermediate goods in turn are produced from intermediate goods produced elsewhere in East Asia, then country *B*'s imports of intermediate goods will increase. In a similar fashion this effect may be propagated further to other countries in East Asia, and the total result is the increases in both exports and imports of many countries in the region.

In the present paper I wish to examine the question empirically. My main interest here is whether we observe in the data the theoretical finding in Vu (2016) mentioned above. More importantly, I wish to establish stylized facts on the macroeconomic interdependence of East Asian countries given the trade structure formed in the region as mentioned above.

Toward this end, I use a vector auto-regression (VAR) model and estimate it for a number of East Asian countries using quarterly data of the period 2000-2016. The VAR approach is suitable for our purpose because it allows us to capture the dynamic and interdependent relationships between macroeconomic variables as well as the dynamic responses of these variables to various types of exogenous shocks. Our VAR incorporates such variables as trade variables (i.e. exports and imports), the exchange rate, and output of each of the countries in question, as well as output of the major trading partners in East Asia and the rest of the world. Regarding trade variables, in addition to aggregate data, more disaggregate data, i.e., data on exports and imports between an East Asian country and Japan are used. Standard VAR exercises such as impulse response analysis and variance

decomposition are performed to understand the international transmission mechanism of various types of macroeconomic shocks.

This paper is related to several strands of literature. The first is the literature on trade in East Asia. See Ando (2005), Fukao, Ishido, and Ito (2003), and Kimura (2006), among others. In this literature, the network of production and trade formed in East Asia has been well recognized and analyzed, but mainly from a microeconomic approach. The present paper differs from this literature in that it looks at the issue from an international macroeconomic point of view.

Another strand of literature is the empirical literature on the effects of external shocks such as an oil shock, a USA monetary shock, and a world demand shock on East Asian economies. See, e.g., Allegret, Couharde, and Guillaumin (2012), Dungey and Vehbi (2015), Gimet (2011), Inoue, Kaya, and Oshige (2015), Maćkowiak (2007), Petri (2006), and Sato, Zhang, and McAleer (2011). Despite that this literature is large, to the best of my knowledge, there is no study that pays attention to the aforementioned trade structure in East Asia when investigating the effects of shocks. One contribution of the present paper is to fill this gap.

A third strand of literature is one that analyzes the international transmission of shocks in East Asia using theoretical open macro models which take into account some characteristics of the trade in East Asia. Some recent important contributions in this literature are Shioji (2006) and Teo (2009), who build New Open Macroeconomic (NOEM) models with firm microfoundations for East Asia. Vu (2016) is the first study that introduces intra-regional trade in intermediate goods into a NOEM model for East Asia. The present paper differs from this literature in that it analyzes the issue using an empirical method.

The rest of the paper is organized as follows. The next section summarizes some important facts about the trade structure in East Asia. Section 3 explains the empirical method of a VAR with block exogeneity and the data used. Empirical results and analysis are provided in Section 4. The last section concludes the paper.


## 2. Some facts about the trade structure in East Asia

In this section, we summarize some important facts about the trade structure of East Asia countries based on data shown in Tables 1 through 5.


2.1. Trade openness in East Asia

Table 1 shows the trade openness of countries in East Asia and other regions of the world in the period 2000-2015. The trade openness is measured as the ratio of trade in goods and/or services to GDP. As seen from the table, the ratio of trade in goods and services to GDP of in East

Asia and Pacific is 0.62, which is lower than that of the European Union and Middle East & North Africa, but is higher than that of other regions or groups of countries in the world such as Latin America & Caribbean, OECD members, the groups of high-income countries, middle-income countries, and low-income countries.

Looking in more detail at each country, we observe that, except the two large countries China and Japan (in terms of GDP), most of the East Asian countries that are the subject of our study are highly open to trade. This is true even if we exclude the exceptional case of the two city states Hong Kong and Singapore which are famous for entrepot trade. For example, the ratio of trade in goods and services to GDP is 0.87, 1.21, 1.31, and 1.66 in Korea, Taiwan, Thailand, and Malaysia, respectively. These numbers are much higher than those in other regions or groups of countries in the world.

Another fact than can be observed from Table 1 is that, in all countries or groups of countries the main part of trade is trade in goods. For the case of East Asian countries, a quick calculation based on data in Table 1 shows that, except the case of Singapore, trade in goods accounts for more than 80 percent of total trade. This fact also justifies our use of data on trade in goods as a proxy for total trade in later sections.

We note that the high degree of openness of East Asian countries suggests the possibility that these economies are more closely linked to their trade partners. In the subsequent subsections we will look in detail at the trade partners of these countries and the intra-regional trade in East Asia.

2.2. Major trade partners of East Asian countries

Table 2 shows the list of major trade partners of each of ten East Asian countries in the period 2000-2015. We observe that for most countries, the USA, China, and Japan are the three most important trade partners. For example, the USA is the most important export destination of China, Japan, the Philippines, and Thailand with the share in total exports of these countries being 0.18, 0.21, 0.18, 0.12, respectively. China is the largest import market for Hong Kong, Indonesia, Japan, Korea, and Malaysia with the share in total imports of these countries being 0.46, 0.14, 0.21, 0.16, and 0.13, respectively. Japan is the largest import market for China, Taiwan, and Thailand with the share being 0.12, 0.20, and 0.19, respectively.

It can also be seen from Table 2 that East Asian countries trade heavily with themselves. For example, seven out of ten major export markets of Korea are located in East Asia with a total share of 0.47, and seven out of ten major import markets of Thailand are also located in East Asia with a total share of 0.53. These numbers for each individual country suggest the fact that intra-regional trade accounts for a main part of trade in East Asia.

2.3. Intra-regional trade in East Asia

Further information on intra-regional trade in East Asia is provided in Table 3. This table displays the share of intra-regional trade in total trade in goods of East Asia, NAFTA, and EU in the period 1990-2015. We observe that in East Asia the share of intra-regional trade increased in the first half of the 1990s, and since then has been stable at around 0.5. That is, in recent years about half of trade of East Asia is conducted within the region. This number is lower than that of EU (0.61 in 2015) but is higher than that of NAFTA (0.39 in 2015).

One factor that gives rise to the presence of this intra-regional trade is distance as suggested by the gravity model. Another factor is the formation of the so-called production and trade network within East Asia, in which intermediate goods are traded heavily among East Asian countries (see Kimura 2006). More evidence about intra-regional trade and trade in intermediate goods in East Asia is provided below.

2.4. Trade in East Asia by type of goods

Table 4 breaks the trade of East Asia in the period 2000-2015 into trade by type of goods. Here traded goods are categorized into primary goods (or raw materials), intermediate goods,[1] and final goods. Note that in this table, a row shows the exports and a column shows the imports of the corresponding region (or group). We can see from the table that in intra-regional trade (i.e. trade between East Asia and East Asia), intermediate goods is dominant which accounts for 0.64 of total trade, while the share of final goods is 0.32, and the rest 0.04 is trade in primary goods. On the other hand, in extra-regional trade (i.e. trade between East Asia and the rest of the world (ROW)) the share of intermediate goods is much smaller: 0.39 in exports of East Asia to the ROW, and 0.47 in imports of East Asia from the ROW. Note also that in exports of East Asia to the ROW, final goods are dominant with a share of 0.59.

Table 5, which is constructed similarly to Table 4, shows the detailed data for each of the major East Asian countries. We observe that Korea, Taiwan, and the ASEAN countries trade intermediate goods heavily with East Asian countries in both exports and imports. Compared with these countries, Japan's exports to East Asia are similarly highly concentrated in intermediate goods (with a share of 0.69), while Japan's imports from East Asia are considerably less concentrated in intermediate goods (0.47). As for China, the concentration in intermediate goods of imports from East Asia is similar to that of other East Asian countries (0.71), while the concentration in intermediate goods of exports to East Asia is considerably smaller (0.46). Note also that, in exports of China to the ROW final goods are dominant with a share of 0.68.

The facts discussed above show that there has been emerging an interesting structure in

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[1] Intermediate goods are defined as manufactured goods (processed or assembled) that are produced from primary goods but are not yet final products (RIETI 2015). In the case of East Asia, parts & components of final products in the two industries electrical machinery and general machinery account for about half of the volume of intra-regional trade in intermediate goods.

production and trade of East Asia in which countries in the region produce and trade intermediate goods heavily with themselves, while they trade more final goods with the rest of the world. In the subsequent sections we will analyze empirically how this trade structure is related to the way East Asian economies respond to various types of external and domestic macroeconomic shocks.

## 3. Empirical framework and data

To analyze the effects of external and domestic macroeconomic shocks on an East Asian country, we use a method of a vector autoregression with block exogeneity (hereafter VARX). As known in the VAR literature, a VARX is suitable to analyze the effects of shocks to a small open economy (SOE).[2] Below are details of the method.

Consider a VAR model which consists of two blocks, namely one that contains variables of relatively large countries (block 1) and one that contains variables of a SOE (block 2). Because the size of the SOE is very small compared to the large countries, it is reasonable to assume that variables in block 2 do not affect variables in block 1. In other words, variables in block 1 are given exogenously to block 2. With this assumption, we could write the structural form of the VARX model as follows.

$$\begin{bmatrix} A_{11} & 0 \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} B_{11}(L) & 0 \\ B_{21}(L) & B_{22}(L) \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \tag{1}$$

In (1), $t$ denotes time and $y_{1t}$ and $y_{2t}$ are column vectors of variables in blocks 1 and 2, respectively. $A_{ij}$ are coefficient matrices and $B_{ij}(L)$ are polynomials made up from matrices of coefficients in the lag operator. $\epsilon_{1t}$ and $\epsilon_{2t}$ are, respectively, column vectors of shocks in blocks 1 and 2 that satisfy $(\epsilon'_{1t}, \epsilon'_{2t})' \sim (0, I)$ where $I$ is an identity matrix.

It can be shown that in the structural VARX model given in (1), the impacts of $\epsilon_{1t}$ on $y_{1t}$ and the impacts of $\epsilon_{2t}$ on $y_{2t}$ are captured by the inverse of $A_{11}$ and $A_{22}$, respectively. We assume that $A_{11}$ and $A_{22}$ have a recursive structure. The justification of this assumption will be given below. With this assumption, the matrix

$$A \equiv \begin{bmatrix} A_{11} & 0 \\ A_{21} & A_{22} \end{bmatrix}$$

and its inverse also have a recursive structure, and the latter can be identified as the Cholesky decomposition of the covariance matrix of the residuals $(u'_{1t}, u'_{2t})'$ in the following reduced-form of the VARX in (1).

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} D_{11}(L) & 0 \\ D_{21}(L) & D_{22}(L) \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{2}$$

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[2] See, e.g., Allegret, Couharde, and Guillaumin (2012), Maćkowiak (2007), Sato, Zhang, and McAleer (2011), and Vu and Nakata (2018).

The reduced-from VAR in (2) can be estimated directly by OLS, and from its estimation result we can identify $A$ (and thus $A_{11}$ and $A_{22}$), $B_{ij}(L)$, and the structural shocks $(\epsilon_{1t}, \epsilon_{2t})'$ in the structural model (1). Once the structural VAR is identified, we can conduct the conventional exercises such as analysis of the impulse response functions (IRFs) and variance decomposition to analyze the transmission of shocks to the SOE.

*Variables and shocks in the VARX*

We include three variables in block 1, namely, real GDP of the USA, China, and Japan. In other words, $y_{1t} = (gdp_{USA,t}, gdp_{CHN,t}, gdp_{JPN,t})'$. The reason to have output of these three countries in the VAR is straightforward from the analysis in the previous section: these countries are the largest trade partners of most of Asian countries, and one of our main interests is in how output shocks originated from them would be transmitted to an East Asian country.

The reasons to treat output the USA, China, and Japan in the exogenous block are twofold. First, the economic sizes of these three countries are much larger than those of any East Asian countries (other than China and Japan). This can be seen from Figure 1. For example, in terms of GDP, Thailand was 1/53 of the US, 1/13 of China, and 1/20, and in 2016 the corresponding numbers became 1/43, 1/24, and1/15. Similarly, the numbers for Taiwan were 1/40, 1/10, and 1/15 in 2005, and 1/33, 1/13, and 1/13 in 2016. A second reason to include output the USA, China, and Japan in block 1 is that doing so will help us a priori exclude some hard-to-interpret results that sometimes arise in a conventional VAR, for example, a shock originated from a small country significantly changes a variable of a much larger country.[3]

In block 2 of the VARX, we include four variables: real exports, real imports, real GDP, and the real effective exchange rate (REER), so $y_{2t} = (exp_{i,t}, imp_{i,t}, gdp_{i,t}, reer_{i,t})'$, where $i$ denotes an East Asian country. Other than the reason that these are variables of great interest, the inclusion of them is motivated by a theoretical consideration: the export and import functions in open macro theory. We also note that, the inclusion of the variables explained above, especially exports and imports East Asian countries, allows us to some extent investigate the implication of trade in intermediate goods in East Asia to the international transmission of shocks. This point will be made clearer in the next section.

Given the variables $y_{1t}$ and $y_{2t}$ and the recursive structure of the matrices $A_{11}$ and $A_{22}$ explained above, the structural shocks in the two blocks of the VARX can be labeled USA output shock, Chinese output shock, Japanese output shock, and country $i$'s export shock, import shock, output shock, and REER shock. Since we use quarterly data in this study (see below), the recursive structure assumed for the matrices $A_{11}$ and $A_{22}$ can be justified because, except the

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[3] Indeed, in an earlier stage of this study, I estimated a conventional VAR and did obtain some results like this.

REER which is ordered last, all other variables are real output, exports and imports which, as is well known as a matter of fact, adjust slowly, and within a period of a quarter it is not unreasonable to assume that they do not respond to shocks coming from variables ordered after them.

*Data used in the estimation of the VARX*

We use a quarterly dataset in this study, which spans the period from 2000Q1 to 2017Q2 and covers the following nine East Asian countries: China, Hong Kong, Indonesia, Japan, Korea, the Philippines, Singapore, Taiwan, and Thailand.[4] The data are obtained from the Global Economic Monitoring (GEM) Database of the World Bank.

The data on all seven variables in the VARX are, in their original form, seasonally adjusted. For variables other than the REER, we use the series measured in constant local currency prices converted to the 2010 US$. For exports and imports, we use the data for merchandise (or goods) because the data for services are not available. The REER here is defined such that an increase in it implies a real appreciation of the home currency.

In addition to the GEM data mentioned above in which exports and imports of a country are total exports and imports of that country, we could also obtain the data on exports to and imports from Japan of East Asian countries from the website of the Ministry of Finance of Japan. Although in their original form, these data are measured at the current prices denominated in Japanese yen, they are converted to the 2010 US$ constant prices using data on export and import deflators and the yen-dollar exchange rates from the GEM database. Since these data can be utilized to understand better the international transmission of shocks in East Asia under the trade structure above, we also estimate the VARX with the GEM trade data replaced by these trade-with-Japan data.

The reduced-form of the VARX is estimated with four lags and a constant term for each of the following six countries: Indonesia, Korea, the Philippines, Singapore, Taiwan, and Thailand. The data on all seven variables are transformed to first-differences of their logarithms multiplied by 100 before being used in estimation. But we note that in the IRFs reported below, these variables are converted to levels.

