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Economic integration in ASEAN + 3: A network analysis

Thi Nguyet Anh Nguyen*
Thi Hong Hanh Pham*
Thomas Vallée*

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(*) LEMNA, Université de Nantes

Economic integration in ASEAN + 3: A network analysis

(Preliminary version)

NGUYEN Thi Nguyet Anh*, PHAM Thi Hong Hanh, VALLÉE Thomas

LEMNA, Institute of Economics and Management, University of Nantes
Chemin de la Censive du Tertre, BP 52231, 44322 Nantes Cedex 3, France
Phone: +33 (0)2 40 14 17 33 / Fax: +33 (0)2 40 14 16 50

Abstract: *This paper aims to analytically and graphically explore the characteristics of ASEAN+3's trade and FDI integration over the period 1990-2012 by applying the tools of network analysis. Our results first find evidence that the degree of trade and FDI integration varies among ASEAN+3 member states over the observation period. Second, ASEAN+3's intra-regional trade network seems to be more densely connected than its intra-regional FDI network. Third, we reveal that large and/or advanced countries tend to be better linked and to form a sub-regional bloc of tightly connected economies. Therefore, ASEAN+3 has been experiencing a widening gap in the trend and patterns of intra-regional trade and FDI among country members at different levels of economic development.*

Keywords: Trade; FDI; network analysis; ASEAN+3

JEL: F02; F14; F21; F40

* Corresponding author. Email address: thi-nguyet-anh.nguyen1@univ-nantes.fr (T.N.A.Nguyen)

1. Introduction

Southeast Asian countries formed a political, economic and cultural alliance on 8 August 1967 called Association of Southeast Asia Nations (ASEAN).¹ Since its establishment, ASEAN has promoted an open-regionalism principle in order to ensure trade liberalization among country members and enhance trade and investment integration with particular non-members. Based on the principle of open market economy and rule-based system, ASEAN has become a dynamic trade zone and an important region for foreign investors to put their real and portfolio investments.

Apart from the initiatives above, ASEAN has also committed to the enlargement of ASEAN Free Trade Area (AFTA) to non-member countries. According to ASEAN members, who are opposed to direct Bilateral Free Trade Agreement (BFTA) between an individual member state and a non-member state, the enlargement of AFTA through an “ASEAN + framework” has been the best way to strengthen ASEAN’s regional cooperation with non-members. The ASEAN economic performances in the last decade explained the attractiveness of the “ASEAN + framework” and the willingness of non-members states to join it. Besides, being the third largest population in the world, after China and India, ASEAN has an important potential market demand and a large potential productive labor supply. In addition, the comparative advantages among ASEAN countries may allow building up complementary production networks in Southeast Asia. In other words, these features allow ASEAN to expand its regionalism wings to other Asian countries and then to establish BFTAs with non-member states in order to join its economic cooperation. Among others, ASEAN+3, which covers ten ASEAN member states and three East Asian countries (China, Japan and Korea), has been considered as the most successful model of “ASEAN + framework”. The ASEAN+3 is also the latest development of East Asian regional cooperation from trade, investment to financial cooperation. According to Urata (2007), free trade arrangements in East Asian region through ASEAN+3 attempt to generate “trade creation” instead of “trade diversion”. Still, a better understanding of the integration process and its evolution within the ASEAN or the “ASEAN + 3” is opportune.

The present paper tends to gain a better understanding of economic integration in ASEAN+3 by employing a network analysis. In the literature, a network analysis has been recently used to study the relevant issues of international trade (e.g. Fagiolo et al., 2007; Iapadre and Tajoli, 2014). The main argument of network analysis is to show trade relations as a network, in

¹ Five ASEAN founding members are Indonesia, Malaysia, the Philippines, Singapore and Thailand. Membership has now extended to include Brunei, Laos, Cambodia, Myanmar and Vietnam.

which countries play the role of nodes and a link indicates the presence of an import/export relation between any two countries. Fagiolo et al. (2007) argue that a network approach enhances our understanding of international economics because it allows investigating the whole structure of interactions among countries and to explore connections, paths and circuits. The authors also indicate that while standard statistics are only able to capture the first order relationships, a network analysis can analyze the second- and higher-order relationships. Furthermore, according to Kali and Reyes (2007), the statistical properties of network analysis can also explain the dynamics of macroeconomic variables related to globalization, growth and financial contagion.

Employing a network analysis, the present paper has triple purposes. The first one is to advance our understanding of the interdependence among ASEAN+3 countries through the construction of a series of network indicators. The second one is to address the question of which countries play the central role in ASEAN+3 economic network. Lastly, we are interesting in investigating whether ASEAN and ASEAN+3 are complementary or substitutionary. On the other hand, our empirical study also seeks to contribute to the related literature in two ways. To the best of our knowledge, this paper is the first to perform a detailed network analysis on trade integration in ASEAN+3. Second, we extend the network approach to analyze the investment connection, which is captured by foreign direct investment (FDI) flows among ASEAN+3 countries.

The reminder of this paper is organized as follows. Section 2 outlines the concerned literature on network analysis. Section 3 provides an overview on ASEAN+3's integration process in terms of both trade and investment. Section 4 explains the methodological approach. Section 5 presents and analyzes the empirical results. Concluding remarks are in Section 6.

2. Network analysis in economic integration

Since long ago, international economists have considered international trade as a network. From a network perspective, the trade flow of goods and services between two countries can be simply described by a line connecting two vertices representing the two trading countries. Looking at trade flows as a network allows to analyze either the relationship between the countries in the network or the overall network structure. Because of this benefit, the network analysis has been widely used in the literature to investigate the international trade relations. In a seminal paper, Snyder and Kick (1979) address world-system/dependency theories of differential economic growth among countries. The authors present a block-

model of the world system basing on four types of international networks: trade flows, military interventions, diplomatic relations, and conjoint treaty memberships. Through this model, Snyder and Kick provide strong evidence for a “core-semi-periphery-periphery” structure of international trade network. Following this work, Smith and White (1992) use a quantitative network analysis of international commodity trade flows (1965, 1970, and 1980) to measure the structure of the world economic system and to identify the roles of each nation in the global division of labor. They find evidence of the change both in the overall structure of the world economy and in the positions of particular countries. This change can be characterized by: (i) an enlargement of the core countries; (ii) a reduction of within-core distance; (iii) and the progressive marginalization of peripheral countries.

Differing from the two above studies, Kim and Shin (2002) focus on the issue of globalization and regionalization by applying social network analysis for longitudinal data on international commodity trade. Three important findings can be drawn from this work. First, the world became increasingly globalized between 1959 and 1996. Second, the structure of the world trade network became decentralized over time. Third, intra-regional density and ties are greater than interregional density and ties. In the same vein, Kastle et al. (2006) tend to operate and measure the concept of globalization by using complex systems network analysis with longitudinal trade data over the period 1938-2003. The authors argue that, while some important aspects of the international trade network have been remarkably stable over the period of interest, several network measures have changed substantially over the same time.

The architecture of globalization is also examined in Kali and Reyes (2007), who map the topology of the international trade network and also provide new network-based measures of international economic integration, at both global system-wide level and local country-level. On the one hand, the authors show that in terms of participation and influence in the network, global trade is hierarchical with a core-periphery structure at meaningful levels of trade, though smaller countries’ economic integration into the network increased considerably over the 1990’s. On the other hand, the position of a country in the network has substantial implications for economic growth. In addition, the network position of a country is a substitute for its physical capital but a complement to its human capital.

In Benedictis and Tajoli (2010), the tools of network analysis are also used to assess the characteristics of international trade networks. The authors suggest that the structure of international trade networks differs across manufacturing industries that employ different types and amounts of intermediate inputs. Accordingly, the structure of some industries’

trade flows gives rise to a dense, widespread network with many links, while others experience a centered network, organized around hubs that centrally coordinate the flows. The authors also find evidence of a positive correlation between the use of differentiated intermediate inputs and the network complexity. In a subsequent work, Benedictis and Tajoli (2011) analyze the evolution of the world trade structure. On the one hand, they study the role of the entrance of a number of new important players into the world trading system in changing the main characteristics of the existing structure of world trade. On the other hand, the authors aim to address the question of whether the changes in the world trade structure are related to the multilateral or the regional liberalization policies. The authors find that the level of world trade integration has been increasing but still far from being complete, with the exception of some areas, which have experienced a strong heterogeneity in the countries' choice of partners. Moreover, they also conclude the relevant role of WTO in trade integration.

More recently, Iapadre and Tajoli (2014) analyze the role played by the BRICs (Brazil, Russia, India and China) in the world trade network, as well as in their regions. They find that the regional role played by each of the BRICs is different. China plays a role of export hub in South-East Asia, importing intermediate goods from the rest of the region and exporting final goods to the rest of the world, while Brazil, India and Russia seem to be the dominant local suppliers in their regions, exporting to the region and importing from the rest of the world. Iapadre and Tajoli (2014) also conclude that the BRICs are the most globalized countries in terms of connectivity to the world trading system in each of their respective regions.

In the international economics literature, the network analysis has been also used to study other relevant issues apart from trade integration. For instance, Fagiolo et al. (2007) exploit both binary and weighted network approaches to compare the degree and patterns of trade and financial integration. The authors show that the trade network is almost fully connected while international financial integration is less pervasive. In addition, the level of international financial integration varies with asset type: it is highest for long-term debt contracts, somewhat lower for equities and rather low for short-term debt. Differing from Fagiolo et al. (2007), Kali and Reyes (2010) use these network-based measures of connectedness to explain stock market returns during the financial crisis. They find that a financial crisis is amplified if the epicenter country is better integrated into the trade network. However, an affected country may dissipate the negative impact if it is well

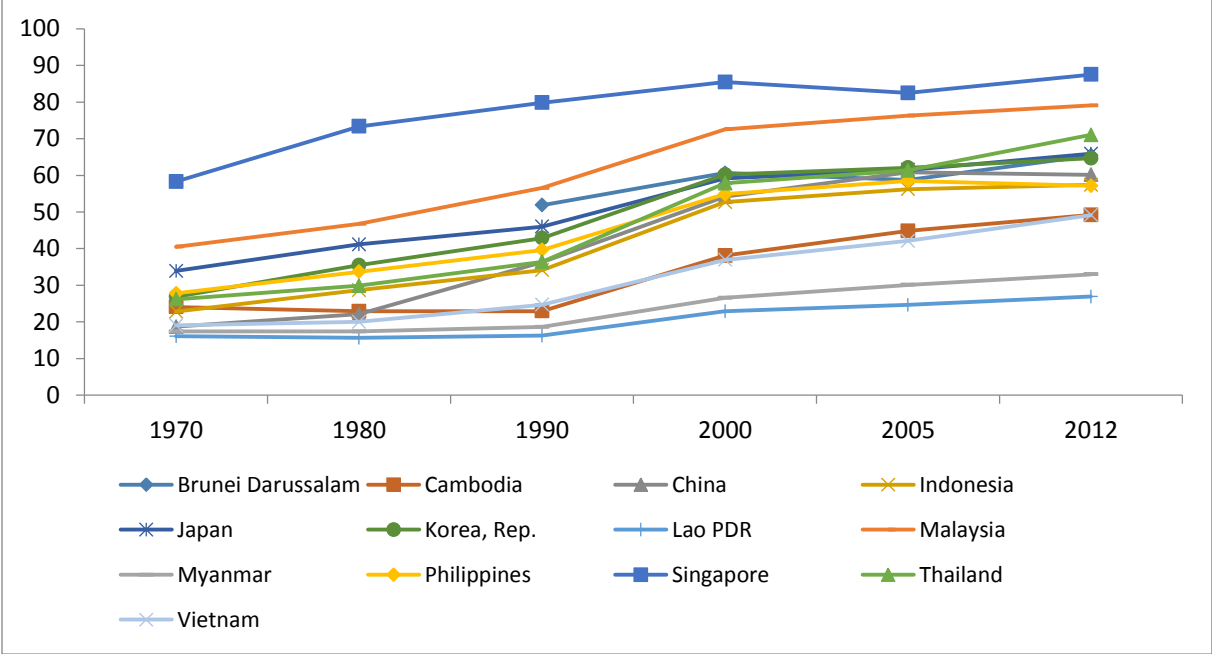
integrated into the network. The authors also conclude the role of network analysis in providing an improved explanation of financial contagion.

