DECOMPOSITION ANALYSIS OF GLOBAL VALUE CHAIN'S IMPACT ON THAI ECONOMY

BY

MR. PUNYAWICH SESSOMBOON

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ECONOMICS (INTERNATIONAL PROGRAM) FACULTY OF ECONOMICS THAMMASAT UNIVERSITY ACADEMIC YEAR 2015

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was approved as partial fulfillment of the requirements for
the degree of Master of Economics (International Program)

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ABSTRACT

A review of literatures concerning the measurement of a country's export ability shows that more comprehensive frameworks are required to accurately account for gross export value. One of such frameworks is the decomposition of value into 3 main categories, namely domestic value-added, foreign value-added and pure double counted exports. Economic data of thirty-two Thai industries during 2000 and 2011 demonstrates that even though computers, electronics and optical equipment were among industry sectors that generated the highest gross export value; such figures did not derive from domestic value-added component. As a result, a process of deducing export ability from gross term of export would generate misleading consequences. To correctly measure the export ability of Thai industries in global value chain, this study presents the comparative examination of Reveal Comparative Advantage (RCA) indices and constructs panel regressions including fixed-effects and Two Stage Least Squares (2SLS) fixed-effect based on the export-led growth strategy. The results show that re-computing RCA is a more accurate indicator to measure comparative advantage of Thai industries in the global value chain compared to the conventional RCA. In addition, constructed panel regressions demonstrate that among three categories of gross export, domestic value-added has the most significant impact on a country's economic growth. Hence, this study suggests that policy-makers should encourage wholesale and retail trade and repairs, since they are among industries that

have the highest degree of competitiveness and could generate the highest domestic value-added exports, as indicated by re-computing RCA and panel regressions respectively.

Keywords: Decomposition analysis, Global value chain, Comparative advantage, Export-led growth, Panel regression

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If there are any mistakes in this thesis, I will be solely responsible for them.

Mr. Punyawich Sessomboon
Thammasat University
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CHAPTER 1
INTRODUCTION

1.1 Statement of the Problem

Thailand has employed the export-led growth as the main growth strategy for over a decade which then leads to a continuous growth. Tang et al. (2015) defined export-led growth as a situation where a country growth follows its ability to export. Figure 1.1 illustrates the degree of trade openness[1] for the Thai economy in the global value chain. This degree has increased by 50% from 86% in 1995 to 136% in 2011. This confirms that the participation of Thai producers and economy have been continuously connected to the global value chain for over a decade.

Even though the participation of Thai producers and economy in the global value chain has increased over a period of time, their net export[2] has not improved as much as their gross export. Figure 1.2 shows that the share of net export per GDP is lower than the gross export's share in every year. For this reason, the contribution of export-led expansion to local economy needs to be precisely measured since the quantitative measure of the impact and gain from conventional export-led growth strategy are misleading that is they try to stimulate only the total amount of gross export without considering export components.

When a country exports its products, the amount of gross export, which can be divided into three categories, including: Domestic Value-Added in Gross Export (DVAING), Foreign Value-Added in Gross Export (FVAING), and Pure Double Counted in Gross Export (PDCING) should be considered[3]. Therefore, in this study, the potential policy formulation for enhancing competitiveness and value added from global value chain participation is examined.