For Japan and China, considering the sizes of their economies as noted above, we treat them as large countries similarly to the USA and estimate a conventional recursive VAR model which contains five variables, i.e. $y_t = (gdp_{USA,t}, gdp_{CHN,t}, gdp_{JPN,t}, exp_{j,t}, imp_{j,t})'$ where $j = CHN, JPN$. This model is also estimated with four lags and a constant term.[5] Notice that this recursive VAR can be considered as a special case of the VARX explained above which is without block 2.

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[4] In addition, Malaysia is excluded from the sample due to the lack of long enough data on exports and imports.
[5] For China, the sample starts from 2005Q1 because data on its exports and imports are only available from this period.

## 4. Empirical results and analysis

In this section we analyze the effects of shocks on East Asian economies based on the impulse response functions (IRFs) and variance decomposition results obtained from the estimated VAR models discussed in the previous section. The results are shown in Figures 2 through 4, and Table 6. In Figures 2 through 4, a shock is quantitatively defined as a *one percent* increase at impact in the variable from which the shock is originated.

*Responses of output of the USA, China, and Japan to shocks*

Figure 2 shows the IRFs of GDP of the USA, China, and Japan to GDP shocks originated from output of these countries. These are the IRFs for block 1 of the VARX. A USA output shock, that increases GDP of the USA at impact by one percent, increases GDP of China and Japan by about 0.4 percent at impact. The effects of the shock are (statistically) significant and persistent in all three countries. The increases of GDP after 3 years are 1.8, 0.8, and 1.6 percent in the USA, China, and Japan, respectively.

A Chinese output shock raises GDP of China by one percent at impact, by definition, and further at longer horizons. The shock, however, only significantly increases GDP of the USA at the horizon of 2 quarters, and GDP of Japan at horizons of 2 to 4 quarters. The effect on GDP of the USA is short-lived.

A Japanese output shock raises GDP of Japan significantly and persistently. The shock causes a significant increase in GDP of the USA at the horizons of 2 to 4 quarters, and a significant decrease in GDP of China after 5 quarters. The latter result appears a bit puzzling. One possibility might be that, because Japan is less dependent on China in intermediate goods as observed in Table 5, so the channel through which the Japanese output shock raises China's exports of intermediate goods and GDP is weak. Indeed, it can be seen in Figures 3 and 4 that the response of total exports of China to the Japanese shock is not significant, although the response of exports of China to Japan is significantly positive.

*Responses of macroeconomic variables in East Asian countries to shocks*

Now let us turn to the responses of the East Asian countries under investigation which are shown in Figure 3. These are the IRFs for block 2 of the VARX.

In response to a USA output shock, an external demand shock to East Asia, exports and imports of all East Asian countries, except Indonesia, increase significantly at some horizons. In addition, with the exception of Korea, GDP of these countries also increases significantly. The increases of both exports and imports of East Asian countries are consistent with the trade structure discussed in Section 2. The underlying mechanism of this is made clear in Vu (2016) and can be

summarized as follows. The increase in GDP of the USA, one major trade partner of many East Asian countries, raises demand for exports of several East Asian countries. Since the main part of these exports is final goods which are produced from intermediate goods which in turn are produced and traded in a network made up from many countries in East Asia, the increase in demand for and thus production of the final goods results in the increase in production of and trade in (i.e. imports and exports of) intermediate goods of all East Asian countries participating in the network. The total result, as seen above, is increases in exports and imports of all East Asian countries. This 'network effect' can be observed further in Figure 4 which depicts the IRFs of *trade with Japan* of East Asian countries to output shocks from the USA, China, and Japan. As shown in this figure, the USA output shock causes significant increases in exports to and imports from Japan of all East Asian countries.

A Chinese output shock causes significant increases in exports (at some horizons) in Hong Kong, Indonesia, Japan, Taiwan, and Thailand. This shock increases in GDP in all East Asian countries except the Philippines.

A Japanese output shock significantly, though only temporarily, raises exports and GDP in the Philippines, Taiwan, and Thailand (countries other than Japan). This shock reduces exports of Korea. The result of negative or insignificant effects of the Japanese output shock on exports and output of the other East Asian countries can be partly explained from the result we observed previously that this shock reduces GDP of China, the largest importer of intermediate goods in the region, and this in turn works in opposite direction to reduce the positive network effects. The more significant effects on output of East Asian countries of output shock from China compared to that from Japan seems to suggest the growing influence of the Chinese economy in East Asia and the economies in the region are integrated toward that of China. A similar finding is reported in Inoue, Kaya, and Oshige (2015).

We now look at the responses of East Asian economies to their internal shocks. A home output shock raises imports in all countries except Thailand. This result is consistent with the implication of the import function in open macro theory. An export shock raises exports and imports as well in all countries except China. This comovement of exports and imports in response to an export shock is consistent of the fact about trade in intermediate goods of East Asian countries. The export shock also significantly raises GDP in all countries except Japan. The response of GDP to an import shock is negative in Korea and Singapore, positive in Taiwan and Thailand, and not significantly different from zero in other countries. A REER shock, that by definition causes a real appreciation of the home currency, significantly reduces exports and imports in China, Hong Kong, Japan, Singapore, and Taiwan, while raises these two variables in Korea and the Philippines. These results are hard to explain from traditional open macro models (e.g. the Mundell-Fleming model) but can arise in a NOEM model with trade in intermediate goods.

*Variance decomposition results*

Table 6 displays the variance decomposition for the four variables, namely GDP, exports, imports, and the REER, of each of the East Asian countries in our study. Overall, we observe that at a short horizon (e.g. that of 1 quarter) most of the variation in each variable is explained by the shock to itself. This is especially true for GDP and the REER. At a longer horizon (e.g. that of 12 quarters) the other shocks may play some role. We also observe that export shocks and external demand shocks explain considerably large fractions of the variance of imports in most of the East Asian countries. This result too can be interpreted as closed related to the trade structure in East Asia where intermediate goods are traded heavily intra-regionally.

To utilize the variance decomposition results more systematically in order to further investigate how the effects of shocks are related to the trade structure in East Asia, we make two conjectures as follows. First, because intermediate goods are imported to produce exported goods (which is also consistent with the IRF result discussed above that a positive export shock raises both exports and imports in many East Asian countries), so the higher the share of intermediate goods in imports of an East Asian country, the higher would be the contribution of export shocks in the variance of imports of that country. The second conjecture is that, because a positive USA output shock raises exports of final goods to the USA from East Asia as well as exports of intermediate goods to East Asia, and as a result the total exports and output of an East Asian country as seen above, so the higher the share of intermediate goods in exports to East Asia of an East Asian country, the higher would be the contribution of USA output shocks in the variance of GDP of that country.

Figure 5 shows evidence supporting these conjectures. In this figure, we plot the contribution of the export shock in variance of imports against the share of intermediate goods in total imports of each of the East Asia from the world, and the contribution of the USA output shock in variance of GDP against the share of intermediate goods in total exports to East Asia using the data calculated in Tables 5 and 6 for East Asian countries. A quick calculation reveals that the correlation coefficients are 0.44 and 0.68 in panels (a) and (b), respectively. Given our analysis above on the effects of the two shocks on East Asian economies, these positive correlations imply that the more a country imports intermediate goods (to produce exported goods), the more variation in its imports is explained by export shocks; and that the more an East Asian country exports intermediate goods to other countries in the region, the more variation in its output is explained by output shocks from the USA.

## 5. Concluding remarks

In this paper we have discussed the trade structure in East Asia and empirically analyzed it

from the international macroeconomic point of view. Among the facts we have seen using detailed data on East Asian countries, the most important and interesting one is the outstanding presence of intermediate goods in intra-regional trade in East Asia. On the other hand, East Asia also trades with the rest of the world and in this trade the final goods account for a much larger share. We then asked how this trade structure is related to the macroeconomic interdependence in East Asia. To answer this question, we used a VAR model to empirically investigate the effects of external and internal shocks to nine East Asian countries and analyzed how these effects are related to the trade structure in the region.

Our main conclusion is that, the transmission of shocks to the East Asian economies is closely related to the trade structure in the region, as suggested by the theoretical model in Vu (2016). More specifically, our main findings are as follows. First, a positive USA output shock raises exports, imports and GDP in most of the East Asian countries, and USA output shocks explain a larger fraction of output in a country where exports are more concentrated in intermediate goods. Second, in many East Asian countries, an export shock that causes an increase in exports also causes an increase in imports, and the contribution of export shocks in the variance of imports of an East Asian country is increasing in the share of intermediate goods in imports of that country. Third, a comparison between the effects of output shocks from China and Japan, the two major trade partners of most East Asian countries other than the USA, shows that in recent years the effects of the former have become more influential in East Asia. This result supports the view that the Chinese economy has been expanding its influence in the region and many East Asian economies are integrated toward that of China.

Further investigation is worth conducting for a deeper understanding of the issue studied here. One direction I have in mind is to utilize more disaggregate trade data, e.g. trade data by industry and by partner. Since each East Asian country is specializing in different industries each of which would have a different structure of vertical intra-industry trade and thus would depend differently on the use of intermediate goods, the differences in their patterns of trade at disaggregate levels may affect the way shocks are propagated across sectors and across countries. In addition, in this paper we have utilized data on trade with Japan of East Asian countries, using data on trade with other countries, e.g. China or an ASEAN country, would provide further useful information.

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**Table 1: Trade openness of countries in East Asia and other regions in the world**

| Country/Group | Trade in goods and services (as ratio to GDP) | Trade in goods (as ratio to GDP) |
|---|---|---|
| China | 0.49 | 0.46 |
| Hong Kong | 3.66 | 3.41 |
| Indonesia | 0.51 | 0.44 |
| Japan | 0.28 | 0.25 |
| Korea | 0.87 | 0.73 |
| Malaysia | 1.66 | 1.49 |
| Philippines | 0.75 | 0.60 |
| Singapore | 3.78 | 2.81 |
| Taiwan | 1.21 | n.a. |
| Thailand | 1.31 | 1.12 |
| Vietnam | 1.53 | 1.42 |
| United States | 0.27 | 0.21 |
| East Asia & Pacific | 0.62 | 0.53 |
| European Union | 0.75 | 0.61 |
| Latin America & Caribbean | 0.44 | 0.39 |
| Middle East & North Africa | 0.83 | 0.68 |
| OECD members | 0.52 | 0.42 |
| High income | 0.58 | 0.46 |
| Middle income | 0.55 | 0.47 |
| Low income | 0.61 | 0.47 |
| World | 0.57 | 0.46 |

Note: The number for each country/group is the average of the period 2000-2015. Source: Author's calculation based on the World Development Indicators 2017 database of the World Bank. Data of Taiwan is from the Key Indicators 2016 database of the Asian Development Bank.

**Table 2: Major trade partners of East Asian countries**

| Ranking | China Exports to | Share | Hong Kong Exports to | Share | Indonesia Exports to | Share | Japan Exports to | Share | Korea Exports to | Share |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | USA | 0.18 | China | 0.49 | Japan | 0.18 | USA | 0.21 | China | 0.23 |
| 2 | Hong Kong | 0.15 | USA | 0.13 | USA | 0.10 | China | 0.16 | USA | 0.13 |
| 3 | Japan | 0.08 | Japan | 0.04 | China | 0.09 | Korea | 0.08 | Japan | 0.07 |
| 4 | Korea | 0.04 | India | 0.02 | Singapore | 0.09 | Taiwan | 0.06 | Hong Kong | 0.06 |
| 5 | Germany | 0.04 | Taiwan | 0.02 | Korea | 0.07 | Hong Kong | 0.06 | Singapore | 0.03 |
| 6 | Netherlands | 0.03 | Germany | 0.03 | India | 0.06 | Thailand | 0.04 | Taiwan | 0.03 |
| 7 | UK | 0.02 | Korea | 0.02 | Malaysia | 0.05 | Singapore | 0.03 | Viet Nam | 0.03 |
| 8 | Singapore | 0.02 | Viet Nam | 0.01 | Taiwan | 0.03 | Germany | 0.03 | India | 0.02 |
| 9 | India | 0.02 | Singapore | 0.02 | Thailand | 0.03 | Australia | 0.02 | Indonesia | 0.02 |
| 10 | Russia | 0.02 | UK | 0.02 | Australia | 0.03 | Indonesia | 0.02 | Mexico | 0.02 |

| Ranking | Malaysia Exports to | Share | Philippines Exports to | Share | Singapore Exports to | Share | Taiwan Exports to | Share | Thailand Exports to | Share |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Singapore | 0.15 | USA | 0.18 | Malaysia | 0.12 | China | 0.23 | USA | 0.12 |
| 2 | USA | 0.13 | Japan | 0.18 | China | 0.11 | Hong Kong | 0.15 | Japan | 0.11 |
| 3 | Japan | 0.11 | China | 0.10 | Hong Kong | 0.11 | USA | 0.13 | China | 0.10 |
| 4 | China | 0.10 | Hong Kong | 0.08 | Indonesia | 0.09 | Japan | 0.07 | Hong Kong | 0.06 |
| 5 | Thailand | 0.05 | Singapore | 0.08 | USA | 0.07 | Singapore | 0.05 | Singapore | 0.06 |
| 6 | Hong Kong | 0.05 | Netherlands | 0.06 | Japan | 0.05 | Korea | 0.04 | Malaysia | 0.05 |
| 7 | Korea | 0.04 | Taiwan | 0.05 | Korea | 0.04 | Viet Nam | 0.03 | Australia | 0.04 |
| 8 | Australia | 0.04 | Germany | 0.04 | Australia | 0.04 | Malaysia | 0.02 | Indonesia | 0.04 |
| 9 | India | 0.03 | Korea | 0.04 | Taiwan | 0.04 | Germany | 0.02 | Viet Nam | 0.03 |
| 10 | Indonesia | 0.03 | Thailand | 0.03 | Thailand | 0.04 | Thailand | 0.02 | India | 0.02 |

Note: The number for each country is the average of the period 2000-2015. Source: Author's calculation based on the Key Indicators 2016 database of the Asian Development Bank.