Overall, the existing literature reveals that using network analysis to analyze international trade issues might yield interesting insights. However, until now the tools of network analysis are mostly applied to study the trade network structure at the world level. Therefore, we use network analysis to shed light on the changes in the trade network structure at the regional level through a case study of ASEAN+3. In addition, the present paper also tends to contribute to the existing literature by employing network analysis to gain a better understanding of economic integration in ASEAN+3 in terms of FDI flows.

3. Integration and ASEAN + 3

We begin with a discussion on the globalization level of each country in ASEAN+3. It is noteworthy that globalization can be interpreted as manifold dimensions. As defined in Dreher et al. (2008), globalization includes three dimensions: economic globalization²; social globalization³; and political globalization⁴. Dreher et al. (2008) also introduce the KOF Index of Globalization covering all three dimensions of globalization. The KOF index defines globalization to be the process of creating networks of connections among actors at multi-continental distances, mediated through a variety of flows including people, information and ideas, capital and goods.

Figure 1: KOF Globalization index of ASEAN + 3



² Economic globalization is characterized as long distance flows of goods, capital and services as well as information and perceptions that accompany market exchanges.

³ Social globalization is expressed as the spread of ideas, information, images and people.

⁴ Political globalization is defined as a diffusion of government policies

Source: Authors' creation from KOF Index

From Figure 1, all ASEAN+3 countries show a substantial increase in the KOF index over the period 1970-2012. Despite of a common increasing trend, Figure 1 also displays the heterogeneity of globalization processes among ASEAN+3 countries. Among others, China has experienced a remarkable change in its KOF index. China's KOF index started from the lowest level in 1970 but has been sustained over a longer period. By contrast, the KOF index of the country with a low economic development level, such as Lao PDR and Myanmar, has been still small. This is probably due to the fact that the globalization process seems to be more favored in a country with strong economic performance.

Table 1: Share of ASEAN+3's trade flows

Year	Exports				Imports			
	ASEAN		ASEAN+3		ASEAN		ASEAN+3	
	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)
1980	3.7	25.5	12.8	88.4	3.4	26.2	12.9	90.7
1990	4.3	25.3	13.3	78.7	4.2	29.7	14.2	80.8
2000	5.7	27.4	16.7	80.9	5.2	32.1	16.1	80.7
2005	6.1	24.8	20.4	83.1	5.6	30.2	18.4	81.6
2010	6.5	22.2	25.0	85.3	6.0	28.1	21.2	82.3
2013	6.7	21.3	26.9	85.8	6.2	26.3	23.6	82.9

Source: Authors' computation from WDI data

We now turn our attention to ASEAN+3 integration in terms of both trade and FDI flows at regional level. In fact, ASEAN+3 has long enjoyed a market driven expansion of trade and FDI. Over the past two decades, the region's trade and FDI have expanded rapidly. As shown in Table 1, ASEAN+3's exports rose from 12.8% of the world total exports in 1980 to 26.9% in 2013, while its imports expanded from 14.2% to 23.6% during 1990-2013. ASEAN+3 has also played a central role in regional trade integration. In 2013, the share of ASEAN+3 in regional exports and imports reached to 85.8% and 82.9% respectively.

Table 2: Share of ASEAN+3's FDI inflows

Year	FDI inflows				FDI outflows			
	ASEAN		ASEAN+3		ASEAN		ASEAN+3	
	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)	World (%)	East Asia & Pacific (%)
1980	4.4	47.9	9.2	54.0	-	-	-	-
1990	6.3	43.3	14.6	64.5	-	-	-	-
2000	1.8	14.6	12.1	49.8	-	-	-	-
2005	3.2	22.2	14.2	89.6	1.4	19.0	7.4	99.4
2010	5.8	19.7	29.3	75.5	3.5	23.9	14.5	68.6

2013	7.4	20.5	36.1	78.3	3.6	15.9	22.4	81.9
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Source: Authors' computation from WDI data

On the other hand, ASEAN+3 has been also the most important destination of FDI. FDI flows into ASEAN+3 more than doubled from 14.6% of the world total FDI inflows in 1990 to 29.3% in 2010 and reached the peak of 36.1% in 2013, while outward FDI of ASEAN+3 considerably increased from 7.4% to 22.4% of the world total outflows over the period 2005-2010.

Table 3: Structure of ASEAN+3 trade activities (% of total trade flows)

Partners	2000		2005		2010	
	Export	Import	Export	Import	Export	Import
Intra-ASEAN	22.8	21.1	25.3	24.5	28.2	26.6
Extra-ASEAN	77.2	78.9	74.7	75.5	71.8	73.4
China	3.5	5.2	8.1	10.6	11.3	12.4
Japan	12.3	18.8	11.2	14.1	11.1	10.8
Korea	3.5	4.4	3.8	4.1	4.8	5.5

Source: Authors' computation from ASEAN Secretariat

ASEAN+3's global expansion of trade has been accompanied by rising intra-regional concentration of trade activities. As reported in Table 3, ASEAN+3's trade activities are significantly characterized by trade flows between the country members. For instance, intra-regional exports as a share of ASEAN's total exports increased from 22.8% in 2000 to 28.2% in 2010, while intra-ASEAN imports also expanded from 21.1% to 26.6% during 2000-2010. In addition, the trade flows between ASEAN and China, Japan, and Korea have also experienced a substantially upward trend over the last decade, which is probably due to the establishment of ASEAN+3 in 1997.

Table 4: FDI sources of ASEAN+3 (% of total inward FDI)

Country sources	2005	2006	2007	2008	2009	2010
Intra-ASEAN	10.0	13.9	12.7	20.1	13.8	16.1
Extra-ASEAN	90.0	86.1	87.3	79.9	86.2	83.9
China	1.5	1.8	2.3	4.0	10.9	3.8
Japan	16.3	18.4	11.7	8.8	9.8	11.0
Korea	1.3	2.2	3.6	3.4	3.5	4.9
EU	27.7	23.6	24.6	14.9	23.9	22.3
U.S	7.9	5.4	11.0	7.5	10.7	11.3

Source: Authors' computation from ASEAN Secretariat

Differing from intra-regional concentration of trade activities, the main sources of ASEAN+3's inward FDI come from both intra and extra-regional countries. Table 4 shows that firms from the major industrialized countries are the main investors in ASEAN. Indeed multinational firms from the European Union (EU), the U.S and Japan provide around 40%

of total inward FDI into ASEAN over the period 2005-2010. On the other hand, firms from ASEAN countries firms have also begun to invest in other member states. For instance, intra-ASEAN FDI flows peaked at 20.1% in 2008 and then dropped to 16.1% in 2010 due to the global financial turmoil. Overall, the recent share of intra-ASEAN FDI flows is still lower than that of extra-ASEAN FDI flows.

According to Kawai and Wignaraja (2007), several factors can explain the expansion of trade and FDI ASEAN+3 economies. First, ASEAN+3 economies have pursued trade and investment liberalization as part of their outward-oriented trade and FDI policies within the multilateral framework. Second, investing into ASEAN+3 allow multinational firms to former their production networks and supply chains throughout this dynamic region. Third, improving physical and digital connectivity and developing logistics support services in East Asia over the past two decade have reduced trade costs of conducting cross-border business and thus encouraged trade and investment activities in the region. Fourth, the remarkable economic growth of the largest emerging market, notably China, has also been considered as an important factor contributing to closer economic linkages among ASEAN+3 member states.

4. Methodological approach

In this paper, to achieve our research objectives, we employ a broad set of indicators, which have been widely addressed in the literature.

4.1. Intensity indices

According to Iapadre and Tajoli (2014), the trade intensity is a simpler approach, in which the intensity indices are measured by a comparison between actual bilateral trade and a properly defined benchmark. Iapadre and Tajoli (2014) also argue that trade intensity indices can be used to assess possible hierarchical structures in the geography of international trade, such as core-periphery or hub-and-spoke patterns. On the other hand, intensity indices also allow one to investigate the tendency of countries belonging to the same region to trade relatively more between each other (intra-regional trade) than with the rest of the world (inter-regional trade) (Iapadre and Plummer, 2011).

The trade intensity can be considered as equivalent with the revealed comparative advantage index developed by Balassa (1965). In this vein, the trade intensity is formulized as follows:

$$I_{ij} = \frac{S_{ij}}{W_j} = \frac{T_{ij}/T_{iw}}{T_{wj}/T_{ww}} \quad (1)$$

where S_{ij} is a partner country j 's share of the reporting country i 's total trade, W_j is its share of the world trade, T_{ij} : is total bilateral trade between reporting country i and partner country j , T_{iw} is trade between reporting country i and the world, T_{wj} is trade between country j and the world, and T_{ww} is the total world trade.

Contrary to the abundant literature on the trade intensity indices, there is no clear theoretical foundation for the FDI intensity. So that, to measure the intensity of FDI relationship, we reuse the idea of bilateral trade intensity index to construct our FDI intensity indices as follows:

$$IF_{ij} = \frac{SF_{ij}}{WF_j} = \frac{TF_{ij}/TF_{iw}}{TF_{wj}/TF_{ww}} \quad (2)$$

where SF_{ij} is a partner country j 's share of the reporting country i 's total FDI, WF_j is its share of the world FDI, TF_{ij} : is total FDI flows between reporting country i and partner country j , TF_{iw} is FDI flows between reporting country i and the world, TF_{wj} is FDI flows between country j and the world, and TF_{ww} is the total world FDI.

