# Formation of production networks in ASEAN: Measuring the real value-added and identifying the role of ASEAN countries in the world supply chains

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# Formation of production networks in ASEAN: Measuring the real value-added and identifying the role of ASEAN countries in the world supply chains

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**Abstract:**

This study addresses the two-fold question of whether the integration-liberalization process of ASEAN is headed towards the creation of a single production base region, and how ASEAN links with other trade blocks. It looks into the degree of intra-ASEAN and extra-ASEAN vertical integration vis-à-vis North America, East Asia, and the European Union through the measurement of value-added creation-absorption in global value chains (GVC) and by locating ASEAN within vertical structures. The study employs an international input-output database and breaks up gross exports into different components of value-added using data from 1997, 2004, and 2012. ASEAN has made significant gains in integrating with East Asia. However, ASEAN as a single production region has gained little, and even lost share in value-added trade with NAFTA and Europe. The truth is that ASEAN has a stronger role across the GVC as a supplier of intermediate goods (33%) than as a supplier of final goods (30%). Vertical structures represent more than 43% of ASEAN gross exports, but it still depends on foreign parts and components (35%) to produce its exports. It may be argued that ASEAN + 6, which entails a wider scope of integration, might offer larger benefits to the ASEAN project.

**JEL Classifications:** F10, F14, F15

**Keywords:** Vertical specialization, AFTA, production networks, value-added trade, global input-output

## 1. Introduction

The Association of Southeast Asian Nations (ASEAN) is undergoing a regional and international integration-liberalization process resulting in gains and challenges. One of the main targets of the ASEAN Free Trade Agreement (AFTA) 2015 is the free movement of goods, services, and investment across ASEAN, and thus become a single production base able to connect and to compete globally. A second and no less important target is its integration into the global economy. However, the patterns and degrees of liberalization across ASEAN countries often follow different integration paths (self-policy focus, extra-ASEAN rather than intra-ASEAN integration), which raises doubts on the feasibility of any of its targets.

Asia is moving towards a more integrated region with the peculiarity of having a fragmented manufacturing structure as a starting point. The pattern of vertical specialization in the region is characterized by a large and rapid expansion on back-and-forth transactions in parts and components (henceforth, IPC) in the form of intra-industry trade. The World trade in IPC increased from about $440 billion in 1992 to nearly $1,000 billion in 2003, and more than $8,000 billion in 2012, accounting for almost a third of the

expansion of manufacturing trade (Athukorala & Yamashita, 2006; Johnson & Noguera, 2012a; Koopman, Powers, Wang, & Wei, 2010). Asia (not including Japan) moved from a 14.1 percent share in IPC in 1990 to 43% percent in 2012, while the six main ASEAN members reached almost 50% in 2012. Asia's advanced production networks have experienced a spectacular global success in the last decades, with a remarkable increase in IPC (Ando, 2008; Kimura, 2006). The share of gross exports corresponding to vertical structures for manufacturing industries moved from 22.5% in 1995 to 30.8 in 2011, with the peculiarity of goods crossing borders more than twice from 19% in 1995 to 25% in 2011(Wang, Wei, & Zhu, 2013).

Those new forms of integration require more dynamic and efficient links to benefit from all the potentials of the region: a large and diverse labor pool, access to raw materials, differences in price factors, a growing population, the rapid economic expansion of most of the regional members, and so on.

This paper examines the participation of ASEAN in global production sharing by addressing the questions of whether the single production base project (producing goods and services together) is an achievable target for ASEAN as the region becomes more integrated; how important is ASEAN's participation in these fragmented structures, to the extent and the way ASEAN integrates with or adds value to the main trading blocks; and to what extent and manner ASEAN is becoming more integrated into the global value chain.

Measuring the participation of ASEAN in global value chains has strong implications for trade policy. In the first place, it allows ASEAN to measure the achievement of its regional targets as a single market and production base. It also permits one to distinguish the role of ASEAN in global value chains, either as a participant in a one-way trade or in structures requiring multiple cross-border transactions that often require more complex and efficient service links. Moreover, it offers valuable insights into the links created both backward and forward with other regions in the World, which help establish ASEAN's role in a particular segment of the GVC and address trade efforts towards stronger partnerships. Value-added also offers indicators on how value is incorporated into ASEAN exports, both by measuring intra-ASEAN content and foreign content, allowing one to evaluate if further integration is helping the creation of domestic networks (higher domestic value added) and creating dependency towards foreign players. It also makes it possible to measure and to address potential benefits by extending the agreement to other countries (i.e., ASEAN + Six). This better understanding of ASEAN within GVCs is the primary objective of this study.

To answer those questions an adjusted world input-output table is employed to decompose value added of ASEAN's gross exports according to where the value of ASEAN gross exports is created and where it is finally absorbed, i.e., either the value goes through intermediate goods (IPC) or final goods or it remains in the region or spreads across the world. The study considers three periods (1997, 2004 and 2012) to compare the integration process across time, as ASEAN economic integration has been in progress since more than two decades ago. The study also compares three main economic regions (trading blocks) to analyze interactions of ASEAN with East Asia (EA from now on), North America (NAFTA), and European Union (EU).

This study is expected to contribute to the existing literature of world input-output analysis, offering an application of indicators of value-added through value-added decomposition methods based on input-output tables as in (Koopman et al., 2010; Koopman, Wang, & Wei, 2012; Wang et al., 2013). While some studies decomposed value-added based on domestic or foreign content, this study goes further and decomposes value-added based on the original source of creation, the final destination, and accounts for the gross export value-added that is often double-counted in common applications of studies based on Leontief input-output tables. This is among the first studies to analyze the integration of ASEAN through vertical structures, using a world

input-output table and tracing the ASEAN value-added across the world. This study is carried out at the country - region level of aggregation, as it aims to analyze regional integration at country-region level, rather than doing so per industry.

## 2. Empirical studies

Taking into account the scope stated in the introduction, the empirical review focuses on two issues: the nature of vertical structures and evidence on factors that promote fragmentation (summarized in Figure 1), and the methodologies on measuring vertical specialization.

The first issue is needed to distinguish one-way and traditional trade flows from trade originated from vertical structures characterized by splitting of production activities across different countries (which means that parts/goods cross borders multiple times to be integrated into final goods before they are finally consumed). Understanding the nature of vertical structures is vital as it is used as a proxy to measure the ASEAN single production base initiative, and that it gives insights on how ASEAN can further expand within these structures. It is also important to understand the conditions necessary for this kind of structures to take place, or the factors that promote its creation.

### 2.1 The nature of vertical structures and factors promoting vertical specialization

Splitting of production activities result from: 1) complete transfers of production activities to single new locations (Athukorala & Menon, 2010) or to arm's length relationships where international buyers link producers and sellers in developed and developing countries, (Athukorala & Yamashita, 2006; Haddad, 2007); and 2) fragmented-specialized processes distributed across countries, engaged in back-and-forth transactions on parts and components (IPC) (Haddad, 2007).

Jones & Kierzkowski (1990) developed a general framework for production fragmentation as production block, which connects each other by service links such as transportation, communication, and coordination. Ando (2006, 2008) and Dean, Fung, & Wang (2008) presented vertical structures as production activities sliced thinner and thinner into many stages, carried out in suitable locations for their particular activities. Hummels, Ishii, & Yi (2001) described it as "a sequential, vertical trading chain stretching across many countries, with each country specializing in particular stages." This visualization of value-added creation is employed as a proxy to measure the single production base initiative of ASEAN where country members allocate available and productive resources into the production of goods-services carried out together.