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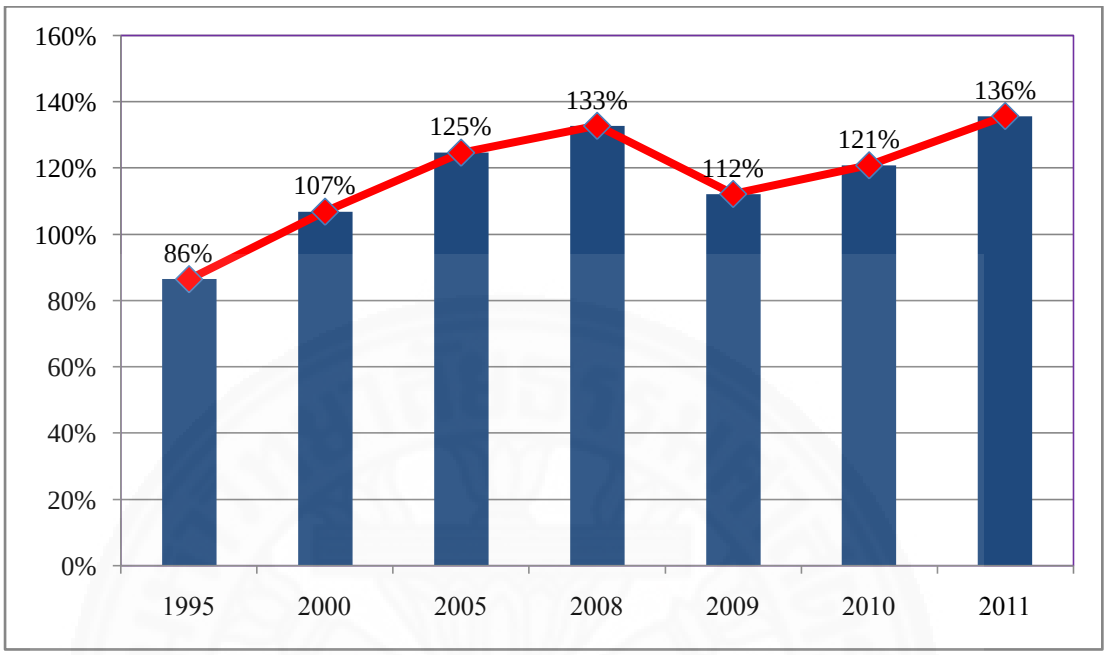
[1] It can be calculated from summation of totals export and import divided by Gross Domestic Product (GDP).

[2] Net export equals gross export minus gross import.

[3] Also see figure 3.1 and its explanation about the basic concept of trade in value-added then we will get more understanding about the double counting problem.

Figure 1.1

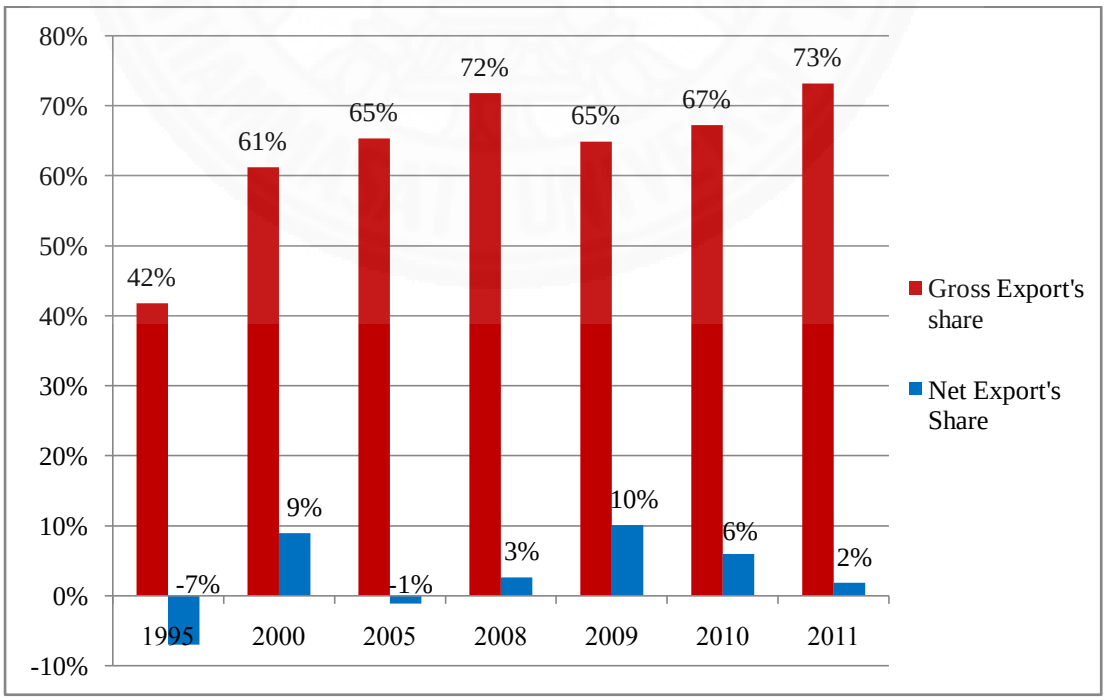
Degree of Trade Openness for Thai Economy



