IV. Role of global production networks in understanding the impacts of the macroeconomic stimulus

By Tereso S. Tullao, Mitzie Irene P. Conchada and John Paolo R. Rivera

Introduction

The economic performance of the Association of Southeast Asian Nations (ASEAN) region has been registering fast economic growth attributable to increases in exports. The increases can be traced from the utilization of global production networks (GPNs), facilitated by forces of liberalization, deregulation, and the impact of information and communication technology (ICT). GPNs are a nexus of interconnected functions and operations in which goods and services are produced, distributed and consumed, and can therefore provide perspectives on patterns of trade and investments (Tullao, Conchada and Aguinaldo, 2005).

The global crisis has resulted in declining exports and tight liquidity due to foreign capital outflow, and ASEAN has not yet decoupled itself from the downturns in the economy of the United States. According to Crispin (2008), as global trade collapses ASEAN will be hit harder, especially the region’s most open economies of Singapore and Malaysia, where merchandise exports represent around 200 per cent and 100 per cent of gross domestic product (GDP), respectively. Likewise, Thailand, Indonesia and the Philippines, whose exports represent a substantial percentage of GDP, could also experience declining growth.

China, with which ASEAN has a trade surplus due to exports of raw materials as well as electronics components and computer parts for re-export to third world nations, might sustain the region’s economies but the situation has faltered with the recent softening in their export figures. Meanwhile, economists say that the stimulus package coming from China has been customized to cushion the domestic economy but that there have been no indications of the region’s sinking economies being lifted (Crispin, 2008).

Credit Suisse’s research has revealed that recent growth of ASEAN exports to China largely comprised intermediate goods intended for final to the United States, Europe and Japan. Credit Suisse investigated how much ASEAN has really decoupled from United States demand, noting that 70 per cent of intra-Asian trade was in intermediate goods and that more than half of China’s total imports were destined for re-export to mainly Western markets. As such, slackening commodity demand, including that in China, will have an adverse impact on several ASEAN economies.

Therefore, it is interesting to study the extent to which the trade-geared economies of ASEAN members will fall into line with the global economy, specifically with the extensive utilization of GPNs by the United States and China. Moreover, is the drop in the United States’ GDP adversely affecting China’s exports to the United States, and imports from ASEAN? Given such key questions, and using GPNs as the focus, the objectives of this chapter are to determine whether the ASEAN manufacturing sector’s exports to China are...
sensitive to China’s exports as well as the United States’ and European Union’s GDPs, while being less sensitive to China’s GDP. The results will have implications for the stimulation of large economies. For example, stimulating China’s economy may or may not be as effective, relative to stimulating the United States economy, in mitigating the impact of an economic crisis in ASEAN.

A. Economic stimulus from developed economies

1. Current account imbalances

Rapid economic growth as well as liberalization measures in trade and investment policies have enabled ASEAN economies to experience expansion in merchandise trade during the past three decades. Consequently, the phenomenal growth of trade in ASEAN has built up trade surpluses with the leading economic blocs of the world. In 1991, East Asia posted a trade surplus with the United States amounting to some US$ 75 billion (table 1). The region’s trade surplus with the United States was primarily derived from China, Japan, the Republic of Korea and Singapore, with Japan and China accounting for US$ 47.67 billion and US$ 14.01 billion, respectively, of the region’s trade surplus with the United States.

Trade expansion in East Asia has continued in recent years and the trade surplus with the United States has grown even further. However, in recent years, in East Asia, China has emerged as the leading trade partner of the United States, accounting in 2006 for 48.5 per cent of total United States imports from the region and 24.8 per cent of United States exports to the region (table 2). Consequently, China has replaced Japan as the East Asian economy with the largest trade surplus (US$ 249.18 billion) with the United States. Japan’s trade surplus with the United States in 2006 was US$ 92.26 billion.

The region’s trade also expanded in the European markets. In 2000, East Asian registered a trade surplus US$ 120 billion with the European Union (table 3). Although Japan had a greater share than China of the European trade in 2000, its trade surplus of US$ 42.96 billion with the European Union was smaller compared with China’s US$ 44.95 billion trade surplus. The Republic of Korea and Singapore also recorded trade surpluses with the European Union.

Table 4 shows that in 2006 China overtook Japan as the leading East Asian trade partner of the European Union. China registered a US$ 164.41 billion trade surplus with the European Union in that year, representing almost 65 per cent of the total trade surplus of East Asia with the European Union. Japan and the Republic of Korea, on the other hand, registered trade surpluses of US$ 40.61 billion and US$ 22.59 billion, respectively in trade surpluses with the European Union. The trade of Singapore with the European Union was almost balanced.
**Table 1. Share of East Asian exports/imports to/from the United States**

<table>
<thead>
<tr>
<th>Country</th>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per cent of exports (US$ billion)</td>
<td>Per cent of imports (US$ billion)</td>
</tr>
<tr>
<td>Japan</td>
<td>55.1</td>
<td>48.7</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>10.2</td>
<td>15.7</td>
</tr>
<tr>
<td>China</td>
<td>11.7</td>
<td>6.4</td>
</tr>
<tr>
<td>Singapore</td>
<td>5.9</td>
<td>8.9</td>
</tr>
<tr>
<td>Total East Asian exports</td>
<td>US$ 173.8 billion</td>
<td>US$ 98.8 billion</td>
</tr>
</tbody>
</table>

Source: United Nations Comtrade Database.