For production fragmentation to take place, Ando (2006, 2008) and Obashi (2010) explained that the splitting of activities along different locations requires low service links cost, efficient transportation and telecommunications, various coordination tasks, and dependence on factors such as labor cost, distance, trade cost, and so on. Athukorala & Yamashita (2006) added that those cost differentials allow firms to specialize and to scale into global production sharing. As production cost lowers, technology spreads, and countries become more integrated, it is expected that production fragmentation will play a more important role in global chains. The presence and active implementation of these supportive elements are valuable to explain the success or the slow process of insertion into GVCs by some regions.

Another important factor is the regional policies. Some literature review coincides with an extended version of ASEAN being more feasible than a fully integrated, single ASEAN. Ando (2008) found greater economic effects on full liberalization in ASEAN plus six strategic members (China, Japan, South Korea, India, Australia, New Zealand) rather than

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individual FTAs. Obashi (2010) found that FTAs between Japan, Korea, China, and ASEAN have the largest potential for production networks expansion and stable relations. Kimura (2006) and Urata (2008) identified MNE's, their investment flows, and technological transfers to support the creation of networks in EA, indicating that ASEAN still relies on external players (particularly East Asian countries) to drive the expansion of vertical structures and as channels to reach new markets. In fact, the rapid growth of vertical structures in Asia has created robust and increasing interdependence within ASEAN and EA countries, larger than NAFTA and more dynamic than EU (Ando & Kimura, 2003; Haddad, 2007). However, a strong interdependence in AFTA trade towards extra-regional trade in final goods has been noted by Athukorala & Yamashita (2006) and Daudin, Schweisguth, & Rifflart (2001).

The fast expansion of East Asian vertical structure networks offers positive experiences for ASEAN, and it traces necessary changes in policy if ASEAN is to expand in GVCs. Ando & Kimura (2003) portrayed the dual track strategy in EA which is successful in fostering both import-substituting and export-oriented policies, mainly in IPC. Haddad (2007) recognized that policies supporting lower tariffs, transportation costs, and technology transfers had fostered production share in East Asia. Ando & Kimura (2003) and Obashi (2010) identified service links to help agglomeration effects to take place; Dean et al., (2008), Haddad (2007) and Yi (2003) believed in rapid growth in trade in inputs; Koopman et al., (2010) pointed out the role of tariffs; Athukorala & Yamashita (2006) considered distance key as multiple border-crossing is essential; Ando (2008) indicated regulatory barriers and common rules as key to increasing efficiency of agreements; Ando & Kimura (2003) noted the strategic role of MNC's in orchestrating vertical trade; Johnson & Noguera (2012b) found trade barriers, distance, and RTA's as key determinants. Figure 1 displays factors promoting vertical specialization found in some empirical studies.

FIGURE 1. FACTORS PROMOTING THE CREATION OF PRODUCTION NETWORKS
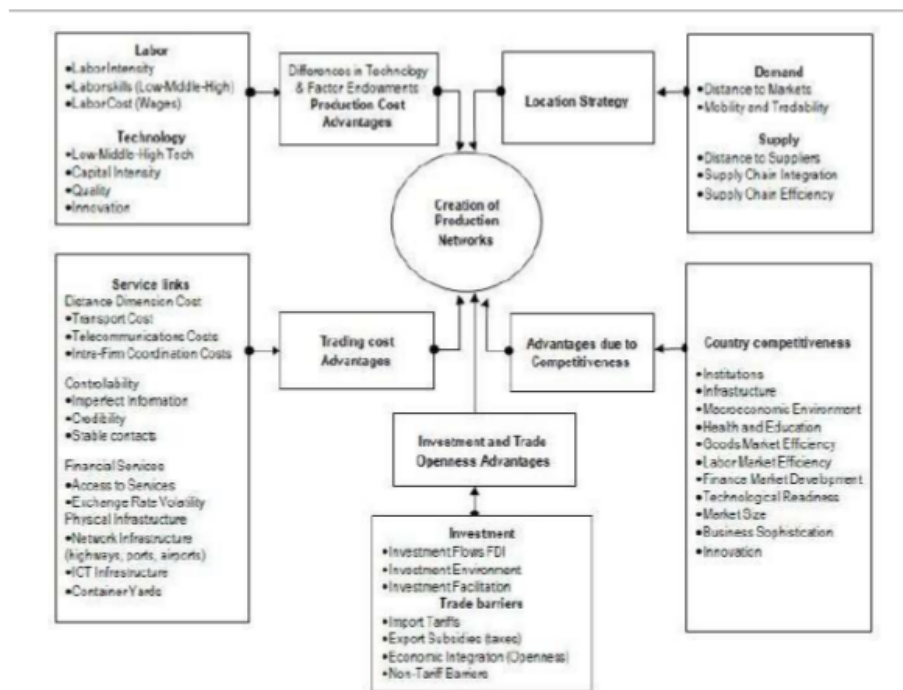


Source: Own elaboration.

### *2.2 Methodologies on measuring vertical specialization*

Different measures of vertical specialization have been proposed (literature on global input-output GIO linkages): D. Hummels, Ishii, & Yi (2001) measures both direct and indirect imported content in a country's exports, as well as the intermediary content exported indirectly by third countries, among other indicators from 1970 to 1990. Fukao, Ishido, & Ito (2003) decomposed trade flows into one-way trade, vertical intra-industry trade, and horizontal intra-industry trade. Ando (2006) looked into the vertical intra-industry trade decomposing trade into one-way trade, vertical intra-industry trade, and horizontal intra-industry trade to look at patterns within machinery industry. A gravity model was used by Athukorala & Yamashita (2006) to find out implications of production fragmentation. Ando (2008) applied a CGE approach to measuring the vertical trade and effects on liberalization. Daudin et al., (2011) developed and computed the share of imported inputs in merchandise exports, vertical trade in world exports, intermediates returning home after being reprocessed by third countries (re-exports), and its evolution over time from 1970 to 2004. Johnson & Noguera (2012b) computed value added exports and the ratio of value added to gross exports (addressing the double counting effect) VAX ratio. Athukorala (2012) used the gravity model to estimate main determinants of export growth, and computed an indicator on fragmentation considering the share of IPC in total manufacturing trade. Shrestha (2015) measured spillover effects through a global linked input-output table as drivers of demand for final goods.

This paper uses the Koopman et al., (2010, 2012) methodology in which they include linear combinations of previous indicators on value-added exports and vertical specialization (VS) as those developed by D. Hummels, Ishii, & Yi (2001), Daudin et al., (2011), Johnson & Noguera (2012b), and others. In Koopman, Wang, & Wei, (2014), a detailed analysis of some limitations of such indicators is depicted. As some of the above empirical methodologies rightly decomposed value-added based on direct and at some indirect degree, they miss some shares of value-added that frequently cross borders and are embedded in other countries' intermediate goods. The shortfall which usually arises as value-added is measured based on the origin of creation without considering who finally absorbs it. This is an essential issue if the study shall address the single production base project where different countries engage in multiple border transactions as they build things together.

