Transmission of US Financial and Trade Shocks to Asian Economies: Implications for Spillover of the 2007–2009 US Financial Crisis

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ABSTRACT

This paper describes an investigation of the transmission of US shocks to Asian economies with consideration of financial linkages and trade linkages. Using the sign restriction vector autoregression (VAR) approach during 2000–2012, our empirical results can be summarized as follows. First, both US financial and trade linkages exert a significant impact on production in Asian economies. Second, through both financial and trade linkages, US spillover shocks account for around 50% of the production fluctuation in Asian economies. Third, during the episodes of 2007–2009 US financial crisis, the impact of financial shocks is greater than that of trade shocks. Results suggest that (i) Asian economies are not decoupled with US; (ii) Different from conventional findings, financial linkages between US and Asian economies are strong, especially for highly developed Asian economies. Therefore, investors and policymakers of Asian economies should take account of US financial conditions.

1. Introduction

Although Asian economies[1] have improved their resilience to financial shocks by a great deal since the Asian financial crisis in 1997, the impact of the 2007–2009 (hereinafter designated as "recent") US financial crisis[2] was surprisingly strong. Asian economies in general had more robust foreign exchange reserves and more flexible monetary policies and currency regimes, enabling them to absorb shocks more readily. Nevertheless, the economic consequences of the crisis have been severe. Furthermore, the damage caused by the recent US financial crisis was severe not only for the financial sector, but also for the real sector. For example, according to the National Bureau of Economic Research (NBER), the US recession began in December 2007 and ended in June 2009. It therefore

[1] For these analyses, Asian economies are those of Korea, Taiwan, Malaysia, and Thailand. We intend to emphasize the industrialized countries and not resource-rich countries. Therefore, we exclude Indonesia. In addition, according to classification by the IMF, Korea and Taiwan are *advanced economies*. In addition, we define Malaysia and Thailand as *emerging economies*. Specifically, according to Penn World Table 7.1, GDP per capita of 2010 in Korea and Taiwan were 28,768 US$ and 32,294 US$. Those of Malaysia and Thailand were 13,993 US$ and 9,212 US$.

[2] The collapse of Bear Stearns on March 16, 2008 and that of Lehman Brothers on September 15, 2008 triggered turmoil not only in the US financial market, but also in the global financial market. The bursting of the U.S. housing bubble, which peaked in 2006, had a major role. Especially, values of securities tied to U.S. real estate pricing plummeted, damaging financial institutions globally. See Baily et al. (2008) for further details related to the origins of the recent financial crisis.

persisted for over 18 months. Consequently, domestic absorption in the US decreased suddenly. Then exports around the world also decreased suddenly along with it. The damage was especially severe in economies that are important exporters of investment and durable consumer goods.

Two main known linkages are known through which the crisis might have spilled over: deterioration in financing conditions (financial shock) and reduction in demand for these economies' exports (trade shock). Especially in rapidly growing Asian economies, trade and financial integration with the US are extensive.

Regarding financial linkage, financial contagion literature summarizes transmission channels of several types: the correlated information channel, or the wake-up call hypothesis; the liquidity channel; the cross-market hedging channel; and the wealth effect channel.[3] Some recent and important papers on financial crises are the following. By applying a dynamic conditional-correlation approach, Chiang et al. (2007) demonstrate that contagion in stock markets were an important channel during Asian crisis in 1997 in Asian economies. Furthermore, Yiu et al. (2010) investigate the dynamics of correlation between 11 Asian stock markets and the US stock market and report that contagion occurred from the US to the Asian financial markets. Next, using an asymmetric generalized dynamic conditional correlation model (AG-DCC),

[3] Forbes and Rigobon (2002) and Samarakoon (2011) separate the impact of financial shocks during normal periods, i.e. interdependence, from incremental effects associated with the crisis period, i.e. contagion.

Kenourgios and Padhi (2012) investigate both equity and bond markets of emerging economies and provide evidence of contagion related to the subprime crisis of 2007. In addition, Dimitriou et al. (2013) empirically investigate the global financial crisis and emerging stock market contagion by multivariate Fractionally Integrated Asymmetric Power ARCH (FIAP-ARCH) dynamic conditional correlation (DCC) framework. Similarly, using the same FIAP-ARCH DCC framework, Dimitriou and Kenourgios (2013) investigate the interdependence of US dollar exchange rates expressed in other major currencies. Different from particularly addressing contagion among financial markets as described above, Gimet (2011) specifically examines the impact of recent global financial crisis on real macroeconomic variables. Furthermore, results reveal that financial linkage became less important for transmission of the recent US Financial Crisis to Asian countries using a vector autoregression (VAR) approach with identification methodology based on contemporaneous zero restrictions.

Next, in light of trade linkages, cross-border vertical linkages, i.e. international trade in intermediate goods, play a key role in trade linkage. Recently, using input–output analysis, Levchenko et al. (2010) and Bems et al. (2010) reveal that sectors using intermediate inputs experienced significantly greater reductions in both imports and exports during the recent crisis. In Asian economies, as explained by Pula and Peltonen (2009) using input–output analysis, international production networks and vertical linkages with advanced economies were more developed than in any other region. Therefore, the sudden fall of demand in US final consumption goods produced amplified

spillover effects on Asian economies through different stages of the sequential process. Different from input–output approaches, Abeysinghe and Forbes (2005) investigate trade linkages and output multiplier effects for Asian economies using panel VAR. The model specifically examines two types of cross-country linkages: direct effects via bilateral trade and indirect effects via output multipliers. They infer that the latter is large. Finally, using structural VAR analysis with identification methodology of Cholesky decomposition, Kim et al. (2011) and Kim and Lee (2012) report that the interdependence of Asian economies with the world increased through trade linkage after the Asian financial crisis of 1997.

As described above, previous studies have dealt with financial and trade linkages, but only separately. In addition, opinions are divergent on which linkage is the more important. Furthermore, empirical evidence related to the extent of considering both real and financial shocks in Asia has been scattered and inconclusive. This paper therefore quantifies which transmission linkage had a major role in US spillovers to Asian economies during the recent US financial crisis. This subject is extremely important because it provides rich information for the debate about whether emerging markets have decoupled from advanced economies. Additionally, it suggests policy implications to reduce and to avert further escalation of stress in emerging economies from advanced economies. The appropriate specific measure to contain the spillover of the financial crisis depends on knowledge of the spillover channel. For example, if the trade linkage is relevant, then economies might need to diversify their trade. On the other hand, if the

financial linkage is relevant, economies might need to impose capital controls or prepare a lender of last resort.

Contrary to past studies using correlation and input–output approach, this paper presents development of dynamic measures for financial and real macroeconomic interdependences, based on the impulse responses from VAR model. This approach presents some advantages over a correlation and input–output approach. First, different from a correlation approach, the VAR approach can simultaneously disentangle several structural shocks, such as financial and trade shocks, in the same estimation model. Consequently, VAR can quantify which transmission linkage had a major role in US spillovers to macroeconomic variable of Asian economies. Because we are going to identify several structural shocks, not a correlation approach but a VAR approach is appropriate for our research. Second, a VAR approach can analyze interaction between real and financial variables, which is an interest of this paper. However, because a simple correlation approach is specialized in analyzing contagion among financial variables, it does not provide a precise reflection of financial and trade linkages. Third, different from a static approach such as input–output analysis, our approach can assess the dynamic impact of financial and trade shocks of the US on Asian economies using impulse response analysis. Additionally, we can estimate the relative importance of financial and trade linkage on macroeconomic variables by variance decomposition. Furthermore, we can assess the relative contribution of financial and trade shocks to fluctuations in variables of Asian economies in time series by historical decomposition

analysis.