**Table 2 (continued)**

| Ranking | China Imports from | Share | Hong Kong Imports from | Share | Indonesia Imports from | Share | Japan Imports from | Share | Korea Imports from | Share |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Japan | 0.12 | China | 0.46 | China | 0.14 | China | 0.21 | China | 0.16 |
| 2 | Korea | 0.10 | Japan | 0.09 | Singapore | 0.14 | USA | 0.11 | Japan | 0.14 |
| 3 | Taiwan | 0.09 | Taiwan | 0.07 | Japan | 0.11 | Australia | 0.06 | USA | 0.10 |
| 4 | USA | 0.08 | Singapore | 0.06 | USA | 0.06 | Saudi Arabia | 0.05 | Saudi Arabia | 0.06 |
| 5 | Germany | 0.05 | USA | 0.05 | Malaysia | 0.06 | UAE | 0.05 | Australia | 0.04 |
| 6 | Australia | 0.04 | Korea | 0.04 | Korea | 0.06 | Korea | 0.04 | Germany | 0.04 |
| 7 | Malaysia | 0.03 | Malaysia | 0.02 | Thailand | 0.05 | Qatar | 0.03 | Qatar | 0.03 |
| 8 | Brazil | 0.02 | India | 0.02 | Saudi Arabia | 0.04 | Malaysia | 0.03 | UAE | 0.03 |
| 9 | Saudi Arabia | 0.02 | Thailand | 0.02 | Australia | 0.03 | Indonesia | 0.04 | Taiwan | 0.03 |
| 10 | Russia | 0.02 | Switzerland | 0.02 | Taiwan | 0.02 | Taiwan | 0.03 | Kuwait | 0.03 |

| Ranking | Malaysia Imports from | Share | Philippines Imports from | Share | Singapore Imports from | Share | Taiwan Imports from | Share | Thailand Imports from | Share |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | China | 0.13 | USA | 0.14 | Malaysia | 0.11 | Japan | 0.20 | Japan | 0.19 |
| 2 | Japan | 0.12 | Japan | 0.13 | China | 0.11 | China | 0.13 | China | 0.13 |
| 3 | Singapore | 0.12 | China | 0.10 | USA | 0.11 | USA | 0.12 | USA | 0.07 |
| 4 | USA | 0.11 | Singapore | 0.08 | Japan | 0.07 | Korea | 0.06 | Malaysia | 0.06 |
| 5 | Thailand | 0.06 | Taiwan | 0.07 | Taiwan | 0.07 | Saudi Arabia | 0.04 | UAE | 0.05 |
| 6 | Taiwan | 0.05 | Korea | 0.07 | Korea | 0.06 | Germany | 0.03 | Singapore | 0.04 |
| 7 | Korea | 0.05 | Thailand | 0.05 | Indonesia | 0.05 | Malaysia | 0.03 | Korea | 0.04 |
| 8 | Indonesia | 0.04 | Saudi Arabia | 0.05 | Saudi Arabia | 0.04 | Australia | 0.03 | Taiwan | 0.04 |
| 9 | Germany | 0.04 | Malaysia | 0.04 | UAE | 0.03 | Singapore | 0.03 | Saudi Arabia | 0.03 |
| 10 | Australia | 0.02 | Indonesia | 0.03 | Germany | 0.03 | Kuwait | 0.02 | Indonesia | 0.03 |

Note: The number for each country is the average of the period 2000-2015. Source: Author's calculation based on the Key Indicators 2016 database of the Asian Development Bank.

**Table 3: Shares of intra-regional trade in total trade of East Asia, NAFTA, and EU**

|  | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 |
|---|---|---|---|---|---|---|
| East Asia | 0.43 | 0.50 | 0.50 | 0.51 | 0.50 | 0.49 |
| NAFTA | 0.36 | 0.40 | 0.45 | 0.41 | 0.39 | 0.39 |
| EU | 0.68 | 0.68 | 0.63 | 0.65 | 0.61 | 0.61 |

Note: The share of intra-regional trade is the ratio of intra-regional trade to the sum of intra- and extra-regional trade. Source: Author's calculation based on data from RIETI-TID Trade Industry Database 2015, the Research Institute of Economy, Trade and Industry, Japan.

**Table 4: Shares by type of goods in intra-regional and extra-regional trade in East Asia**

| From \ To | Intermediate goods | | Final goods | | Primary goods | |
|---|---|---|---|---|---|---|
|  | East Asia | Rest of the world | East Asia | Rest of the world | East Asia | Rest of the world |
| East Asia | 0.64 | 0.39 | 0.32 | 0.59 | 0.04 | 0.02 |
| Rest of the world | 0.43 | 0.47 | 0.24 | 0.39 | 0.33 | 0.14 |

Note: Numbers are the average of the period 2000-2015, and the share for each year $t$ are calculated as $share_{ij,t}^k = X_{ij,t}^k / X_{ij,t}^{all}$, with $X =$ export volume, $i =$ the exporting country, $j =$ the importing country, $k =$ type of goods (either primary, intermediate, or final goods), $all =$ all types of goods (the sum over $k$). Source: Author's calculation based on data from RIETI-TID Trade Industry Database 2015, the Research Institute of Economy, Trade and Industry, Japan.

**Table 5: Shares by type of goods in trade between East Asian countries and their major trade partners**

Intermediate goods

| From \ To | CHN | HKG | IDN | JPN | KOR | MAL | PHL | SGP | TWN | THL | ASEAN | EA | Not EA | USA | World |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHN | — | 0.44 | 0.55 | 0.33 | 0.57 | 0.61 | 0.68 | 0.57 | 0.60 | 0.59 | 0.60 | 0.46 | 0.32 | 0.25 | 0.37 |
| HKG | 0.56 | — | 0.70 | 0.44 | 0.75 | 0.67 | 0.74 | 0.54 | 0.60 | 0.77 | 0.68 | 0.63 | 0.40 | 0.29 | 0.50 |
| IDN | 0.54 | 0.40 | — | 0.54 | 0.55 | 0.61 | 0.40 | 0.57 | 0.58 | 0.51 | 0.56 | 0.54 | 0.40 | 0.23 | 0.48 |
| JPN | 0.68 | 0.69 | 0.71 | — | 0.71 | 0.70 | 0.81 | 0.71 | 0.67 | 0.74 | 0.72 | 0.69 | 0.43 | 0.42 | 0.56 |
| KOR | 0.77 | 0.84 | 0.83 | 0.71 | — | 0.78 | 0.82 | 0.81 | 0.81 | 0.74 | 0.79 | 0.77 | 0.47 | 0.44 | 0.63 |
| MAL | 0.81 | 0.78 | 0.60 | 0.72 | 0.77 | — | 0.70 | 0.73 | 0.83 | 0.64 | 0.70 | 0.75 | 0.52 | 0.47 | 0.65 |
| PHL | 0.70 | 0.78 | 0.51 | 0.55 | 0.62 | 0.82 | — | 0.85 | 0.78 | 0.71 | 0.81 | 0.70 | 0.52 | 0.47 | 0.63 |
| SGP | 0.78 | 0.83 | 0.85 | 0.60 | 0.79 | 0.84 | 0.81 | — | 0.78 | 0.72 | 0.82 | 0.80 | 0.62 | 0.51 | 0.73 |
| TWN | 0.77 | 0.83 | 0.79 | 0.67 | 0.82 | 0.81 | 0.89 | 0.88 | — | 0.71 | 0.83 | 0.79 | 0.56 | 0.51 | 0.70 |
| THL | 0.60 | 0.63 | 0.59 | 0.43 | 0.51 | 0.61 | 0.54 | 0.69 | 0.60 | — | 0.64 | 0.57 | 0.31 | 0.25 | 0.45 |
| ASEAN | 0.68 | 0.75 | 0.70 | 0.56 | 0.62 | 0.72 | 0.63 | 0.68 | 0.71 | 0.62 | 0.68 | 0.66 | 0.42 | 0.33 | 0.56 |
| EA | 0.71 | 0.59 | 0.69 | 0.47 | 0.65 | 0.71 | 0.75 | 0.69 | 0.67 | 0.67 | 0.70 | 0.64 | 0.39 | 0.33 | 0.51 |
| Not EA | 0.39 | 0.57 | 0.50 | 0.35 | 0.42 | 0.64 | 0.54 | 0.60 | 0.47 | 0.46 | 0.56 | 0.43 | 0.47 | 0.41 | 0.46 |
| USA | 0.46 | 0.58 | 0.46 | 0.45 | 0.52 | 0.76 | 0.78 | 0.72 | 0.52 | 0.62 | 0.69 | 0.53 | 0.55 | — | 0.55 |
| World | 0.54 | 0.59 | 0.62 | 0.40 | 0.52 | 0.68 | 0.67 | 0.65 | 0.58 | 0.58 | 0.64 | 0.54 | 0.45 | 0.38 | 0.47 |

**Table 5 (continued)**

Final goods

| From \ To | CHN | HKG | IDN | JPN | KOR | MAL | PHL | SGP | TWN | THL | ASEAN | EA | Not EA | USA | World |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHN | — | 0.55 | 0.36 | 0.64 | 0.36 | 0.36 | 0.27 | 0.42 | 0.34 | 0.39 | 0.38 | 0.52 | 0.68 | 0.74 | 0.62 |
| HKG | 0.22 | — | 0.27 | 0.49 | 0.20 | 0.32 | 0.25 | 0.45 | 0.32 | 0.22 | 0.31 | 0.28 | 0.57 | 0.70 | 0.45 |
| IDN | 0.10 | 0.34 | — | 0.13 | 0.07 | 0.17 | 0.27 | 0.26 | 0.07 | 0.23 | 0.24 | 0.15 | 0.41 | 0.62 | 0.26 |
| JPN | 0.30 | 0.29 | 0.28 | — | 0.26 | 0.29 | 0.18 | 0.28 | 0.32 | 0.25 | 0.27 | 0.29 | 0.57 | 0.58 | 0.43 |
| KOR | 0.23 | 0.15 | 0.16 | 0.27 | — | 0.21 | 0.15 | 0.18 | 0.19 | 0.25 | 0.20 | 0.22 | 0.52 | 0.56 | 0.37 |
| MAL | 0.11 | 0.21 | 0.19 | 0.22 | 0.11 | — | 0.17 | 0.24 | 0.13 | 0.21 | 0.23 | 0.19 | 0.41 | 0.52 | 0.28 |
| PHL | 0.23 | 0.20 | 0.41 | 0.38 | 0.26 | 0.13 | — | 0.13 | 0.18 | 0.23 | 0.16 | 0.24 | 0.46 | 0.52 | 0.32 |
| SGP | 0.22 | 0.16 | 0.13 | 0.37 | 0.20 | 0.15 | 0.16 | — | 0.21 | 0.27 | 0.17 | 0.19 | 0.36 | 0.49 | 0.26 |
| TWN | 0.22 | 0.17 | 0.20 | 0.32 | 0.17 | 0.19 | 0.11 | 0.11 | — | 0.28 | 0.16 | 0.21 | 0.43 | 0.49 | 0.29 |
| THL | 0.29 | 0.35 | 0.35 | 0.51 | 0.31 | 0.29 | 0.44 | 0.29 | 0.35 | — | 0.31 | 0.36 | 0.65 | 0.71 | 0.50 |
| ASEAN | 0.19 | 0.23 | 0.20 | 0.30 | 0.17 | 0.19 | 0.27 | 0.24 | 0.19 | 0.24 | 0.23 | 0.23 | 0.50 | 0.62 | 0.35 |
| EA | 0.24 | 0.40 | 0.24 | 0.46 | 0.27 | 0.25 | 0.21 | 0.27 | 0.29 | 0.28 | 0.26 | 0.32 | 0.59 | 0.66 | 0.46 |
| Not EA | 0.22 | 0.38 | 0.20 | 0.27 | 0.19 | 0.22 | 0.17 | 0.22 | 0.24 | 0.18 | 0.21 | 0.23 | 0.39 | 0.39 | 0.36 |
| USA | 0.34 | 0.38 | 0.30 | 0.42 | 0.34 | 0.21 | 0.13 | 0.27 | 0.35 | 0.28 | 0.25 | 0.34 | 0.39 | — | 0.38 |
| World | 0.23 | 0.39 | 0.23 | 0.35 | 0.22 | 0.24 | 0.20 | 0.25 | 0.26 | 0.24 | 0.24 | 0.28 | 0.43 | 0.48 | 0.39 |

Note: Abbreviation: CHN: China, HKG: Hong Kong, IDN: Indonesia, JPN: Japan, KOR: Korea, MAL: Malaysia, PHL: the Philippines, SGP: Singapore, TWN: Taiwan, THL: Thailand, EA: East Asia. See the note for Table 4 for more details of the data source and the definition of the share for each type of goods.

**Table 6: Variance decomposition for variables of East Asian countries**

| Shock | Horizon | China | | | | Japan | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Exp. | Imp. | GDP | REER | Exp. | Imp. | GDP | REER |
| USA | 1 quarter | 0.19 | 0.01 | 0.01 | 0.07 | 0.19 | 0.01 | 0.07 | 0.20 |
| output | 4 quarters | 0.11 | 0.13 | 0.05 | 0.15 | 0.53 | 0.26 | 0.42 | 0.22 |
| shock | 12 quarters | 0.11 | 0.13 | 0.05 | 0.14 | 0.49 | 0.27 | 0.40 | 0.25 |
| CHN | 1 quarter | 0.06 | 0.31 | 0.99 | 0.20 | 0.00 | 0.02 | 0.01 | 0.02 |
| output | 4 quarters | 0.37 | 0.27 | 0.79 | 0.31 | 0.10 | 0.06 | 0.03 | 0.09 |
| shock | 12 quarters | 0.33 | 0.25 | 0.66 | 0.31 | 0.12 | 0.06 | 0.05 | 0.09 |
| JPN | 1 quarter | 0.03 | 0.16 | 0.00 | 0.01 | 0.18 | 0.20 | 0.92 | 0.01 |
| output | 4 quarters | 0.03 | 0.14 | 0.02 | 0.02 | 0.12 | 0.11 | 0.47 | 0.04 |
| shock | 12 quarters | 0.04 | 0.16 | 0.04 | 0.04 | 0.12 | 0.11 | 0.42 | 0.06 |
| Export shock | 1 quarter | 0.72 | 0.01 | 0.00 | 0.02 | 0.63 | 0.00 | 0.00 | 0.00 |
| | 4 quarters | 0.33 | 0.10 | 0.11 | 0.07 | 0.13 | 0.01 | 0.01 | 0.02 |
| | 12 quarters | 0.30 | 0.12 | 0.17 | 0.09 | 0.14 | 0.03 | 0.04 | 0.05 |
| Import shock | 1 quarter | 0.00 | 0.51 | 0.00 | 0.00 | 0.00 | 0.77 | 0.00 | 0.05 |
| | 4 quarters | 0.14 | 0.33 | 0.01 | 0.12 | 0.03 | 0.40 | 0.00 | 0.17 |
| | 12 quarters | 0.17 | 0.29 | 0.03 | 0.11 | 0.05 | 0.36 | 0.01 | 0.18 |
| REER shock | 1 quarter | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 0.00 | 0.00 | 0.72 |
| | 4 quarters | 0.03 | 0.03 | 0.02 | 0.34 | 0.08 | 0.16 | 0.07 | 0.47 |
| | 12 quarters | 0.04 | 0.05 | 0.04 | 0.32 | 0.08 | 0.17 | 0.08 | 0.37 |