## 3. Materials and methods

This research uses value-added (henceforth, VA) trade analysis based on vertical specialization and production network through a global Input-Output table integrated to trade flows. It measures and analyzes value added for ASEAN countries and for three main trading blocks in the World (East Asia - EA, EU, and NAFTA). This methodology is an extension of Koopman et al., (2010, 2012) with the added feature of integrating regions and tracing inter-temporal variations of value-added across 15 years of the ASEAN integration process. It employs a different database, and applies it to a new issue - the single production base project - not found in other studies.

Vertical specialization (VS hereafter) and the production network approach to measure global integration have been developed by different authors: Ando (2006), Athukorala & Yamashita (2006), Daudin et al., (2011), Hummels et al., (2001), Hummels, Rapoport, & Yi (1998), Johnson & Noguera (2012b), and Koopman et al., (2010, 2012). The general framework of this study consists in breaking up a country's gross exports into exports of value added, domestic value added which returns home, foreign value added, and some additional double counted terms (Figure 2). All the terms are accounted according to the source of value added VA creation and the country where VA is finally absorbed. The advantages of this methodology versus previous empirical approaches are as follows: 1)

complete decomposition of gross exports according to sources of creation and absorption, which allows tracing links within the GVC, 2) computation of double counted trade value often reported by ordinary trade statistics, 3) identification of value added created along the value chain, and 4) measurement of regional value-added creation-absorption, which allows addressing regional trade policies as well as country-specific ones. This study includes different metrics developed by other authors and integrated them into a single approach.

FIGURE 2. ASEAN GROSS EXPORTS VALUE ADDED
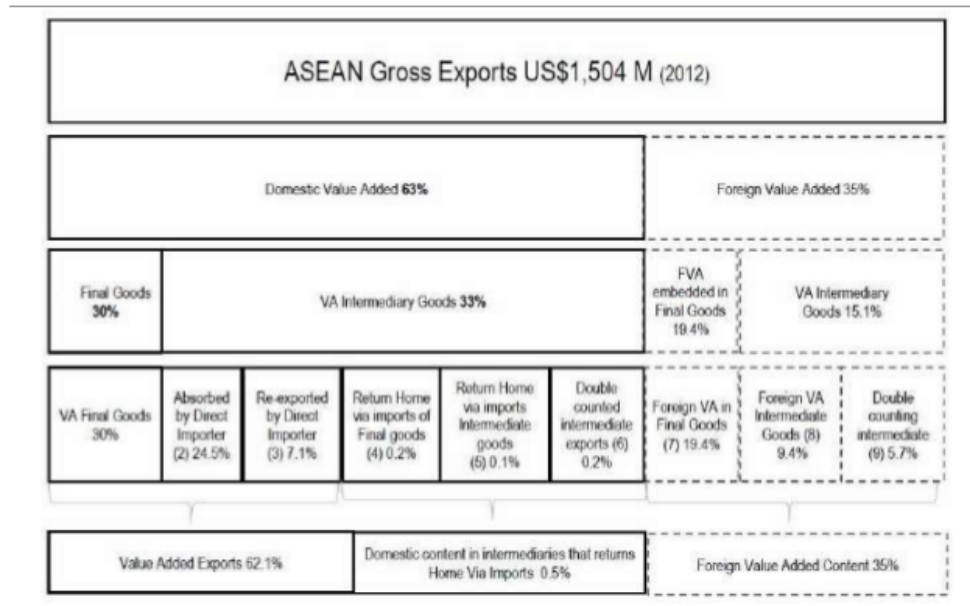


## Model specification and estimation procedures

The complete and detailed model is depicted by Koopman et al., (2010, 2012). Due to space limitation, the methodology is not presented here in detail. The total gross exports are split into nine terms comprised in the main equation. The main equation is a further decomposition of Leontief input-output. However, while different components of the traditional Leontief matrices allow the derivation of the value added in production and trade based on the values and types of inputs employed in production and based on the flows of gross output, they do not allow tracing value-added when intermediate inputs cross borders multiple times before finally being consumed. To address the issue, a derivation of the gross exports accounting model is carried out into four general stages:

## 1) Construction of ICIO Matrix. The G-country, N-sector ICIO Model

It is assumed that each G-country produces goods in N differentiated tradable sectors. Goods can be consumed as final goods or intermediate inputs. Both intermediate and final goods are either exported to other countries or used/consumed at home.

$$X_s = \sum_r^G (A_{Sr}X_r + Y_{sr}), \ r,s \dots G, \tag{1}$$

[3]

" $X_s$ is the Nx1 gross output vector of country $s$; $Y_{sr}$ is the Nx1 final demand vector that gives demand in country $r$ for final goods produced in $s$; and $A_{Sr}$ is the NxN IO coefficient matrix, giving intermediate use in $r$ or goods produced in $s$ " (Koopman et al., 2010, 2012). [9]

Equation 1, the G-country, N-sector production and trade system is written as a matrix notation in ICIO, as well as the gross output decomposition matrix and VA presented by block matrix notations.

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_3 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & \dots & A_{1G} \\ A_{22} & A_{22} & \dots & A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ A_{G1} & A_{G2} & \dots & A_{GG} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} + \begin{bmatrix} Y_{11} + & Y_{12} + \dots + & Y_{1G} \\ Y_{22} + & Y_{22} + \dots + & Y_{2G} \\ & \dots \dots & \\ Y_{G1} + & Y_{G2} + \dots + & Y_{GG} \end{bmatrix}, \tag{2}$$

and rearranging,

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} = \begin{bmatrix} I - A_{11} & -A_{12} & \dots & -A_{1G} \\ -A_{22} & I - A_{22} & \dots & -A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ -A_{G1} & -A_{G2} & \dots & I - A_{GG} \end{bmatrix}^{-1} \begin{bmatrix} \sum_r^G Y_{1r} \\ \sum_r^G Y_{2r} \\ \vdots \\ \sum_r^G Y_{Gr} \end{bmatrix} =$$

$$\begin{bmatrix} B_{11} & B_{12} & \dots & B_{1G} \\ B_{21} & B_{22} & \dots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \dots & B_{GG} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_G \end{bmatrix}, \tag{3}$$

$$\begin{bmatrix} X_{11} & X_{12} & \dots & X_{1G} \\ X_{21} & X_{22} & \dots & X_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ X_{G1} & X_{G2} & \dots & X_{GG} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \dots & B_{1G} \\ B_{21} & B_{22} & \dots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \dots & B_{GG} \end{bmatrix} \begin{bmatrix} Y_{11} & Y_{12} & \dots & Y_{1G} \\ Y_{21} & Y_{22} & \dots & Y_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{G1} & Y_{G2} & \dots & Y_{GG} \end{bmatrix}, \tag{4}$$

[1] [8]

$Y_s$ is a N×1 vector, which gives the global use of $s'$ final goods. $Y_{sr}$ denotes the N×N block Leontief inverse matrix commonly known as the total requirement matrix. It gives the amount of gross output in the producing country $s$ that is required for a one-unit increase in the final demand of destination country $r$.