However, in this paper, sign restriction VAR model reported by Uhlig (2005) is used herein for the Asian economies. This approach necessitates the imposition of only a few sign restrictions on the identified structural shocks. Furthermore, the model presented by Canova (2005) is used herein.[4] It uses sign restriction VAR to investigate the transmission of US shocks to Latin America with consideration of financial and trade linkage. This empirical method presents two important benefits. First, this approach can avoid some problems of identification arising from "traditional" models such as Cholesky decomposition, contemporaneous zero restrictions and long-run restrictions of Blanchard–Quah decomposition.[5] Therefore, the results are not altered by the order of the variables or selection of a different Cholesky decomposition. Second, in our approach, with only minimum restrictions, it is possible to identify several structural shocks that are difficult to formalize in the same model. Therefore, we can compare and assess financial shocks and trade shocks clearly.

The remainder of the paper is organized as follows. Section 2 provides information related to the empirical model that is used in this analysis and the data. Section 3

[4] Also, Fratzscher et al. (2010), Tillmann (2013) and Bracke and Fidora (2012) used sign restriction VAR in the field of international macroeconomics.

[5] The notable identification problems of the "traditional" VAR approach is the "Price Puzzle." The problem is that the reactions of the other variables do not look "as they should." That is to say, after a contractionary monetary policy shock, even with interest rates rising and money supply decreasing, inflation rises than falls.

presents empirical results and discusses the results briefly. Finally, section 4 concludes the paper.

2. Estimation Procedure

2.1 Sign Restriction VAR

Sign restriction VAR requires the imposition of only a few sign restrictions that have an economically meaningful interpretation. Broadly speaking, this methodology includes two steps. The first is to estimate the reduced form VAR. The second step is to draw randomly from the posterior distributions of reduced form VAR coefficients and to keep the draw which satisfies the sign restrictions. The specific procedure is the following.

First, consider a VAR model in reduced form as presented below.

$$y_t = B(L)y_{t-1} + u_t \tag{1}$$

In that equation, y_t is an $n \times 1$ vector of endogenous variables, $B(L)$ is a lag polynomial, and u_t is an $n \times 1$ vector of error terms with variance covariance matrix Σ. A constant is added to this equation, but it is omitted here for clarity of exposition. Having estimated the parameters of this reduced-form VAR, we are interested in the responses of the variables in y_t to various structural shocks. To this end, the vector of prediction errors, u_t, of the reduced-form VAR must be translated into a vector of economically meaningful structural innovations. The fundamental assumption in this context is that

these structural innovations are mutually orthogonal. Consequently, identification amounts to providing sufficient restrictions to solve uniquely for the following decomposition of the $n \times n$ estimated covariance matrix of the VAR given in (1).

$$\Sigma = AA' \tag{2}$$

This equation defines one-to-one mapping from the vector of orthogonal structural shock shocks v_t to the reduced-form residuals $u_t = Av_t$. Because of the orthogonality assumption and the symmetry of Σ, only $n(n-1)/2$ restrictions on A must be imposed. Conventionally, recursive ordering of the variables (Cholesky decomposition), contemporaneous restrictions on the error terms, or decomposition in temporary and permanent components (Blanchard–Quah decomposition) is used.

However, different from a conventional approach, this paper presents an alternative identification approach developed by Uhlig (2005) and by Mountford and Uhlig (2009). The approach imposes sign restrictions on the impulse response functions of a set of variables. Uhlig (2005) shows that, given arbitrary decomposition of A of the matrix Σ, a structural impulse vector a can be represented as $a = Aq$ for some *n*-dimensional vector q of unit length. To identify one structural shock, we first estimate the coefficients of the $B(L)$ matrix using OLS. For a given structural impulse vector a, the impulse responses of n variables up to horizon S are calculable as

$$r_s = [I - B(L)]^{-1} a \,, \tag{3}$$

where r_s denotes the vector of impulse response function at horizon s. Sign restrictions can be imposed on $m \leq n$ variables over the horizon $0,..., S$, which implies that the structural VAR is identifiable by potentially imposing restrictions only on a smaller subset of variables. Identification of the model is then achieved by simulation. The general idea of the simulation can be summarized as follows.

First, for each draw we use a normal-Wishart prior for $(B(L), \Sigma)$ as in Uhlig (2005). Second, we repeatedly draw possible vectors q from a flat prior distribution and compute the corresponding impulse response functions up to horizon s. Third, for each draw, we check whether the sign restrictions imposed for the identification of a particular shock are satisfied. We see this draw as successful and keep it if the restrictions on all variables are satisfied. Otherwise, it is discarded. Finally, after completion of the simulation, the set of successful draws is useful to compute the median impulse response functions and corresponding confidence bands.[6] This empirical methodology is designated as the pure sign restriction approach.

2.2 Data

A four-variable simple VAR model is estimated. The variables are *Industrial Production of US* (Y_US), *Financial Condition Index of US* (FCI), *Import Volume of US* (IMP), and

[6] In our case, we abort the simulation after having accepted a total of 1,000 draws.

the single *Industrial Production of industrial Asian economies* (Y_i) with country index i, which is used to denote Korea (KOR), Taiwan (TWN), Malaysia (MAL), and Thailand (THA).

The reasons for the choice of variables are as follows. The variables are selected to ascertain the impact of the US financial and trade shock on the production of Asian economies. To consider the spillover of US domestic absorption, i.e. trade shocks originating in the US, we include Y_US and IMP. Regrettably, because of limitations in the availability of data, we use IMP instead of exports of single Asian economies to the US. With the worsening economic conditions in the US, lower demand for imports was expected to result. The subsequent pronounced deterioration was noted in the exports of Asian countries to the US. We identified US trade shock from these two variables and calculated its impact on Y_i. This choice of variables is based on reports of studies by Kim et al. (2011) and Kim and Lee (2012), which use aggregate output of world, the Asian region and individual Asian to identified trade linkage. Furthermore, we extend these preceding studies with inclusion of IMP.

To consider the spillover of US financial shocks, we include FCI in the model. The choice of variable is in line with Eickmeier et al. (2011), which uses FCI in the context of a VAR model to identify the international transmission of US financial shocks. Different from narrowly defined financial shock such as credit shocks, stock price shocks, and house price shocks, FCI can be interpreted as reflecting overall financial conditions. The FCI is constructed as a weighted average of numerous variables (105

measures of financial activity) each expressed relative to their sample averages and scaled by their sample standard deviations.. Many financial condition indices exist[7], among which we use *Chicago Fed National Financial Conditions Index*. This index measures risk, liquidity and leverage in money, debt, and equity markets as well as in the traditional and "shadow" banking systems of the US. Consequently, it is useful in monitoring the comprehensive financial stability of the US. Positive values of the FCI denote financial conditions that are tighter than average, whereas negative values denote financial conditions that are looser than average. FCI is constructed as a weighted average of numerous variables (105 measures of financial activity) each expressed relative to their sample averages and scaled by their sample standard deviations.[8] However, to measure financial conditions, "traditional" approaches use corporate bond spreads and stock prices. Because these variables exclusively represent financial conditions of the market, we use FCI of the Chicago Fed, which covers comprehensive financial conditions of the US. Because this single variable includes rich information of the US financial condition, we include FCI in the VAR model to identify the US financial shock.

The variables are monthly data during January 2000 to June 2012. This period

[7] These variables measure the effects of representative financial variables such as interest rates, stock prices, and exchange rates on the real economy. In addition, recent research on FCI includes a variable for credit markets.

[8] For further information, visit the Federal Reserve Bank of Chicago's web site: http://www.chicagofed.org/webpages/publications/nfci/index.cfm.

encompasses a substantial portion of the "Great Moderation[9]" era as well as the latest US financial crisis. However, for Thailand, to exclude the impact of 2011 Thailand floods[10], the sample periods end at June 2011. All data except FCI are taken from Datastream of Thomson Reuters and FCI were referred from the Federal Reserve Bank of Chicago. In estimation, except FCI, we log linearized and seasonally adjusted the variables. Finally, all the data are presented in Figure 1. As the figure shows, it is apparent that FCI suddenly rises and that both the Y_US and IMP suddenly drop after 2008. Then we can infer that the industrial production of Asian economies dropped suddenly because of the US spillover effect.

<< FIGURE 1 >>

2.3 Identifying Assumptions

Two US shocks were identified using sign restrictions and treated as exogenous with

[9] "Great Moderation" refers to reduction in the volatility of business cycle fluctuations such as GDP growth, industrial production, and unemployment, starting in the mid-1980s. Furthermore, this terminology was brought to the wider public by Bernanke in a speech at the 2004 meeting of the Eastern Economic Association.