To calculate the FDI intensity, we use FDI stocks instead of FDI flows for two reasons. First, FDI stocks represent the long-term investment position of host and home country, while FDI flows represent the annual investment position, especially in the case of small countries. Second, the value of FDI stock, which is accumulated flows, in almost cases is positive. By contrast, calculating the FDI intensity in the case of disinvestment, in which the value of FDI flows is negative, is not an easy task. According to Iapadre (2006), the traditional specifications of intensity indices as formularized above suffer from some limitations: (i) the range of bilateral intensity indices is not homogeneous across region and is asymmetric around the geographic neutrality threshold; (ii) it is difficult to interpret the dynamic changes in intensity indices. To resolve these problems, Iapadre (2006) and Iapadre and Tajoli (2014) present another indicator, namely the bilateral *revealed trade preference index* (RTP) among the country members of a region. This index is constructed from the homogeneous bilateral intensity index (HI_{ij}) and the complementary extra-bilateral intensity index (HE_{ij}).

$$\begin{cases} HI_{ij} = \frac{S_{ij}}{V_{ij}} = \frac{T_{ij}/T_{iw}}{T_{oj}/T_{ow}} \\ HE_{ij} = \frac{1-S_{ij}}{1-V_{ij}} \end{cases} \quad (3)$$

where T_{oj} is trade flows between the rest of the world (excluding country i) and country j , T_{ow} is trade flows between the rest of the world and the world. Basing on the value of HI_{ij} and HE_{ij} , the RTP index is given as follows:

$$RTP_{ij} = (HI_{ij} - HE_{ij})(HI_{ij} + HE_{ij}) \quad (4)$$

The RTP index varies from -1 (no bilateral trade) to +1 (only bilateral trade) and is equal to zero in the case of geographic neutrality. According to Iapadre and Tajoli (2014), this index is perfectly symmetric across partner countries and independent of country size. The authors also argue that the RTP index can be also used to map the intensity of trade within a region r . In this case, Formulas 4 becomes:

$$RTP_{ir} = (HI_{ir} - HE_{ir})(HI_{ir} + HE_{ir}) \quad (5)$$

On the other hand, we can also determine separately the revealed import and export preference indices (RXP_{ir} and RMP_{ir} , respectively). These two indicators are used to calculate the *revealed trade leadership* index (Iapadre and Tajoli, 2014) as follows;

$$RTL_{ir} = \frac{RXP_{ir} - RMP_{ir}}{2} \quad (6)$$

The RTL_{ir} index allows one to determine the role (local supplier versus export hub) of each country member in a specific region.

4.2. Weighted network analysis' indicators

Network analysis is an application of network theory to analyze the relational data. De Benedictis et al. (2013) show that network analysis provides the fundamental information on the dyad ij . That is, network analysis is a useful approach to assess the relationship between countries in terms of both trade and FDI.

In ASEAN+3 framework, we consider its trade network as a weighted network, since in the binary trade matrix, 100% of links are bilateral and each node has exactly the same number of links. By contrast, concerning FDI network, we refer to both binary and weighted network analysis, because in the binary FDI matrix, there is approximately 55% of bilateral relations and each node has different number of links. In addition, both trade and FDI networks are considered as directed complete networks. The main reason is that in ASEAN+3 trade and FDI network, every node (or every country) is directly connected to every other node (or other country) in both direction.

To gain better understanding of the connectivity in ASEAN+3 network, we use a broad set of centrality measures, which have been widely used in the concerned literature (e.g. Freeman, 1978; Newman, 2001; Bogartti, 2005; and Opsahl, 2010). The centrality approach, which is

based on the number of trade or FDI links of a given country (binary or unweighted network) and their strength (weighted network), assesses how well connected a country is to the rest of the network, and how influential a country is for a specific region. According to Jackson (2010), centrality measures can be classified into four main groups: *i*) degree centrality assessing how a node is connected to others; *ii*) closeness centrality showing how easily a node can be reached by other nodes; *iii*) betweenness centrality describing how important a node is in terms of connecting other nodes; and *iv*) eigenvector centrality measure (or the Bonacich centrality) referring to how important, central, influential and tightly clustered a node's neighbors are. In this paper, we only focus on two indicators, notably the degree centrality and the eigenvector centrality, for several reasons. First, all links in ASEAN+3 network are directed between two countries. Second, the transactions between countries are independent. Third, there is no node (or country) being a part of transactions among two nodes.

Finally, in the weighted networks, we calculate either the absolute values (e.g. flows of exports and stocks of FDI) or the relative ones (e.g. flows of exports by GDP and stocks of FDI by GDP), which allow us to avoid the excessive impact of the country size. Moreover, it also allows better determining the specialization in the overall process of production.

Degree centrality

Degree centrality is the simplest measure of a node's position in a network. In a binary network, the degree centrality corresponds to the number of connections of each node. In a weighted network, the links between nodes are not equivalent and weighted according to their strength.

In a given network, N is the total number of nodes (countries), and \mathbf{a}_{ij} is the element in the trade adjacency matrix A , in which i is the row-indicator corresponding to exporting countries, and j is the column-indicator corresponding to importing countries. If $\mathbf{a}_{ij} = 1$, the two countries i and j are trade partners. If $\mathbf{a}_{ij} = 0$, the two countries i and j are not trading partners. In a weighted network described by $N \times N$ with the weight matrix $A = [a_{ij}]$, in which $a_{ij} > 0$ if the link i to j exists, otherwise $a_{ij} = 0$.

In an unweighted (or binary) network, the centrality of node is measured by the number of the connections between nodes.

$$C_D = \sum_{j \neq i}^N \mathbf{a}_{ij} \quad (7)$$

Due to the dependence of degree centrality measure on the number of existing nodes in a network, it is difficult to compare networks of different node-size. According to De

Benedictis et al. (2013), it is usually better to calculate the normalized version of C_D as follows:

$$C_D^N = \frac{\sum_{j \neq i}^N a_{ij}}{(N-1)} \quad (8)$$

This indicator ranges from 0 to 1, implying that the more is the degree centrality close to 1, the more a country is directly connected to the rest of the network. In a directed network, we distinguish in-degree centrality and out-degree centrality. In our case, the out-degree is the total number of countries to which country i exports its products, the in-degree is the total number of countries that export their products to country i .

$$\begin{cases} C_{D-out}^N = \frac{\sum_{j \neq i}^N a_{ij}}{(N-1)} \\ C_{D-in}^N = \frac{\sum_{j \neq i}^N a_{ji}}{(N-1)} \end{cases} \quad (9)$$

The ratio of these two indicators indicates the relative connectivity of a country in terms of inflows (with a ratio greater than 1) or outflows (with a ratio smaller than 1). Normalizing the number of links in Equation 7 by the total number of links L in the network gives the following measures:

$$\begin{cases} C_{D-out}^P = \frac{\sum_{j \neq i}^N a_{ij}}{L} \\ C_{D-in}^P = \frac{\sum_{j \neq i}^N a_{ji}}{L} \end{cases} \quad (10)$$

In a weighted network, we can also determine the strength centrality (C_S) regarding to trade volumes between two countries as follows:

$$\begin{cases} C_{S-out}^N = \frac{\sum_{j \neq i}^N w_{ij}}{(N-1)} \\ C_{S-in}^N = \frac{\sum_{j \neq i}^N w_{ji}}{(N-1)} \end{cases} \quad (11) \quad \text{and} \quad \begin{cases} C_{S-out}^P = \frac{\sum_{j \neq i}^N w_{ij}}{\sum_i \sum_j w_{ij}} \\ C_{S-in}^P = \frac{\sum_{j \neq i}^N w_{ji}}{\sum_j \sum_i w_{ij}} \end{cases} \quad (12)$$

where w_{ij} is, for example, the exports or the exports by GDP from country i to country j while w_{ji} imports of country i from country j , and $\sum_i \sum_j w_{ij} = \sum_j \sum_i w_{ji}$ is the in-strength and out-strength by total network trade. In general, the degree and the strength centrality take into consideration the direct links of a node and its nearest neighborhood, but ignore the position of a node in the network's structure.

Eigenvector centrality

The eigenvector centrality index, which is initialed by Bonacich (1972), measures the importance of a node in terms of its connection to other central nodes (Iapadre and Tajoli, 2014). That is, it assigns relative scores to all nodes in the network based on the principal that connections to high-scoring nodes contribute more to the score of the node in question

than equal connections to low-scoring nodes. Mathematically, the eigenvector centrality of country i is defined as the sum of the centrality of its neighbors j scaled by a constant λ . In an undirected network with adjacency matrix A , the measure (C_E) is computed as follows:

$$C_E(i) = \lambda^{-1} \sum_j a_{ij} C_E(j) \quad (13)$$

In a directed network, we can also distinguish:

- *hub centrality*: this indicator allows one to determine the high “hub” score country, which is the key exporter or investor in the network.

$$C_{E\text{-hub}}(i) = \beta \sum_j a_{ij} C_{E\text{-autho}}(j) \quad (14)$$

- *authority centrality*: this indicator allows one to determine the high “authority” score country, which is the key importer of main destination of investment in the network.

$$C_{E\text{-autho}}(i) = \alpha \sum_j a_{ij} C_{E\text{-hub}}(j) \quad (15)$$

Overall, we use the listed above indicators to analyze the structure of ASEAN+3 network in terms of both trade and FDI integration.

5. Results

In this section, we report and analyze the network analysis’ results on trade and FDI integration in ASEAN+3. To calculate all network analysis’ indicators listed above, we collect our panel data from different international data sources: UN Comtrade; Organization for Economic Co-operation and Development (OECD); ASEAN; and United Nations Conference on Trade and Development (UNCTAD).

5.1. Trade integration

As mentioned above, we use the network analysis to first study the structure of trade integration in ASEAN+3. In Table 5, we report the trade intensity indices. We also report the values of trade balance in order to compare the role of each ASEAN+3 member state in regional trade system and the world trade system. First, looking at ASEAN’s RTL indices, Singapore, Thailand, Malaysia and Indonesia can be seen as intra-regional *local suppliers*. This is because their intra-regional trade leadership are positive, especially over the period 1990 - 1997. By contrast, small and less developed countries, such as Cambodia and Lao, have been considered as intra-regional export hubs. Interestingly, Malaysia has experienced a downward trend in intra-regional trade introversion, since the country is exporting more to the world and becoming *export hub* in ASEAN. For instance, since 1998 Malaysia’s RTL value

has been slightly negative, while its trade balance with the world has been significantly positive.

Second, the participation of China, Korea and Japan has influenced the picture of intra-regional trade relations. China and Japan have been important intra-regional *export hub* but played a relevant role in supplying goods and services to the rest of the world (except the case of Japan from 2011 to 2013). Over the period 2011-2013, we also observe that Korea, which was an intra-regional *export hub*, turned into a *local supplier* due to opposite change in its intra-regional import and export preferences. Regarding the role of founding ASEAN country members, Singapore maintains its role as *local supplier* and its strong trade integration at regional and global levels. On the other hand, after the implement of ASEAN+3, both intra-regional import and export preferences of most ASEAN countries have dropped due to the market share with large economies (China, Japan and Korea), with the exception of Brunei Darussalam.

<Insert Table 5>

The patterns of ASEAN+3's trade network are also reflected through a set of centrality indices. As mentioned in the methodological section, each country in ASEAN+3 has the bilateral trade relationship with other member states. So that, we only compute the weighted degree centrality index, which is formulated in Equation 11. The result is reported in Table 6, in which the weighted degree centralities are summarized in columns *n-outdegree* and *n-indegree*. For instance, the average flow of Japan's exports and imports is 7,915.29 and 6,111.64 million US dollars respectively over the period 1990 -1997. Together with the weighted degree centrality indices, their ranking indicates the integration level of each country in ASEAN+3's trade network. Furthermore, we can also observe the changes in ASEAN+3's trade structure over the observation period. According to Table 6a, and using the flows of exports as the weights for the network, China, Japan and Korea are the most integrated country in the regional trade network. In particular, Japan and Korea have always played a central role in the trade network in both cases with or without ASEAN+3 creation. Not surprisingly, the role of China in the regional trade network has changed since 2006 due to its official integrated activities into ASEAN+3. As shown in Table 6b, when taking in account the flows of exports by GDP, the role of China and Japan appears much more asymmetric. They rank respectively second and first in terms of In-Degree but 12th and 13th for the Out-Degree. This result clearly shows that China and Japan are main importers from the ASEAN+3 area, but they mainly export outside the ASEAN+3. So, China and Japan due to the importance of their exports and imports are the more central countries in the network

with an outside ASEAN strategy for their sales in foreign markets. These results confirm the previous ones and their role of an intra-regional *export hub*.