Source: Author's calculation based on OECD

Figure 1.2

Share of Gross Export and Net Export to GDP for Thai Economy

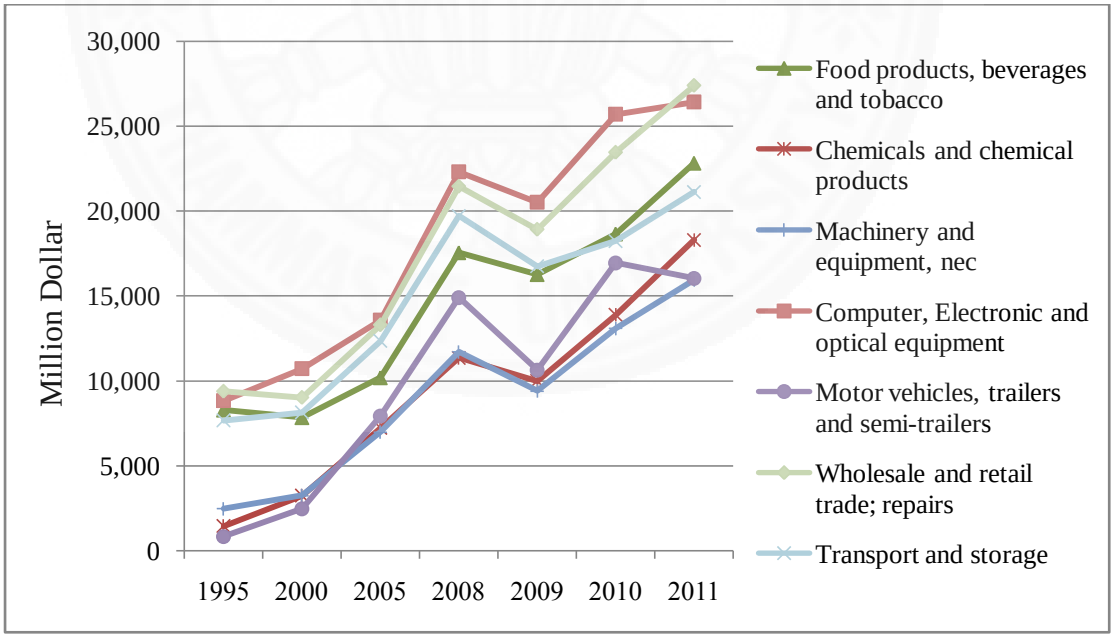


Source: Author's calculation based on OECD

The exploration for the top seven exporting industries[4] is illustrated in Figure 1.3; computer, electronic and optical equipment are the main components of Thai exports measures in gross export value. The other industries which are also grouped in the top seven Thai exporting industries consist of wholesale, retail trade and repairs; food products, beverages and tobacco; transport and storage; chemicals and chemical products; motor, vehicles, trailers and semi-trailers; and lastly, machinery and equipment. Furthermore, it is pointed out in Figure 1.4 that there are only three industries, including: computer, electronic and optical equipment; food products, beverages and tobacco; and motor, vehicles, trailers and semi-trailers which have the highest value in both net export and in terms of gross exports. With this finding, the gross export should not be directly used to identify the ability to export because a large amount of gross export does not always guarantee a similar amount of net exports in the same direction.