[10] Many industries have been forced to suspend production in central Thailand because of flooding. In November 2011, industrial production in Thailand dropped suddenly by nearly 45% from the previous year. Furthermore, the damage spilled over to other regions and countries by local and global supply chains.

respect to Asian economies. The first shock, the spillover of the US financial condition to Asian economies, is defined as the finance shock. The second shock, the spillover of the US real shock through trade linkage to Asian economies, is defined as the trade shock. Both structural shocks are adverse and are expected to degrade the production of Asian economies. Our approach necessitates the imposition of only a few sign restrictions that have an economically meaningful interpretation while avoiding some identification problems that are present in more "traditional" structural VAR models.

Table 1 presents the procedure for identification. The signs in the table are the restriction and the blank cells in the table are unrestricted. To identify financial shocks, we assume that if the US financial condition deteriorates, then US production will drop because tightening financial conditions will decrease the demand for investment and consumption. Then, through financial linkages, such as decline of capital flow, withdrawal of lending by international banking, financial market comovement, it can be expected that Asian economic production will decline. Therefore, in our four-variable VAR model, we impose a negative sign to Y_US and positive sign to FCI for an identified financial shock that originated in the US. It is noteworthy that positive values of the FCI denote tighter financial conditions. Here, we imposed no restriction on Y_i or IMP. The emphasis of our analysis is the response of production of Asian economies: Y_i.

<< TABLE 1 >>

However, to identify trade shocks, we assume that if US production drops, then US domestic absorption and US import will decline. Then, we can expect that the production of Asian economies will decline by the decrease of exports to the US. Therefore, we impose a negative sign to both Y_US and IMP to identify trade shocks originating in the US. Here, we imposed no restrictions on Y_i or FCI. The main focus of our analysis is the response of production of Asian economies: Y_i. Based on these restrictions, we will quantify which US transmission shock played the more important role in spillovers to Asian economies.

Estimation of a four-variable VAR model includes the constant term and time trend. The lag length is chosen using the Akaike Information Criterion (AIC). The lag lengths for Korea, Taiwan and Malaysia are four; that for Thailand is three. Furthermore, sign restrictions are imposed for the horizon of K=12 months.

3. Empirical Results and Discussion

3.1 Dynamics of Transmission

Figures 2–5 present the respective responses of Y_i against (adverse) financial and trade shocks from the US. In the columns of the figure, from the left, the financial shock and trade shock are lined up in order. In the rows of the figure, from the top, the responses of Y_US, FCI, IMP, and Y_i are lined up in order. Following the process described by Uhlig (2005), each figure shows the median as well as the 16% and 84% quantiles to denote the significance of our results. In addition, the responses are one standard

deviation in size. Furthermore, the impulse response functions for a horizon are calculated up to 18 months after the shock.

<< FIGURE 2 - 5 >>

The response of Y_i is sought in this study. Therefore, this variable is examined specifically. The responses of Y_i are shown at the bottoms of the figures. For all Asian economies, results show that the responses of Y_i are all significantly negative against (adverse) financial shocks, which indicates that an adverse financial shock was transmitted to Asian economies and that production then deteriorated because of the deterioration of the US' financial condition. Consequently, a financial shock can be regarded as one shock that decreased the production of Asian economies after the recent US financial crisis. This result is consistent with those reported by Canova (2005), which indicate that the US financial shock played a crucial role in transmission to Latin America. Furthermore, in the economically advanced countries of Korea and Taiwan, the financial shock takes 2–3 lag periods to affect production. In contrast, in the emerging economies of Malaysia and Thailand, 5–6 lag periods passed before affecting production. The immediate spillover of the US financial shock to advanced economies implies that financial linkage strengthens along with economic development.

Next, the responses of Y_i against (adverse) trade shock are all shown to be significantly negative. In addition, except Taiwan, the trade shock takes two lag periods

to affect production. Furthermore, for Taiwan, it takes five lag periods to affect production. These results are consistent with the absorption approach of international macroeconomic. Because of the decline of production and imports in the US, Asian exports and economic production declined through trade linkage. Consequently, a trade shock can be regarded as one shock that decreased the production of Asian economies after the recent US financial crisis. In contrast to a financial shocks, this result is not consistent with results reported by Canova (2005), which show that the US trade shock plays a negligible role in the transmission to Latin America.[11]

Therefore, the empirical results presented herein show that these two structural shocks cause the decline of production in four Asian economies. However, the question remains of which structural shocks played an important role in the transmission of recent US financial crisis. The next section presents quantification of the transmission channels' roles in US spillovers to Asian economies.

3.2 Importance of US shocks

The preceding section shows that the two structural shocks described above contributed to the decline of production in Asian economies. However, their relative importance has not been explained. We have yet to ascertain which structural shock played the most important role. Consequently, by conducting variance decomposition analysis, the

[11] Precisely, Canova (2005) identified demand and supply shocks of US and assumed that these shocks spill over to Latin America through trade linkages.

fraction of the forecast error variance of Y_i by financial and trade shock are explained over the entire sample period. Table 2 reports the fraction of the forecast error variance of Y_i explained by financial shock and trade shock. In all Asian economies, and in all horizons, the results show that around 50% of the variation in production of Asian economies is explained by the sum of the two shocks that originated in the US, which indicates that Asian economies are vulnerable to US structural shocks and are not instead decoupling from the US. This result is consistent with those reported by Canova (2005) and Mackowiak (2007), which demonstrated that external shocks are an important source of output fluctuations in small open emerging economies.

<< TABLE 2 >>

Turning now to the relative importance of the structural shocks, a closer examination reveals that the financial shock is slightly stronger than the trade shock in the advanced economies of Korea and Taiwan. For example, at the horizon of four months from Table 2, in Korea (Taiwan), the financial shock and trade shock respectively explained 25.36% (27.85%) and 23.40% (23.08%) of production. In contrast, the trade shock is larger than the financial shock in the emerging economies of Malaysia and Thailand. For example, in Malaysia (Thailand), the financial shock and trade shock respectively explained 18.23% (19.59%) and 25.62% (24.69%) of production.

Viewed from a different perspective, when exclusively examining the impact of

financial shock, at any horizon, the impact of the financial shock in advanced economies is greater than in emerging economies. For example, at the horizons of four months from Table 2, in Korea (Taiwan), the financial shock explained 25.36% (27.85%) of production, but in Malaysia (Thailand), the financial shock explained 18.23% (19.59%). Development and internationalization of financial market improved according to the level of economic development. Therefore, this result implies that the spillover of financial shock becomes greater along with economic development.

How important are financial and trade shocks for the fluctuation of production in Asian economies during episodes of global recessions? It can be expected that the impacts of crisis-related shocks are time-variant and that they depend strongly on financial and economic conditions. Usually, financial conditions are not stable throughout the period. They are expected to deteriorate greatly after the eruption of a crisis. Therefore, assessment of the relative importance among structural shocks and how this evolved over time necessitates the use of historical decomposition analysis.[12] The sudden drop of production in Asian economies after the recent US financial crisis is the target of interest here. Therefore, the historical decomposition is computed. Figures 6–9 respectively present results for Korea, Taiwan, Malaysia, and Thailand.

<< FIGURE 6 - 9 >>

[12] See Doan (2009) for details.