## 2) Build value-added share matrix by source

$V_s$ is the correspondent 1×N direct value-added coefficient vector. It gives the ratio of direct domestic value added in total output for country $s$. $V_s$ is defined as the GxGN matrix of direct domestic value added for G-countries. Multiplying these direct value-added shares with the Leontief inverse matrices produces the G×GN VA share (hereafter VB) matrix.

$$VB = \begin{bmatrix} V_1B_{11} & V_1B_{12} & \dots & V_1B_{1G} \\ V_2B_{21} & V_2B_{22} & \dots & V_2B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ V_GB_{G1} & V_GB_{G2} & \dots & V_GB_{GG} \end{bmatrix},\tag{5}$$

To obtain domestic VA in a country's gross output, a new VA coefficient matrix is created (V ŝ), with a GN-by-GN dimension and the direct value added coefficients along the diagonal. This GNxGN matrix is multiplied with the right-hand side of equation (4) to obtain **VBY** matrix. Differentiating the source of inputs in $B_{sr}$ and the final point of production and destination identified in $Y_{sr}$ facilitates the decomposition of production processes as each country adds value along the way.

$$BY = \begin{bmatrix} \hat{V}_1 & 0 & \dots & 0 \\ 0 & \hat{V}_2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \hat{V}_G \end{bmatrix}\begin{bmatrix} X_{11} & X_{12} & \dots & X_{1G} \\ X_{21} & X_{22} & \dots & X_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ X_{G1} & X_{G2} & \dots & X_{GG} \end{bmatrix} =$$
$$\begin{bmatrix} V_1\sum_r^G B_{1r}Y_{r1} & V_1\sum_r^G B_{1r}Y_{r2} & \dots & V_1\sum_r^G B_{1r}Y_{rG} \\ V_2\sum_r^G B_{2r}Y_{r1} & V_2\sum_r^G B_{2r}Y_{r2} & \dots & V_2\sum_r^G B_{2r}Y_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ V_G\sum_r^G B_{Gr}Y_{r1} & V_G\sum_r^G B_{Gr}Y_{r2} & \dots V_G\sum_r^G B_{Gr}Y_{rG} \end{bmatrix},\tag{6}$$

"Elements in the diagonal columns of equation (6) give each country's production of value-added absorbed at home. The exports of VA can be defined as the elements in the off-diagonal columns of this GN by G matrix (excluding the VA produced by the home country that returns home after being processed abroad)", (Koopman et al., 2010, 2012).

## 3) Decomposition of gross exports

The composition of the gross exports is based on nine different terms. The complete accounting of Gross Exports (E) is described by Koopman et al., (2012). A country's total VA exports to the world equal:

$$VT_{s*} = \sum_{r\neq s}^{G} VX_{sr} = V_s\sum_{r\neq s}^{G}\sum_{g=1}^{G} B_{sg}Y_{gr}\tag{7}$$

Equation (7) is rewritten according to where (home or abroad) and how the VA exports are absorbed (intermediate or final goods). Country's gross exports can be defined as

$$VT_{s*} = V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \ , \tag{8}$$

Equation (8) is the value-added (VA) export decomposition equation, including the different value added terms: 1st term is VA in country's $s$ final goods exports to $r$; 2nd VA in intermediate exports from $s$ to be re-processed and consumed by $r$; 3rd is VA in intermediate exports that will be re-processed by $r$ and re-exported to $t$ countries. Country's gross exports can be defined as

$$E_{s*} = \sum_{r \neq s}^{G} E_{sr} = \sum_{r \neq s}^{G} A_{sr} X_r + Y_{sr} \tag{9}$$

$E_{sr}$ includes those goods produced at country $s$ but exported to country $r$. Equation (9) can be further decomposed according to various components (where the intermediate and final goods are finally absorbed).

$$uE_{s*} = V_s B_{SS} E_{s*} + \sum_{r \neq s}^{G} V_r B_{rs} E_{s*}$$

$$= VT_{s*} + \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} X_s \right\} \tag{10}$$

$$+ \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} X_r \right\}$$

While $VT_{s*}$ in equation 10 indicates the value added exports in final goods, the second and third part of the equation depicted four different flows of the country $s$ value-added through various channels and at different stages in the production process. Koopman et al., (2012) offers the detailed step by step proof.

Based on each country gross output identity, $X_s$ and $X_r$ can be obtained as:

$$X_s = (I - A_{ss})^{-1} Y_{ss} + (I - A_{ss})^{-1} E_{s*} \qquad X_r$$
$$= (I - A_{rr})^{-1} Y_{rr} + (I - A_{rr})^{-1} E_{r*} \tag{11}$$

Finally, substituting the new equations where the elements are split based on the sources of creation and destination, the N sector generalized version of gross exports accounting equation can be defined as:

$$uE_{s*} = \left\{ V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \right\}$$

$$+ \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} (I - A_{ss})^{-1} Y_{ss} \right\}$$

$$+ V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} (I - A_{ss})^{-1} E_{s*} \tag{12}$$

$$+ \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} (I - A_{rr})^{-1} Y_{rr} \right\}$$

$$+ \sum_{t \neq s}^{G} V_t B_{ts} A_{sr} \sum_{r \neq s}^{G} (I - A_{rr})^{-1} E_{r*}$$

### 4) Decomposition of value-added

Value-added is aggregated into three blocks. The sum of all the nine terms yields 100% of the gross exports (GE). The number indicates the term position in equation (12) as well as the columns in Table 1:

Value-added exports (VT hereafter)

- Domestic Value-added (DV hereafter) in direct final goods exports
- DV in intermediate exports absorbed directly by direct importers
- DV in intermediate re-exported to third countries

Domestic content in intermediate exports that finally return home (Daudin et al., 2011).

- DV in intermediate that returns via final imports
- DV in intermediate that returns via Intermediate imports
- Double counted intermediate exports produced at home (the goods are first exported but they finally return home through its intermediate imports to produce final goods)

Value added Foreign Content (VS)

- Foreign Value-added (FV from now on) in final goods exports
- FV in intermediate goods exports
- Double counted intermediate exports produced abroad (the goods are first exported but they finally return home through its intermediate imports to be consumed at home.

As a summary, the first three terms represent the value-added in exports; the fourth and fifth include value-added initially being exported as intermediary but eventually returning to the home country to be consumed at home. The seventh and eighth terms include foreign value-added in the home's country exports. The sixth and ninth terms are double-counted portions (registered in both countries as exports) due to back-and-forth transactions of intermediate goods. While domestic content in exports is expressed from the first to the sixth term, the measure of GDP embedded in exports includes only from

the first to the fifth. From fourth to ninth include value-added of goods that cross nations multiple times, giving our indicator for vertical structure participation.

### Data

This research uses the YNU-GIO Table, Inter Country Input-Output table (ICIO) developed by the CESSA, (Sato & Shrestha, 2014). It includes 29 endogenous countries (covering 11 main Asian economies and leading countries in Europe and North America) and 59 exogenous countries. Sato and Shrestha, Nagendra (2014) carried out a series of harmonization in the data, linking OECD input-output tables with data on trade flows from UN COMTRADE. Trade flow data at 4 - 5 SITC digit (3,121 groups) were matched based on the stage of process as in UN Broad Economic Categories (BEC) as intermediate goods (1,933) or final goods (1,188). Eventually, the data were harmonized based on ISIC industrial data at 4-digit level (145 groups) and further aggregated at 2-digit level (62 categories) to eventually be converted into the OECD international input-output classification (48 categories). Finally, the data is set based on OECD I-O classification into a global 35 industry input-output table (YNU-GIO). The ICIO table allows one to look at intermediate inputs by country / by sector, and the final output. Inputs can be local or imported, and the final output can be supplied locally or globally. This study used the YNU-GIO data of 1997, 2004 and 2012.