Regarding other member states, founding ASEAN country members, such as Singapore and Malaysia, have also maintained an important position in the regional trade system. The trade position of Singapore in the weighted network is opposite to the Chinese one (see Table 6b and Figure 2) being an important exporter to the ASEAN+3 countries and a less central importer. Comparing to Singapore, Brunei Darussalam is not a central country in terms of absolute values of exports and imports from and to ASEAN+3 Countries, but the country also experiences a strong asymmetric position by ranking second in the out-degree measure and 13th in the in-degree. By contrast, Figure 2 shows a more symmetric position in the Trade Network of other ASEAN+3 countries, such as Korea, which however tends to be out-ASEAN market oriented as China and Japan. Regarding the case of Indonesia, the country moved from an export oriented position within the ASEAN+3 to an import oriented one, as China. Meanwhile, with the small value of degree centrality indices, less developed countries, such as Cambodia, Lao and Myanmar, have only played a peripheral in ASEAN+3 network with no clear positions.

<Insert Table 6a and 6b and Figure 2>

The center-periphery picture of ASEAN+3's trade network is also drawn by the weighted eigenvector index. This index allows us to analyze the interdependence among ASEAN+3 countries and resolve the question of which countries play the most central role in ASEAN+3 economic network. We present the results of eigenvector centrality indices in Tables 7a and 7b, in which the country with the highest value of eigenvector centrality is the most connected one in the network.

<Insert Table 7a and 7b>

Again, two stories can be set out depending on the ways we weight the network. Using the absolute values of exports from a country to another one, the *eigenvector*, *hub* and *authority* indices are reproduced in Table 7a. In Table 7b, similar calculations are made using the relative values (e.g. X/GDP) in order to take in account the country size. We first discuss the results reported in Table 7a, then those reported in Table 7b.

As expected, looking at the eigenvector centrality index in table 7a, Japan is ranked first during the period from 1990 to 2005, meaning that this country is very well connected to all other countries in the region. From 1990 to 1997, with the value of normalized index of 55.53, Korea ranks second because of its strong link with Japan, the most important node in the network. Following Korea, the third position of Singapore confirms that this country is well connected to with Japan, Korea as well as other central countries in ASEAN+3. Over the period 1998 - 2005, China improved its positions in the network, from the fourth to the second most central node. Since 2006 with the official integration in ASEAN+3, China has occupied the most central role. By contrast, small countries, such as Cambodia, Lao, Myanmar and Vietnam, are still far from the influence of China as well as of Japan and Korea. Besides the eigenvector index, Table 7b also reports the values of hub and authority centrality indices describing the trade flows' direction: country with a high *hub* value is a key exporter, while country with high *authority* value is a main imports destination. In this regard, Japan plays a role as the first hub in ASEAN+3, following by China and Korea and Singapore. Regarding the authority index, again top dominated countries with highest score are the triangle China - Japan - Korea.

The results on authority index and eigenvector index reported in Table 7b does not change the main previous conclusions. . However, with respect to the Hub index, and as measured by their values of exports by GDP, China, Japan and to a less extent Korea, are no more exporters to the ASEAN+3 countries. They are strongly specialized as a *hub* but for outside the ASEAN+3 region. Philippines, Malaysia, Vietnam and Brunei are the key exporters to the region, while the positions of Cambodia, Lao PDR, Thailand and Myanmar are more symmetric.

<Insert Figure 2>

Apart from the results discussed above, intra-regional trade connectivity can be also visualized through the use of mapping, which shows the intense relationships among country members. As displayed in Figure 2, each country is represented by a node and labeled with its name. The arrows present the direction of links, exports or imports. The size of ties is strength of trade flow between two countries. the picture of ASEAN+3's trade relationships highlights some significant trend through three milestones 1995, 2005 and 2013: (i) the leading role of China, Japan and Korea in intra-regional trade; (ii) the change in trade

structure before and after official implement of ASEAN+3; (iii) an increasing trend in connectivity to the network of peripheral countries such as Philippines, Vietnam and Cambodia. Figure 2 also shows that in 1995, founding ASEAN countries, notably Singapore, Malaysia and Thailand were still closed to the triangle China - Japan - Korea, and dominated ASEAN trade system. However, ten years later, these three countries moved farther from the central places. Similarly, the group of small countries has remained such an important distance from the central network. Overall, despite a rising trend in intra-regional trade integration level, the participation of large and/or advanced countries, notably Japan, China and Korea, in a common trade bloc - ASEAN+3, seems to dominate trade flows of small and less developed countries.

5.2. FDI integration

As mentioned in the introduction section, this paper also tends to apply the tools of network analysis to investigate intra-regional FDI connections. We start with a discussion on the FDI intensity indices of ASEAN. First, as reported in Table 8, the level of intra-regional FDI integration is quite different across the ten country members. For instance, Brunei Darussalam and Singapore's linkages in terms of FDI inflows with ASEAN country members appear relatively weak, as the indices of intra-regional inward FDI preference are negative, while the main FDI destinations of these two countries are ASEAN regions. By contrast, Thailand has experienced a robust connection with ASEAN, since both indices of intra-regional FDI preferences are strongly positive. Second, there is no common and pronounced tendency of regional FDI integration. For instance, intra-regional FDI preferences have declined Singapore, particularly on the outward FDI side, while the opposite trend is true in the case of Malaysia. Third, our empirical results confirm the dominant role of five ASEAN founding members as FDI local suppliers, as the preference index is higher for outward FDI than for inward FDI.

We now turn our attention to the changes in intra-regional FDI integration due to an enlargement of ASEAN AFTA (from ASEAN to ASEAN+3). On the one hand, as showed in Table 4, ASEAN+3 is characterized by extremely high rates of intra-regional inward FDI preference (except the case of Brunei Darussalam). On the other hand, the enlargement of ASEAN seems to alter the structure of FDI introversion in East Asia. First, the participation of China, Korea and Japan in the "ASEAN + framework" model has modified the position of some ASEAN countries in the regional FDI mapping. For instance, instead of being a main

FDI supplier in ASEAN, Thailand has become a FDI destination in ASEAN+3. Second, the new comer countries, in particular China, have become the main rivals of ASEAN countries in attracting intra-regional FDI. Third, China can be seen as a FDI hub in ASEAN+3, which could be explained by the fact that larger host country's market may be associated with higher FDI due to larger potential demand and lower costs due to scale economies.

<Insert Table 8>

While the results of intensity indices allow us to detect the tendency of intra-regional FDI, those of centrality indices are used to assess whether FDI connectivity in the network is evenly distributed. To begin with, we report the degree centrality measures in Table 9, in which we distinguish weighted and unweighted network. The first index is degree centrality measuring how well connected a country to the rest of ASEAN+3 network. We find that in terms of both inward and outward FDI, large and/or advanced economies are ranked in the first positions. Among others, Singapore has experienced the best place in the network. Differing from advanced countries, developing countries appear less connected to the system due to their less open economies. On the other hand, Table 9 shows that the FDI position of each country in ASEAN+3 do not change much over the time (except the case of Korea).

<Insert Table 9>

The second index is strength centrality, which weights the FDI links according their value in current U.S. dollars. Table 9 draws a slightly different picture about FDI positions in ASEAN+3 network. On the one hand, in terms of inward FDI, China has maintained the first rank throughout the observation period, followed by Indonesia over 2001-2006 and by Singapore over the recent period. On the other hand, Japan and Singapore plays a central role in supplying FDI flows to ASEAN+3 network. In addition, we also reveal that the most important FDI flows are mainly transferred between large and/or advanced country members. In other words, small and less developed countries are only considered as the satellites in regional FDI network.

A look at the weighted network as measured by the stock of FDI by GDP does not change the previous results (see the last part of Table 9). The potential asymmetric position is enforced. Hence China, who ranks 5 in Out-degree and 1 in In-Degree, ranks now 9 and 1 respectively. The position of Japan is more strongly impacted, moving from the first position in terms of main capital supplier to the ASEAN+3 Region, to the 5th one when taking in account its level of wealth as measured by GDP. Singapore now becomes the first capital exporter in ASEAN+3.

The last set of centrality indicators, which are reported in Tables 10a and 10b, assesses not only the number and amount of connections, but also the influence of each country on a specific network. The values of eigenvector centrality confirm the most important FDI positions in FDI network of large and/or advanced economies, in particular China and Japan. Nevertheless the position is not as so strong when looking at the absolute values (Table 10a) rather than the relative ones (Table 11b). Anyway, it means that these countries are not only very well connected, but also have FDI link with most of relevant players in the regional network. By contrast, developing countries are only considered as relatively peripheral countries (such as Cambodia, Lao PDR, Myanmar) with such a small eigenvector centrality index. Singapore is the more connected when taking in account the country size.

<Insert Table 10a and 10b>

Eigenvector centrality is also decomposed into hub score and authority score. This decomposition allows one to determine the role in supplying or receiving of a country, in FDI network. Not surprisingly, China has been ranked first in terms of authority, implying that China has been the most important FDI destination in ASEAN+3. As suggested in a survey work released by OECD (2000), the main factors, which make China become an attractive destination for foreign investors, can be classified into six sub-categories: (i) China's market size and economic growth performance; (ii) natural and human resource endowments; (iii) the infrastructure quality; (iv) the degree of trade openness and access to international markets; (v) the institutional quality; and (vi) the investment policies. In terms of being a Hub, the position of China is not so good, being at the 7th position in absolute value and the 11th one in relative value. After China, ASEAN emerging countries, notably Indonesia, Thailand and Singapore, have occupied the following positions in terms of FDI recipients. Looking at the values of hub score, Japan has been the first hub in ASEAN+3 FDI network, followed by Korea and Singapore. Taking in account the GDP, Singapore moved to the first position. In general, China and Japan play a central role in ASEAN+3's FDI network: China is a leading authority, while Japan is by far the most important supplier.

<Insert Figure 3>

Eigenvector centrality indices also allows us to map FDI distribution in ASEAN+3. The width of the link between two countries is proportional to their eigenvector centrality. As

displayed in Figure 3, ASEAN+3's FDI looks geographically segmented, with the central role played by three new-comer countries (Japan, Korea, and China), on one side, and ASEAN founding member states (Indonesia, Thailand, Malaysia, and Singapore), on the other side. In other words, ASEAN+3's FDI activities are quite dominated by large and/or advanced economies, while developing country members seem to stand outside the crowd. Overall, the asymmetry of the FDI map results in an open question about the role of ASEAN+3 in coordinating regional FDI flows in order to reduce the inequality of FDI distribution among country members.