As the figures show, results from historical decomposition for production of Korea, Taiwan, Malaysia and Thailand indicate that during the recent US financial crisis, on one level or another, financial shocks are the most influential shocks; trade shocks play a smaller role. These results demonstrate that, in four Asian economies, the spillover of the US financial shock was greater than the trade shock during the transmission of the recent US financial crisis. In addition, as the figures show, the sum of the financial shock and trade shock explains a substantial amount of the fluctuation of production.[13]

Moreover, in the advanced Asian economies of Korea and Taiwan, a great difference is evident in size between the financial and trade shock. That is to say, a financial shock is far stronger than a trade shock in advanced economies. For instance, Figures 6 and 7 show that, at the peak of the production drop, the financial shock is about 2.43 times larger than the trade shock in Korea (at December 2008), and 2.95 times larger in Taiwan (January 2009). In contrast, in the emerging economies of Malaysia and Thailand, only a small difference exists between the financial shock and trade shock. That is to say, the financial shock is only slightly larger than the trade shock. For example, from Figures 8 and 9, at the peak of the production drop, the financial shock is only about 1.66 times larger in Malaysia (March 2009), and 1.12 times larger in Thailand (January 2009). This result implies that the spillover of the financial shock became greater according to the

[13] Production series of Asian economies (Y_i) are detrended using a Hodrick–Prescott (HP) filter.

level of economic development.

3.3 Interpretation of the results

The spillover of recent US financial crisis to Asian economies is a hotly disputed issue. Especially, no consensus exists in the discussion of transmission of financial shock, specifically whether financial shock from the US has a strong or weak impact on Asian economies. Contrary to this, in the discussion of transmission of trade shock from US, the consensus is unanimity and trade shocks are presumed to have had a substantial impact on Asian economies. Here, we discuss our empirical results with comparison to earlier studies of financial and trade linkage in Asia.

Regarding trade linkage with the US, our empirical result is consistent with those of preceding studies and reconfirms that the US trade shock has a marked impact on Asian economies. In contrast with Asian economies, according to Canova (2005), the spillover of trade shocks from the US to Latin America is not significant. Characteristics of the trade structure of Asia economies might account for the differences of the results with Latin America. Especially, according to Pula and Peltonen (2009), because trade between Asia and the US is dictated by intra-industry processing and assembly through vertically integrated production chains, the regional economies can be highly sensitive to an external shock from US. Although the share of US market in terms of Asian economies total export is on the decline, when considering the share of intermediate goods that are traded for assembly and production, relations between the US and Asia have

strengthened over time.

Next, in the case of financial linkage with the US, arguments of two kinds are put forth. The first argument is that US financial spillover is not great because financial sectors of Asian economies are not highly developed and because the level of internationalization is low. For example, according to Tille (2012), Asian economies are characterized as having limited reliance on international banking. Countries with a greater position in cross-border bank lending suffered from larger contractions in capital flows. Moreover, Asian economies have done a great deal to improve their resilience to financial shocks since the Asian financial crisis in 1997. This time, Asian economies in general have both greater foreign exchange reserves and more flexible monetary policies and currency regimes, which enable them to absorb shocks with less damage to their own respective economies. Therefore, according to Gimet (2011), financial linkage with Asian countries declined and became less important for transmission of the recent US Financial Crisis. The second argument holds that US financial spillover is large. Instead of the international banking network, the financial market co-movement has increased globally in recent years because of greater financial openness since the 1990s. Given the predominant influence of the US financial shock in the Asian financial market, stock markets in Asian economies tend to track closely with changes in the US market. For example, as reported by Chiang et al. (2007), Yiu et al. (2010), and Fujiwara and Takahashi (2012), in the stock and bond markets, the US and Asia have been closely interconnected. Moreover, interdependence in financial markets is a strengthening trend.

According to our empirical results, we can interpret our results as follows. Although the impact of trade shock spillover to Asian economies is considerable, the size of the financial shock is greater than that. Therefore, probably although international banking networks are not strong and that resilience to financial crisis has improved since the Asian financial crisis in 1997, the impact of financial market integration is greater than that.

4. Concluding Remarks

From preceding studies, no consensus arises from the discussion of transmission of financial shock in Asian economies. Especially, using the VAR approach, Gimet (2011) reported that financial linkage is unimportant for transmission of the recent US Financial Crisis. However, because “traditional” VAR approaches such as Cholesky decomposition, contemporaneous zero restrictions, and long-run restrictions of Blanchard–Quah decomposition have identification problems, we use the sign restriction approach of Uhlig (2005) to overcome these problems. According to our empirical results, different from conventional studies, we infer that the financial shock from the US had a significant impact on Asian economies. Furthermore, during episodes of the recent US financial crisis, although the impact of the trade shock spillover to Asian economies was considerable, the size of financial shock spillover was also significant and greater than that. Therefore, our empirical finding from VAR analysis supports the empirical results reported by Chiang et al. (2007) and Yiu et al. (2010) based on use of a correlation

approach.

The economic meaning of our finding is the following. First, Asian economies are highly integrated with US even in the financial sector. Consequently, Asian economies can not avoid the influence of US financial shocks. According to Chiang et al. (2007), Yiu et al. (2010), and Fujiwara and Takahashi (2012), development of international linkages of stock and bond markets in recent years might account for the result. Second, because financial market integration has heretofore increased along with economic development, the US financial spillover becomes greater along with economic development. Therefore, in the advanced Asian economies of Korea and Taiwan, financial shocks exert a far stronger effect than trade shocks do. Third, results of our studies show that investors and entrepreneurs who expect to conduct production and marketing activities in Asian economies should stay abreast of US financial conditions.

Results of our study present important policy implications[14]: Given that the greater share of fluctuation of production in Asian economies is attributable to the US financial shock, Asian policymakers must carefully monitor world financial centers and global financial conditions. Especially, because financial markets involving the US and Asian countries are highly integrated, the US financial shock will immediately spread to Asian financial markets. Therefore, policymakers should predict financial conditions of the US

[14] Based on lessons from Asian financial crisis of 1997 and the recent US and global financial crisis, Fukuda (2009) and Kawai (2010) proposed the financial architecture of a stabilized financial system in Asia.

and establish an early warning system as a useful leading indicator in predicting financial crises. Furthermore, during the crisis, panic among lenders and investors will engender a withdrawal of credit and fire sales, causing credit crunches and bankruptcies. Therefore, to eliminate the fears of investors, reinforcement of financial stabilization treaties such as the Chiang Mai Initiative[15] is needed in addition to global treaties and policy coordination. Examples include the swap lines opened with various emerging economies by the US Federal Reserve and the European Central Bank, the extension of the Chiang Mai Initiative, and the increase in available resources of the IMF and other multilateral institutions.

[15] The Chiang Mai Initiative is a multilateral currency swap arrangement among the 10 members of the Association of Southeast Asian Nations (ASEAN), China (including Hong Kong), Japan, and South Korea. The goal of this agreement is to provide foreign currency, especially US dollars, to participating economies in times of need.

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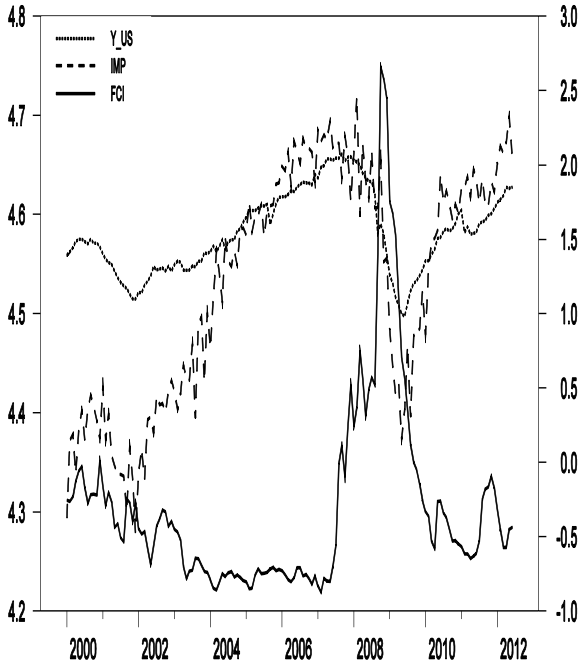
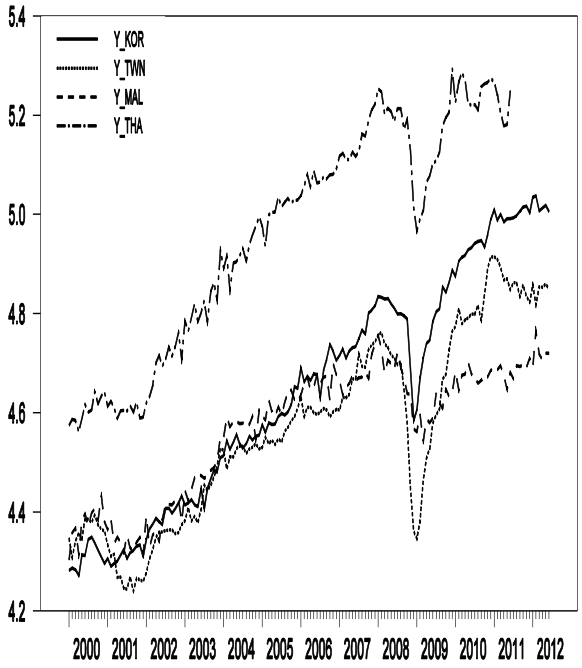
Figure 1: Industrial Production, Import and Financial Condition Index.