**Table 2. Share of East Asian exports/imports to/from the United States**

<table>
<thead>
<tr>
<th>Country</th>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per cent of exports (US$ billion)</td>
<td>Per cent of imports (US$ billion)</td>
</tr>
<tr>
<td>Japan</td>
<td>24.2</td>
<td>26.8</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>7.6</td>
<td>14.6</td>
</tr>
<tr>
<td>China</td>
<td>48.5</td>
<td>24.8</td>
</tr>
<tr>
<td>Singapore</td>
<td>2.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Total East Asian exports</td>
<td>US$ 627.5 billion</td>
<td>US$ 222.4 billion</td>
</tr>
</tbody>
</table>

Source: United Nations Comtrade Database.

**Table 3. Share of East Asian exports/imports to/from the European Union**

<table>
<thead>
<tr>
<th>Country</th>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per cent of exports (US$ billion)</td>
<td>Per cent of imports (US$ billion)</td>
</tr>
<tr>
<td>Japan</td>
<td>32.8</td>
<td>30.2</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>9.6</td>
<td>11.1</td>
</tr>
<tr>
<td>China</td>
<td>26.6</td>
<td>17.2</td>
</tr>
<tr>
<td>Singapore</td>
<td>6.2</td>
<td>10.5</td>
</tr>
<tr>
<td>Total East Asian exports</td>
<td>US$ 258.6 billion</td>
<td>US$ 138.6 billion</td>
</tr>
</tbody>
</table>

Source: United Nations Comtrade Database.
These statistics show that East Asia has generated a trade surplus of an increasing and significant magnitude, mainly by China, over time and across the two major trading blocs in the world. Aside from the change, it is apparent from the data that these countries have recorded huge trade surpluses that have persisted during several years. Consequently, several economies in the East Asian region have balance of payments (BoP) surpluses (table 5).

### Table 5. Balance of payments (US$ million)

<table>
<thead>
<tr>
<th>Country</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>-1 529.00</td>
<td>-2 804.00</td>
<td>-14 100.00</td>
<td>-2 392.00</td>
<td>125.00</td>
</tr>
<tr>
<td>European Union</td>
<td>-32 802.00</td>
<td>-15 560.00</td>
<td>-22 912.00</td>
<td>2 562.00</td>
<td>5 956.00</td>
</tr>
<tr>
<td>China</td>
<td>116 586.00</td>
<td>206 153.00</td>
<td>207 342.00</td>
<td>246 855.00</td>
<td>461 691.00</td>
</tr>
<tr>
<td>Japan</td>
<td>187 150.00</td>
<td>160 850.00</td>
<td>22 330.00</td>
<td>31 980.00</td>
<td>36 520.00</td>
</tr>
<tr>
<td>Singapore</td>
<td>6 703.28</td>
<td>12 193.00</td>
<td>12 314.70</td>
<td>17 007.50</td>
<td>19 640.10</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>25 791.100</td>
<td>38 675.000</td>
<td>19 864.000</td>
<td>22 090.10</td>
<td>15 109.10</td>
</tr>
<tr>
<td>Malaysia</td>
<td>10 180.600</td>
<td>22 050.000</td>
<td>3 619.610</td>
<td>6 863.78</td>
<td>13 143.70</td>
</tr>
</tbody>
</table>


The trend shown in table 5 is consistent with the temporal and geographical variations in the trade balance of the region. Although Japan registered a higher BoP surplus of US$ 187 billion in 2003, in 2007 its trade surplus of US$ 36 billion was overtaken by China in 2007 with a surplus of US$ 461 billion. During recent years, the United States and the European Union have experienced BoP deficits, although the European Union registered BoP surpluses in 2006 and 2007. The United States also recorded a BoP surplus in 2007. However, compared with the surpluses generated by Malaysia and Singapore, the United States and European Union BoP surpluses were relatively small.

### Table 4. Share of East Asian exports/imports to/from the European Union

<table>
<thead>
<tr>
<th>Selected countries for 2006</th>
<th>Exports</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent of exports</td>
<td>Per cent of imports</td>
</tr>
<tr>
<td>Japan</td>
<td>19.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>10.1</td>
<td>11.3</td>
</tr>
<tr>
<td>China</td>
<td>48.2</td>
<td>31.6</td>
</tr>
<tr>
<td>Singapore</td>
<td>4.8</td>
<td>9.6</td>
</tr>
<tr>
<td>Total East Asian exports</td>
<td>US$ 507.3 billion</td>
<td>US$ 253.5 billion</td>
</tr>
</tbody>
</table>

Source: United Nations Comtrade Database.
2. Adjustments in current account imbalances

(a) Accommodating transactions in the current account

A deficit or net outflow of monetary assets in the current account must be offset by a surplus or a net inflow of monetary and financial assets to achieve balanced national accounts. Similarly, a surplus or net inflow of monetary assets in the current account must be offset by a deficit or net outflow in the BoP. If the current account deficit is not financed wholly by a surplus in the capital account, there will be changes in official transactions.

A country can decrease its international reserves, sell gold or use its special drawing rights allocation at the International Monetary Fund (IMF) in order to lessen the imbalance in its BoP. On the other hand, if the current account surplus is not fully covered by a deficit in the capital account, the country will accumulate more international reserves and gold, or increase its allocation of special drawing rights.

On the other hand, if a country chooses to lessen its reserves, it becomes more vulnerable to contagion effects and attacks on its currency, as was seen in Asian countries during the 1997 Asian financial crisis. China was able to insulate itself from the currency devaluing effects of that crisis largely due to its reserves. During the current global financial crisis, it is more likely hold on to its reserves in case a contagion effect on Asian investments reoccurs.

(b) Changes in the exchange rate

A current account deficit may also be addressed by devaluing the domestic currency. An increase in the domestic currency value of foreign goods will discourage imports and encourage exports, since this action makes the foreign currency price of exports relatively cheaper. Similarly, a current account surplus can be addressed by an appreciation of the domestic currency.