## 4. Results and discussion

Table 3 present the accounting of five different regions for 1997, 2004, and 2012; all figures are expressed as a share of gross exports. The column number follows the same arrangement as that of Koopman et al., (2012) indicating the order of each item in the equation (12). The global data are displayed based on aggregation of five regions: East Asia (EA), ASEAN, NAFTA, EU, and other economies (OE). The results and analysis are divided into three parts: gross export decomposition and the nature of trade of ASEAN, interactions of ASEAN with other regions across time, and policy implications.

An important fact is that gross exports in ASEAN grew by 235% from 1997 to 2012, which is a great performance, second only after East Asia, which was reported to have attained 338% growth over the 15-year period. High rates of growth were registered in other regions as well, although at lower rates of growth than Asia.

Some results differ from other studies, as they are overvalued (1) while others appear undervalued. Different sources of data and the aggregation at countries and regional level may be a major reason. As far as the author knows, this is the first study to apply this methodology with this data source and the first study to aggregate based on regions.

### Gross export decomposition and the nature of trade in ASEAN

Column 1 in Table 1 indicates the DV exports in direct final goods. ASEAN has a relatively low and falling DV in final goods (37.5% in 1997 and 30.5% in 2012). In comparison with other regions, e.g., EA and NAFTA registered a domestic value-added of more than 50%, while EU at 46%, ASEAN has a relatively low participation in value chains as an exporter of value-added through final goods. At country level Thailand, Philippines, and Vietnam reached almost 50% of DV in its exports, equal to EA, NAFTA, and EU values.

Column 2 indicates DV of exports through intermediary goods directly absorbed by importers to be embedded in local goods as 24% in 2012, an increase of 3.4% from 1997. Column 3 reports 7.1% in DV content in intermediate goods that were initially imported

by a foreign country but were eventually re-exported to third countries. This concept of trade also experienced growth of 1.5% versus 1997 (importers use the intermediary goods to produce exports). Both concepts of intermediate goods account for a total of 31.6% of DV embedded in gross exports, indicating that almost a third of total gross ASEAN exports is through intermediary goods, defining an important vocation in global value chains.

TABLE 1. GROSS EXPORTS DECOMPOSITION ASEAN 2012 (SHARE OF TOTAL GROSS EXPORTS)

| Region/ Country | Gross exports | Value added exports (VT) | | | Domestic Value Added return home (VS1*) | | | Foreign Value Added FV | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| ASEAN | $449 | 37.5% | 21.9% | 5.6% | 0.2% | 0.1% | 0.2% | 19.8% | 8.3% | 4.3% |
| Singapore | $170 | 27.4% | 15.6% | 3.2% | 0.20% | 0.1% | 0.3% | 31.2% | 11.5% | 4.6% |
| Malaysia | $93 | 36.5% | 22.5% | 7.4% | 0.40% | 0.2% | 0.3% | 17.6% | 8.1% | 6.4% |
| Thailand | $72 | 45.6% | 24.9% | 6.7% | 0.10% | 0.1% | 0.1% | 13.2% | 7.2% | 4.0% |
| Indonesia | $63 | 50.9% | 30.7% | 7.5% | 0.10% | 0.1% | 0.0% | 6.1% | 3.4% | 1.7% |
| Philippines | $38 | 45.2% | 27.4% | 6.3% | 0.10% | 0.1% | 0.0% | 11.9% | 5.8% | 2.6% |
| Vietnam | $12 | 45.6% | 26.1% | 6.1% | 0.00% | 0.0% | 0.0% | 12.9% | 6.7% | 3.0% |
| EAST ASIA | $961 | 53.1% | 28.5% | 5.9% | 0.4% | 0.4% | 0.1% | 7.1% | 3.5% | 1.3% |
| NAFTA | $1,336 | 55.3% | 28.4% | 4.3% | 1.6% | 1.2% | 0.2% | 5.5% | 2.8% | 0.8% |
| EU | $2,472 | 50.0% | 21.9% | 5.0% | 0.4% | 0.2% | 0.1% | 14.4% | 5.6% | 2.3% |
| ASEAN | $662 | 31.6% | 21.4% | 6.5% | 0.2% | 0.1% | 0.3% | 21.3% | 9.5% | 6.4% |
| EAST ASIA | $1,743 | 48.2% | 29.1% | 6.6% | 0.5% | 0.4% | 0.1% | 8.7% | 4.9% | 2.2% |
| NAFTA | $1,767 | 52.5% | 29.8% | 4.7% | 1.8% | 1.3% | 0.1% | 5.7% | 3.1% | 0.9% |
| EU | $4,021 | 46.5% | 23.0% | 5.5% | 0.4% | 0.3% | 0.1% | 14.7% | 6.2% | 2.9% |
| ASEAN | $1,504 | 30.5% | 24.5% | 7.1% | 0.2% | 0.1% | 0.2% | 18.9% | 9.4% | 5.7% |
| Singapore | $554 | 22.8% | 15.8% | 3.9% | 0.15% | 0.03% | 0.3% | 29.6% | 11.5% | 5.8% |
| Malaysia | $265 | 24.4% | 30.1% | 10.5% | 0.28% | 0.26% | 0.36% | 12.2% | 13.0% | 11.1% |
| Thailand | $268 | 41.9% | 22.2% | 5.7% | 0.13% | 0.09% | 0.09% | 17.2% | 7.6% | 4.0% |
| Indonesia | $213 | 28.4% | 45.4% | 14.1% | 0.36% | 0.30% | 0.08% | 3.3% | 4.5% | 3.1% |
| Philippines | $77 | 45.1% | 29.6% | 8.4% | 0.06% | 0.07% | 0.03% | 8.4% | 5.5% | 3.1% |
| Vietnam | $124 | 46.8% | 16.5% | 4.0% | 0.03% | 0.03% | 0.03% | 22.0% | 6.6% | 3.0% |
| EAST ASIA | $4,109 | 55.4% | 21.7% | 5.5% | 0.5% | 0.5% | 0.1% | 10.6% | 4.1% | 2.0% |
| NAFTA | $3,130 | 50.6% | 30.7% | 6.0% | 1.4% | 1.2% | 0.2% | 5.3% | 3.3% | 1.2% |
| EU | $6,132 | 46.8% | 18.2% | 5.9% | 0.4% | 0.2% | 0.2% | 18.2% | 5.8% | 3.7% |

Notes: Gross Exports in US$ billions. (1) Domestic Value added (DV) in direct final goods exports, (2) Domestic Value in intermediates exports absorbed directly by direct importers, (3) DV in intermediates re-exported to third countries, (VS1*) Domestic content in intermediate exports that finally return home, (4) DV in intermediates that return via final imports, (5) DV in intermediates that return via Intermediate imports, (6) Double counted intermediate exports produced at home, (7) Foreign Value added (FV) in final goods exports, (8) FV in intermediate goods exports, (9) Double counted intermediate exports produced abroad.