US



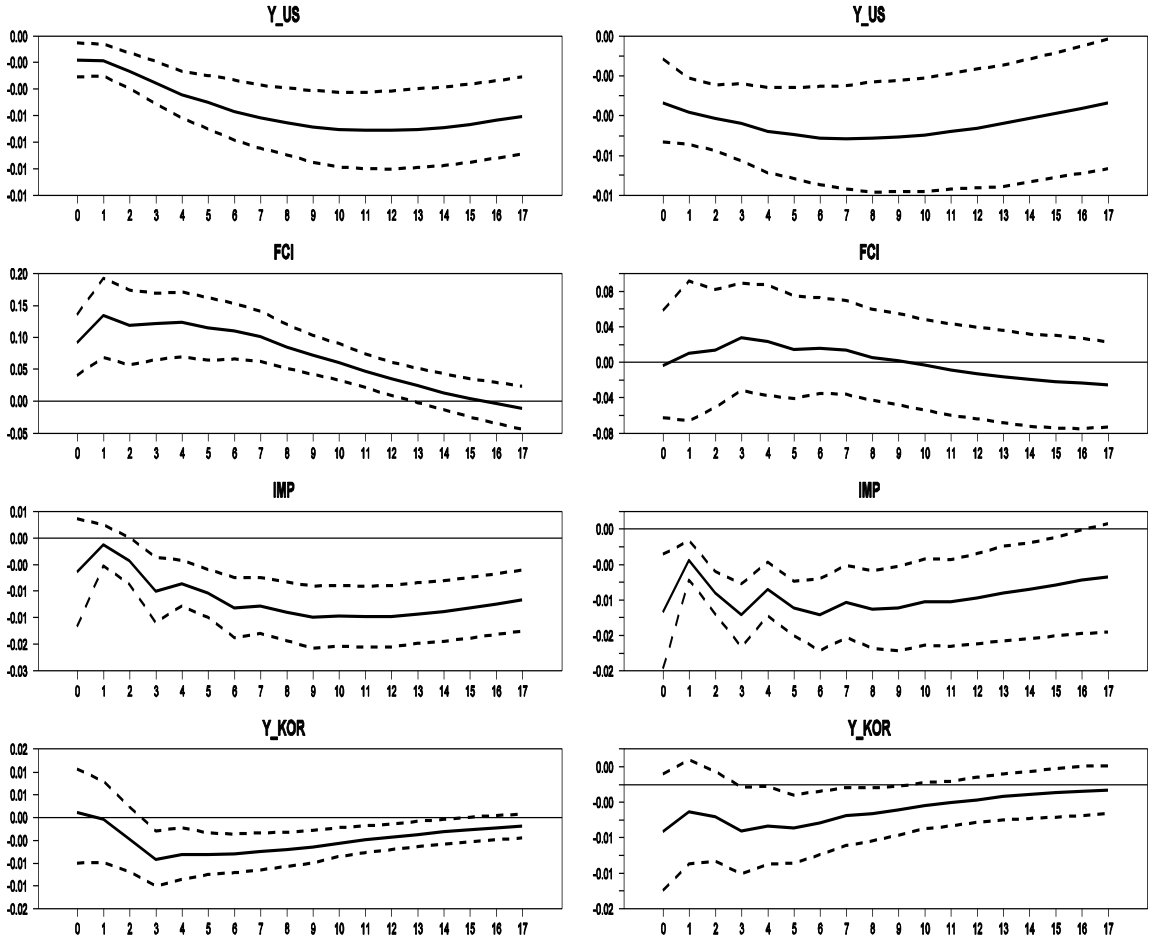
Asia



Note: Y_US, Y_KOR, Y_TWN, Y_MAL, and Y_THA respectively denote the industrial production of the US, Korea, Taiwan, Malaysia, and Thailand. IMP and FCI denote import and financial condition indexes of the US. The axis of FCI is on the right side. Positive values of the FCI denote more stringent financial conditions.

Figure 2: Impulse Response for Korea.

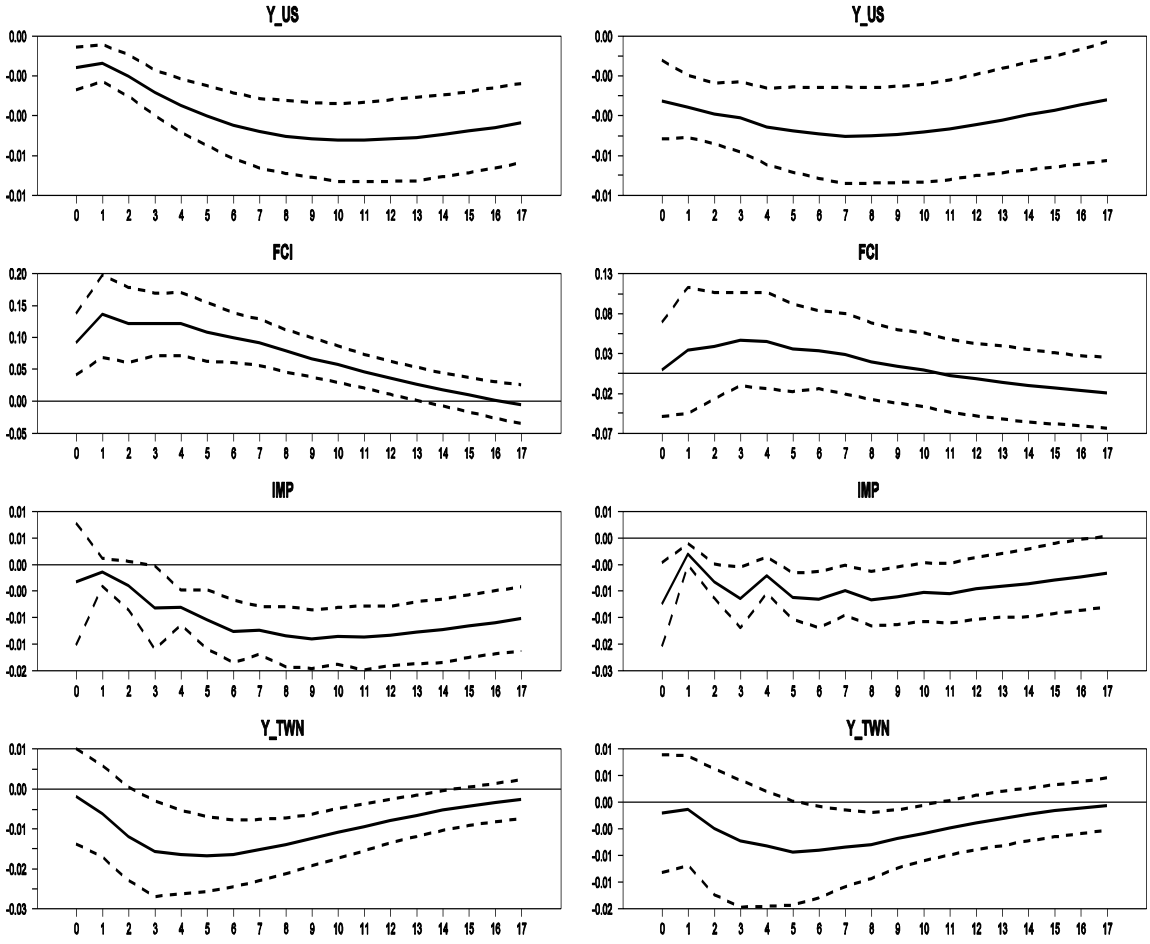
Financial Shock Trade Shock



Note: Impulse response to adverse financial and trade shocks that originated in the US. Each figure shows the median as well as the 16% and 84% quantiles. The impulse response functions for a horizon are calculated up to 18 months after the shock.