Finally, when comparing the results of the exports and FDI networks, the following facts can be highlighted. First, as shown in Table 11b, the correlations between the Out measures (Out-Degree and Hub) and the In measures (In-Degree and Authority) are strongly negatives within the trade network and between trade and financial networks. Within the financial network, Out-Degree and In-Degree are not negatively correlated, meaning that ASEAN+3 countries have a more symmetric position in the financial network. Such a strong specialization does not appear in the network weighted by the absolute values (see Table 11a). Figure 4 highlights that no country is a hub (resp. Authority) for exports and an authority (resp. Hub) for FDI. The asymmetry in the network is measured first by the difference between the ranks in Out-degree and In-Degree. A positive (resp. negative) value means that the country is mainly an exporter (resp. importer) in the ASEAN+3 area. The second measure is the difference between the rankings as a Hub or an Authority. A positive value means that the country is mainly a Hub (resp. Authority). As shown in Figure 4 and reported in Table 11, no country, except Thailand, appears in the top left and bottom right spaces. This implies that no country is at the same time a Hub and an importer, or an Authority and an exporter. Regarding the the trade and financial networks' specialization, China's position, which is clearly in the bottom right space in both networks, means that China is importing from the ASEAN+3 countries both goods and capital, while exporting outside the Region. By contrast, the position of Japan is not identical in goods and capital networks. While Japan is importing goods from ASEAN+3 as China in order to export outside the region (e.g. an intra-regional "export hub" for getting outside), in terms of capital flows its relationship with the other ASEAN+3 Countries is more symmetric. To a lesser extent, Korea is opposite to Japan, being in a more neutral position in the trade network, and

a provider of financial capital to the region. At the opposite, Vietnam is mainly an exporter of goods to the region, but a capital receiver.

6. Conclusion

The present paper has investigated the properties of ASEAN+3's economic integration by using both weighted and unweighted network analysis. To the best of our knowledge, this paper is also the first one employing the network approach to study FDI integration's issues in a specific economic region. In this regard, our empirical research provides a number of important findings.

First, the level of trade and FDI integration varies among ASEAN+3 member states over the observation period. Second, ASEAN+3's intra-regional trade network is more densely connected than its intra-regional FDI network. Third, comparing to standard statistics, network analysis allows one to explore not only the first-order but also the second- and higher-order trade and FDI relationships of any given country in the world or in a specific region. Therefore, following the results of network analysis, we reveal that large and/or advanced countries tend to be better linked and to form a sub-regional bloc of tightly connected economies. In other words, this paper supports a major evidence that larger and richer countries are central players in ASEAN+3's trade and FDI network. Consequently, ASEAN+3 has experienced a widening gap in the trend and patterns of intra-regional trade and FDI among country members.

On the other hand, we also find that the enlargement from ASEAN to ASEAN+3 can be seen as a main factor altering the structure of economic integration in East Asia. However, this enlargement seems only strengthen trade and FDI connections among large and/or advanced economies. This result suggests that ASEAN+3 does not complement, but is gradually substituting ASEAN in terms of economic integration, only in favor of founding ASEAN countries (Singapore, Thailand, Indonesia, and Malaysia) and three new comer countries (China, Korea, and Japan).

A set of policy implications can be derived from our empirical findings. First, ASEAN+3 policy makers should revisit the existing intra-regional trade and investment agreements in order to restructure trade and FDI connections among country members. Second, poorly connected nodes (developing countries) should be facilitated to connect to central ones (central countries in regional trade and FDI map) and use them as hubs to link with the rest of ASEAN+3 network.

To conclude, our present research basing on the network approach provides a better understanding of the properties of ASEAN+3's economic integration, but it does not link the empirical results with trade and FDI theory. In other words, this work does not attempt to test empirically a theoretical model or to address specifically a trade and FDI issue. Therefore, investigating the properties of ASEAN+3's economic integration via a theoretical model will be carried out in our future research.

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Table 5: Trade intensity indices

Country	1990 - 1997				1998 - 2005				2006-2010				2011 - 2013			
	RIP	REP	RTL	TB	RIP	REP	RTL	TB	RIP	REP	RTL	TB	RIP	REP	RTL	TB
ASEAN																
Brunei Darussalam	-0.10	-0.22	-0.06	8.57	0.64	0.42	-0.11	25.13	0.89	0.57	-0.16	44.54	0.88	0.47	-0.21	48.32
Cambodia	-	-	-	-15.01	0.81	-0.15	-0.48	-10.21	0.81	0.17	-0.32	-5.88	0.67	0.35	-0.16	-6.39
Indonesia	0.25	0.46	0.11	1.02	0.67	0.54	-0.07	7.39	0.77	0.58	-0.09	0.34	0.71	0.61	-0.05	-0.72
Lao PDR	-	-	-	-13.74	-0.06	-0.15	-0.05	-10.84	0.95	0.85	-0.05	-8.55	0.93	0.83	-0.05	-2.98
Malaysia	0.61	0.75	0.07	-0.45	0.71	0.68	-0.02	20.37	0.71	0.68	-0.01	3.39	0.70	0.67	-0.01	12.42
Myanmar	-	-	-	-0.96	0.90	0.86	-0.02	-0.15	0.89	0.89	0.00	0.00	0.86	0.86	0.00	0.00
Philippines	0.35	0.42	0.04	-6.92	0.57	0.48	-0.04	-6.19	0.69	0.50	-0.09	-1.46	0.62	0.49	-0.07	-3.60
Singapore	0.64	0.74	0.05	13.59	0.75	0.73	-0.01	21.00	0.72	0.77	0.02	26.30	0.62	0.73	0.06	23.95
Thailand	0.43	0.61	0.09	-4.84	0.59	0.57	-0.01	7.60	0.61	0.63	0.01	6.48	0.52	0.65	0.07	2.99
Vietnam	-	-	-	-8.11	0.73	0.50	-0.12	-5.97	0.67	0.47	-0.10	-9.74	0.52	0.40	-0.06	1.15
ASEAN+3																
Brunei Darussalam	-0.17	-0.03	0.07	8.57	0.54	0.65	0.05	25.13	0.80	0.84	0.02	44.54	0.79	0.83	0.02	48.32
Cambodia	-	-	-	-15.01	0.70	-0.57	-0.64	-10.21	0.74	-0.43	-0.59	-5.88	0.60	-0.17	-0.38	-6.39
Indonesia	0.52	0.67	0.07	1.02	0.64	0.61	-0.02	7.39	0.69	0.60	-0.05	0.34	0.68	0.61	-0.03	-0.72
Lao PDR	-	-	-	-13.74	-0.10	-0.41	-0.16	-10.84	0.90	0.56	-0.17	-8.55	0.90	0.50	-0.20	-2.98
Malaysia	0.68	0.61	-0.04	-0.45	0.70	0.50	-0.10	20.37	0.67	0.53	-0.07	3.39	0.62	0.57	-0.02	12.42
Myanmar	-	-	-	-0.96	0.92	0.68	-0.12	-0.15	0.90	0.73	-0.08	0.00	0.90	0.79	-0.05	0.00
Philippines	0.53	0.38	-0.08	-6.92	0.62	0.43	-0.10	-6.19	0.61	0.50	-0.06	-1.46	0.55	0.56	0.00	-3.60
Singapore	0.65	0.48	-0.08	13.59	0.67	0.52	-0.07	21.00	0.60	0.58	-0.01	26.30	0.45	0.51	0.03	23.95
Thailand	0.66	0.49	-0.09	-4.84	0.68	0.47	-0.11	7.60	0.64	0.49	-0.08	6.48	0.57	0.50	-0.04	2.99
Vietnam	-	-	-	-8.11	0.77	0.50	-0.13	-5.97	0.76	0.37	-0.20	-9.74	0.73	0.36	-0.19	1.15
China	0.09	-0.06	-0.07	1.77	0.53	0.19	-0.17	3.07	0.36	-0.03	-0.19	6.48	0.15	-0.08	-0.11	2.62
Japan	0.34	0.20	-0.07	1.46	0.51	0.25	-0.13	1.49	0.46	0.35	-0.05	0.94	0.39	0.39	0.00	-1.91
Korea	0.50	0.38	-0.06	-1.20	0.56	0.38	-0.09	6.27	0.50	0.40	-0.05	1.95	0.35	0.44	0.04	3.12

Notes: RIP: Revealed import preference; REP: Revealed export preference; RTL: Revealed trade leadership; TB: Trade balance (% of GDP)

Table 6a: Trade weighted degree centrality indices (Export values)

Country	1990 - 1997				1998 - 2005			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei Darussalam	179.75	10	131.04	10	225.77	10	103.76	12
Cambodia	12.23	12	57.38	12	12.62	12	142.70	11
Indonesia	1,759.33	6	1,201.02	7	2,658.31	6	2,316.98	7
Lao PDR	6.82	13	25.54	13	10.95	13	85.80	13
Malaysia	2,181.13	5	2,679.15	4	3,603.64	5	4,136.91	5
Myanmar	44.87	11	116.82	11	110.12	11	196.23	10
Philippines	426.23	8	855.67	8	1,179.28	8	1,811.18	8
Singapore	3,158.96	2	3,849.24	2	5,596.99	3	5,021.33	4
Thailand	1,412.85	7	2,107.35	6	2,592.02	7	2,920.31	6
Vietnam	187.67	9	305.49	9	631.78	9	1,010.23	9
China	2,767.77	4	2,413.49	5	7,960.26	2	8,156.67	2
Japan	7,915.29	1	6,111.64	1	11,390.39	1	10,014.26	1
Korea	2,815.25	3	3,014.34	3	5,581.44	4	5,637.21	3
Country	2006 - 2010				2011- 2013			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei Darussalam	541.52	10	277.59	12	802.83	12	553.74	12
Cambodia	43.35	13	466.62	10	129.38	10	961.27	11
Indonesia	5,655.49	7	6,473.36	6	9,207.84	6	10,865.27	6
Lao PDR	56.83	12	172.42	13	191.26	13	424.94	13
Malaysia	7,284.98	5	8,174.90	5	10,391.51	5	11,490.16	5
Myanmar	329.12	11	460.41	11	588.65	11	1,158.32	10
Philippines	1,864.76	8	3,206.95	9	2,340.38	9	4,690.03	9
Singapore	13,431.71	3	9,941.89	4	17,065.32	4	12,806.40	4
Thailand	6,148.57	6	6,421.43	7	9,323.44	7	10,186.52	7
Vietnam	1,811.87	9	3,691.17	8	3,911.22	8	7,493.02	8
China	22,642.83	1	24,385.59	1	37,135.44	1	35,790.92	1
Japan	21,999.93	2	18,783.33	2	27,315.86	2	26,170.32	2
Korea	13,194.96	4	12,550.25	3	21,120.07	3	16,932.27	3

Table 6b: Trade weighted degree centrality indices (Exports/GDP values)