**Table 6 (continued)**

| | | Hong Kong | | | |
|---|---|---|---|---|---|
| Shock | Horizon | 0.08 | 0.15 | 0.17 | 0.05 |
| USA output shock | 1 quarter | 0.22 | 0.29 | 0.25 | 0.12 |
| | 4 quarters | 0.21 | 0.25 | 0.22 | 0.09 |
| | 12 quarters | 0.06 | 0.11 | 0.28 | 0.03 |
| CHN output shock | 1 quarter | 0.05 | 0.07 | 0.25 | 0.09 |
| | 4 quarters | 0.04 | 0.06 | 0.22 | 0.20 |
| | 12 quarters | 0.11 | 0.07 | 0.02 | 0.03 |
| JPN output shock | 1 quarter | 0.18 | 0.11 | 0.03 | 0.06 |
| | 4 quarters | 0.18 | 0.12 | 0.06 | 0.05 |
| | 12 quarters | 0.76 | 0.57 | 0.15 | 0.04 |
| Export shock | 1 quarter | 0.49 | 0.37 | 0.13 | 0.07 |
| | 4 quarters | 0.39 | 0.28 | 0.12 | 0.04 |
| | 12 quarters | 0.00 | 0.10 | 0.01 | 0.00 |
| Import shock | 1 quarter | 0.01 | 0.08 | 0.03 | 0.06 |
| | 4 quarters | 0.03 | 0.08 | 0.04 | 0.07 |
| | 12 quarters | 0.00 | 0.00 | 0.37 | 0.01 |
| Home output shock | 1 quarter | 0.01 | 0.06 | 0.27 | 0.10 |
| | 4 quarters | 0.10 | 0.17 | 0.30 | 0.19 |
| | 12 quarters | 0.00 | 0.00 | 0.00 | 0.84 |
| REER shock | 1 quarter | 0.03 | 0.02 | 0.03 | 0.51 |
| | 4 quarters | 0.05 | 0.04 | 0.04 | 0.36 |
| | 12 quarters | 0.08 | 0.15 | 0.17 | 0.05 |

Table 6 (continued)

| Shock | Horizon | Indonesia | | | | Korea | | | | Philippines | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Exp. | Imp. | GDP | REER | Exp. | Imp. | GDP | REER | Exp. | Imp. | GDP | REER |
| USA | 1 quarter | 0.06 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.19 | 0.27 | 0.24 | 0.00 | 0.13 | 0.00 |
| output | 4 quarters | 0.07 | 0.11 | 0.01 | 0.08 | 0.21 | 0.29 | 0.21 | 0.19 | 0.23 | 0.22 | 0.24 | 0.05 |
| shock | 12 quarters | 0.08 | 0.09 | 0.03 | 0.08 | 0.23 | 0.28 | 0.21 | 0.21 | 0.22 | 0.18 | 0.23 | 0.05 |
| CHN | 1 quarter | 0.00 | 0.03 | 0.02 | 0.01 | 0.13 | 0.00 | 0.07 | 0.19 | 0.01 | 0.02 | 0.02 | 0.00 |
| output | 4 quarters | 0.04 | 0.04 | 0.06 | 0.05 | 0.14 | 0.07 | 0.15 | 0.23 | 0.01 | 0.03 | 0.07 | 0.04 |
| shock | 12 quarters | 0.05 | 0.04 | 0.10 | 0.06 | 0.13 | 0.06 | 0.14 | 0.21 | 0.02 | 0.07 | 0.08 | 0.08 |
| JPN | 1 quarter | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.00 | 0.01 | 0.20 | 0.25 | 0.17 | 0.04 |
| output | 4 quarters | 0.01 | 0.11 | 0.07 | 0.04 | 0.05 | 0.04 | 0.02 | 0.03 | 0.19 | 0.25 | 0.15 | 0.05 |
| shock | 12 quarters | 0.01 | 0.10 | 0.08 | 0.06 | 0.08 | 0.06 | 0.03 | 0.03 | 0.26 | 0.28 | 0.21 | 0.10 |
| Export shock | 1 quarter | 0.94 | 0.08 | 0.05 | 0.01 | 0.84 | 0.44 | 0.04 | 0.03 | 0.55 | 0.01 | 0.00 | 0.01 |
| | 4 quarters | 0.81 | 0.09 | 0.10 | 0.06 | 0.45 | 0.20 | 0.05 | 0.08 | 0.50 | 0.03 | 0.01 | 0.09 |
| | 12 quarters | 0.78 | 0.18 | 0.10 | 0.07 | 0.37 | 0.20 | 0.11 | 0.07 | 0.42 | 0.06 | 0.01 | 0.08 |
| Import shock | 1 quarter | 0.00 | 0.88 | 0.13 | 0.16 | 0.00 | 0.51 | 0.00 | 0.00 | 0.00 | 0.73 | 0.02 | 0.04 |
| | 4 quarters | 0.02 | 0.62 | 0.17 | 0.13 | 0.07 | 0.32 | 0.14 | 0.17 | 0.01 | 0.39 | 0.03 | 0.05 |
| | 12 quarters | 0.03 | 0.51 | 0.19 | 0.13 | 0.09 | 0.29 | 0.14 | 0.23 | 0.01 | 0.31 | 0.04 | 0.05 |
| Home | 1 quarter | 0.00 | 0.00 | 0.79 | 0.00 | 0.00 | 0.00 | 0.71 | 0.04 | 0.00 | 0.00 | 0.66 | 0.00 |
| output | 4 quarters | 0.04 | 0.01 | 0.58 | 0.12 | 0.04 | 0.08 | 0.42 | 0.03 | 0.03 | 0.08 | 0.47 | 0.05 |
| shock | 12 quarters | 0.04 | 0.02 | 0.49 | 0.11 | 0.05 | 0.08 | 0.36 | 0.03 | 0.04 | 0.08 | 0.40 | 0.06 |
| REER shock | 1 quarter | 0.00 | 0.00 | 0.00 | 0.80 | 0.00 | 0.00 | 0.00 | 0.47 | 0.00 | 0.00 | 0.00 | 0.90 |
| | 4 quarters | 0.02 | 0.02 | 0.01 | 0.53 | 0.03 | 0.01 | 0.01 | 0.27 | 0.02 | 0.01 | 0.03 | 0.66 |
| | 12 quarters | 0.02 | 0.06 | 0.01 | 0.49 | 0.06 | 0.03 | 0.02 | 0.22 | 0.03 | 0.03 | 0.03 | 0.59 |

**Table 6 (continued)**

| Shock | Horizon | Singapore | | | | Taiwan | | | | Thailand | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Exp. | Imp. | GDP | REER | Exp. | Imp. | GDP | REER | Exp. | Imp. | GDP | REER |
| USA output shock | 1 quarter | 0.00 | 0.01 | 0.11 | 0.01 | 0.14 | 0.11 | 0.16 | 0.09 | 0.03 | 0.02 | 0.02 | 0.10 |
| | 4 quarters | 0.09 | 0.28 | 0.20 | 0.12 | 0.18 | 0.23 | 0.21 | 0.09 | 0.19 | 0.31 | 0.14 | 0.09 |
| | 12 quarters | 0.17 | 0.28 | 0.23 | 0.13 | 0.20 | 0.23 | 0.25 | 0.12 | 0.18 | 0.28 | 0.17 | 0.08 |
| CHN output shock | 1 quarter | 0.15 | 0.08 | 0.15 | 0.01 | 0.18 | 0.05 | 0.50 | 0.00 | 0.06 | 0.05 | 0.02 | 0.10 |
| | 4 quarters | 0.13 | 0.07 | 0.14 | 0.03 | 0.19 | 0.09 | 0.36 | 0.04 | 0.11 | 0.06 | 0.02 | 0.10 |
| | 12 quarters | 0.10 | 0.07 | 0.13 | 0.09 | 0.16 | 0.10 | 0.28 | 0.13 | 0.10 | 0.07 | 0.03 | 0.09 |
| JPN output shock | 1 quarter | 0.12 | 0.08 | 0.03 | 0.09 | 0.03 | 0.03 | 0.00 | 0.02 | 0.02 | 0.01 | 0.05 | 0.07 |
| | 4 quarters | 0.08 | 0.05 | 0.07 | 0.07 | 0.03 | 0.05 | 0.03 | 0.04 | 0.02 | 0.09 | 0.05 | 0.07 |
| | 12 quarters | 0.07 | 0.05 | 0.07 | 0.09 | 0.05 | 0.05 | 0.07 | 0.04 | 0.10 | 0.09 | 0.13 | 0.14 |
| Export shock | 1 quarter | 0.73 | 0.50 | 0.10 | 0.02 | 0.65 | 0.44 | 0.12 | 0.12 | 0.89 | 0.35 | 0.45 | 0.01 |
| | 4 quarters | 0.47 | 0.32 | 0.08 | 0.03 | 0.45 | 0.26 | 0.14 | 0.12 | 0.54 | 0.19 | 0.43 | 0.01 |
| | 12 quarters | 0.37 | 0.29 | 0.07 | 0.06 | 0.37 | 0.26 | 0.14 | 0.11 | 0.48 | 0.20 | 0.34 | 0.04 |
| Import shock | 1 quarter | 0.00 | 0.34 | 0.00 | 0.04 | 0.00 | 0.37 | 0.00 | 0.00 | 0.00 | 0.57 | 0.04 | 0.01 |
| | 4 quarters | 0.14 | 0.23 | 0.02 | 0.04 | 0.02 | 0.31 | 0.04 | 0.03 | 0.07 | 0.34 | 0.06 | 0.04 |
| | 12 quarters | 0.18 | 0.23 | 0.11 | 0.06 | 0.05 | 0.25 | 0.06 | 0.05 | 0.07 | 0.33 | 0.05 | 0.06 |
| Home output shock | 1 quarter | 0.00 | 0.00 | 0.61 | 0.02 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.42 | 0.03 |
| | 4 quarters | 0.03 | 0.03 | 0.48 | 0.16 | 0.07 | 0.03 | 0.16 | 0.06 | 0.07 | 0.01 | 0.28 | 0.19 |
| | 12 quarters | 0.04 | 0.05 | 0.36 | 0.13 | 0.08 | 0.04 | 0.13 | 0.06 | 0.07 | 0.02 | 0.26 | 0.17 |
| REER shock | 1 quarter | 0.00 | 0.00 | 0.00 | 0.81 | 0.00 | 0.00 | 0.00 | 0.77 | 0.00 | 0.00 | 0.00 | 0.67 |
| | 4 quarters | 0.06 | 0.02 | 0.02 | 0.54 | 0.07 | 0.03 | 0.05 | 0.63 | 0.00 | 0.02 | 0.01 | 0.50 |
| | 12 quarters | 0.08 | 0.03 | 0.03 | 0.45 | 0.09 | 0.07 | 0.06 | 0.49 | 0.01 | 0.02 | 0.03 | 0.42 |

Source: Calculated by the author based on the estimated VAR model and data described in Section 3.

**Figure 1: GDP of East Asian countries relative to the USA in 2005 and 2016**



| | USA | CHN | JPN | KOR | IND | TWN | THL | MAL | SGP | PHL |
|---|---|---|---|---|---|---|---|---|---|---|
| ■2005 | 1.00 | 0.24 | 0.39 | 0.06 | 0.04 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 |



| | USA | CHN | JPN | KOR | IND | TWN | THL | MAL | SGP | PHL |
|---|---|---|---|---|---|---|---|---|---|---|
| ■2016 | 1.00 | 0.54 | 0.35 | 0.08 | 0.06 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 |
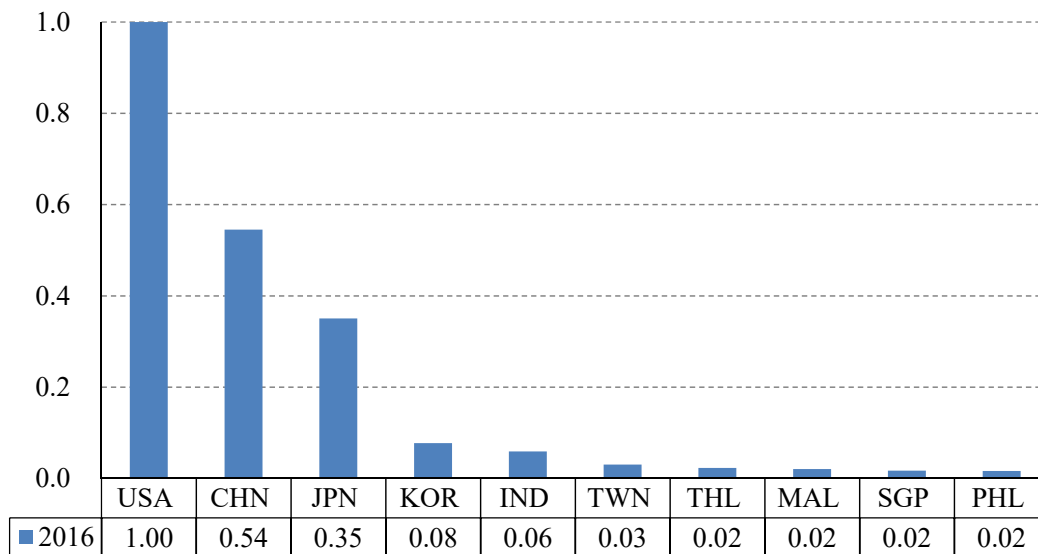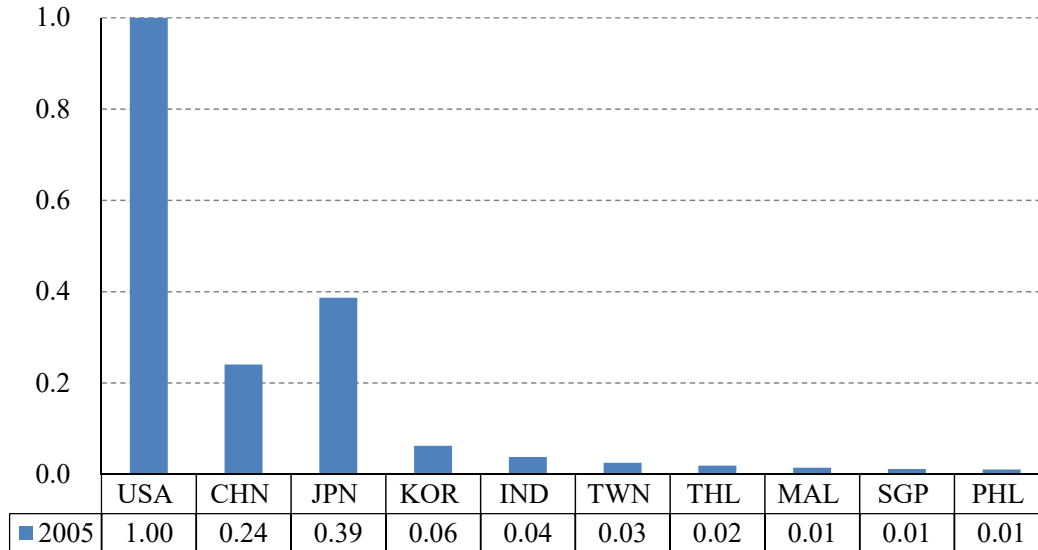
Note: Abbreviation: CHN: China, IDN: Indonesia, JPN: Japan, KOR: Korea, MAL: Malaysia, PHL: the Philippines, SGP: Singapore, TWN: Taiwan, THL: Thailand. GDP of the USA is normalized to 1. GDP measured at constant 2010 US$ is used in the calculation. Source: Author's calculation based on the Global Economic Monitoring database of the World Bank.