The view that China’s currency is undervalued has led to debates on whether or not it should appreciate its currency with regard to the United States dollar. Rogoff (2007) as well as Kim and Yang (2008) postulated that greater exchange rate flexibility in Asia could help to reduce the imbalances in the BoP accounts of the United States and China. Cooper (2006) cited two arguments for adjusting China’s undervalued currency. First, it will help reduce global imbalances. Second, it will help to avoid overheating of China’s rapidly growing economy. Moreover, greater monetary flexibility in the face of economic shocks can be obtained from a more flexible exchange rate regime (Kim and Yang, 2008).

However, a real appreciation in China’s domestic currency can lead to inflation, since that will trigger economic activity (Kim and Yang, 2008). Apart from this, Kim and Yang (2008) warned that huge adjustments and regulatory mechanisms needed to be put in place if a change from a managed to a more flexible exchange rate regime was to be made, or else the country might experience a crisis due to an unorderly shift in exchange rate policy.

On the other hand, Rogoff (2007) also warned that the effects of autonomous exchange rate adjustments must not to be counted on as the main drivers for bringing
balance to BoP accounts, but that adjustments in savings and investment imbalances
should also be considered. Devereux and Genberg (2007) stated that an appreciation in
China’s currency would even improve the current account balance at low trade elasticity,
and lower the current account balance by only 1.5 per cent of GDP, assuming a high level of
trade elasticity.

(c) Changes in domestic expenditure

A current account deficit implies excessive domestic demand that cannot be met by
domestic production. Thus, there is a need to curb domestic demand including consumption
through higher taxes, investments through higher interest rates, and government
expenditure through reduced fiscal deficit and a budget surplus. On the other hand,
a current account surplus implies that domestic demand is deficient in meeting domestic
production. As such, there is a need to expand domestic consumption through lower taxes,
investments through lower interest rates, and government expenditure through deficit
spending.

A contractionary fiscal policy is an option to cool down overheating economies, since
it also has the effects of contractionary monetary policy without the additional inflow of
capital as well as increased exchange rates (Kim and Yang, 2008). Salvatore (2007)
suggested that the United States deficit might be lessened through a contractionary fiscal
policy, and that the surplus of emerging economies such as China be reduced by fiscal
expansion. Together with a contemporaneous restructuring of other economies, such as
Japan and Europe, that should be able to bring balance to the current accounts of those
economies. Devereux and Genberg (2007) agreed that fiscal policy was an effective
measure in bringing balance to the BoP and, compared to a nominal adjustment in the
exchange rate, it is not so much affected by elasticities in trade between two countries.
However, Salvatore (2007) warned that fiscal policy must be used with caution because
rapid shocks in one country’s expenditure could make other countries slow to adapt, thus
putting them at a disadvantage by reducing their economic growth and making them less
likely to trade with other nations.

With regard to the relationship between the BoPs of the United States and China,
Eichengreen and Park (2006) suggested a contemporaneous adjustment in fiscal policy
between the two countries such that the United States must decrease its spending, in order
to lessen demand, and reduce imports as well as adapt to the slowing down of demand. On
the other hand, China should increase domestic spending in order to create a buffer that
would absorb the lost demand for its products.

3. Decoupling theory

According to Park (2009), Asia cannot decouple itself and cannot experience higher
economic growth compared to the economic slowdown in the global market. Also, studies by
ADB have revealed that the Asian economies still relies heavily on external demand and
global economic conditions. Moreover, Asian economies are highly dependent on exports,
and those involved in regional integration have further strengthened regional ties. Stronger
regional trade and regional investment flows may shield countries from changes in the external environment (Park, 2009).

Furthermore, Park (2009) believed that as long as the situation of China was remained good, Asia would be able to cope with any economic challenge. Asian exports are still very sensitive to changes in United States demand, proof of which can be seen in the existing relationship between the growth rate of Asia’s exports and United States imports (However, this does not include oil imports from the United States.). Park (2009) claimed that in the 1980s, 1990s and 2000s the correlation between the growth rate of United States non-oil imports and emerging Asian exports had improved, especially after the Asian financial crisis when they increased substantially. In the 2000s, the correlation was 82 per cent, implying that when United States imports were lower, Asian exports suffered.

In line with intraregional trade, Park (2009) said that Asia’s exports to other countries in Asia might not be related to United States imports. However, statistics show that Philippine exports to Malaysia and Indonesian exports to China revealed that they are highly related to the changes and fluctuations in United States imports. Such is the case because regional production networks must serve external demands within the region. Park (2009) noted that the United States has subsidiaries in Japan and Europe. Some 90 per cent of the goods produced by the subsidiaries in Japan are sold to Japanese consumers while about 60 per cent of the European subsidiaries output is sold to European consumers. In contrast, United States subsidiaries in East Asia (excluding Japan) sell less than 40 per cent of their goods to the region’s consumers; the remainder is exported. Similarly, the Japanese subsidiaries located in different parts of Europe sell 60 per cent of their products to European consumers. In the United States, 90 per cent of Japanese subsidiaries’ products are sold to United States consumers. On the other hand, Japanese subsidiaries in Asia export more than half of their production.

Park (2009) further noted that China was indeed the hope for intraregional trade that is destined for external markets other than those in Asia. China’s exports to the United States, Japan and Europe are highly correlated with China’s imports from Asia. China imports and ships to bigger countries outside Asia. Thus, more than 60 per cent of Asian exports eventually cater to the demands of the United States, Japan and Europe. Park (2009) concluded that as long as this cycle remained unbroken, Asia would be tied to the economic fortunes of the economies of the United States, Japan and Europe.