Figure 1.3

The Top Seven Exporting Industries for Thai Economy

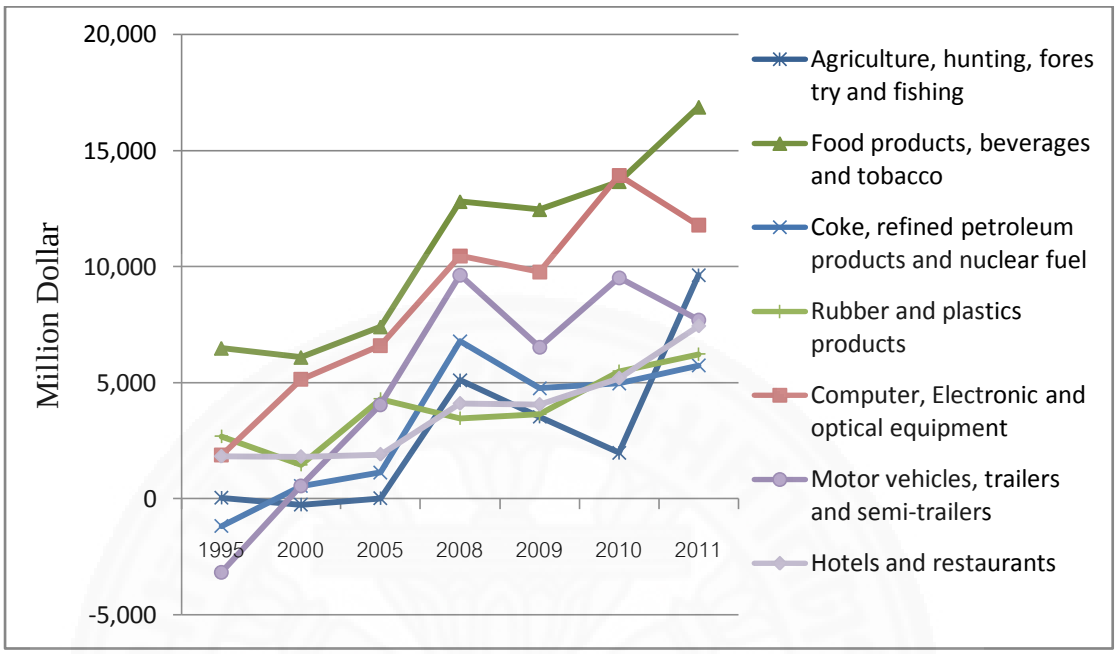


Source: Author's calculation based on OECD

[4] The summation of these industries' gross export is greater than 50% of total Thai export in every year.

Figure 1.4

The Top Seven Net Exporting Industries for Thai Economy

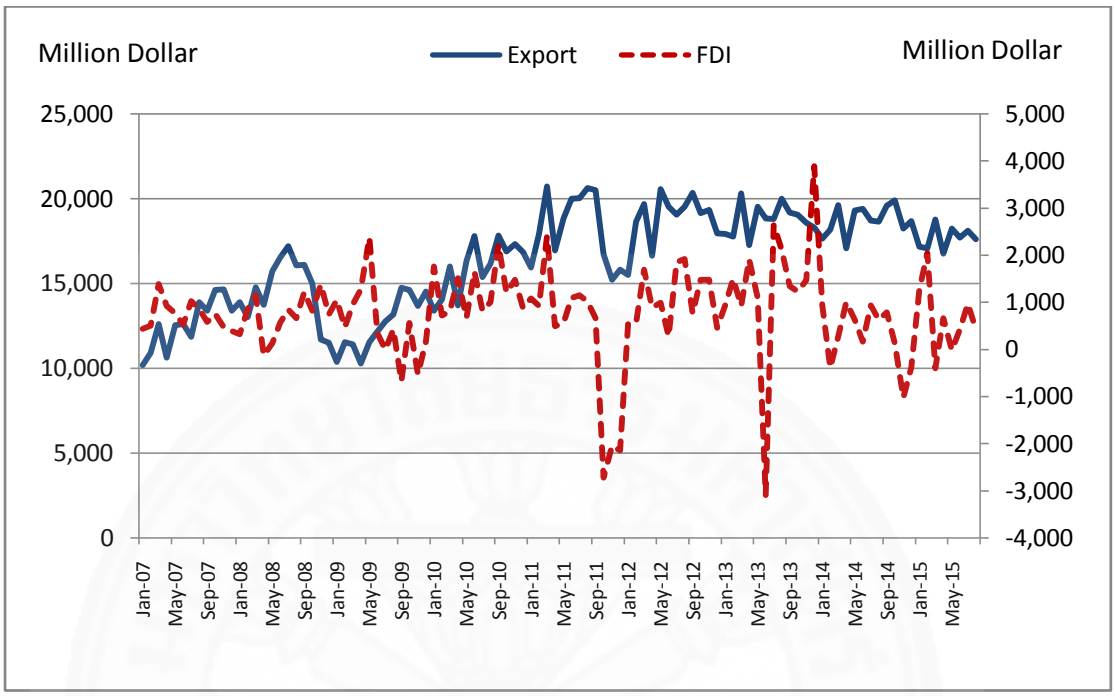


Source: Author's calculation based on OECD

One of the most interesting issues related to the impact of the global value chain on the Thai economy is the effect of Foreign Direct Investment (FDI) on exports. Figure 1.5 illustrates the positive correlation between FDI and the gross exports of Thailand. The higher value of FDI implies that there is a larger value of investment from foreign investors. This can be assumed that these foreign investors relocate their investments to the Thai economy and contribute to a higher production for exports.