Value-added initially being exported as intermediary materials but eventually sent back home as embedded value-added in imports of final goods (column 4), accounts for only 0.2% of ASEAN gross exports. On the other hand, the value-added initially exported as intermediary goods and then imported back home via intermediary goods embedding domestic value-added (column 5) accounts for only 0.1%. This indicates that most of the ASEAN DV exported does not return home, but it is absorbed overseas. These results are in line with other studies (Koopman et al., 2012) indicating that the participation of developing countries in this variety of trade is still limited. Versus other regions, column 4 in NAFTA represents 1.4% and column 5 a total of 1.2%. This indicates that almost 3% of total initial exports from NAFTA returns home via final goods or intermediate goods that will be consumed in NAFTA, engaged in back-and-forth transactions.

Regarding foreign content, ASEAN has the largest share of foreign value added (FV) in exports of final goods (column 7) with 19.4%. In terms of FV-added absorbed in

intermediary goods exported, ASEAN also ranks 1st with 9.4% (column 8). All in all, foreign value added embedded in ASEAN exports represents more than 35% of gross exports, indicating a large dependency with intermediate inputs from foreign countries. The share of FV is, in fact, growing, versus 1997 when it was 33%.

Out of the total 35% of FV, Intra-ASEAN supplies only 22% of it, showing dependency in intermediate goods with extra-ASEAN countries (78%) and a relatively low integration in intra-ASEAN production. East Asia is taking a more active role in supplying intermediate goods to ASEAN (nearly 30%) while the intra-ASEAN value added share is proportionally lower than 1997 levels (22%). NAFTA and EU show better regional integration, with almost 50% of its FV-added (VA) in final goods (column 7) from other regional members, and more than 65% of its FV embedded in regional exports of intermediate goods. East Asia is also highly integrated, supplying 40% of its total value-added from within the region. EU is the most integrated region as it has a large share of regional FV in its export (18% GE).

### TABLE 1 (cont-d). GROSS EXPORTS DECOMPOSITION ASEAN 2012
### (SHARE OF TOTAL GROSS EXPORTS)

| Region/ Country | VAX ratio | Local content DVA | VS share | Double counted | Multiple cross border | One-way trade | VS1 | Total VS |
|---|---|---|---|---|---|---|---|---|
| | (11) | (13) | (14) | (15) | (16) | (17) | (18) | (19) |
| ASEAN | 87% | 88% | 12% | 13% | 19% | 81% | 17% | 50% |
| Singapore | 46% | 47% | 47% | 48% | 51% | 43% | 16% | 63% |
| Malaysia | 66% | 67% | 32% | 33% | 41% | 59% | 20% | 52% |
| Thailand | 77% | 78% | 24% | 25% | 31% | 70% | 12% | 36% |
| Indonesia | 89% | 89% | 11% | 11% | 19% | 82% | 15% | 26% |
| Philippines | 79% | 79% | 20% | 21% | 27% | 73% | 19% | 40% |
| Vietnam | 78% | 78% | 23% | 23% | 29% | 72% | 19% | 42% |
| EAST ASIA | 66% | 67% | 33% | 34% | 39% | 61% | 11% | 23% |
| NAFTA | 90% | 93% | 7% | 10% | 15% | 85% | 15% | 22% |
| EU | 77% | 78% | 22% | 23% | 28% | 72% | 14% | 36% |
| ASEAN | 83% | 84% | 16% | 17% | 46% | 77% | 19% | 57% |
| EAST ASIA | 61% | 62% | 38% | 39% | 23% | 54% | 13% | 29% |
| NAFTA | 89% | 92% | 8% | 11% | 16% | 84% | 20% | 28% |
| EU | 75% | 76% | 24% | 25% | 30% | 70% | 16% | 40% |
| ASEAN | 83% | 84% | 16% | 17% | 43% | 77% | 20% | 55% |
| Singapore | 43% | 43% | 47% | 48% | 51% | 39% | 20% | 67% |
| Malaysia | 65% | 66% | 36% | 37% | 48% | 55% | 18% | 54% |
| Thailand | 70% | 70% | 29% | 29% | 35% | 64% | 17% | 46% |
| Indonesia | 88% | 89% | 11% | 12% | 26% | 74% | 21% | 32% |
| Philippines | 83% | 83% | 17% | 17% | 26% | 75% | 21% | 38% |
| Vietnam | 67% | 67% | 32% | 32% | 36% | 63% | 16% | 48% |
| EAST ASIA | 64% | 65% | 35% | 36% | 23% | 57% | 15% | 31% |
| NAFTA | 88% | 91% | 9% | 12% | 18% | 82% | 19% | 28% |
| EU | 72% | 73% | 27% | 28% | 34% | 66% | 18% | 45% |

Notes: (11) VAX Ratio = column 1+2+3, (12) GDP Exports =1+2+3+4+5 (not reported), (13) Domestic Value Added = 1+2+3+4+5+6, (14) VS Share = 7+8+9, (15) Double Counted (4+5+6+7+8+9), (16) Multiple Cross Border =3+4+5+6+7+8+9, (17) One-Way =1+2, (18) VS1 (Indirect domestic Value Added in Foreign Exports), (19) Total Vertical Specialization (VS and VS1).

Column 6 and 9 indicate the content of gross exports that are double-counted by different countries in ordinary trade statistics, mainly due to back and forth transactions of parts and components and other factors (Koopman et al., 2012). ASEAN registered the largest share of double-counted value-added at 6% of total gross exports. This value mainly represents intermediary goods exported to ASEAN, re-processed within ASEAN, and re-

exported back to foreign countries, meaning that the real value-added does not belong to ASEAN but to the suppliers of intermediate goods. Only a small share of ASEAN value-added is re-processed overseas and returns home (column 6). These figures are congruent with other studies pointing out how low labor cost processes are often transferred to developing countries that enjoy a comparative advantage in labor-intensive jobs where exported goods contain a significant share of foreign value-added.

East Asia and ASEAN together experienced a more dramatic change in participation in vertical structures. From this deeper insertion into vertical structures, it is possible to observe a fast and large increase in value-added exports of the region (Column 11 in Table 1), GDP in exports (12), and Domestic content in exports (13), indicating that the insertion within this kind of structures benefits the expansion of trade and significantly contributes to GDP creation. While NAFTA and EU lowered their share of exports through vertical structures, East Asia and ASEAN gained participation (or at least kept their share with other regions) from 1997 to 2012. ASEAN significantly increased its involvement in back-and-forth trade from 27% in 1997 to 35% in 2012, as indicated in column 14 (Table 1). Value added crossing nations at least twice increased from 39% to 43% indicating the relevance of vertical trade for ASEAN, higher in percentage share than any other region.

### ASEAN links with other regions

Table 2 presents the accounting of gross exports based on main blocs of value-added aggregated at the region level. Column 10 indicates value-added exports, indicating who exports and who absorbs the value added. Column 11 indicates the FV content embedded in exports and the source region of value-added.