B. Global production networks

1. Concept of global production networks

The pattern of trade and investments in the international market is partly characterized by GPNs. Tullao, Conchada and Aguinaldo (2005) noted that GPNs are one of the trends in today’s competitive world. Multinational corporations (MNCs) create production networks in various countries comprising factories and research centres, and other aspects of a business. GPNs have replaced transnational corporations (TNCs) as the most effective form of industrial organization. This change has emerged in response to three
constituent processes of globalization: (a) the ascendancy of liberalization policies; (b) the rapid uptake of ICT; and (c) the onset of global competition. Moreover, the networks combine concentrated dispersion of the value chain across firms and national boundaries with a parallel process of integration of hierarchical layers of network participants (Tullao, Conchada, and Aguinaldo, 2005).

2. Drivers of global production networks

There are three major driving forces that moved industrial organization from TNCs towards global network flagships – liberalization, ICT and competition. These forces led to the emergence of global flagships, and the integration of their dispersed supply, knowledge and customer bases into GPNs (Ernst and Kim, 2002).

First, liberalization or institutional changes, consist of four elements, i.e., trade liberalization, liberalization of capital flows, liberalization of foreign direct investment (FDI) policies, and privatization. These institutional changes have permitted the integration of the domestic markets with the global markets for goods, services and capital through changes in domestic regulations and policies. The impact of liberalization has resulted in a decrease in costs and risks in international transactions by providing a level playing field, the minimization of uncertainties and various choices for market access. Liberalization has made it easier for TNCs to identify locational specialization among competing countries (Tullao, Conchada and Aguinaldo, 2005)

Second, globalization of production has likewise been promoted significantly by the demand and supply impacts of ICT. International production rather than exports is perceived as a primary source of competitive advantage as it enables better linkages in international markets. In effect, ICT reinforces globalization by increasing the demand for it, and by creating new opportunities. Although segments of production are dispersed across countries, ICT provides a network infrastructure that allows for greater coordination among all players in GPNs (Tullao, Conchada and Aguinaldo, 2005)

Last, with liberalization and rapid developments in ICT, competition in the global arena has become complex, fierce and dynamic. Because competition cuts across national boundaries, firms are forced to have some presence in all major markets and must be able to integrate activities across countries to reap the benefits of coordination. Since competition also cuts across sectors and market segments, it has become more difficult to develop as well as nurture niches for a long period. This complexity forces firms to be on guard and always on the lookout for advantages that they can exploit, using liberalization and ICT as the main conduits (Tullao, Conchada and Aguinaldo, 2005)

3. Global production networks and their roles in ASEAN

The ASEAN region has benefited from GPNs. MNCs such as the Ford Motor Corporation perceived the region as a successful GPN. Using the provisions for trade in ASEAN, Ford was able to build complementary products at their facilities in Thailand and the Philippines. They specialize in producing cars in the Philippines and trucks in Thailand. Likewise, Malaysia is harnessing its competitive advantage to make it more attractive for
FDI in terms of minimal costs, good infrastructure, a highly-skilled workforce, a stable socio-political environment and attractive tax incentives. Their industrial zones have attracted numerous firms in electronics, computer peripherals and semiconductors such as Acer, Alcatel, Canon, Fujikura, Hewlett Packard, Intel, Motorola, Sony, among many others (Tullao, Conchada and Aguinaldo, 2005).

In the Philippines, the rapid growth of the telecommunications industry is attributed, to a certain extent, to the domination of call centres. These are networks of national and international connections dealing with customer consultations and logistical support. They usually comprise technical or product support services, customer care or service, bill collection, reservation services, fund raising, surveys, direct mail follow-ups, product testing, customer acquisition and customer activation. Language proficiency, inexpensive labour, cultural characteristics, a mature telecommunication infrastructure and the strong Western orientation of the Filipinos have made the Philippines one of the most popular destinations for call centres in the world (Tullao, Conchada and Aguinaldo, 2005).

It should not be overlooked that GPNs have served as a channel through which knowledge and technology are transferred from the home country to the ASEAN region. This is manifested through a more educated labour force, in terms of acquired skills and work habits, and an enhanced infrastructure in the areas of telecommunications and transportation.

C. Vulnerability to stimulus packages from the United States, European Union and China

1. Vector autoregression

In examining the sensitivity of the ASEAN trade sector to external factors such as the economic performance of the United States, the European Union and China, together with the existence of GPNs, a Vector Autoregression (VAR) model was employed. The model utilizes a dynamic multivariate time series, which is widely used in analyzing the dynamic behaviour of time series variables for forecasting, structural inference and policy analysis (Enders, 2004). VAR resembles a simultaneous or structural equation except that several endogenous variables are considered together. Each endogenous variable is explained by its lagged values of all other endogenous variables in the model (Gujarati, 2003). Thus, the VAR methodology is a-theoretic, in which the data generation of the process determines the model.

2. Data requirements

The data requirements for this study are time series data for the GDP of the United States (USGDP), the European Union (EUGDP), China (PRCGDP), Japan (JAPGDP) and ASEAN (ASEANGDP). The time series data for China’s imports from ASEAN (PRCM) or ASEAN exports to China (ASEANX) are also required. Likewise, the imports of the United States (USM), the European Union (EUM) and Japan (JAPM) are needed. Last, other necessary variables such as inflation (ASEANINF) and nominal exchange rate
(ASEANNEER) for ASEAN are included. Such datasets are sourced from the International Financial Statistics and the ASEAN Secretariat database.

3. Preliminary tests

(a) Phillips-Perron Stationary Test

Before implementing a time series analysis such as VAR, the data must be subjected to unit root testing to verify stationarity. According to Gujarati (2003), stationarity is necessary in order to guard against spurious regressions wherein there would exist a nonsensical relationship when one non-stationary time series endogenous variable is regressed against one or more exogenous non-stationary time series variables.