**Figure 2: Responses of GDP of the USA, China, and Japan to GDP shocks from the USA, China, and Japan**
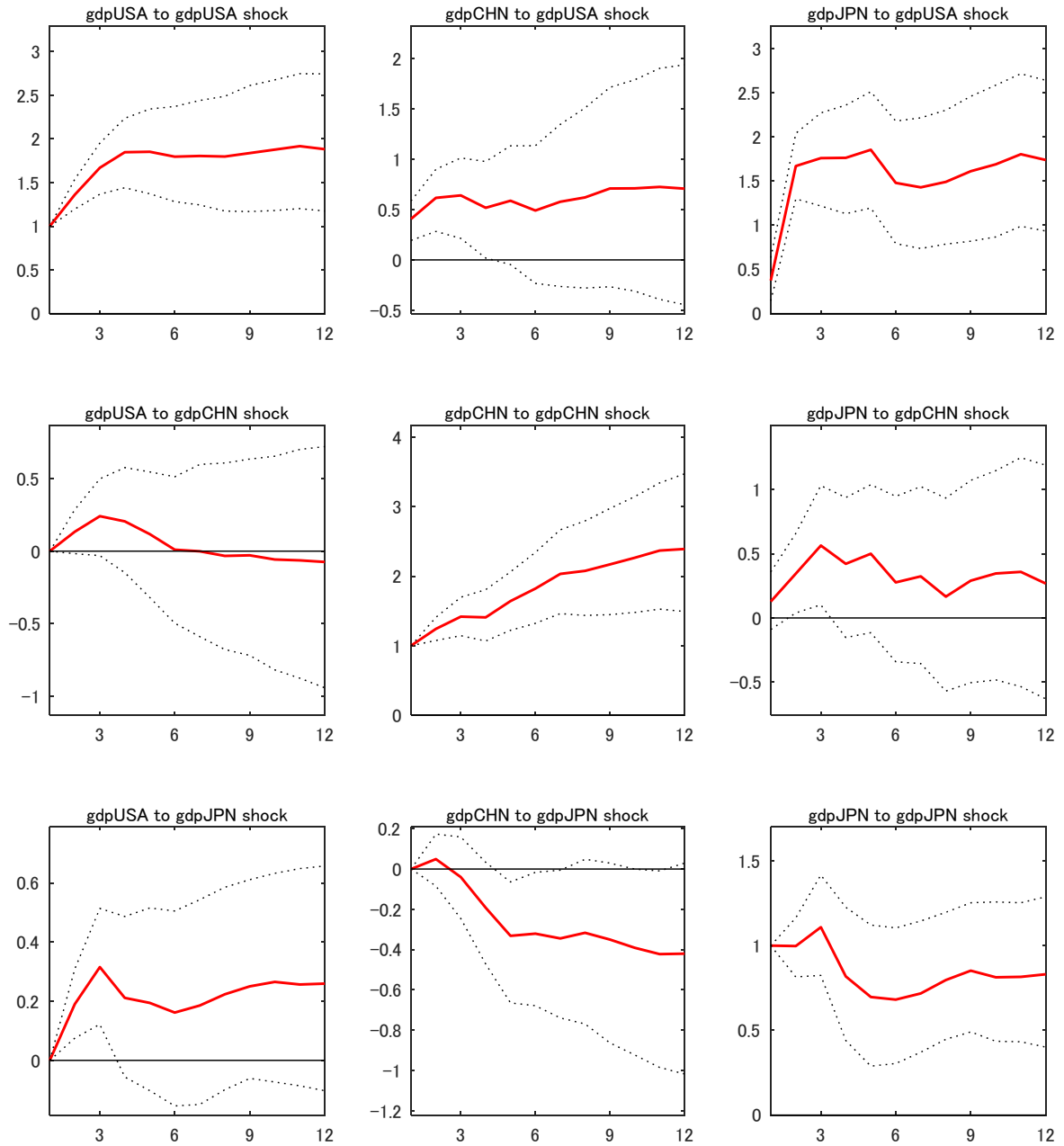


Note: A shock is defined as a one percent increase in the variable from which the shock is originated. In each box, the horizontal axis shows quarters after the shock and the vertical axis shows percentage changes in the variable. Error bands are obtained by a bootstrapping method. Dashed lines are 16th and 84th quantiles, and solid lines are the median. Source: Calculated by the author using the VAR model and data described in Section 3.