Figure 3: Impulse Response for Taiwan.

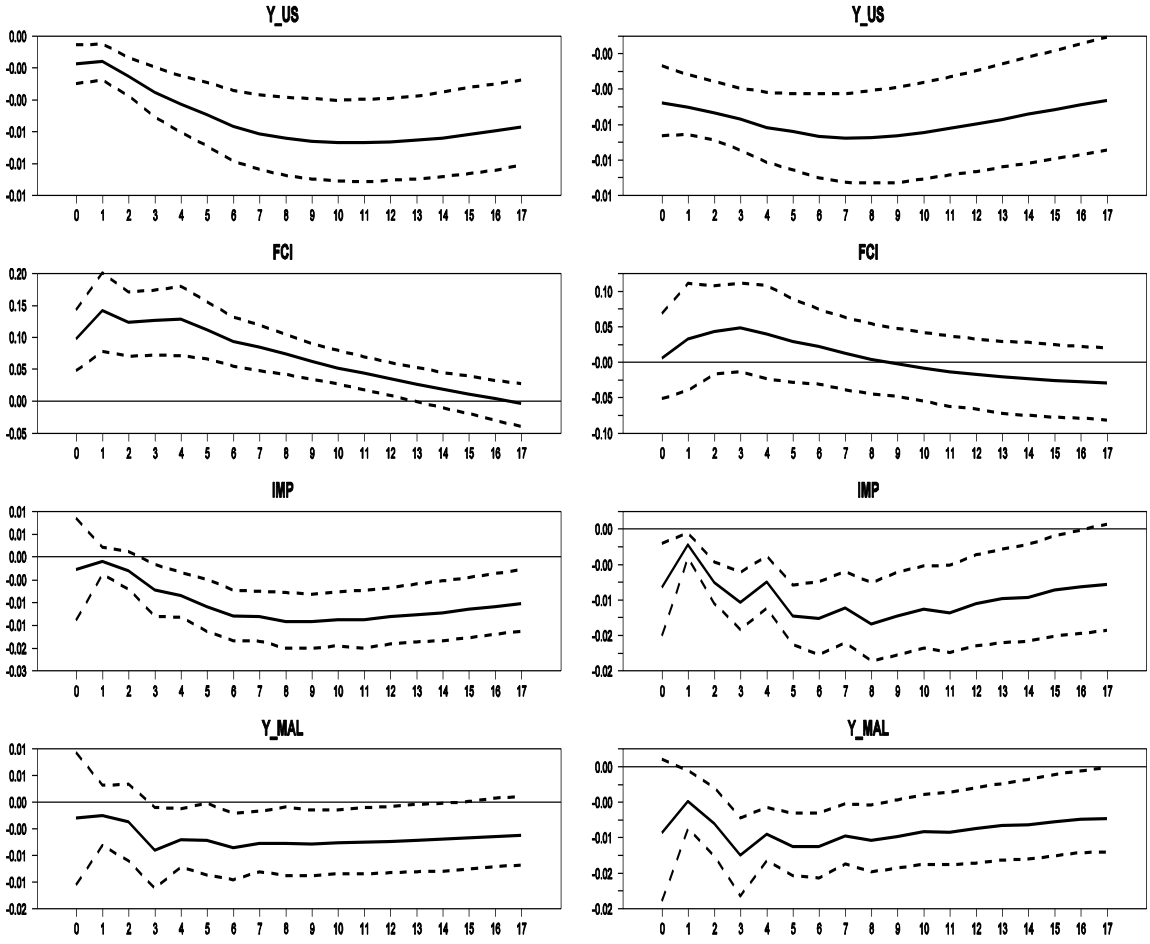
Financial Shock Trade Shock



Note: Impulse response to adverse financial and trade shocks that originated in the US. Each figure shows the median as well as the 16% and 84% quantiles. The impulse response functions for a horizon are calculated up to 18 months after the shock.

Figure 4: Impulse Response for Malaysia.

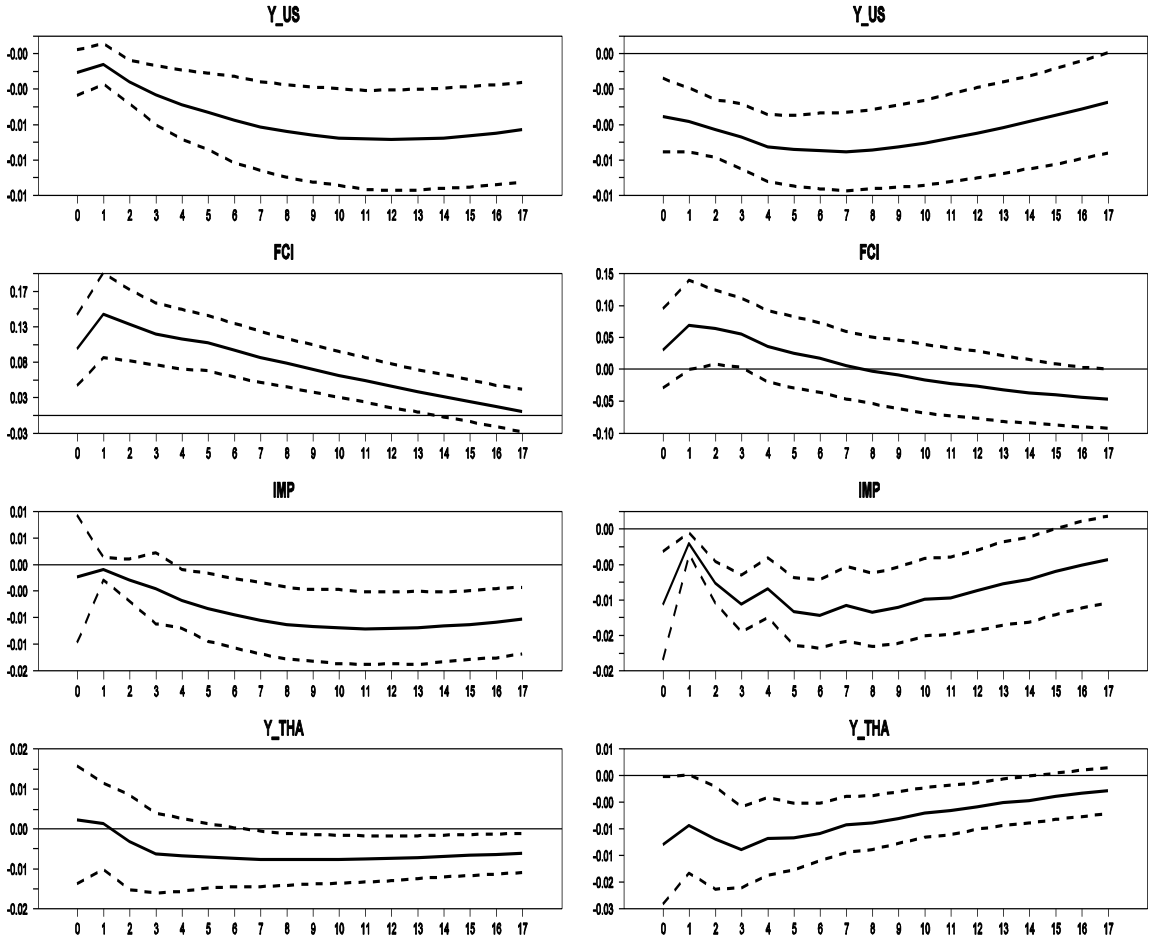
Financial Shock Trade Shock



Note: Impulse response to adverse financial and trade shocks that originated in the US. Each figure shows the median as well as the 16% and 84% quantiles. The impulse response functions for a horizon are calculated up to 18 months after the shock.