To determine the unit root of the variables in the system, which is the number of times a non-stationary time series, \( Y_t \), has to be differenced to make it stationary (Gujarati, 2003). A test, the Phillips-Perron (PP) Unit Root Test, can be implemented to determine stationarity.

According to Gujarati (2003), in an \( m \)-variable VAR model, all the \( m \) variables must be jointly stationary. If the \( m \) variables are non-stationary, there is a need to transform the time series data appropriately through differentiation, depending on the order of integration. The results derived from the transformed data might be unsatisfactory (Gujarati, 2003); therefore, the usual approach by VAR adherents is to work in level values even if the series is non-stationary. The regression could be estimated in first-differences, but then any long-term information carried by the levels of the variables is lost (Mulligan, 2003). Thus, this study generates VAR results using level values of the time series.

(b) Johansen Cointegration Test

Co-integration is an econometric property of time series variables wherein if two or more series are non-stationary, but a linear combination of them is stationary, then the series are said to be cointegrated. Co-integration can be determined using the Johansen Cointegration Test (see annex 2). This test is used to establish how many cointegrating vectors the system has, and it includes the “\( \lambda \)-max” test for hypotheses on individual eigenvalues, and the “trace” test for joint hypotheses. Supposing that the eigenvalues \( \lambda_j \) are sorted from largest to smallest, the null hypothesis for the “\( \lambda \)-max” test on the \( i \)th eigenvalue is that \( \lambda_i = 0 \). The corresponding trace test, instead, considers the hypothesis \( \lambda_j = 0 \) for all \( j \geq i \). Such a test was implemented to determine whether there is long-term co-movement among all the variables of interest in the VAR (\( p \)) model.

If both trace and \( \lambda \)-max tests rejected the null hypothesis that the smallest eigenvalue is 0, it can be concluded that the series is, in fact, stationary (Enders, 2004). The rejection of the hypothesis denotes the number of cointegrating equations. If there is cointegration, OLS estimates of the structural relationships have the property of consistency (Mulligan, 2003).
(c) Model specification

The VAR ($p$) model to be estimated will determine the susceptibility of ASEAN to shocks from its major trading partners such as the United States, the European Union, Japan and China. The specific VAR ($p$) models of interest are shown by equations 1 to 3. Note that the optimal lag structure $p$ of the VAR model is determined by the lowest Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) (Gujarati, 2003).

$$PRCXT = F (USGDPT, EUGDPT, PRCGDPT, JAPGDPT, ASEANGDPT, USM, EU, JAPM, ASEANX, ASEANINF, ASEANNEER)$$ (1)

$$ASEANX \_T = F (USGDPT, EUGDPT, PRCGDPT, JAPGDPT, ASEANGDPT, PRCX, ASEANINF, ASEANNEER)$$ (2)

$$ASEANGDPT \_T = F (USGDPT, EUGDPT, PRCGDPT, JAPGDPT, ASEANXT, ASEANINF, ASEANNEER)$$ (3)

Based on equations above, the variance decompositions and impulse response functions can be generated, which will serve as bases for inferences. Variance decompositions partition the variations in a variable of interest to shocks in other variables in the system including its own innovations (Gujarati, 2003). It provides measures of relative importance of various shocks in explaining the concerned variable. Meanwhile, impulse-response functions trace the response of variables in the system to shocks in other variables and capture the direction, magnitude and persistence of this response (Enders, 2004).

In line with existing studies, a Reduced Form VAR was implemented to examine the extent to which the trade-geared economies of ASEAN members will fall into line with the global economy and specifically with the extensive utilization of GPNs by the United States and China. VAR expresses the current value of each $m$ series as a weighted average of the past of all series plus a disturbance term, $\varepsilon_t$, that represents all factors that affect the series but is not taken account explicitly. To begin, a VAR model is specified by equation 4:

$$Y_t = A^0_0 + \sum_{k=1}^{p} A_k Y_{t-k} + \varepsilon_t$$ (4)

where $Y_t$ is a vector of $n$ variables specified earlier, $A^0_0$ is an $n \times 1$ vector of constant terms, $A_k$ is an $n \times n$ matrix of coefficients, $\varepsilon_t$ is an $n \times 1$ vector of stochastic error terms\(^1\) and $p$ is the order of autoregression. However, there is uncertainty about $\varepsilon_t$ because the past observations of $Y_t$ are unknown and it will have to be estimated from the available data. Such uncertainty is lessened by assuming that $\varepsilon_t$ is a random vector having a zero mean, the error covariance matrix $S$ is positive definite and $\varepsilon_t$ is uncorrelated with past observations of $Y_t$. Thus, the lag order of the VAR ($p$) is set such that the error terms are serially uncorrelated.

\(^1\) In VAR, the vector of stochastic error terms is also called impulses, innovations or shocks (Gujarati, 2003).
The interpretation of the VAR \((p)\) shown by equation 4 is normally based on its moving average representation. By successive substitution, equation 4 has a moving average representation shown by equation 5:

\[
Y_t = B_0 + \sum_{k=1}^{q} B_k \varepsilon_{t-k} + \varepsilon_t
\]  

(5)

where \(Y_t\) is a vector of \(n\) variables to be specified later, \(B_0\) is an \(n \times 1\) vector of constant terms, \(B_k\) is an \(n \times n\) matrix of coefficients, \(\varepsilon_t\) is an \(n \times 1\) vector of error terms and \(q\) is the moving average order. The lag order of the VAR \((q)\) is set such that the stochastic disturbance terms are non-autocorrelated.