Country	1990 - 1997				1998 - 2005			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei Darussalam	2.43	9	0.14	10	3.56	2	0.07	12
Cambodia	0.45	12	0.05	12	0.30	13	0.12	10
Indonesia	4.09	7	0.54	7	1.45	8	1.47	7
Lao PDR	0.27	13	0.02	13	0.59	10	0.04	13
Malaysia	15.64	4	2.13	4	3.50	3	2.78	3
Myanmar	0.81	11	0.09	11	1.18	7	0.11	11
Philippines	2.86	8	0.39	8	1.39	6	0.70	9
Singapore	22.07	2	2.80	2	5.73	1	2.95	5
Thailand	17.51	3	2.24	3	1.88	4	2.60	4
Vietnam	1.27	10	0.16	9	1.57	5	0.64	8
China	5.72	6	0.91	6	0.51	11	2.73	2
Japan	54.21	1	7.06	1	0.31	12	6.69	1
Korea	10.62	5	1.52	5	0.89	9	1.94	6
Country	2006 - 2010				2011- 2013			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei Darussalam	4.40	2	0.06	13	4.84	2	0.08	13
Cambodia	0.44	13	0.21	10	0.91	11	0.28	10
Indonesia	1.12	9	2.92	4	1.07	8	2.35	6
Lao PDR	1.01	10	0.06	12	1.93	6	0.10	12
Malaysia	3.52	3	2.60	6	3.43	3	2.37	5
Myanmar	1.36	6	0.11	11	0.96	9	0.16	11
Philippines	1.17	8	0.74	9	0.94	10	0.64	9
Singapore	7.06	1	2.62	5	5.97	1	2.34	7
Thailand	2.33	4	3.07	3	2.55	4	2.94	3
Vietnam	1.95	5	0.97	8	2.53	5	1.46	8
China	0.54	11	4.72	2	0.45	13	6.04	2
Japan	0.46	12	6.19	1	0.49	12	6.40	1
Korea	1.29	7	2.37	7	1.70	7	2.61	4

**Figure 2: Evolution of the asymmetry in the rank of the weighted degree centrality indexes
(Rank in Out-degree - Rank in In-degree)**

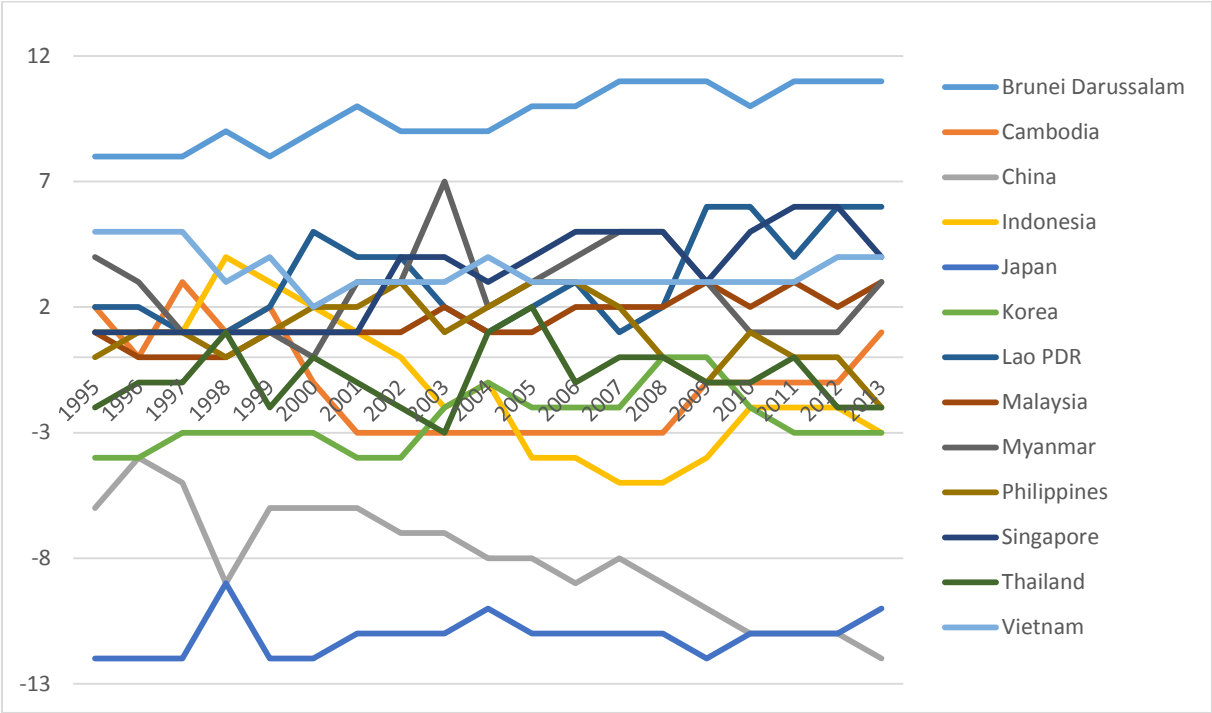


Table 7a: Trade centrality indices (X Network)

Country	1990 - 1997							1998 - 2005						
	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei	0.03	4.32	10	0.02	9	0.01	10	0.02	2.28	10	0.01	12	0.01	13
Cambodia	0.00	0.63	12	0.00	12	0.00	12	0.01	0.71	12	0.00	13	0.01	12
Indonesia	0.21	29.92	7	0.20	6	0.18	7	0.17	24.29	6	0.21	6	0.17	7
Lao PDR	0.00	0.23	13	0.00	13	0.00	13	0.00	0.43	13	0.03	11	0.02	11
Malaysia	0.28	39.45	5	0.24	5	0.32	5	0.22	30.79	5	0.26	4	0.27	5
Myanmar	0.01	1.31	11	0.00	11	0.01	11	0.01	1.44	11	0.05	9	0.06	10
Philippines	0.09	12.96	8	0.04	8	0.12	8	0.11	15.72	8	0.06	8	0.11	8
Singapore	0.38	53.99	3	0.26	4	0.46	2	0.28	40.20	4	0.24	5	0.29	4
Thailand	0.24	34.41	6	0.14	7	0.31	6	0.17	23.63	7	0.13	7	0.17	6
Vietnam	0.03	4.59	9	0.02	10	0.03	9	0.05	7.75	9	0.04	10	0.07	9
China	0.33	47.06	4	0.28	2	0.35	4	0.52	72.96	2	0.49	2	0.52	1
Japan	0.63	88.44	1	0.81	1	0.39	3	0.59	82.76	1	0.59	1	0.46	2
Korea	0.39	55.53	2	0.27	3	0.50	1	0.43	60.47	3	0.33	3	0.40	3

Country	2006 - 2010							2010 - 2013						
	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei	0.02	2.61	10	0.01	10	0.01	12	0.02	3.10	10	0.01	10	0.01	12
Cambodia	0.01	0.99	12	0.00	13	0.01	11	0.01	1.67	12	0.00	13	0.01	11
Indonesia	0.17	24.36	6	0.14	6	0.15	7	0.19	27.48	5	0.17	6	0.19	7
Lao PDR	0.00	0.32	13	0.00	12	0.00	13	0.00	0.69	13	0.00	12	0.00	13
Malaysia	0.18	25.39	5	0.17	5	0.19	5	0.19	27.19	6	0.18	5	0.19	6
Myanmar	0.01	1.51	11	0.01	11	0.01	10	0.02	2.76	11	0.01	11	0.02	10
Philippines	0.07	10.56	9	0.05	8	0.08	9	0.08	11.43	9	0.05	9	0.09	9
Singapore	0.26	36.68	4	0.27	4	0.23	4	0.24	34.26	4	0.26	4	0.22	4
Thailand	0.16	22.16	7	0.14	7	0.17	6	0.18	24.84	7	0.15	7	0.19	5
Vietnam	0.09	12.70	8	0.04	9	0.09	8	0.14	20.04	8	0.07	8	0.15	8
China	0.59	83.19	1	0.45	2	0.73	1	0.60	85.05	1	0.53	2	0.69	1
Japan	0.54	76.59	2	0.67	1	0.40	2	0.50	70.95	2	0.56	1	0.46	2
Korea	0.44	62.21	3	0.45	3	0.38	3	0.44	62.21	3	0.49	3	0.35	3

Table 7b: Trade centrality indices (X/GDP Network)

Country	1990 - 1997							1998 - 2005						
	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei	0.34	47.82	4	0.53	2	0.01	12	0.34	47.82	4	0.53	2	0.01	12
Cambodia	0.03	3.64	13	0.03	12	0.01	11	0.03	3.64	13	0.03	12	0.01	11
Indonesia	0.22	30.83	7	0.19	5	0.20	7	0.22	30.83	7	0.19	5	0.20	7
Lao PDR	0.04	5.15	12	0.04	11	0.00	13	0.04	5.15	12	0.04	11	0.00	13
Malaysia	0.40	57.06	3	0.36	3	0.40	2	0.40	57.06	3	0.36	3	0.40	2
Myanmar	0.09	12.48	11	0.11	8	0.01	10	0.09	12.48	11	0.11	8	0.01	10
Philippines	0.14	19.88	9	0.18	7	0.08	8	0.14	19.88	9	0.18	7	0.08	8
Singapore	0.47	66.16	2	0.60	1	0.25	4	0.47	66.16	2	0.60	1	0.25	4
Thailand	0.26	36.28	5	0.22	4	0.24	5	0.26	36.28	5	0.22	4	0.24	5
Vietnam	0.14	19.41	10	0.19	6	0.05	9	0.14	19.41	10	0.19	6	0.05	9
China	0.22	31.13	6	0.07	10	0.25	3	0.22	31.13	6	0.07	10	0.25	3
Japan	0.48	68.01	1	0.02	13	0.70	1	0.48	68.01	1	0.02	13	0.70	1
Korea	0.20	27.94	8	0.10	9	0.23	6	0.20	27.94	8	0.10	9	0.23	6

Country	2006 - 2010							2010 - 2013						
	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank	Eigenvec	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei	0.34	48.23	4	0.57	2	0.0078	12	0.38	54.17	3	0.64	1	0.01	12
Cambodia	0.04	5.13	13	0.02	13	0.0162	10	0.08	10.58	12	0.07	11	0.02	10
Indonesia	0.30	41.71	6	0.11	8	0.4076	3	0.22	31.61	9	0.11	8	0.27	4
Lao PDR	0.05	7.09	12	0.05	11	0.0038	13	0.12	16.76	10	0.14	7	0.01	13
Malaysia	0.36	50.34	3	0.30	3	0.3458	4	0.32	45.66	5	0.32	3	0.25	5
Myanmar	0.08	11.90	11	0.09	9	0.0108	11	0.07	9.17	13	0.08	10	0.01	11
Philippines	0.11	15.60	10	0.12	7	0.0748	9	0.09	12.95	11	0.11	9	0.06	9
Singapore	0.48	67.28	1	0.65	1	0.1496	7	0.40	56.64	2	0.51	2	0.15	7
Thailand	0.23	33.06	7	0.22	4	0.1824	6	0.24	33.84	7	0.24	5	0.19	6
Vietnam	0.16	22.09	9	0.19	5	0.078	8	0.23	31.93	8	0.27	4	0.12	8
China	0.33	46.66	5	0.05	10	0.4168	2	0.36	51.44	4	0.04	12	0.46	2
Japan	0.41	58.53	2	0.04	12	0.6232	1	0.44	61.59	1	0.04	13	0.70	1
Korea	0.23	32.64	8	0.13	6	0.2564	5	0.27	37.99	6	0.18	6	0.29	3