Figure 1.5

FDI and Gross Export of Thailand (Unit: millions of US dollar)



Source: Author's calculation based on Bank of Thailand

This study contributes to four main issues regarding the decomposition analysis of the global value chain's impact on the Thai economy. The first issue is the decomposition analysis of gross export of Thai industries based on Domestic Value-Added in Gross Export (DVAING), Foreign Value-Added in Gross Export (FVAING) and Pure Double Counted in Gross Export (PDCING). The second issue is the comparison between Conventional Revealed Comparative Advantage index (RCA) and New Revealed Comparative Advantage index (NRCA) of Thai industries. The third issue is the linkage of Thai industries in a global value chain based on the degree of Vertical Specialization (VS index) and the magnitudes of International Forward as well as Backward Multipliers. The final issue is the result of the regression model which employs decomposed data from the first three issues based on export-led growth strategy.

1.2 Objectives of the Study

1.2.1 To decompose the value of gross export of Thai industries into Domestic Value-Added, Foreign Value-Added and Pure Double Counted in order to explore the embedded components.

1.2.2 To compare the Revealed Comparative Advantage indices between conventional trade and new trade approaches of Thai industries in order to examine the better measurement of export performance in the global value chain.

1.2.3 To explore the linkage and impact of Thai industries on their downstream and upstream in the global value chain based on the degree of Vertical Specialization and the magnitudes of International Forward as well as Backward Multipliers in order to quantify the impact of the global value chain on Thai industries as well as apply them with the export-led growth strategy.

1.2.4 To propose the economic policy for a better Thai export-led growth strategy based on the regression model showing contribution of Domestic Value-Added, Foreign Value-Added and Pure Double Counted.

1.3 Scope of Study

This study focuses on export-led growth strategy which employs two methods: Panel Fixed-Effect and Panel Two Stage Least Square (2SLS) Fixed-Effect. The empirical models are based on the panel data of Thai economy in five years: 2000, 2005, 2009, 2010 and 2011; the main source of data is OECD Inter-Country Input-Output Tables, 2015.

1.4 Definitions

1.4.1 Vertical Specialization Chain

Vertical Specialization Chain is the production process in which producers rely on their upstream and downstream linkages among countries (trade interdependence among countries).

1.4.2 Domestic Value-Added in Gross Export (DVAING)

DVAING is the value that represents the ability to create value-added in exported products.

1.4.3 Foreign Value-Added in Gross Export (FVAING)

FVAING is the value-added of foreign country which embodied in exported product, such as, returns from foreign labor and capital.