(d) Variance decomposition and impulse response analysis

Given the above-mentioned backdrop on VAR, \(Y_t\) is expressed as a linear combination of contemporaneous and previous innovations. Based on equation 5, the variance decompositions and impulse response functions can be generated that will serve as bases for statistical inferences. Variance decompositions partition the variation in a variable of interest to shocks in other variables in the system including its own innovations (Gujarati, 2003). Thus, they provide natural measures of relative importance of various shocks in explaining the concerned variable (Enders, 2004). Meanwhile, the impulse-response functions trace the responses of the variables in the system to one standard deviation shocks in other variables (Gujarati, 2003). They capture the directions, magnitudes and persistence of a variable’s responses to impulses in the system (Enders, 2004).

One important aspect that needs to be pointed out, which pertains to the generation of variance decompositions and impulse-response functions, is that innovations in equation 5 may be contemporaneously correlated. This means that a shock in one variable may work through the contemporaneous correlation with innovations in other variables. Since isolated shocks to individual variables cannot be identified due to contemporaneous correlation, the responses of a variable to innovations in another variable of interest cannot be adequately represented (Enders, 2004). To solve this identification problem, an empirical strategy that orthogonalizes the innovations using the Cholesky factorization can be used (Enders, 2004).

The results of the variance decomposition in equation 1 are shown in figure 1. It plots the variations, shown in figure 1 in \(PRCX\) accounted by innovations coming from the other variables of interest. The variations are plotted together with two standard deviation bands. Generally stated, if the bands do not encompass zero, then the variations are significantly different from zero. Notice that \(PRCX, PRCGDP,\) and \(USGD\) cause significant variations in \(PRCX\) reaching up to approximately 30 per cent. Comparatively, the disturbances coming from \(JAPGD, ASEANGDP, USM, EUM, JAPM,\) and \(ASEAN\) are relatively the same. Domestic variations coming from \(ASEANINF\) and \(ASEANNEER\) have a relatively small impact on \(PRCX\), explaining only approximately 1 per cent of the variation. Note that the influences of the economic performance of China’s major trading partner, the United States, bring about variations in China’s exports during the period studied. Indeed, it
shows that China's trade performance is not decoupled from the United States. Such a finding is consistent with the findings of Park (2009).

The results of the impulse-response function (figure 2) show that the shocks in PRCX are mainly generated by PRCX itself and the GDPs of the United States, the European Union, Japan and ASEAN but during initial periods only. This supports the initial results that the economic performances of China's major trading partners appear to be the major source of their export fluctuations. Note that the response of PRCX to one standard deviation shock in domestic variables such as ASEANINF and ASEANNEER are insignificant. Therefore, given the variance decomposition results, the effect of USGDP, EUGDP, JAPGDP and ASEANGDP are relatively more important. Such results imply that the economies are highly coupled. Likewise, this reinforces the findings of Park (2009).
The results of the variance decomposition in equation 2 are shown in figure 3. Note that ASEANX and USGDP also cause significant variations in ASEANX up to 30 per cent. Likewise, the disturbances from PRCGDP, JAPGDP, ASEANGDP, USM, EUM, JAPM, and PRCX are similar. Domestic innovations from ASEANNEER and ASEANINF have a minimal contribution to variations in ASEANX. Indeed, the demand for ASEAN’s products by China and then by the United States is significant. The United States stimulates China’s demand for ASEAN’s raw materials due to the former country’s increased demand for finished goods. Thus, the economies of ASEAN, China and the United States are highly coupled. Again, it reinforces the initial results presented here as well as the findings of Park (2009).
The results of the impulse response function (figure 4) show that the shocks in PRCX are mainly generated by PRCX itself and the GDPs of the United States, the European Union, Japan and ASEAN but during initial periods only, confirming that the economic performance of China’s major trading partners is the major source of their export fluctuations. Note that the response of PRCX to shocks in domestic variables such as ASEANINF and ASEANNEER are insignificant. Thus, the effect of USGDP, EUGDP, JAPGDP and ASEANGDP are relatively more important.

The results of the variance decomposition in equation 3 are shown in figure 5. Note that ASEANGDP, PRCGDP and JAPGDP cause significant variations in ASEANGDP up to 50 per cent. The disturbances from the other variables are similar. Domestic innovations in ASEANNEER and ASEANINF make a minimal contribution to variations in ASEANX. Indeed, the demand for ASEAN’s products by China and Japan is significant in stimulating the ASEAN economy. Likewise, the economies of ASEAN, China and Japan are highly coupled.
The results of the impulse response function (figure 6) show that the shocks in ASEANGDP are mainly generated by ASEANGDP, PRCGDP and JAPGDP. Note that the response of PRCX to shocks in domestic variables such as ASEANINF and ASEANNEER are insignificant. Thus, the effect of USGDP, EUGDP, JAPGDP and ASEANGDP are relatively more important.

Therefore, across all equations estimated together with accompanying variance decomposition and impulse-response functions, it can be seen that the economic performance of the United States affects economic growth in the ASEAN region as well as China’s trading activities. Likewise, China’s performance, when it comes to international trade with its major trading partners, affects the economy of ASEAN. Such results are consistent with the findings of Park (2009), wherein China has a vital role in intraregional trade that is destined for external markets other than those of Asia. Indeed, China’s exports to United States, Japan, and Europe are indeed correlated with China’s imports from ASEAN. Most importantly, the results demonstrated that the ASEAN region is indeed tied to the economic performance of developed countries, especially the United States.
Figure 5. Variance decomposition for equation 3

Variance Decomposition ± 2 S.E.