Table 8: FDI intensity indices

Country	Revealed inward stock preference		Revealed outward stock preference		Revealed FDI leadership	
	2001-2006	2007-2012	2001-2006	2007-2012	2001-2006	2007-2012
ASEAN						
Brunei Darussalam	-0.74	-0.65	0.94	0.93	0.84	0.79
Cambodia	0.90	0.81	-0.75	0.37	-0.82	-0.22
Indonesia	-1.00	0.17	0.16	0.89	0.58	0.36
Lao PDR	0.14	0.83	-0.14	0.79	-0.14	-0.02
Malaysia	-1.00	0.36	-1.00	0.61	0.00	0.15
Myanmar	0.79	0.78	0.00	0.00	-0.40	-0.39
Philippines	0.43	0.04	-1.00	-0.17	-0.72	-0.11
Singapore	-0.13	-0.28	0.88	0.31	0.51	0.55
Thailand	0.52	0.59	0.92	0.92	0.20	0.16
Vietnam	0.23	0.26	0.00	0.00	-0.11	-0.13
ASEAN+3						
Brunei Darussalam	-0.75	-0.52	0.73	0.69	0.74	0.60
Cambodia	0.93	0.95	-0.93	-0.35	-0.93	-0.65
Indonesia	-1.00	0.25	0.18	0.88	0.59	0.32
Lao PDR	0.49	0.98	-0.36	0.65	-0.42	-0.20
Malaysia	-1.00	0.32	-1.00	0.35	0.00	0.01
Myanmar	0.50	0.72	0.00	0.00	-0.25	-0.36
Philippines	0.96	0.93	-1.00	-0.30	-0.98	-0.62
Singapore	0.71	0.59	0.70	0.69	-0.01	0.05
Thailand	0.95	0.97	0.73	0.80	-0.11	-0.09
Vietnam	0.78	0.91	0.00	0.00	-0.39	-0.45
China	0.75	0.54	-0.62	-0.70	-0.69	-0.62
Japan	-0.23	0.16	0.06	0.09	0.15	-0.03
Korea	0.92	0.93	0.69	0.46	-0.12	-0.23

Table 9: FDI degree centrality indices

Country	Unweighted Degree Centrality							
	2001-2006				2007-2012			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei	0.17	10	0.18	13	0.24	11	0.25	13
Cambodia	0.08	13	0.57	4	0.24	10	0.58	6
Indonesia	0.51	6	0.39	9	0.53	8	0.54	7
Lao PDR	0.17	11	0.22	12	0.17	13	0.33	11
Malaysia	0.47	7	0.42	8	0.72	6	0.50	10
Myanmar	0.14	12	0.31	11	0.19	12	0.33	12
Philippines	0.43	8	0.56	5	0.56	7	0.63	4
Singapore	0.99	2	0.83	1	1.00	1	1.00	1
Thailand	0.83	3	0.46	7	0.87	4	0.97	2
Vietnam	0.22	9	0.36	10	0.28	9	0.51	9
China	0.71	4	0.61	3	1.00	2	0.65	3
Japan	0.61	5	0.56	6	0.74	5	0.61	5
Korea	1.00	1	0.75	2	0.96	3	0.53	8

Country	Weighted Degree Centrality (Stock of FDI)							
	2001-2006				2007-2012			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei	17.39	7	3.68	13	19.52	9	13.54	13
Cambodia	0.15	11	23.27	11	2.01	12	261.55	11
Indonesia	181.19	4	1266.64	2	328.76	7	4116.99	3
Lao PDR	0.36	10	8.07	12	1.00	13	143.39	12
Malaysia	0.00	12	1191.95	3	3126.89	4	2892.48	5
Myanmar	0.53	9	96.50	10	4.45	10	433.70	10
Philippines	0.00	13	481.83	7	98.87	8	1196.41	8
Singapore	3337.14	2	1141.83	5	10495.34	2	4693.19	2
Thailand	175.42	5	1186.56	4	1053.78	6	3852.11	4
Vietnam	1.14	8	205.56	8	3.41	11	1299.64	7
China	162.38	6	3613.58	1	1368.02	5	12675.47	1
Japan	5068.11	1	178.50	9	13955.27	1	1001.82	9
Korea	1265.52	3	756.95	6	4315.83	3	1638.77	6

Country	Weighted Degree Centrality (Stock of FDI / GDP)							
	2001-2006				2007-2012			
	n-Outdegree	Rank	n-Indegree	Rank	n-Outdegree	Rank	n-Indegree	Rank
Brunei	0.0285	2	0.0002	12	0.0170	6	0.0007	13
Cambodia	0.0002	10	0.0017	11	0.0020	10	0.0043	11
Indonesia	0.0093	6	0.0628	3	0.0063	7	0.1425	2
Lao PDR	0.0010	7	0.0002	13	0.0018	11	0.0027	12
Malaysia	0.0000	11	0.0810	2	0.1218	2	0.1000	4
Myanmar	0.0003	9	0.0088	10	0.0018	12	0.0132	10
Philippines	0.0000	12	0.0190	6	0.0037	8	0.0215	8
Singapore	0.3530	1	0.0393	5	0.5492	1	0.1025	3
Thailand	0.0128	5	0.0397	4	0.0395	4	0.0850	5
Vietnam	0.0000	13	0.0125	8	0.0000	13	0.0248	7
China	0.0007	8	0.1447	1	0.0027	9	0.2765	1
Japan	0.0140	4	0.0123	9	0.0310	5	0.0373	6
Korea	0.0198	3	0.0175	7	0.0467	3	0.0135	9

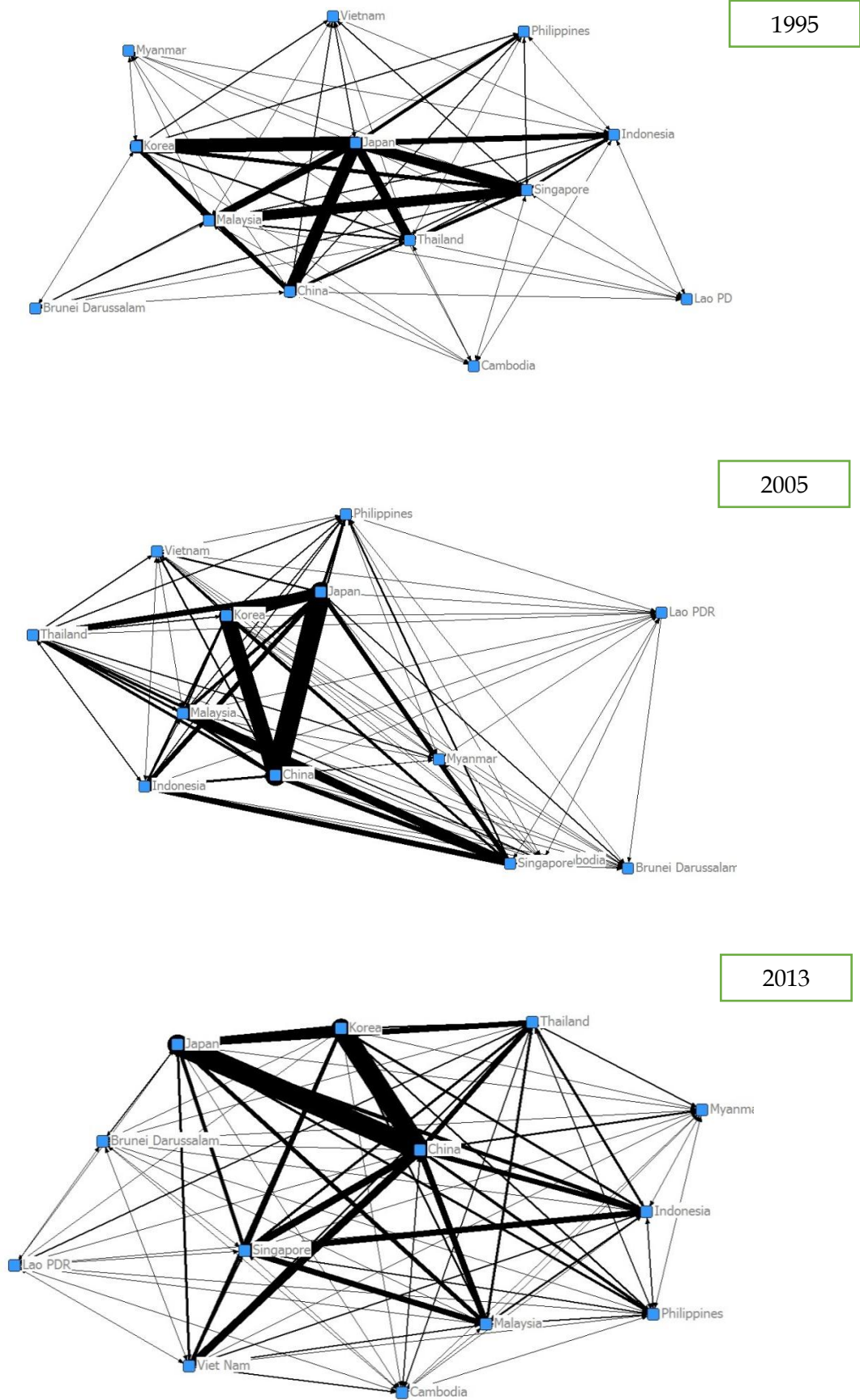
Table 10a: FDI centrality indices in the weighted Networks (FDI)

Country	2001-2006		2007-2012		2001-2006		2007-2012		2001-2006		2007-2012	
	nEigenvec	Rank	Hub	Rank	Authority	Rank	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei Darussalam	0.400	11	0.002	7	0.001	13	0.164	13	0.001	9	0.001	13
Cambodia	0.411	12	0.000	10	0.003	11	1.225	11	0.000	13	0.005	11
Indonesia	30.024	5	0.042	5	0.295	4	24.738	6	0.022	6	0.236	3
Lao PDR	0.134	13	0.000	10	0.001	12	0.792	12	0.000	12	0.002	12
Malaysia	26.871	7	0.000	10	0.277	5	23.027	7	0.058	4	0.210	5
Myanmar	1.603	10	0.000	9	0.012	10	2.552	10	0.000	10	0.016	10
Philippines	10.958	8	0.000	10	0.120	7	8.473	8	0.002	8	0.091	7
Singapore	67.351	3	0.524	2	0.310	2	65.905	3	0.577	2	0.220	4
Thailand	27.830	6	0.017	4	0.306	3	29.541	5	0.032	5	0.304	2
Vietnam	3.150	9	0.000	8	0.024	9	6.521	9	0.000	11	0.059	8
China	72.186	2	0.006	6	0.760	1	80.112	1	0.022	7	0.849	1
Japan	79.308	1	0.812	1	0.027	8	76.075	2	0.758	1	0.047	9
Korea	37.144	4	0.250	3	0.207	6	35.700	4	0.289	3	0.140	6

Table 10b: FDI centrality indices in the weighted Networks (FDI/GDP)