## Figure 3: Responses of East Asian economies to external and domestic shocks

**China**
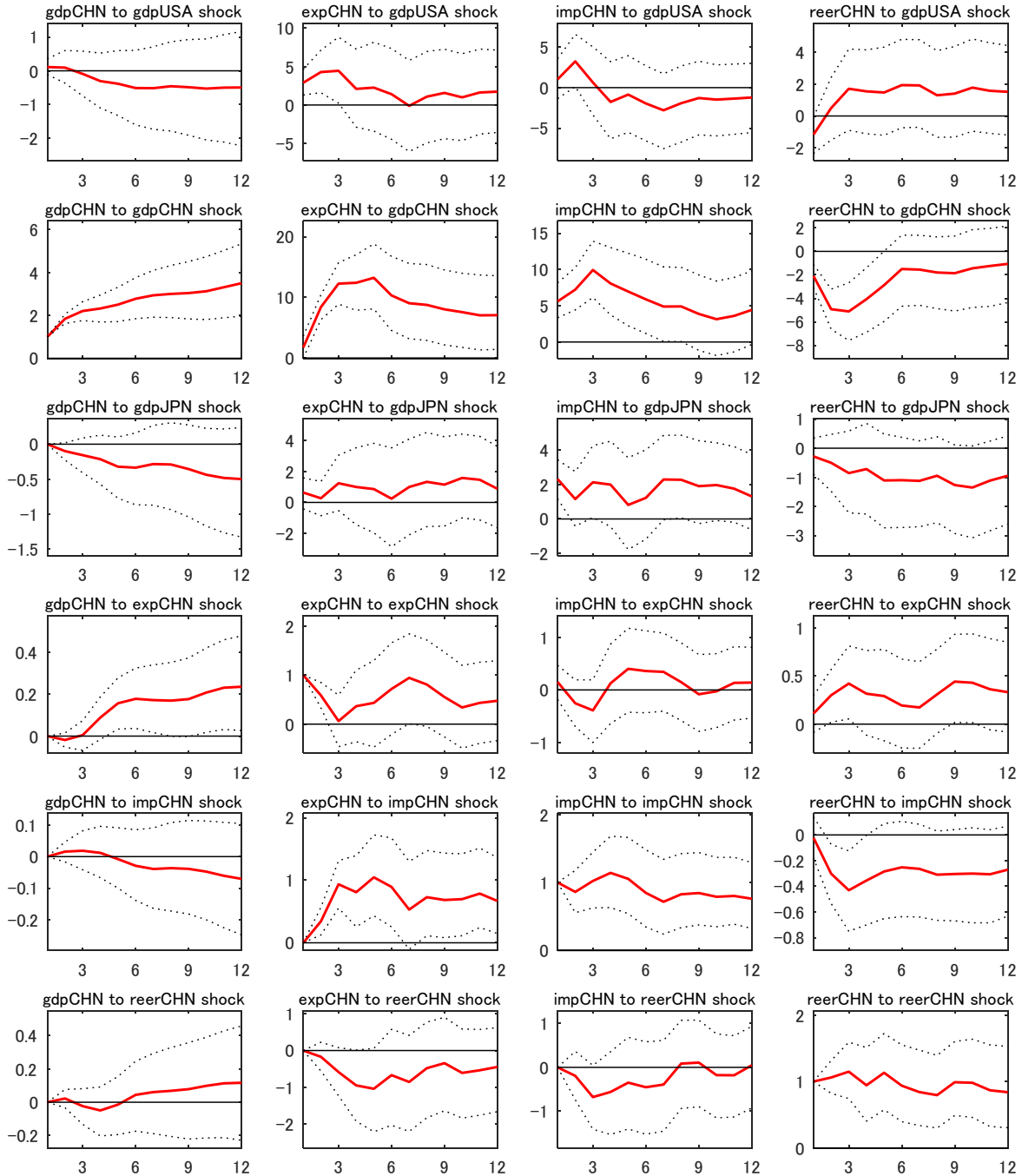
**Hong Kong**
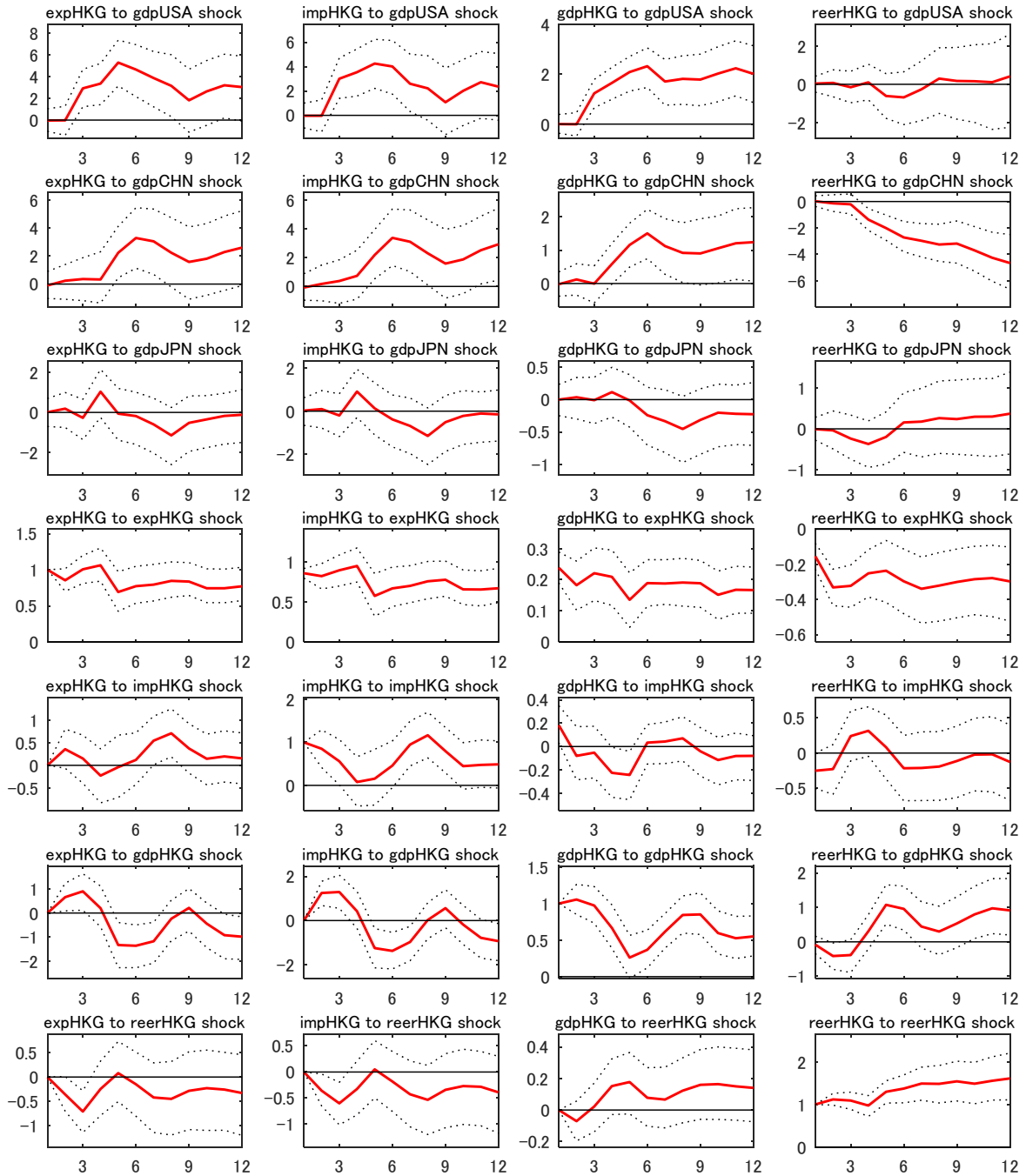
**Indonesia**
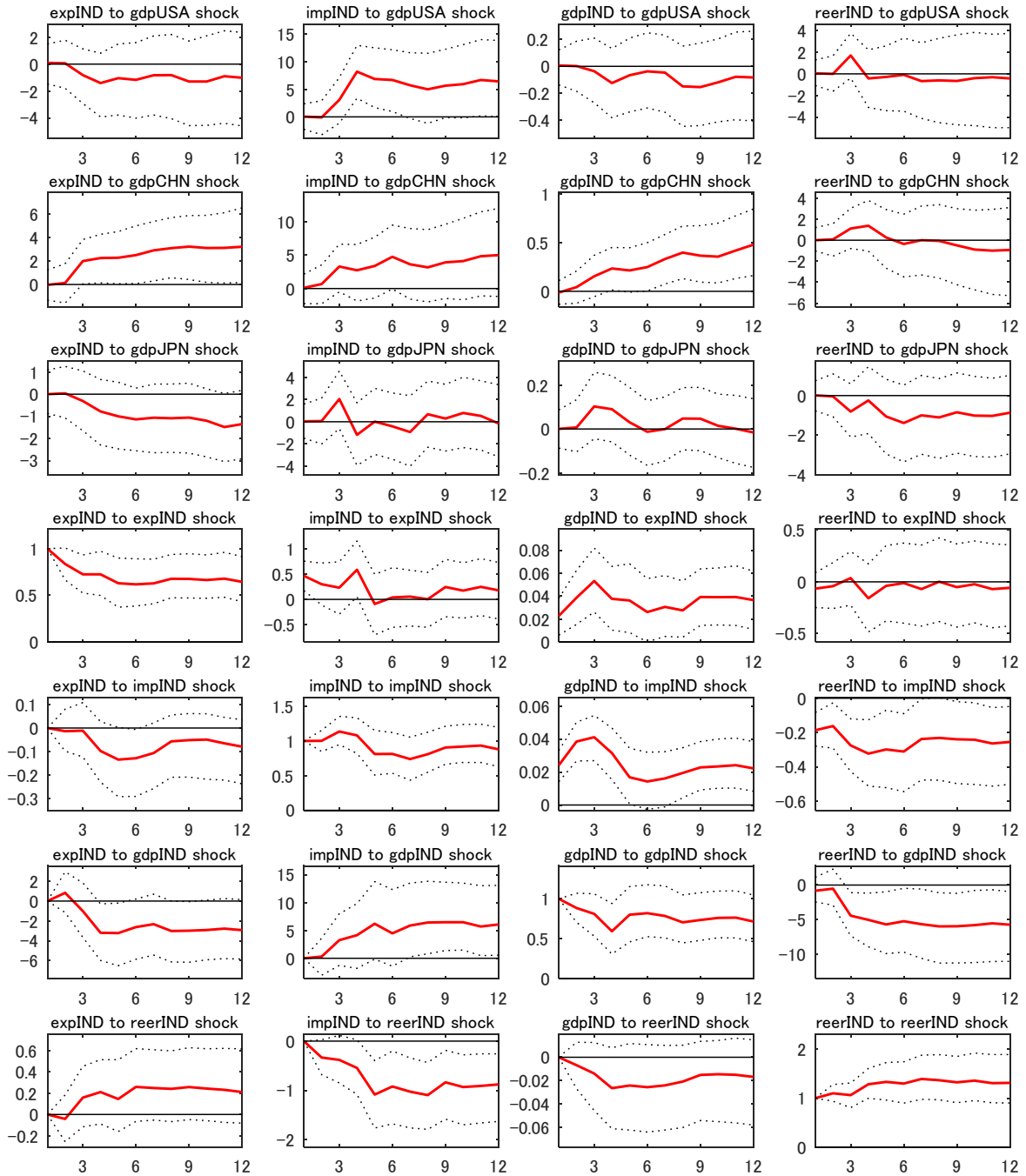
**Japan**
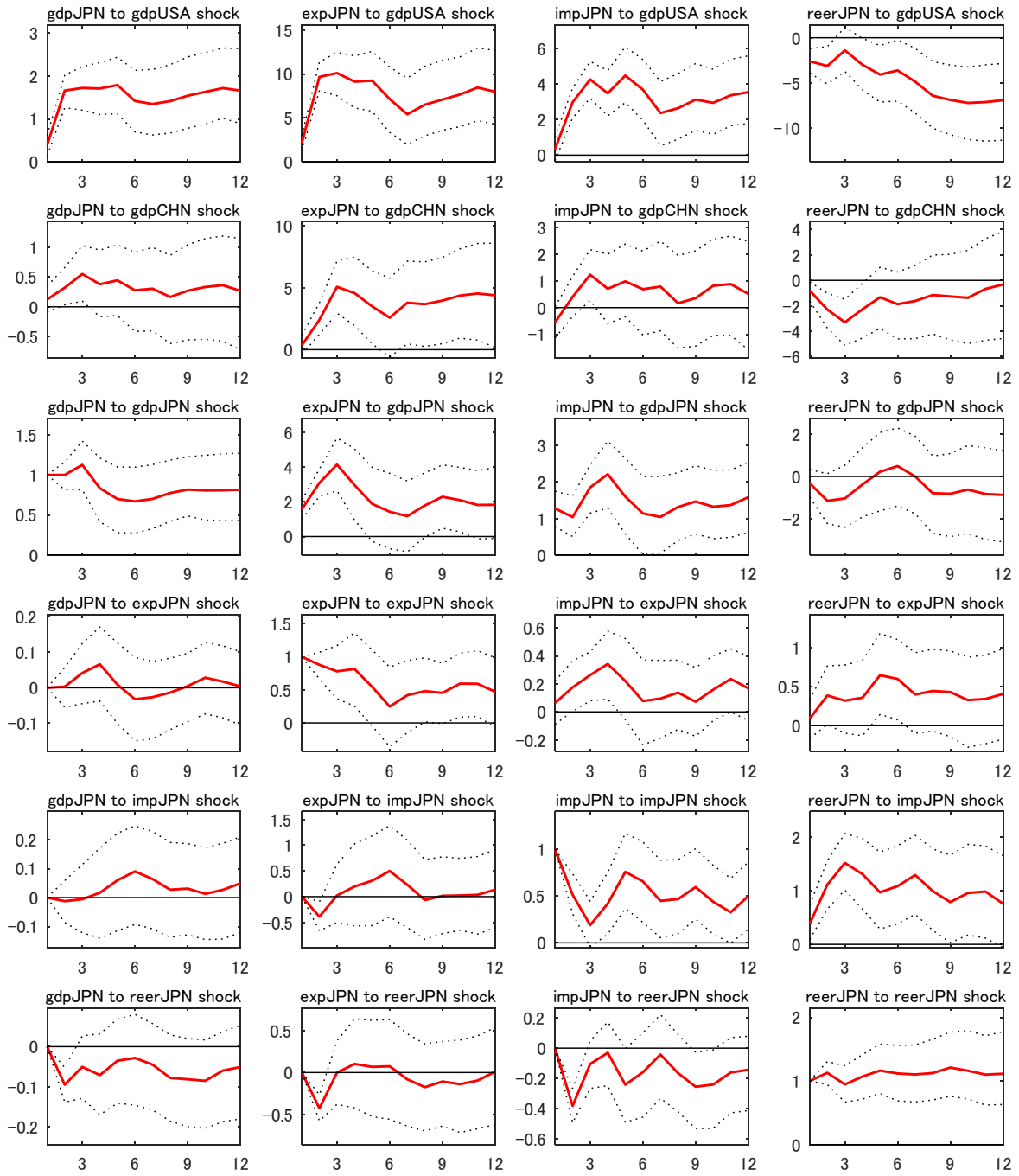