Per cent ASEANGDP variance due to ASEANGDP

Per cent ASEANGDP variance due to USGDP

Per cent ASEANGDP variance due to EUGDP

Per cent ASEANGDP variance due to ASEANX

Per cent ASEANGDP variance due to JAPGDP

Per cent ASEANGDP variance due to PRCGDP

Per cent ASEANGDP variance due to ASEANINF

Per cent ASEANGDP variance due to ASEANNEER

Figure 6. Impulse response for equation 3

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of ASEANGDP to ASEANGDP

Response of ASEANGDP to USGDP

Response of ASEANGDP to EUGDP

Response of ASEANGDP to PRCGDP

Response of ASEANGDP to JAPGDP

Response of ASEANGDP to ASEANX

Response of ASEANGDP to ASEANINF

Response of ASEANGDP to ASEANNEER
D. Conclusion and policy implications

ASEAN plays a vital role in global trade, particularly manufactured goods such as electronics, due to its increasing trade volume in and out of the region. This has resulted in the utilization of GPN wherein raw materials and work-in-progress goods are sourced from ASEAN’s developing economies. In turn, those countries export the semi-finished goods to China for production of final goods both for domestic consumption and for export to the rest of the world. Thus, it is the huge world demand, especially the developed countries, that fuels trade between China, ASEAN and the rest of the world. This suggests that countries are interdependent and that no single economy can decouple from the rest of the world in terms of economic performance. For example, a drop in China’s exports to the rest of the world will have negative consequences for the ASEAN economies that supply the necessary raw materials required by China to produce for exports to the rest of the world.

Using VAR to investigate the impacts of trade between China and ASEAN reveals that the economies of China and ASEAN are interdependent in trade. Results show that the economic growth experienced by ASEAN has brought about positive effects for China’s export sector, since ASEAN is the major supplier of raw materials and a major destination for China’s exports. Moreover, the shocks from China to ASEAN come through ASEAN exports, which will eventually affect ASEAN’s GDP. Also, the impact of China’s GDP on ASEAN exports has occurred with several lags, implying that the shocks have delayed effects distributed across time.

Also, variations in ASEAN’s exports and GDP in one period are dominated by variations of ASEAN’s exports and GDP in previous periods. Internal variation exists because ASEAN is a large economy. Likewise, disturbances from China that have had an impact on ASEAN exports will continue in the more recent variations in ASEAN exports. Also, despite the linkages of ASEAN with China, the United States and the rest of the world, ASEAN is susceptible to internal disturbances.

Furthermore, innovations coming from China’s GDP significantly affect ASEAN’s GDP. Therefore, China’s economic growth affects ASEAN exports, which, in turn, affects ASEAN’s economic growth, indicating that China’s economic growth has a direct effect on ASEAN’s export growth. Eventually, China’s economic growth will bring about economic growth in ASEAN. Similarly, this reflects that fact that the share of China’s international trade in GDP is much higher than other large economies in the world, indicative of the remarkable role that international trade has played in China’s growth process. Consequently, ASEAN needs to make intensive efforts to maintain economic stability.

Given these results, ASEAN needs to promote trade. As the results suggest, the economic conditions of China and ASEAN are correlated. Therefore, it is important that the strong economic linkages within the region are not weakened by tariff increases or non-tariff barriers in individual countries as a means of protecting domestic producers.

Finally, there is a need to strengthen regional cooperation efforts to promote macroeconomic coordination and cooperation initiatives in capacity-building, human resource development, research and development, trade facilitation and investment generation.
Annexes

Annex 1. Optimal VAR lag selection

A. For equation 1

VAR system, maximum lag order 4

The asterisks indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike Information criterion, BIC = Schwartz Bayesian criterion and HQC = Hannan-Quinn criterion.

<table>
<thead>
<tr>
<th>lags</th>
<th>loglik</th>
<th>p(LR)</th>
<th>AIC</th>
<th>BIC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-5031.59813</td>
<td>167.341875</td>
<td>172.694020</td>
<td>169.443262</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-4784.42117</td>
<td>0.00000</td>
<td>164.013586</td>
<td>174.306172</td>
<td>168.054715</td>
</tr>
<tr>
<td>3</td>
<td>-4512.20681</td>
<td>0.00000</td>
<td>159.877639</td>
<td>175.110666</td>
<td>165.858510</td>
</tr>
<tr>
<td>4</td>
<td>-3973.94154</td>
<td>0.00000</td>
<td>147.159405*</td>
<td>167.332873*</td>
<td>155.080017*</td>
</tr>
</tbody>
</table>

The optimal lag structure is 4, based on the lowest AIC, BIC and HQC (Gujarati, 2003). Thus, we have a VAR (4) model. Testing for higher order lag structure is not feasible due to lack of observations.

B. For equation 2

VAR system, maximum lag order 5

The asterisks indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike criterion, BIC = Schwartz Bayesian criterion and HQC = Hannan-Quinn criterion.

<table>
<thead>
<tr>
<th>lags</th>
<th>loglik</th>
<th>p(LR)</th>
<th>AIC</th>
<th>BIC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3239.25221</td>
<td>109.155810</td>
<td>112.270214</td>
<td>110.376374</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-3119.16220</td>
<td>0.00000</td>
<td>107.874171</td>
<td>113.791538</td>
<td>110.193242</td>
</tr>
<tr>
<td>3</td>
<td>-2961.96565</td>
<td>0.00000</td>
<td>105.375923</td>
<td>114.096254</td>
<td>108.793503</td>
</tr>
<tr>
<td>4</td>
<td>-2754.03630</td>
<td>0.00000</td>
<td>101.214305</td>
<td>112.737600</td>
<td>105.730392</td>
</tr>
<tr>
<td>5</td>
<td>-2554.76549</td>
<td>0.00000</td>
<td>97.336574*</td>
<td>111.662832*</td>
<td>102.951169*</td>
</tr>
</tbody>
</table>

The optimal lag structure is 5, based on the lowest AIC, BIC, and HQC (Gujarati, 2003). Hence, we have a VAR (5) model. Testing for higher order lag structure is infeasible due to lack of observations.
C. For equation 3

VAR system, maximum lag order 4

The asterisks indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike Information criterion, BIC = Schwartz Bayesian criterion and HQC = Hannan-Quinn criterion.