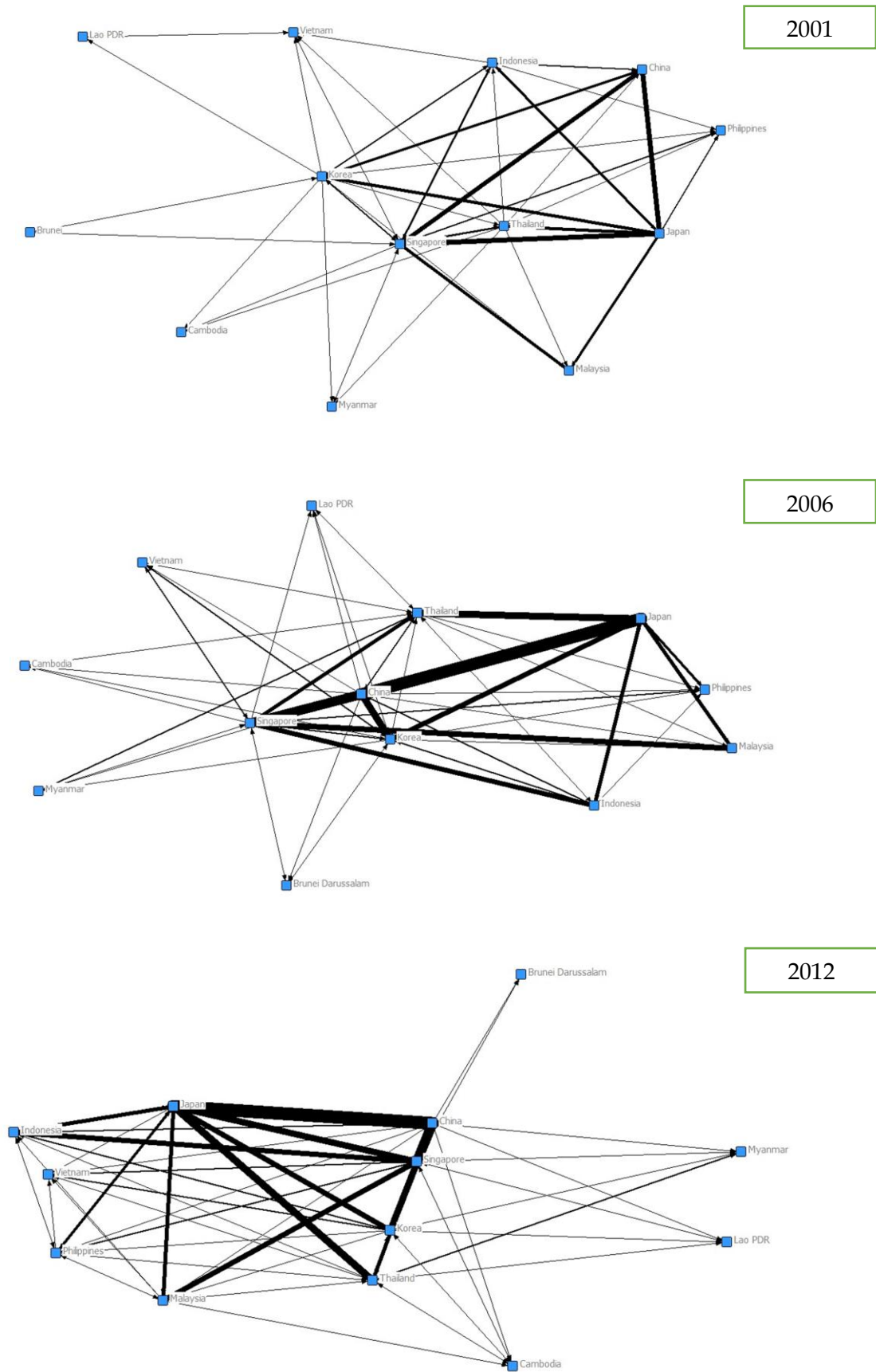
Country	2001-2006		2001-2006		2001-2006		2007-2012		2007-2012		2007-2012	
	nEigenvec	Rank	Hub	Rank	Authority	Rank	nEigenvec	Rank	Hub	Rank	Authority	Rank
Brunei Darussalam	17.1327	6	0.0003	8	0.0023	11	5.9227	9	0.0015	9	0.0022	13
Cambodia	0.7010	12	0.0002	9	0.0072	10	0.7415	12	0.0010	11	0.0040	11
Indonesia	36.5607	4	0.0253	4	0.3545	3	39.2337	4	0.0103	6	0.3623	2
Lao PDR	0.2617	13	0.0005	6	0.0022	12	0.6235	13	0.0020	7	0.0028	12
Malaysia	46.6070	3	0.0000	10	0.4867	2	40.0742	3	0.0832	3	0.3408	3
Myanmar	3.8705	11	0.0000	12	0.0368	9	3.6512	11	0.0003	12	0.0363	9
Philippines	10.0818	8	0.0000	11	0.1035	5	6.1740	8	0.0015	8	0.0610	6
Singapore	98.7752	1	0.9972	1	0.0020	13	96.9638	1	0.9893	1	0.0232	10
Thailand	22.7742	5	0.0162	5	0.2210	4	26.7727	5	0.0332	5	0.2447	4
Vietnam	5.1215	10	0.0000	13	0.0495	8	4.6872	10	0.0000	13	0.0393	7
China	73.2335	2	0.0005	7	0.7437	1	78.7878	2	0.0010	10	0.8152	1
Japan	9.4148	9	0.0298	3	0.0685	7	15.0883	6	0.0472	4	0.1140	5
Korea	15.3870	7	0.0635	2	0.0977	6	12.3627	7	0.0930	2	0.0387	8

Figure 3: Changes in ASEAN+3's trade mapping



Source: Authors' creation'

Figure 4: Changes in ASEAN+3's FDI mapping



Source: Authors' creation

Table 11a: Pearson Correlation Matrix of the measures of the 2012 weighted network (Flows of X or stock of FDI).

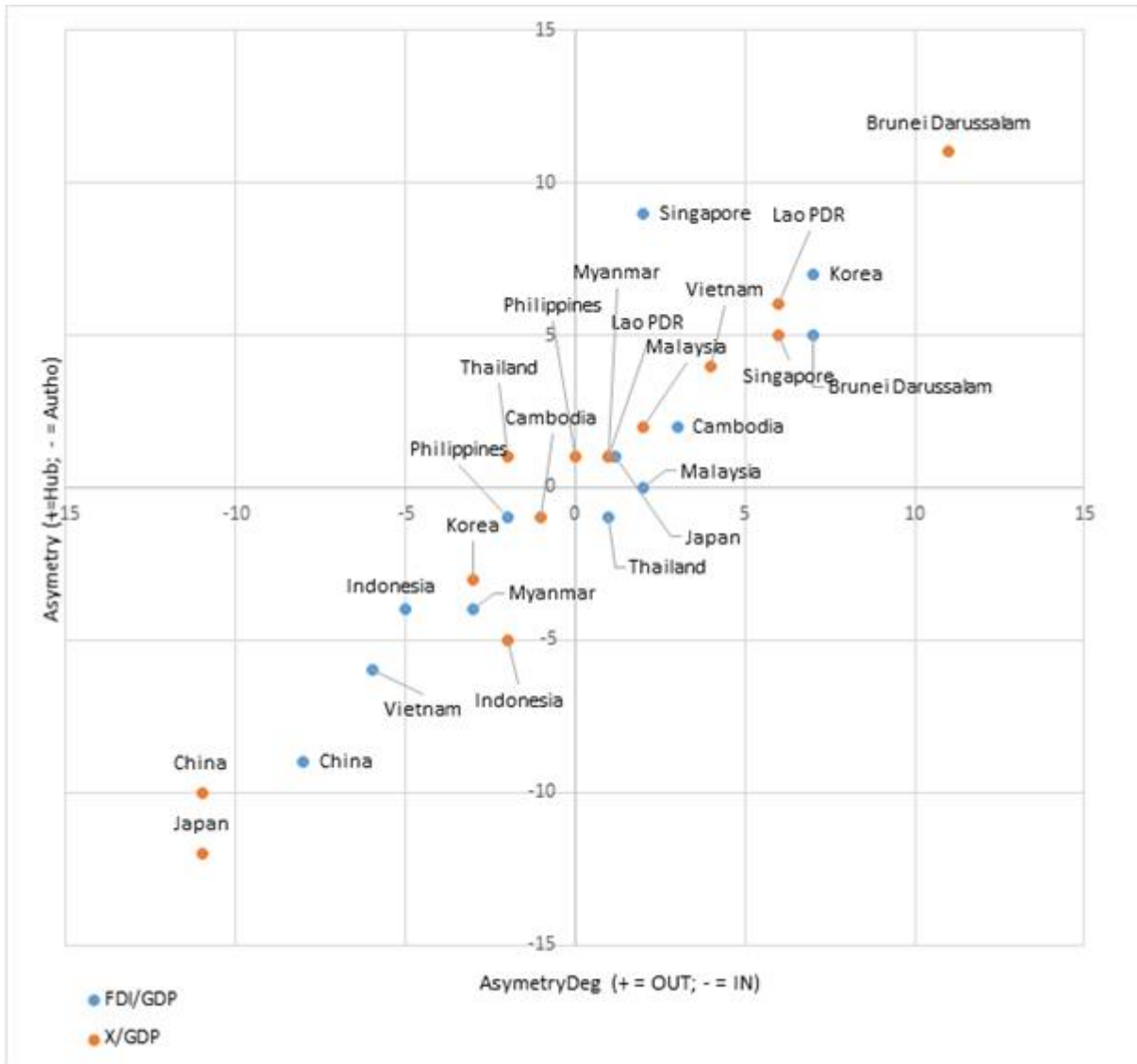
		X					FDI				
		OutDeg	InDeg	Eig.	Hub	Auth.	OutDeg	InDeg	Eig	Hub	Auth
X	OutDeg	1									
	InDeg	0.987	1								
	Eig.	0.984	0.97	1							
	Hub	0.948	0.907	0.978	1						
	Auth.	0.982	0.994	0.979	0.917	1					
FDI	OutDeg	0.779	0.798	0.681	0.554	0.775	1				
	InDeg	0.504	0.428	0.571	0.709	0.421	-0.051	1			
	Eig.	0.96	0.931	0.93	0.914	0.912	0.763	0.604	1		
	Hub	0.783	0.802	0.688	0.56	0.782	1	-0.053	0.762	1	
	Auth.	0.501	0.43	0.561	0.685	0.423	-0.008	0.985	0.627	-0.01	1

Table 11b: Pearson Correlation Matrix of the measures of the 2012 weighted network (Flows of X to GDP, or stock of FDI to GDP).

		X/GDP					FDI/GDP				
		OutDeg	InDeg	Eig.	Hub	Auth.	OutDeg	InDeg	Eig	Hub	Auth
X/GDP	OutDeg	1									
	InDeg	-0.29	1								
	Eig.	0.434	0.663	1							
	Hub	0.934	-0.326	0.463	1						
	Auth.	-0.353	0.952	0.642	-0.361	1					
FDI/GDP	OutDeg	0.716	0.085	0.416	0.474	-0.003	1				
	InDeg	-0.118	0.614	0.358	-0.175	0.408	0.167	1			
	Eig.	0.325	0.496	0.514	0.156	0.298	0.695	0.82	1		
	Hub	0.671	0.071	0.377	0.432	-0.015	0.984	0.151	0.685	1	
	Auth.	-0.314	0.613	0.272	-0.296	0.437	-0.123	0.944	0.61	-0.158	1

Source: Authors' creation

Figure 5: Specialization as measured by asymmetry in network rankings in 2012



Source: Authors' creation