**Korea**
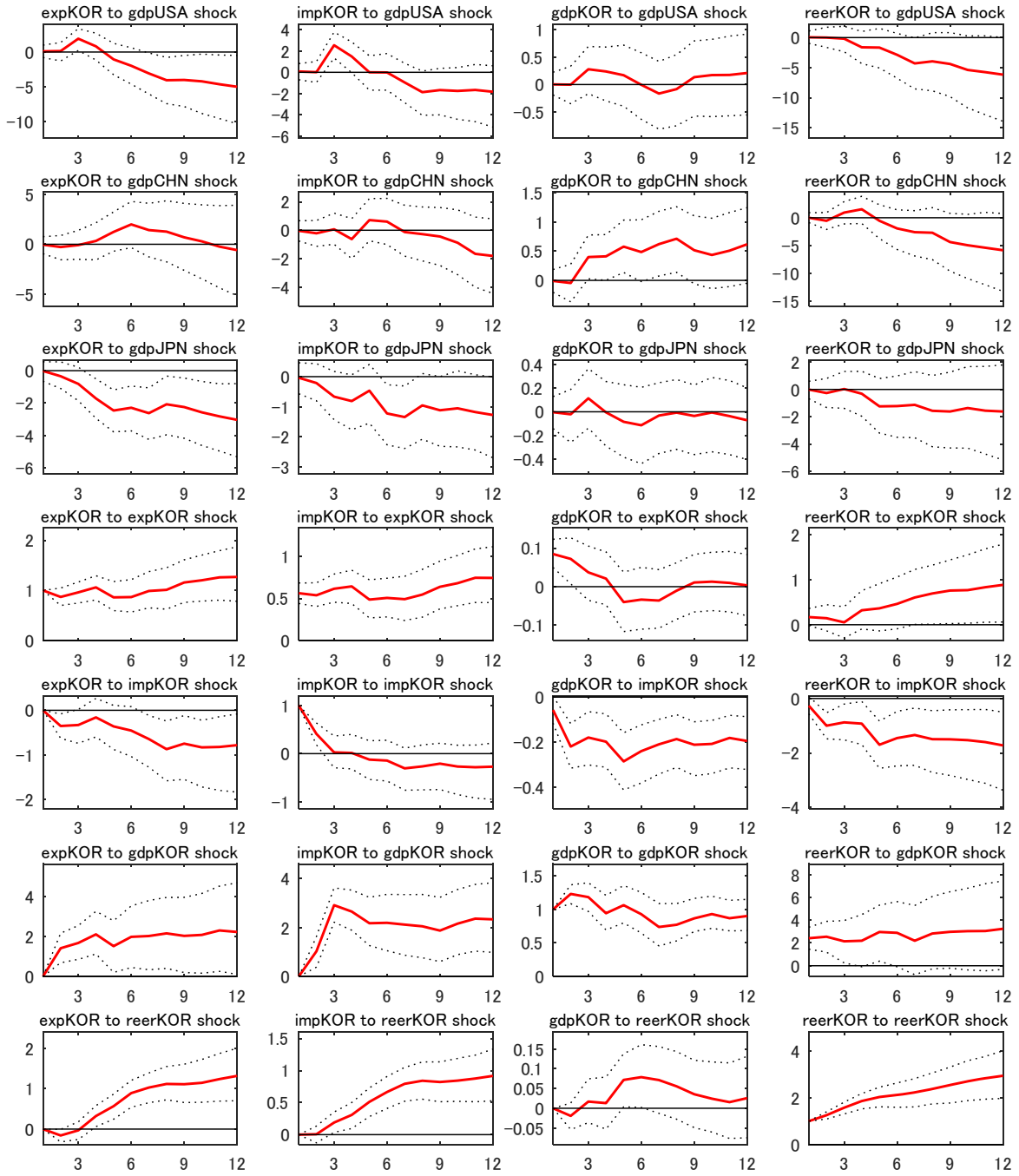
**Philippines**
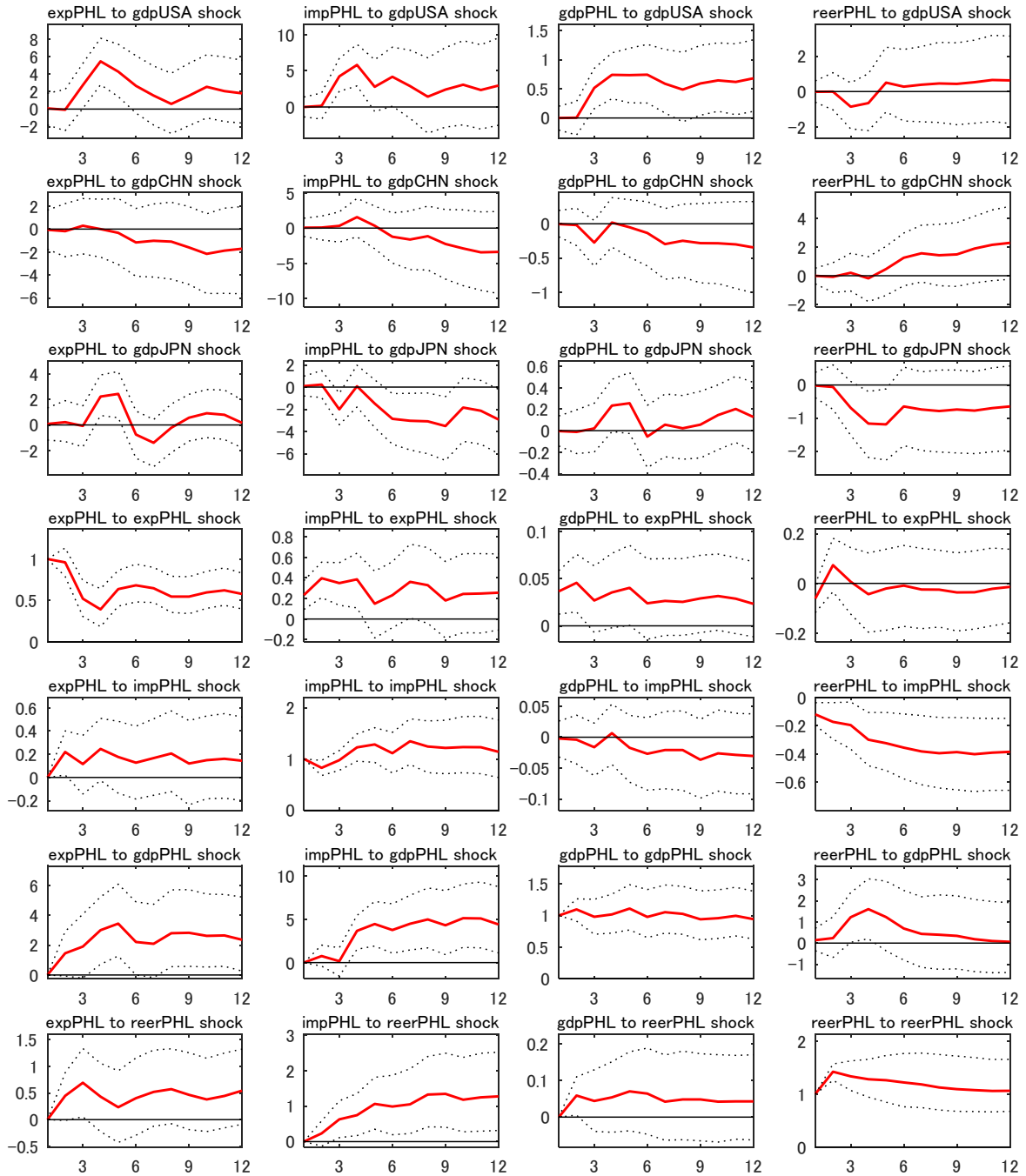
**Singapore**
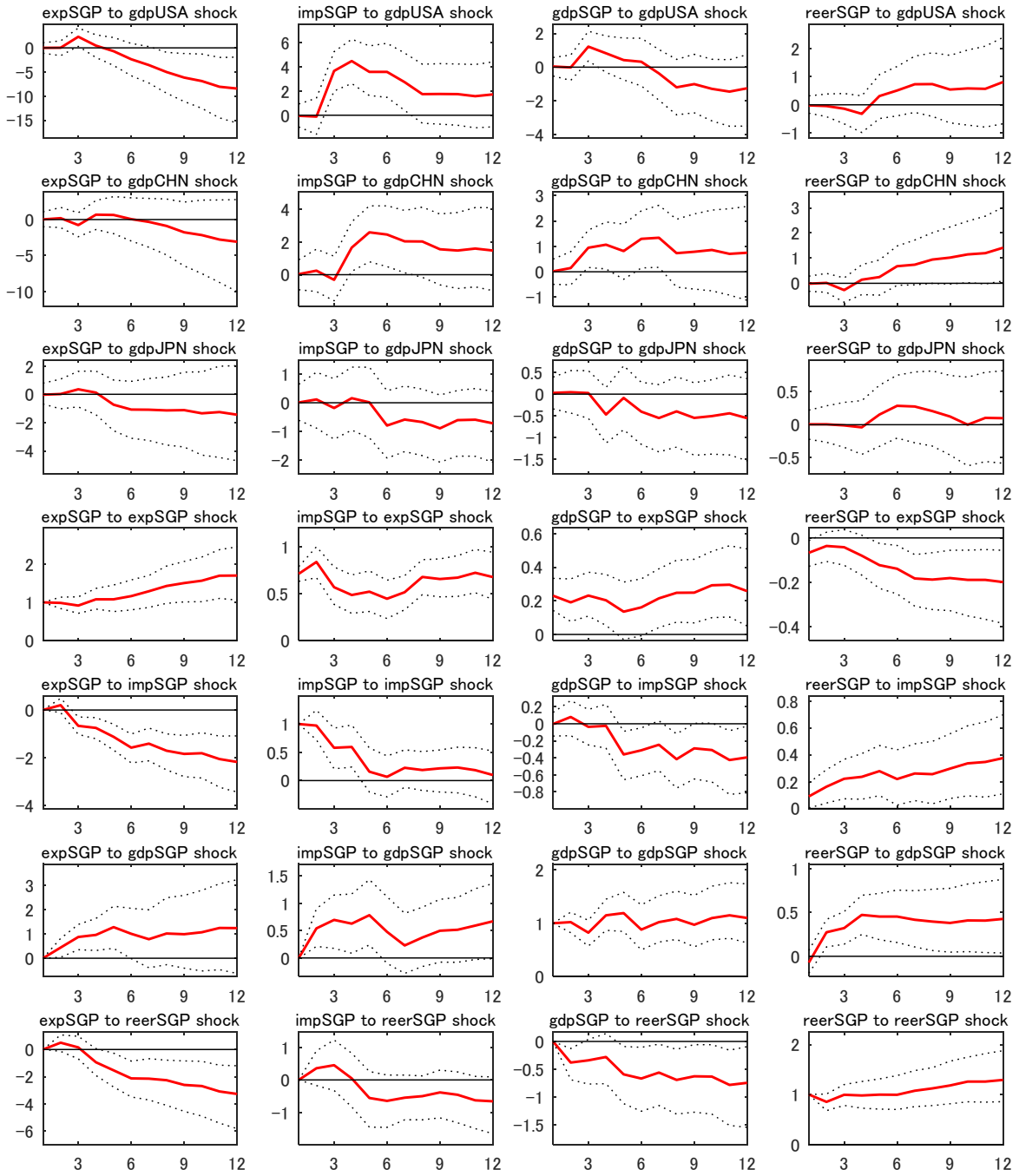
**Taiwan**
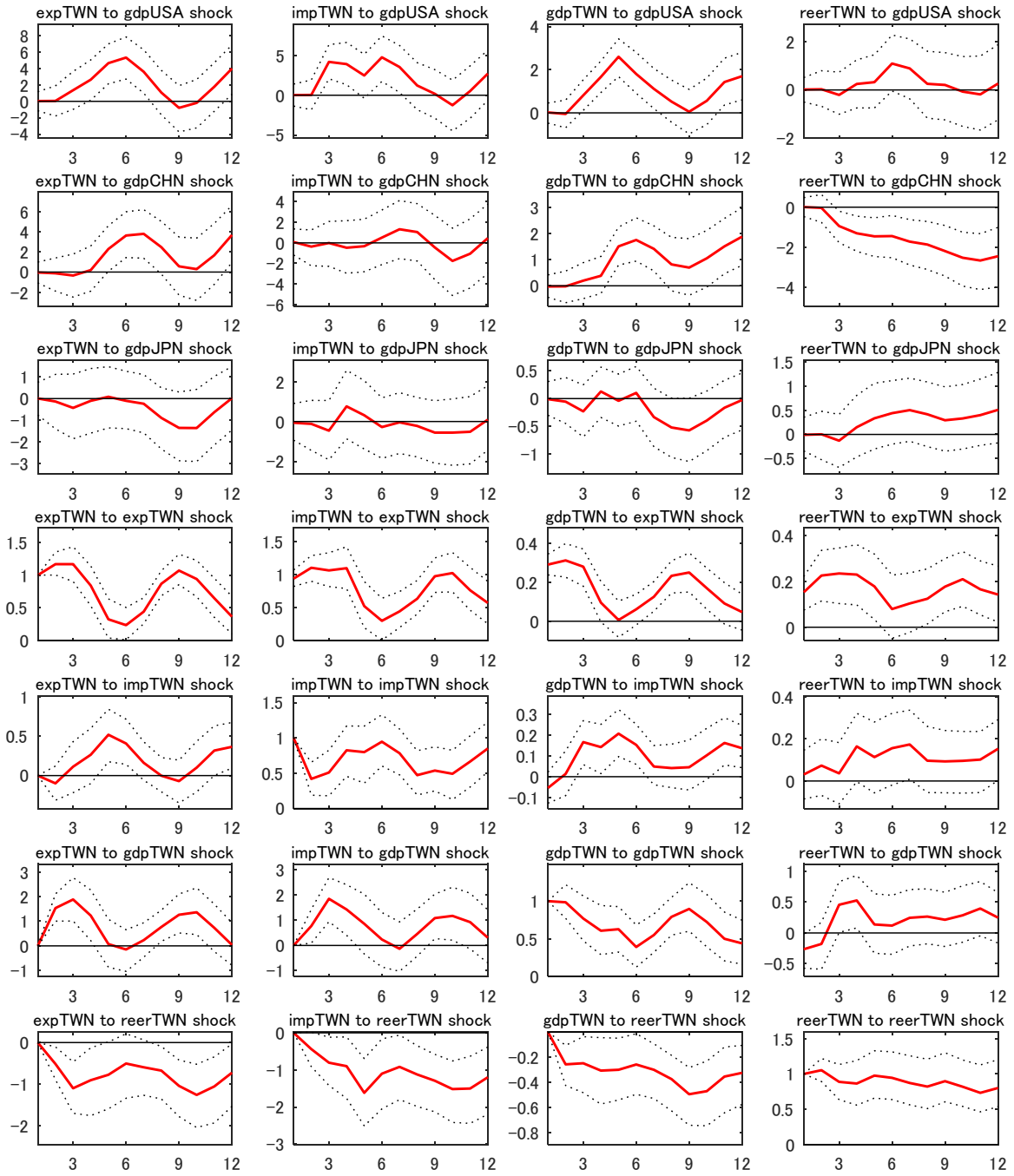
**Thailand**
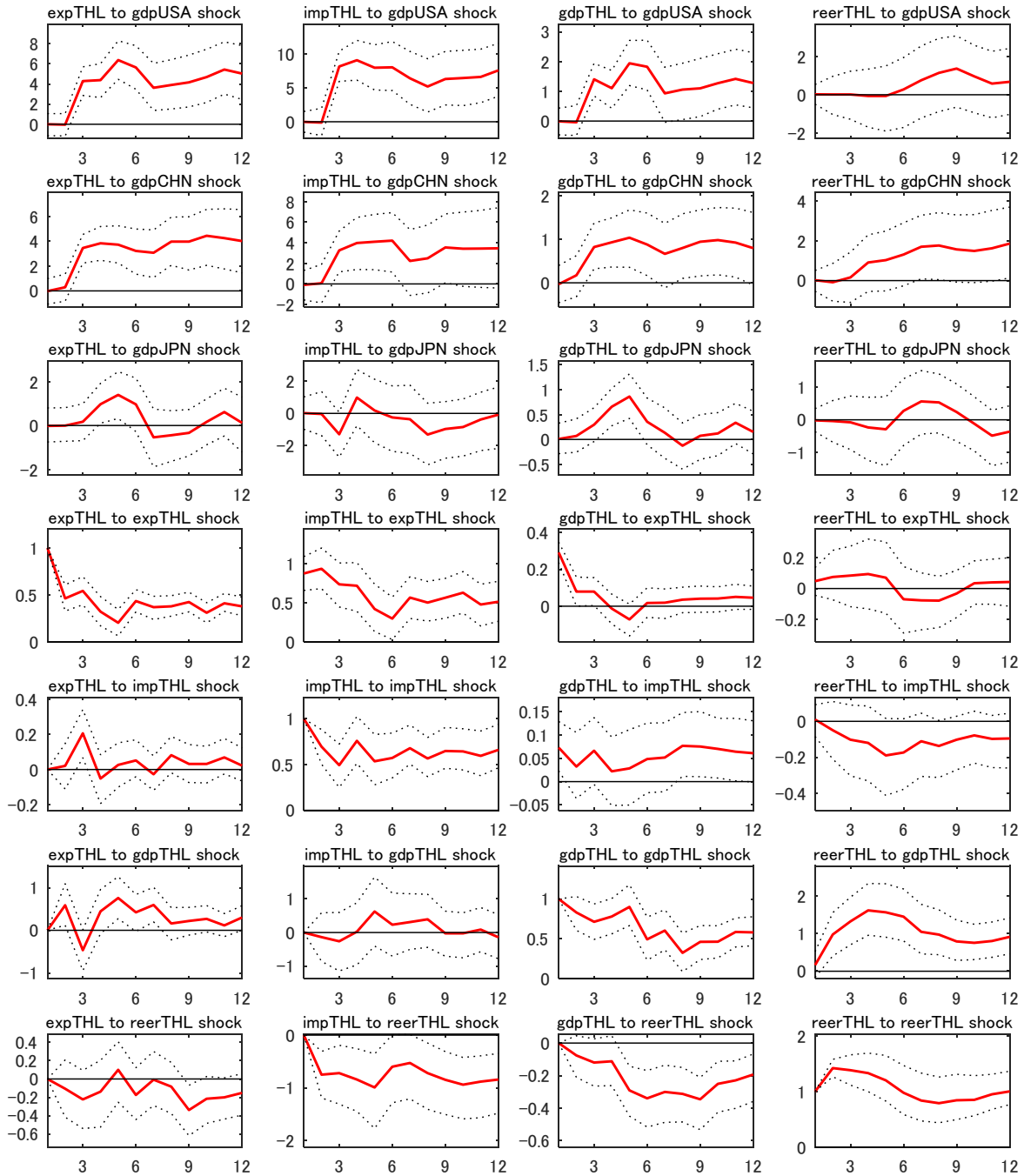