<table>
<thead>
<tr>
<th>lags</th>
<th>loglik</th>
<th>p(LR)</th>
<th>AIC</th>
<th>BIC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-2708.57681</td>
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<td>89.696026</td>
<td>92.166247*</td>
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<tr>
<td>2</td>
<td>-2617.80982</td>
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<td>88.832575</td>
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<tr>
<td>3</td>
<td>-2520.50643</td>
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<td>87.758272</td>
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<td>90.452358</td>
</tr>
<tr>
<td>4</td>
<td>-2317.43199</td>
<td>0.00000</td>
<td>83.272000*</td>
<td>92.329475</td>
<td>86.828193*</td>
</tr>
</tbody>
</table>

The optimal lag structure is 4, based on the lowest AIC, BIC, and HQC (Gujarati, 2003). Hence, we have a VAR (4) model. Testing for higher order lag structure is infeasible due to lack of observations.
Annex 2. Johansen Cointegration Test

A. For equation 1

Johansen test:
Number of equations = 12
Lag order = 4

Case 3: Unrestricted constant

<table>
<thead>
<tr>
<th>Rank</th>
<th>Eigenvalue</th>
<th>Trace</th>
<th>test p-value</th>
<th>Lmax</th>
<th>test p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.99042</td>
<td>1 329.5</td>
<td>[0.0000]</td>
<td>288.18</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>1</td>
<td>0.98398</td>
<td>1 041.4</td>
<td>[0.0000]</td>
<td>256.30</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>2</td>
<td>0.97455</td>
<td>785.05</td>
<td>[0.0000]</td>
<td>227.60</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>3</td>
<td>0.87596</td>
<td>557.45</td>
<td>[0.0000]</td>
<td>129.41</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>4</td>
<td>0.84624</td>
<td>428.04</td>
<td>[0.0000]</td>
<td>116.09</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>5</td>
<td>0.78441</td>
<td>311.96</td>
<td>[0.0000]</td>
<td>95.131</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>6</td>
<td>0.64050</td>
<td>216.82</td>
<td>[0.0000]</td>
<td>63.429</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>7</td>
<td>0.58392</td>
<td>153.40</td>
<td>[0.0000]</td>
<td>54.367</td>
<td>[0.0000]</td>
</tr>
<tr>
<td>8</td>
<td>0.50342</td>
<td>99.029</td>
<td>[0.0000]</td>
<td>43.401</td>
<td>[0.0001]</td>
</tr>
<tr>
<td>9</td>
<td>0.42274</td>
<td>55.629</td>
<td>[0.0000]</td>
<td>34.067</td>
<td>[0.0002]</td>
</tr>
<tr>
<td>10</td>
<td>0.24357</td>
<td>21.562</td>
<td>[0.0045]</td>
<td>17.307</td>
<td>[0.0142]</td>
</tr>
<tr>
<td>11</td>
<td>0.066324</td>
<td>4.2548</td>
<td>[0.0391]</td>
<td>4.2548</td>
<td>[0.0391]</td>
</tr>
</tbody>
</table>

Both the trace and λ-max test reject the null hypothesis that the smallest eigenvalue is 0, so it may be concluded that the series is in fact stationary (Enders, 2003). The rejection of the hypothesis denotes that the number of cointegrating equations, in this case, is at most 10. Since there is cointegration, OLS estimates of the structural relationships have the property of consistency (Mulligan, 2003).

B. For equation 2

Johansen test:
Number of equations = 9
Lag order = 5

Case 3: Unrestricted constant

<table>
<thead>
<tr>
<th>Rank</th>
<th>Eigenvalue</th>
<th>Trace</th>
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<th>Lmax</th>
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<tr>
<td>0</td>
<td>0.88300</td>
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<td>130.88</td>
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<td>0.86020</td>
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<td>120.02</td>
<td>[0.0000]</td>
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<tr>
<td>2</td>
<td>0.75182</td>
<td>282.36</td>
<td>[0.0000]</td>
<td>85.010</td>
<td>[0.0000]</td>
</tr>
</tbody>
</table>
Both the trace and $\lambda$-max test reject the null hypothesis that the smallest eigenvalue is 0, so it may be concluded that the series is in fact stationary (Enders, 2003). The rejection of the hypothesis denotes that the number of cointegrating equations, in this case, is at most 7. Since there is cointegration, OLS estimates of the structural relationships have the property of consistency (Mulligan, 2003).

### C. For equation 3

Johansen test:

Number of equations = 8

Lag order = 4


Case 3: Unrestricted constant

<table>
<thead>
<tr>
<th>Rank</th>
<th>Eigenvalue</th>
<th>Trace</th>
<th>test p-value</th>
<th>Lmax</th>
<th>test p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.90048</td>
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</tr>
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<tr>
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<td>30.652</td>
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</tr>
<tr>
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<td>25.988</td>
<td>[0.0772]</td>
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<tr>
<td>5</td>
<td>0.27563</td>
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<td>7</td>
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<td>[0.0902]</td>
<td>2.8707</td>
<td>[0.0902]</td>
</tr>
</tbody>
</table>

Both the trace and $\lambda$-max test reject the null hypothesis that the smallest eigenvalue is 0, so it may be concluded that the series is in fact stationary (Enders, 2003). The rejection of the hypothesis denotes that the number of cointegrating equations, in this case, is at most 7. Since there is cointegration, OLS estimates of the structural relationships have the property of consistency (Mulligan, 2003).
References