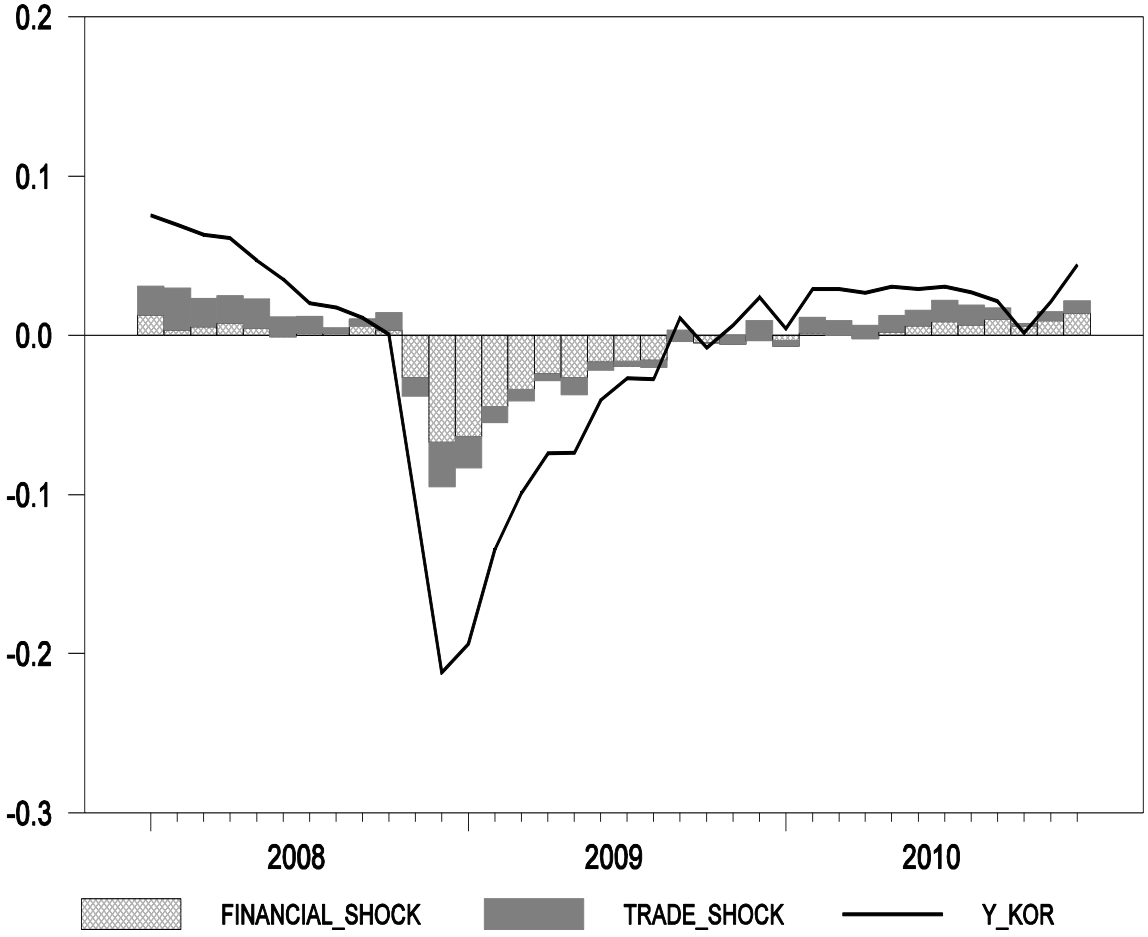
Figure 5: Impulse Response for Thailand.

Financial Shock Trade Shock



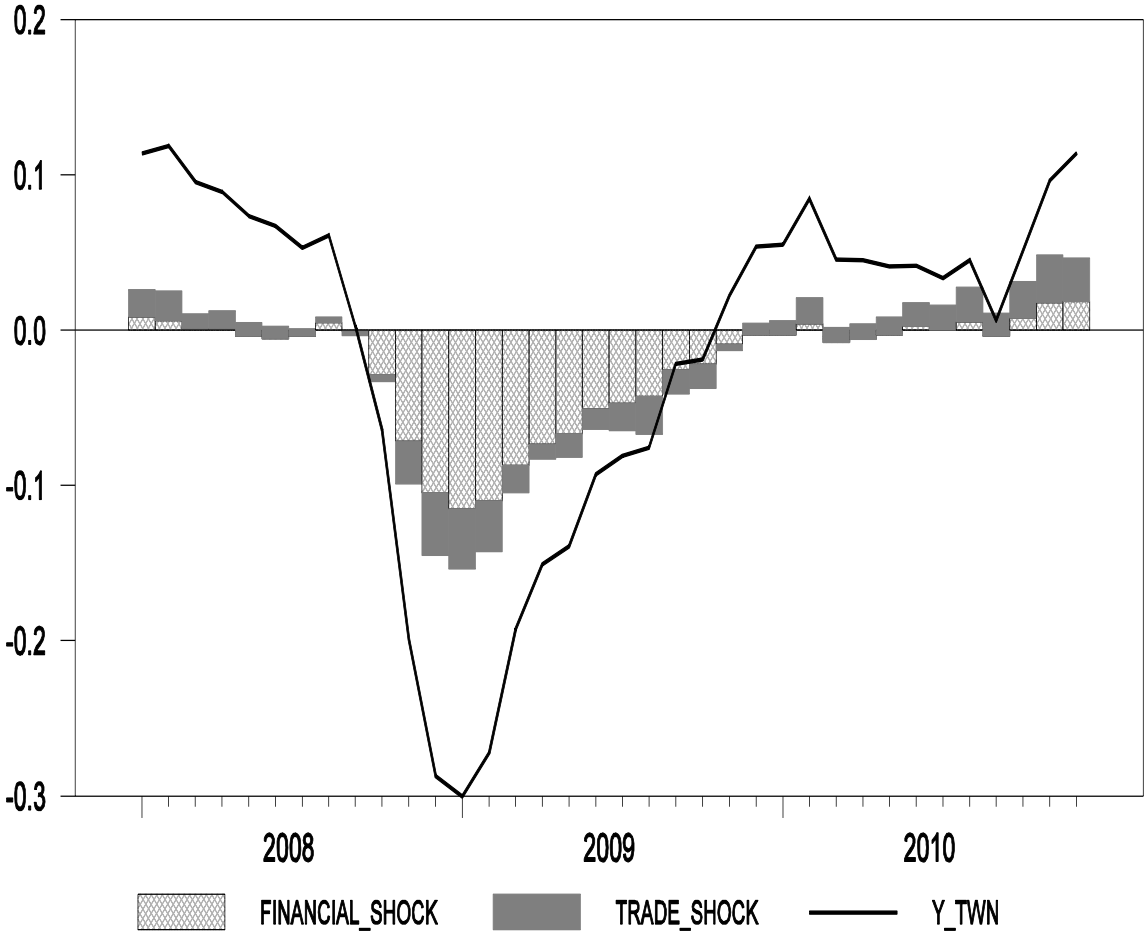
Note: Impulse response to adverse financial and trade shocks that originated in the US. Each figure shows the median as well as the 16% and 84% quantiles. The impulse response functions for a horizon are calculated up to 18 months after the shock.

Figure 6: Historical Decomposition of Industrial Production for Korea.