1.4.4 Pure Double Counted in Gross Export (PDCING)

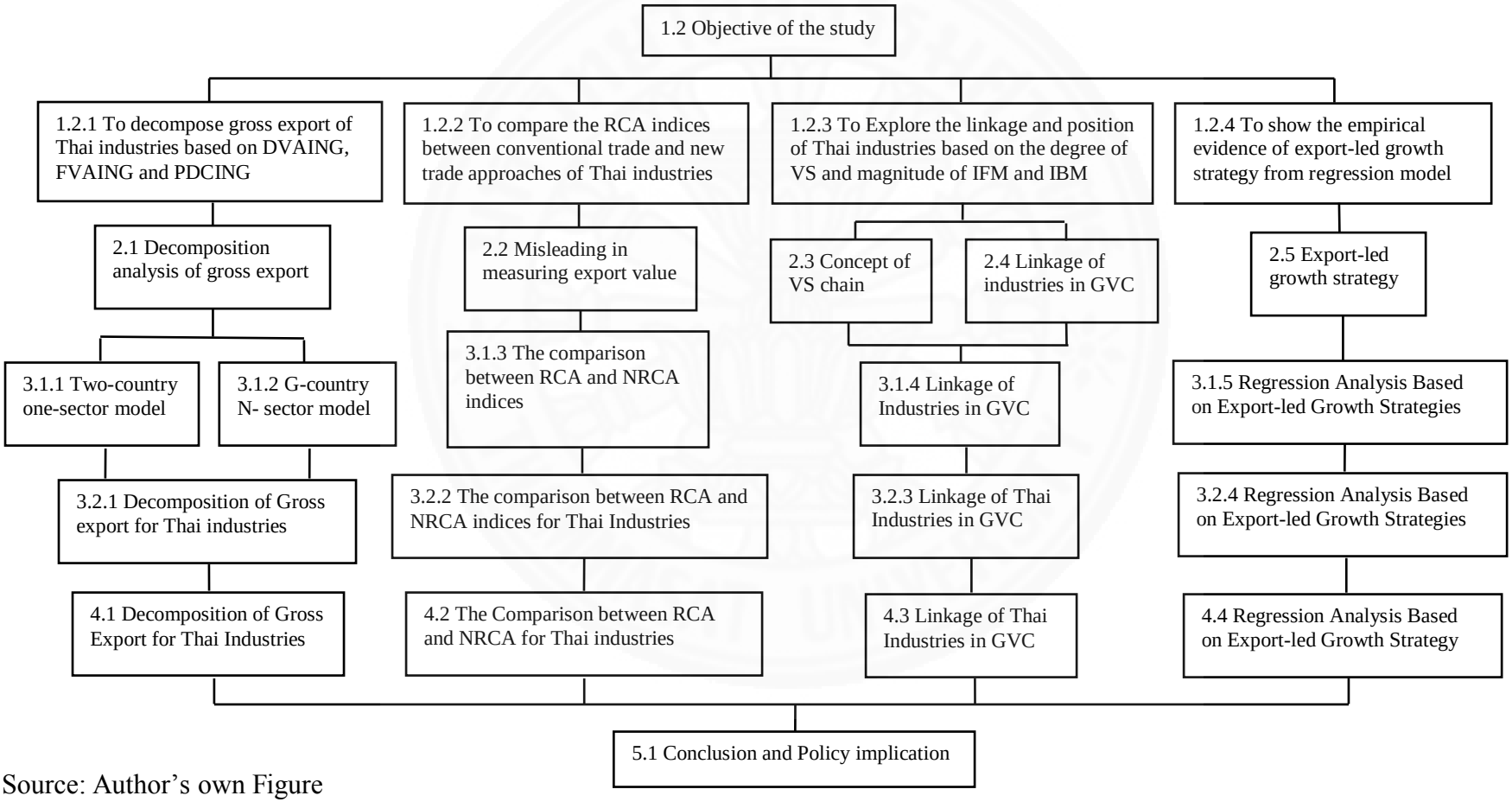
PDCING is the value of both domestic and imported intermediate inputs embodied in exported products.

1.5 Organization of Study

The study is organized in five chapters. The second chapter is the review of literature which provides the concept of decomposition analysis of gross export, misleading in measuring export value, Vertical Specialization (VS) chain, the linkage of industry in the global value chain, and the model of export-led growth strategy. In the third chapter, the technique to decompose gross export, New Revealed Comparative Advantage (NRCA), the method to compute VS index, International Forward and Backward Multipliers, and creation of export-led growth model are proposed. The empirical result of decomposition analysis of gross export, comparison between conventional RCA and NRCA, VS index, International Multipliers and the regression result based on export-led growth strategy are discussed in the fourth chapter. Finally, the fifth chapter presents the conclusion and policy implication, limitation, and the recommendation for future research.

Figure 1.6

Organization of Study



Source: Author's own Figure

CHAPTER 2
REVIEW OF LITERATURE

Section 2.1 discusses the research relating to decomposition analysis of gross export; section 2.2 examines misleading factors in measuring export value; section 2.3 explains the concept of vertical specialization chain. Subsequently, section 2.4 presents the linkage of industry in the global value chain that used to quantify the impact of the global value chain on a particular industry in a particular country. Lastly, section 2.5 discusses the model of export-led growth strategy.