TABLE 2. ACCOUNTING GROSS EXPORTS BY REGION. 1997, 2004, 2012. ORIGIN AND DESTINATION OF VALUE ADDED (SHARE OF GROSS EXPORTS)

| Region | Value added exports (VT) (10) | | | | VS Foreign Content of Region (VS) (11) | | | | Domestic Content in Region's Exports (13) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | East Asia | ASEAN | NAFTA | EU | East Asia | ASEAN | NAFTA | EU | East Asia | ASEAN | NAFTA | EU |
| **1997** | | | | | | | | | | | | |
| East Asia | 20% | 12% | 24% | 10% | 3% | 3% | 2% | 3% | 20% | 12% | 24% | 10% |
| ASEAN | 18% | 12% | 13% | 8% | 7% | 7% | 7% | 6% | 18% | 12% | 13% | 8% |
| NAFTA | 16% | 4% | 33% | 14% | 1% | 1% | 0% | 5% | 16% | 5% | 35% | 15% |
| EU | 4% | 2% | 10% | 38% | 1% | 1% | 1% | 3% | 4% | 2% | 10% | 49% |
| OE | 14% | 6% | 17% | 50% | 1% | 1% | 0% | 0% | 14% | 6% | 17% | 51% |
| **2004** | | | | | | | | | | | | |
| East Asia | 24% | 9% | 23% | 11% | 5% | 2% | 4% | 2% | 25% | 9% | 23% | 11% |
| ASEAN | 20% | 10% | 10% | 8% | 10% | 8% | 6% | 5% | 20% | 11% | 10% | 8% |
| NAFTA | 15% | 3% | 39% | 16% | 1% | 0% | 6% | 1% | 15% | 4% | 41% | 16% |
| EU | 4% | 1% | 11% | 40% | 1% | 0% | 3% | 18% | 4% | 1% | 11% | 48% |
| OE | 15% | 5% | 18% | 48% | 1% | 0% | 1% | 1% | 15% | 5% | 18% | 48% |
| **2012** | | | | | | | | | | | | |
| East Asia | 22% | 9% | 19% | 10% | 4% | 2% | 4% | 2% | 23% | 9% | 19% | 10% |
| ASEAN | 22% | 11% | 8% | 7% | 10% | 8% | 4% | 4% | 22% | 12% | 8% | 7% |
| NAFTA | 19% | 4% | 34% | 14% | 2% | 1% | 5% | 1% | 19% | 5% | 35% | 14% |
| EU | 8% | 2% | 9% | 34% | 3% | 1% | 3% | 18% | 8% | 2% | 9% | 40% |
| OE | 23% | 6% | 15% | 37% | 1% | 0% | 1% | 1% | 23% | 6% | 15% | 38% |

Source: Own elaboration.
Notes: Origin of exports is indicated by the row while destination of export is indicated by the column.

Regarding dependency across regions, since 1997 East Asia accounted for the largest export destination of DV from ASEAN, which was 35% to 38%, while intra-ASEAN value added accounted for less than 20%. NAFTA as the destination of value-added from ASEAN decreased from 20% in 1997 to 14% in 2012. More than 60% of ASEAN value-added exports went to Asian countries, indicating the high relevance and dependency of the region for ASEAN.

Since 1997, the largest recipient of GDP and domestic content of ASEAN exports has been East Asia (increasing trend). NAFTA, EU, and OE are constantly absorbing less of ASEAN's GDP and domestic export content.

Another significant shift in ASEAN's model of trade is the increasing share of value-added exports (DV) that cross nations at least twice, rising from 27% in 1997 to 33% in 2004 and 35% in 2012. As gross exports have significantly increased in ASEAN from 1997 to 2012 (235%), a larger share of value-added crossing multiple nations denotes an important role in ASEAN trade pattern.

Regarding foreign content embedded in ASEAN exports, the largest contribution comes from East Asia (10% of ASEAN's gross exports). Value-added from ASEAN countries rose by only 1% over time. NAFTA and EU initially increased their share of value-added embedded in ASEAN exports (1997 to 2004) but eventually decreased. On the other hand, ASEAN value-added embedded in other regions has grown slightly, from 2.99% in 1997 to 3.87% in 2012, indicating an expansion of ASEAN in global chains and the possible positive spillover effects in the growth of exports by trading partners. Even though ASEAN supplies significant amounts of intermediary goods to the world, it still represents a relatively small share of global needs, illustrating that ASEAN exports may contain relatively low value-added. The region has an enormous potential to add more value to its intermediary goods, as almost 33% of its exports will be further processed before being finally consumed.

Out of the 7.1% of value-added created through export of intermediate inputs that will be further processed and eventually exported from importer countries (column 3), 75% belong to Asian countries, indicating the relevance of Asian value chains to drive trade for ASEAN. However, ASEAN lowered its contribution as a source of intermediate inputs that were processed within ASEAN and re-exported to other regions, from 53% in 1997 to 40% in 2012. ASEAN increased its role in value chains with East Asia (EA), shifting focus to EA rather than building ASEAN chains. EU also strengthened its participation in EA value chains from 1% to 4% indicating how EA is rapidly expanding in building global value chains.

East Asia shifted from high dependency from NAFTA, from 24% of intermediate goods in 1997 to only 19% in 2012, while its contribution to domestic content in the region's exports grew from 20% to 23%. This indicates that regional value chains have been developed in neighboring countries. The contribution of ASEAN in East Asia's foreign value content fell from 12% to 9%. However, ASEAN kept its shares with other regions.

Regarding domestic value-added that crosses nations at least twice, the indicator of vertical specialization-ASEAN increased its dependency with East Asia's moving from 7% to 10% of total gross exports under this kind of structures. On the other hand, 6% of its total gross exports belong to trade with NAFTA under production networks, while only 4% of value-added exports to ASEAN was done together. This highlights the fact that ASEAN is, in fact, increasing its participation in global value chains and defining a new major source of exports for the region. However, it also indicates that ASEAN vertical structures have not been significantly influenced by the process of integration which started two decades ago. The region still focuses on extra-ASEAN demand. This finding is in line with some of the findings in other empirical studies highlighting the fact that multinational corporations are the main source of vertical structures, commonly originated in developed countries: (Haddad, 2007; Kimura, 2006; Koopman et al., 2010; Obashi, 2010; Yi, 2003), and others.

NAFTA increased its FV content from East Asia from 3% to 4% and kept NAFTA and EU at the same levels. EU lowered the FV from other EU, from 28% to 24%, while increasing its share with EA and NAFTA. This fact also shows that ASEAN is not increasing its share in other regions while East Asia is gaining significantly more weight in global value chains.

### *Policy implications*

### 1) ASEAN as a single production base

Regarding the question of whether ASEAN is producing more under vertical structures, the answer is undoubtedly yes. Column 14 in Table 3 indicates an increase from $148 billion US in 1997 to $526 in 2012 (33% to 35% of gross exports), growing 251% in these 15 years. However, ASEAN has strengthened ties with East Asia, while lowering its rate of growth with NAFTA, EU, and other regions (OE). ASEAN, as a single production region, has increased its current gross exports from almost US$ 36 in 1997 to more than US$ 120 billion in 2012, a tree-fold growth in terms of value. This indicates that in fact ASEAN is producing more together, but the predominant focus is extra-ASEAN.

Vertical specialization in ASEAN is gaining weight and is becoming more important. However, value added created together as ASEAN region still plays a role of only 8% out of the 36% of total FV content in ASEAN exports. Far more has to be done to push the region towards the target of creating a single production because now the region takes more value from extra-ASEAN than from within. ASEAN is still dependent on other regions to access strategic inputs for their exports, while the region is still producing relatively low-value-added raw materials used by other countries to create additional value.