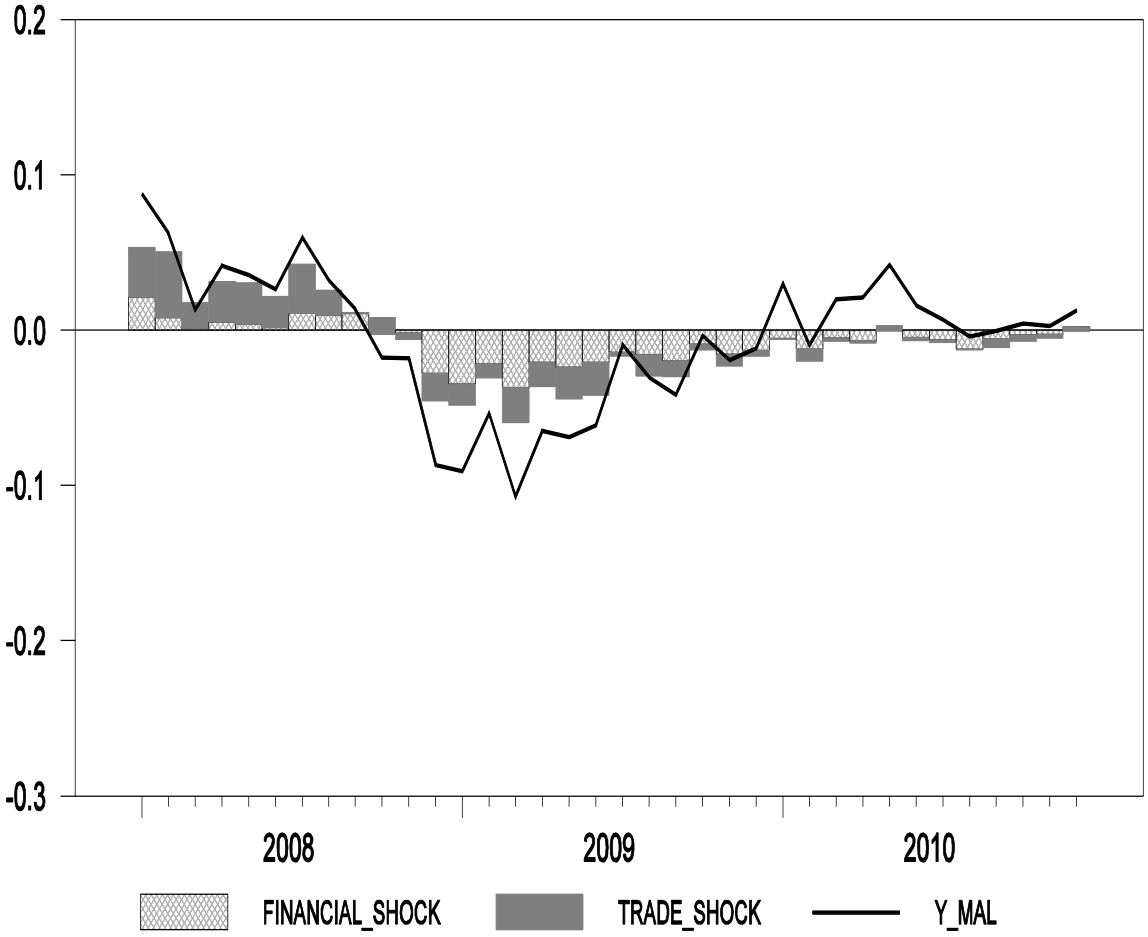
Note: Y_KOR is the industrial production of Korea detrended using a Hodrick–Prescott (HP) filter. The Financial Shock and Trade Shock originated in the US.

Figure 7: Historical Decomposition of Industrial Production for Taiwan.



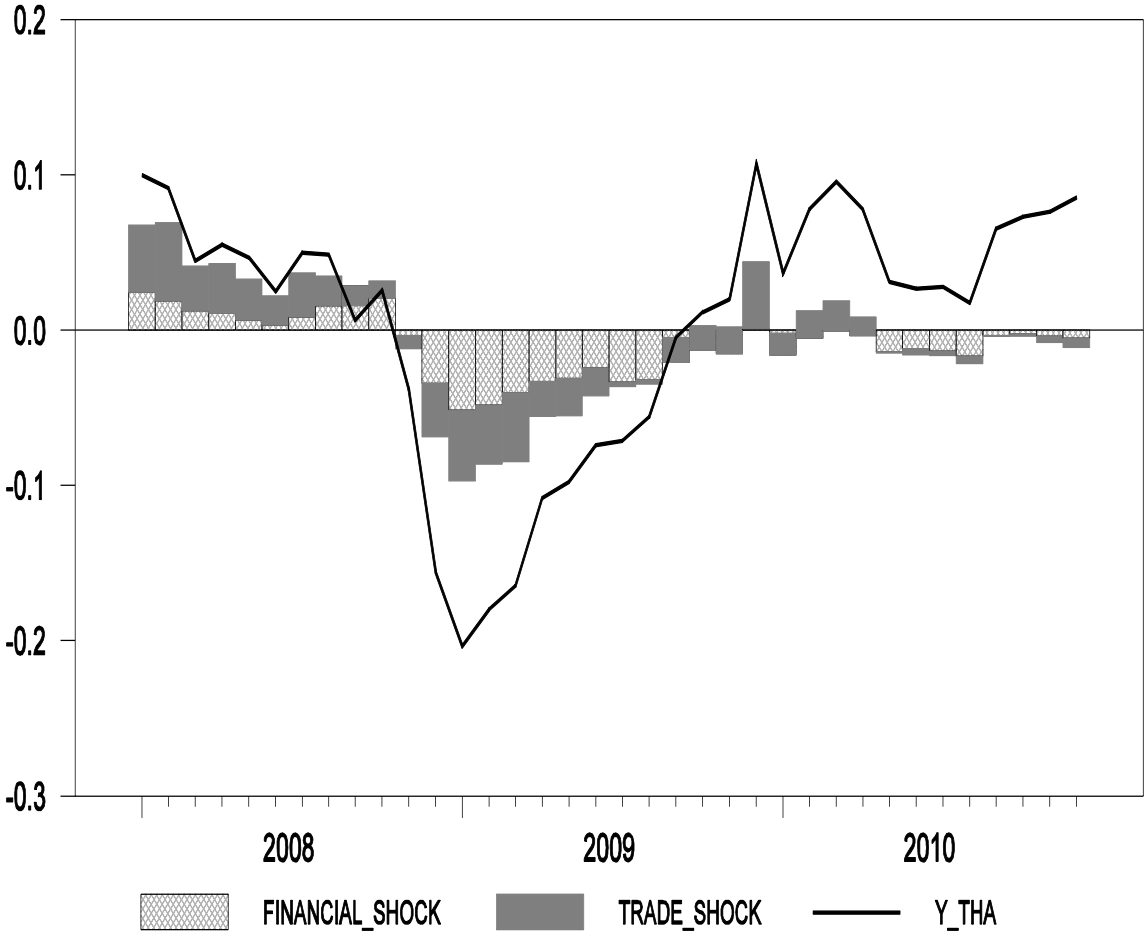
Note: Y_TWN is the industrial production of Taiwan detrended using a Hodrick–Prescott (HP) filter. The Financial Shock and Trade Shock originated in the US.

Figure 8: Historical Decomposition of Industrial Production for Malaysia.



Note: Y_MAL is the industrial production of Malaysia detrended using a Hodrick–Prescott (HP) filter. The Financial Shock and Trade Shock originated in the US.

Figure 9: Historical Decomposition of Industrial Production for Thailand.



Note: Y_THA is the industrial production of Thailand detrended using a Hodrick–Prescott (HP) filter. The Financial Shock and Trade Shock originated in the US.

Table 1: Patterns of Sign Restrictions

	Financial shock	Trade shock
Y_US	negative (12 months)	negative (12 months)
FCI	positive (12 months)	
IMP		negative (12 months)
Y_i		

Note: Numbers in parentheses are the periods of restriction. Y_US, FCI, and IMP, Y_i respectively denote industrial production of the US, the financial condition index, imports of the US, and industrial production of Asian economies with country index i, which denotes Korea (KOR), Taiwan (TWN), Malaysia (MAL), and Thailand (THA).

Table 2: Variance Decomposition for Industrial Production of Asian Economies (%)

	Financial Shock			Trade Shock		
	4 months	8 months	12 months	4 months	8 months	12 months
Korea	25.36	26.37	26.62	23.40	25.78	25.26
Taiwan	27.85	27.00	26.42	23.08	24.05	23.65
Malaysia	18.23	19.59	20.96	25.62	28.76	28.46
Thailand	19.59	21.77	23.27	24.69	26.83	26.71