Note: Notation: *exp* is real exports; *imp* is real imports; *reer* is real effective exchange rate (an increase of which means a real appreciation of the home currency). See the note for Figure 2 for more details.

**Figure 4: Responses of trade with Japan of East Asian countries to output shocks from the USA, China, and Japan**

**China**
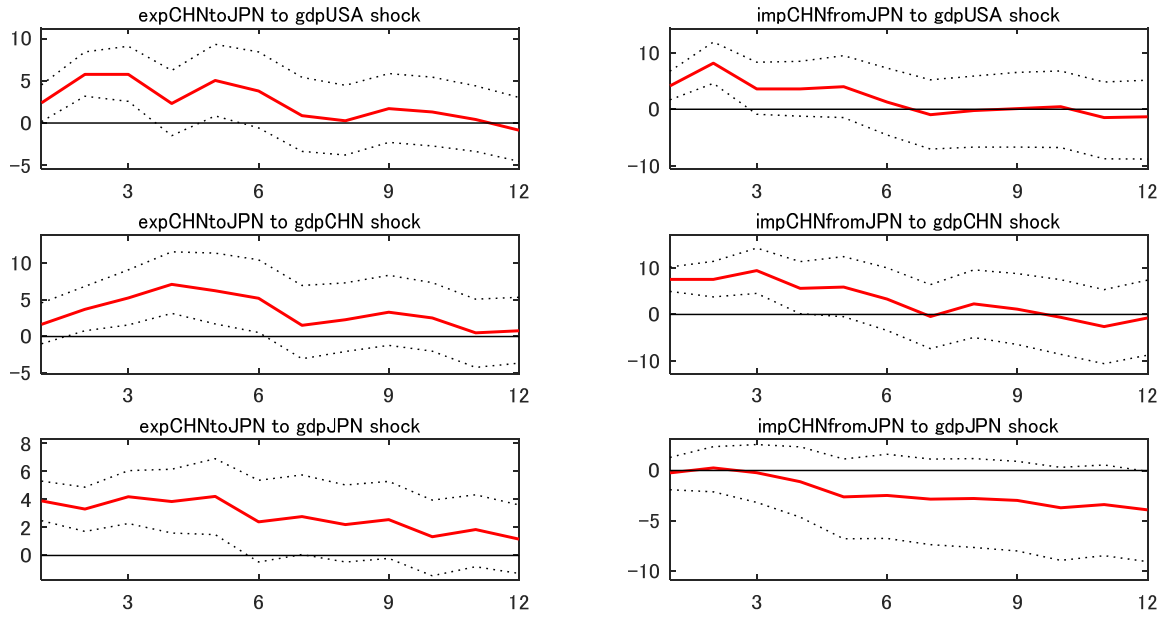


**Hong Kong**

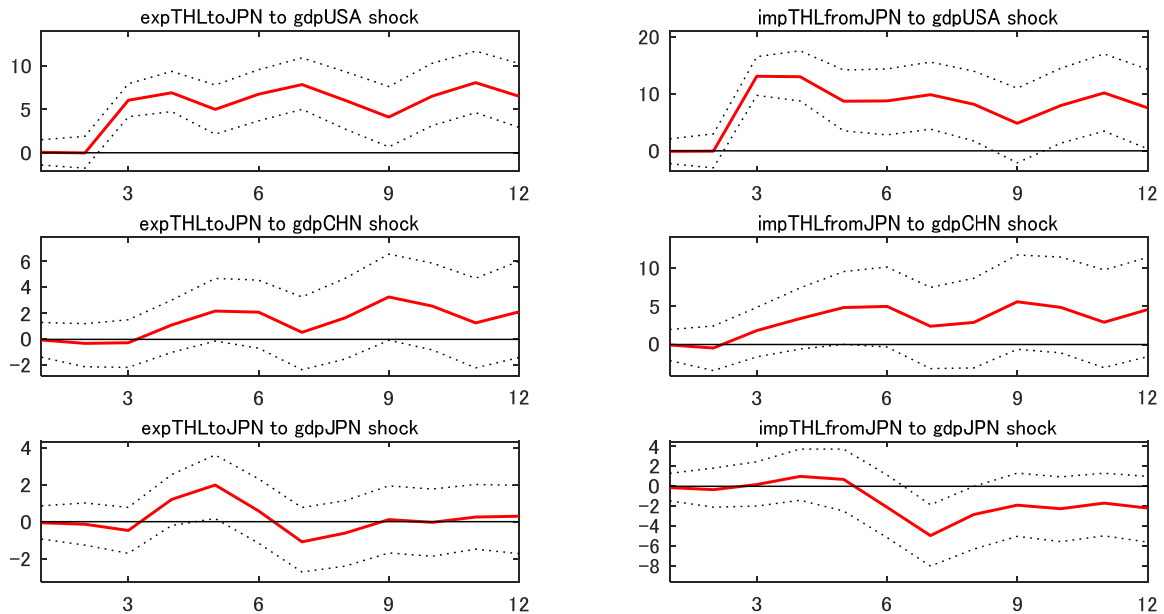**Indonesia**



**Korea**
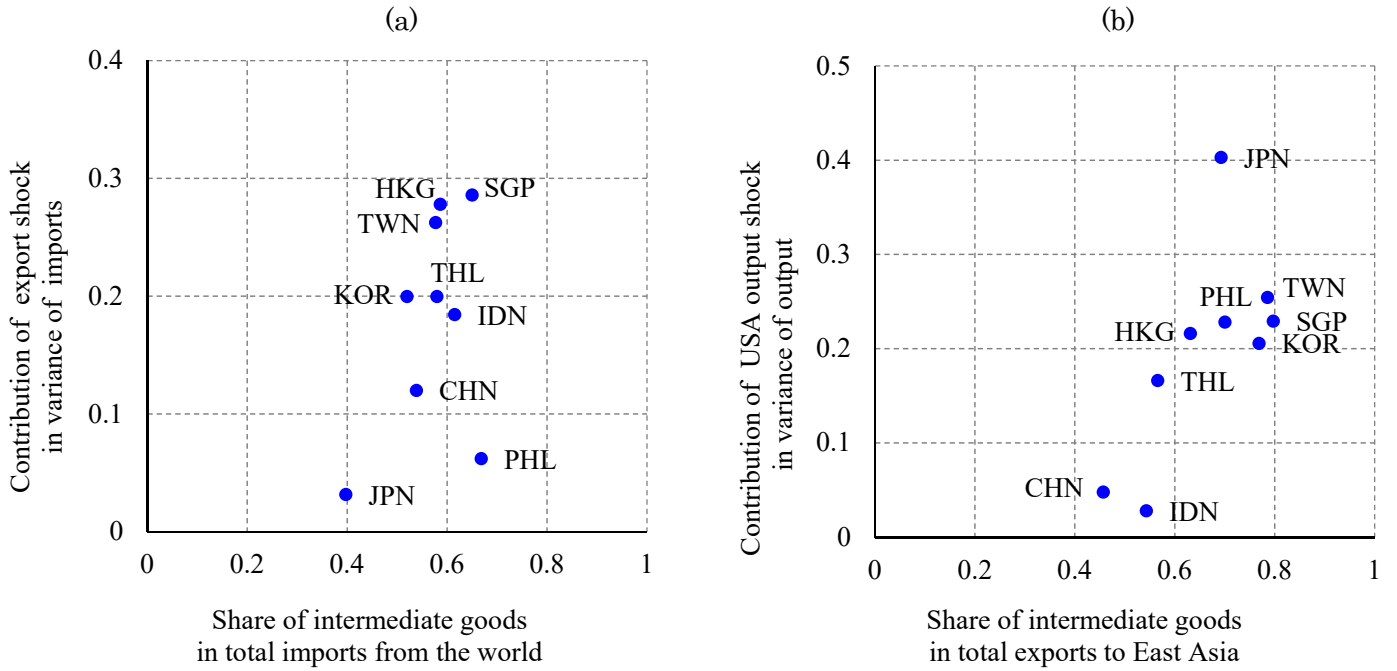


36
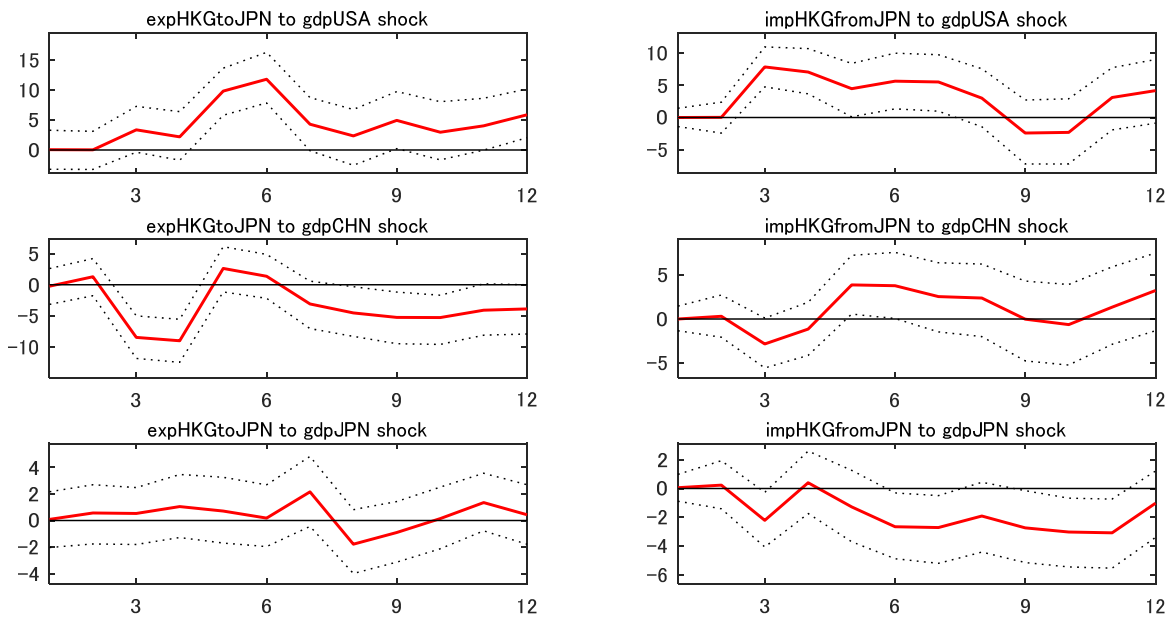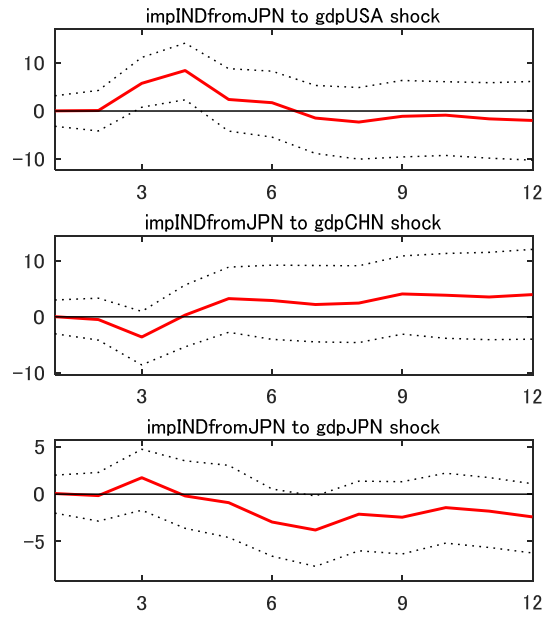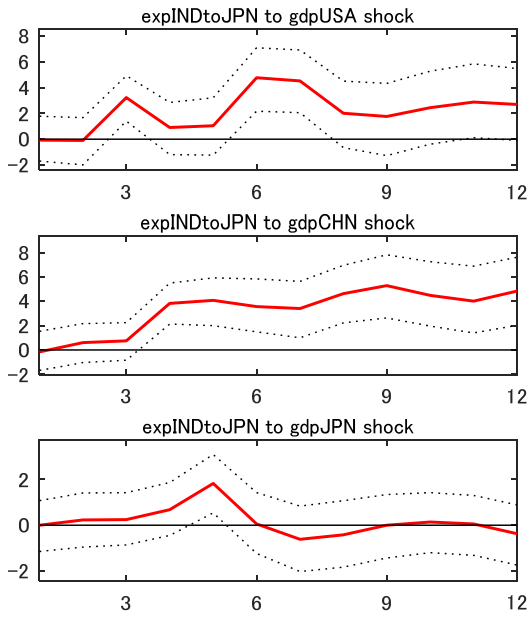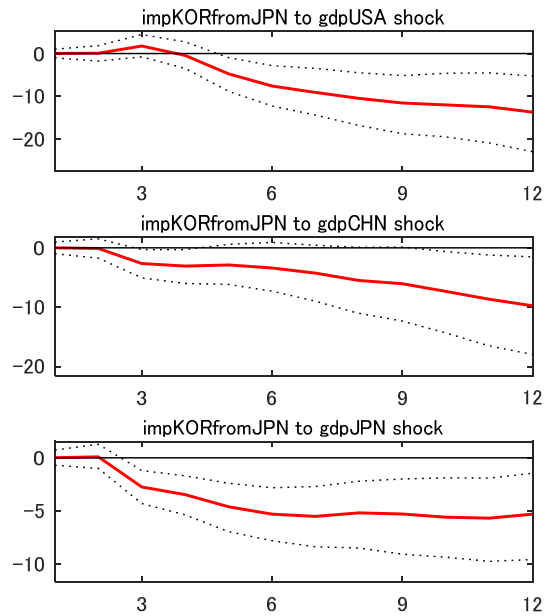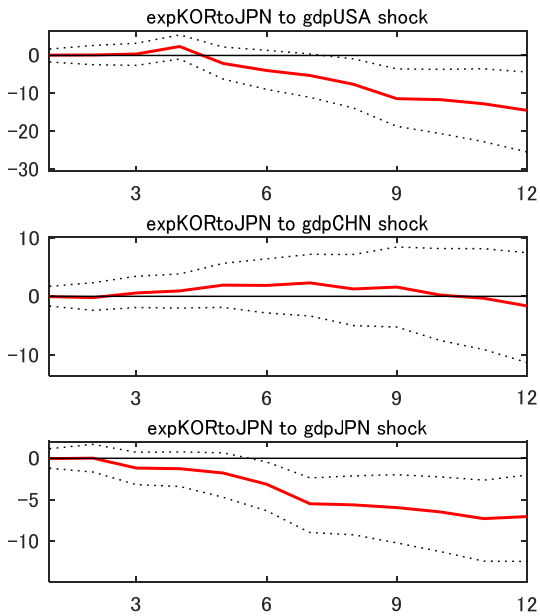
## Philippines
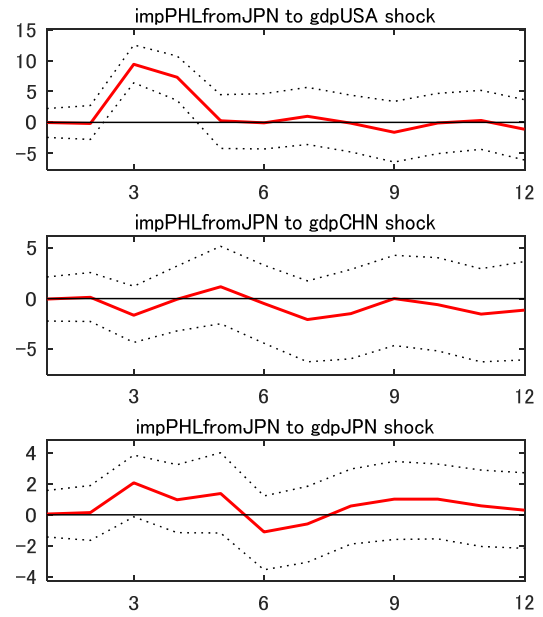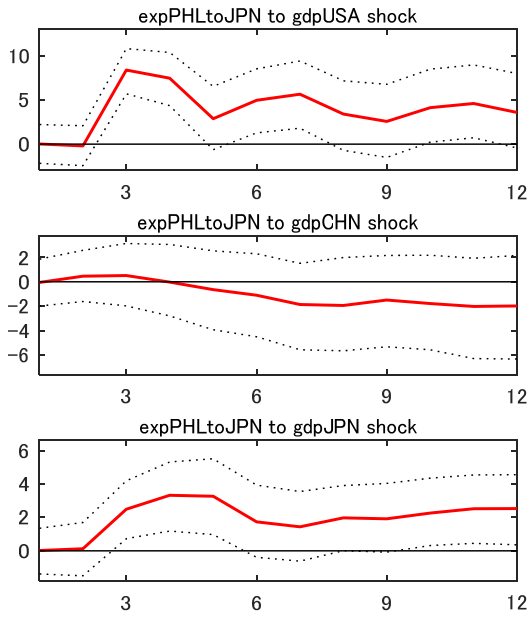


## Singapore
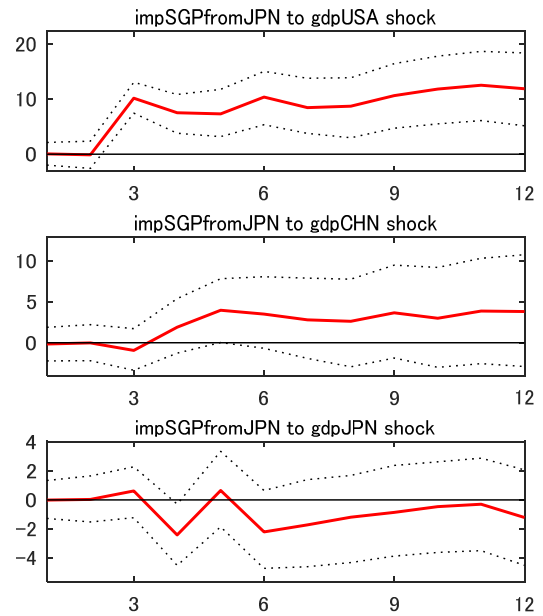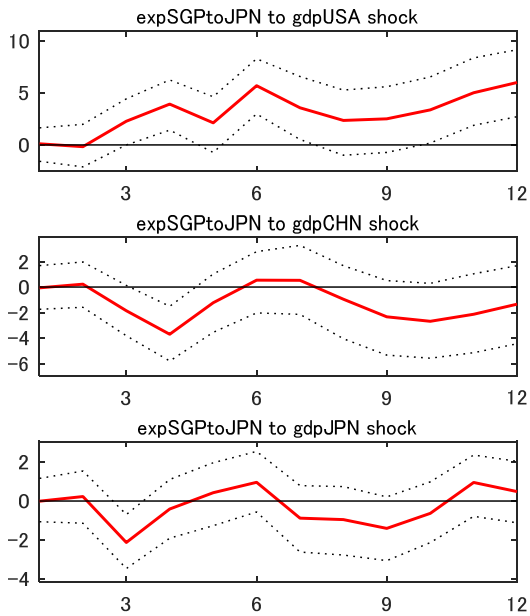
# Taiwan
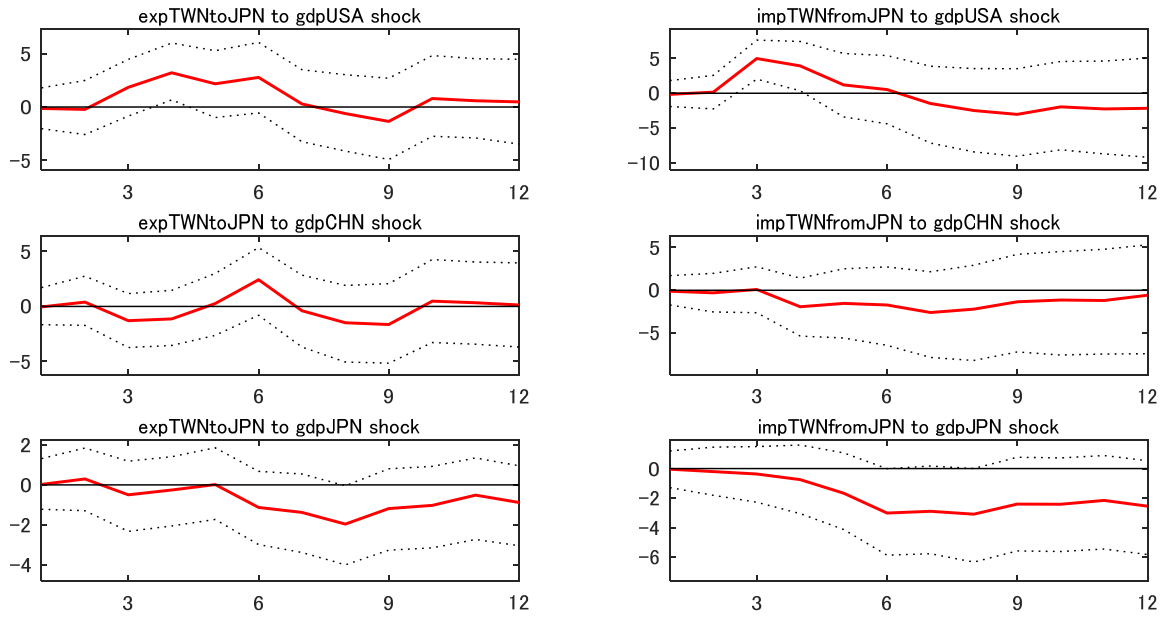


# Thailand



Note: Notation: *expZtoJPN* is real exports of country *Z* to Japan; *impZromJPN* is real imports of country *Z* from Japan. See the note for Figure 2 for more details.

**Figure 5: Relations between the share of intermediate goods in trade and the contribution of shocks in the variance of macroeconomic variables in East Asia**



Source: Data on variance decomposition is from Table 6 with the horizon of 12 quarters. Data on the share of intermediate goods in trade is from Table 5.