### TABLE 3. GROWTH IN VALUE ADDED TERMS FROM 1997-2012, ALL REGIONS

| 1997-12 | VAX ratio (11) | GDP exports (12) | DVA (13) | VS share or FV (14) | Double counted (15) | Multiple cross border trade | One-way trade |
|---|---|---|---|---|---|---|---|
| East Asia | 304% | 305% | 305% | 483% | 482% | 423% | 304% |
| ASEAN | 219% | 219% | 219% | 251% | 251% | 262% | 209% |
| NAFTA | 133% | 132% | 132% | 199% | 179% | 192% | 128% |
| EU | 129% | 129% | 129% | 201% | 200% | 199% | 125% |

Source: Own elaboration.
Notes: Value added exports (VAX ratio), GDP exports, Domestic Value Added (DVA), Foreign value in exports (FV).

Asia as a region serves as an important driver of indirect exports for ASEAN. Almost 6% of total value-added of ASEAN goes as intermediate goods that will be further processed in Asian countries and exported to the world. Asian networks matter for ASEAN and the region should consider working closer with its neighbors. Looking at all the different indicators, the authors suggest that ASEAN makes more economic sense when it is integrated as ASEAN+6, driving additional demand through EA's booming exports and by incorporating its supply chain with Asian countries. However, this will raise pressures on even larger imports from East Asia (in fact growing substantially) and eventually drive out competition from within the ASEAN region.

### 2) Role of vertical structures in ASEAN

ASEAN is the region with the largest share of value-added crossing nations more than twice with 43% (our measure of vertical specialization). Versus other regions, EU registered 34%, NAFTA 18%, and EA a total of 23%. The growth of vertical structures in

the final year data shows that ASEAN did not just export more of the same goods but it was more integrated into global value chains, taking advantage of the expansion of world trade and developing new sources of specialization. Vertical structures are responsible then for more than a third of the region exports, indicating that ASEAN should include within its trade and industrial policies ways to continue enhancing the creation and development of these structures in the region.

ASEAN is exporting proportionally less domestic value-added through final goods than intermediates, indicating an important role as a supplier of parts and components to the world. Indonesia (59%) and Malaysia (42%) played a particularly important role as a supplier of intermediate goods, indicating a strategic role as a producer within the initial section of the value chain. This calls for an action plan to increase value-added in exports, as the region may be missing opportunities to further process raw materials or develop local supply chains to add more value to local resources. The fact that value-added in final exports is below 35% indicates a low regional content. Only Malaysia and Singapore lowered the foreign content in their exports in the 15-year period of study.

On the other hand, goods produced and exported from ASEAN have significant share of foreign content (more than 35%). At the country level, Singapore shows 30.2%, Vietnam 22.6%, and Thailand 17.7%. These indicate the dependency of the region towards extra-ASEAN countries to supply intermediary goods that are not being produced regionally and are needed to complete exports. While gross exports have highly increased in ASEAN, local content in terms of share is falling, calling for a more active policy towards supply chain development and upgrade industry capabilities.

ASEAN registered a substantial growth and somehow a dependency towards East Asian countries, both as a source of supply of intermediate goods and as destination of exports. This fact indicates that the ASEAN plus six (China, Japan, Korea, India, Australia, and New Zeeland) initiative might make more economic sense rather than being limited to ASEAN alone. While East Asia offers a substantially larger market and is a driver of indirect exports to the world, it also places pressure on ASEAN as it develops dependency in the supply of intermediate inputs, intensifies competition, and opens the door of potential negative spillover effects upon slowdown in East Asian exports. In gross terms 64% of the gross exports of ASEAN are absorbed within the ASEAN +6. The total of 78% of the IPCs were exported within the ASEAN + 6 and 50% of the final goods as well. In value added export terms, East Asia absorbs a third of ASEAN value added exports, almost 8% more than in 1997. Trade for ASEAN is clearly moving East and shall influence ASEAN trade policy.

## 3) Participation of ASEAN in fragmented structures

ASEAN significantly increased its involvement in back-and-forth trade (fragmented structures) from 33% in 1997 to more than 35% in 2012. It is noticeable that ASEAN reached almost 39% of its exports under vertical structures in 2004, indicating a fast expansion from mid-1990's to mid-2000's, then slowed down.

Even though the share of exports of ASEAN under vertical structures is significant, only 8% of gross exports represent value-added was created together in ASEAN, a gain of less than 1% over the last 15 years. While other regions tend to be more regionally integrated and therefore supply and produce together, ASEAN is not growing internally but outwardly. Its trade links are dependent on other markets, both as a source of supply for critical intermediate inputs and as the destination of exports.

On the other hand, vertical structures in ASEAN are expanding relatively slowly than other regions since the contribution of ASEAN into other region's (EU, NAFTA) vertical chains has decreased in the last 15 years. East Asia has gained substantially in global chains especially in the 2000's, replacing ASEAN in some markets or substituting intermediate goods locally (regional supply chain development).

The speed of growth of FV in ASEAN exports is growing faster than the share of ASEAN value added embedded in other regions. However, in light of the massive growth of exports in the region (235%) in the last years, the vertical structures in ASEAN is helping to enlarge the value of trade. There is less local value-added, but the size of the export cake is significantly larger. ASEAN is producing more things together and is becoming more integrated into global value chains, even though a lot more has to be done to both build regional chains to increase local value-added and to help the region to gain access to new chains.

## 5. Conclusion

This study looked into the process of integration of ASEAN and particularly in the creation of the single production base region under the optic of vertical structures. The role of ASEAN along the supply chain was found strongest as a supplier of intermediate goods rather than a supplier of final goods. On the other hand, ASEAN still depends on parts and components (IPC) imports to produce its exports (35% of foreign value-added), and still, exports raw materials and IPC's with relative low-value added.

ASEAN's largest destination of DV exports and largest source of foreign content is East Asia, followed by ASEAN itself, while it kept relatively the same roles with EU and NAFTA. The focus on Asia offers the following important implications: 1) distance is an important factor for ASEAN success in exports; 2) demand for ASEAN intermediates is driven by Asia's growth in exports and local consumption; 3) developing the right ASEAN+6 policies will give greater benefits (indirect exports raised significantly); and 4) ASEAN has developed dependency from EA (positive and negative effects).

ASEAN's participation in fragmented structures appears to be high. It is the region with the largest percentage share of gross exports crossing borders more than twice (43%), even though globally still represents a small share of global value-added (15%). Its value-added through re-exports is growing as well, indicating its role as supplier of IPC's. Its role in final assembly is also considered important in reference to the high content of foreign content in ASEAN exports. Unfortunately, GDP in exports has decreased over time, indicating that value-chains have not developed in the region.

ASEAN is expanding exports both through direct exports and by integration with East Asia; however, this also represents a threat because shocks in East Asian markets might affect the future expansion of ASEAN exports. A lower participation of EU and NAFTA in ASEAN implies a possible loss due to competition and a re-orientation of EU and NAFTA towards other strategic partners.

Finally, fragmented production structures matter for ASEAN exports, either as ASEAN countries producing together to the world (even though the share is not growing) or through other regions. ASEAN is integrating more extra-ASEAN (especially towards East Asia) rather than intra-ASEAN. ASEAN's content crossing internal borders multiple times has increased only slightly in the last fifteen years, indicating that a single production base is not yet the engine of exports growth for the region.

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