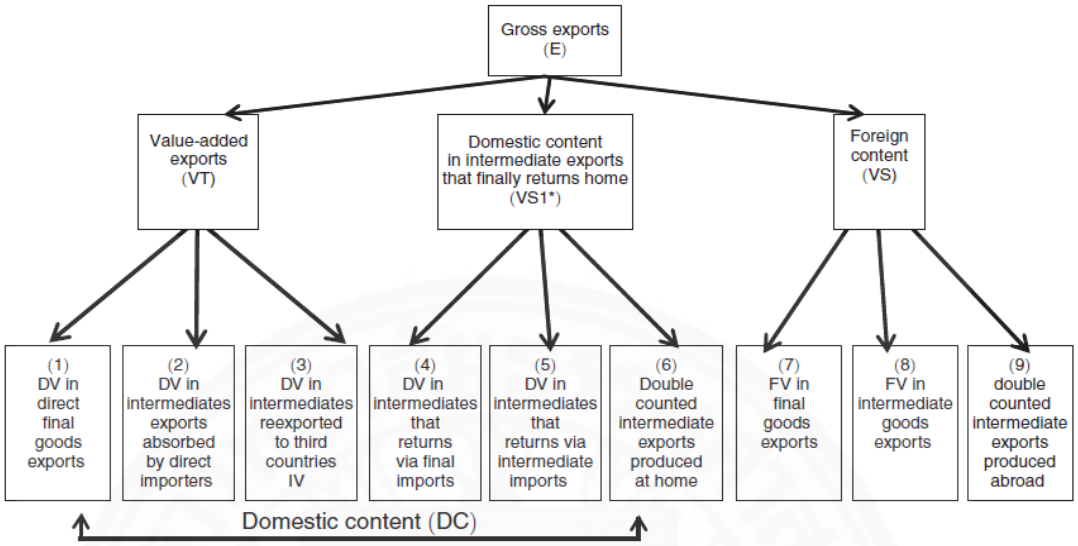
2.1 Decomposition Analysis of Gross Export

When any country exports goods and service to other countries, Koopman et al. (2012) found that the amount of gross export can be decomposed into nine categories (see Figure 2.1): domestic value-added in direct final goods exports, domestic value-added in intermediate exports absorbed by direct importers, domestic value-added in intermediate re-exportation to a third country, domestic value-added in intermediates that returns via final imports, domestic value-added in intermediates that returns via intermediate imports, double counted intermediate exports produced at home, foreign value-added in final goods exports, foreign value-added in intermediate goods exports and double counted intermediate exports produced abroad. The concept and lesson in calculating these nine categories of gross export will be described in Chapter 3 (Theoretical Framework and Research Methodology) of this study.

The impacts of a country's export on economic growth may not be directly measured by employing only gross term of export because all of the nine gross export categories mentioned above play an important role on economic growth. In addition, this section answers the first objective which aims to decompose gross export combinations into the various categories as mentioned, and to further analyze the export-led growth strategy in the regression part.

Figure 2.1

Accounting of Gross Exports



Source: Koopman et al. (2012)

2.2 Misleading in Measuring Export Value

In order to measure export ability accurately, export value which includes double counted term[1] should not be employed in the conventional trade theory since it directly measures export value from gross term of export and can lead to misinterpretation of actual export value. In preventing this misleading problem from trade in the global value chain, Johnson and Noguera (2012) employed the value-added export method to correctly measure export value. The value-added export can also clarify the characteristic as well as export ability of any country in global value chain (OECD, 2013).

The second objective in this study is to explore a more accurate measurement of export ability through the framework in this section. In the past, export ability was measured by conventional Revealed Comparative Advantage (RCA) index calculated from gross export value, yet this approach led to misinterpretation of export ability. A new trading approach provides an accurate

[1] Double counted term is the intermediate use in producing exported product which finally embodied there.

measurement of export ability by re-calculating RCA or employing new RCA that calculated from value-added export instead of gross export. The concept for creating value-added export can be explained through the example in Figure 2.2. According to Figure 2.2, country 1 exports intermediate goods (A) with the value of $100 to country 2, then country 2 can combine these imported intermediate goods with its domestic intermediate goods (B), labor and capital (C) to create value-added of $50. Finally, country 2 exports these goods with the total of $150 (E) to country 3. From this example, it does not mean that export ability of country 2 is exactly $150 because two-thirds of this amount ($100) accounts for the imported intermediate use (double counted term by definition). In term of value-added export, country 2 can only create $50 of value. Therefore, in order to avoid a misleading problem on a trading system, this study measures export ability through the use of value-added export instead of gross export.

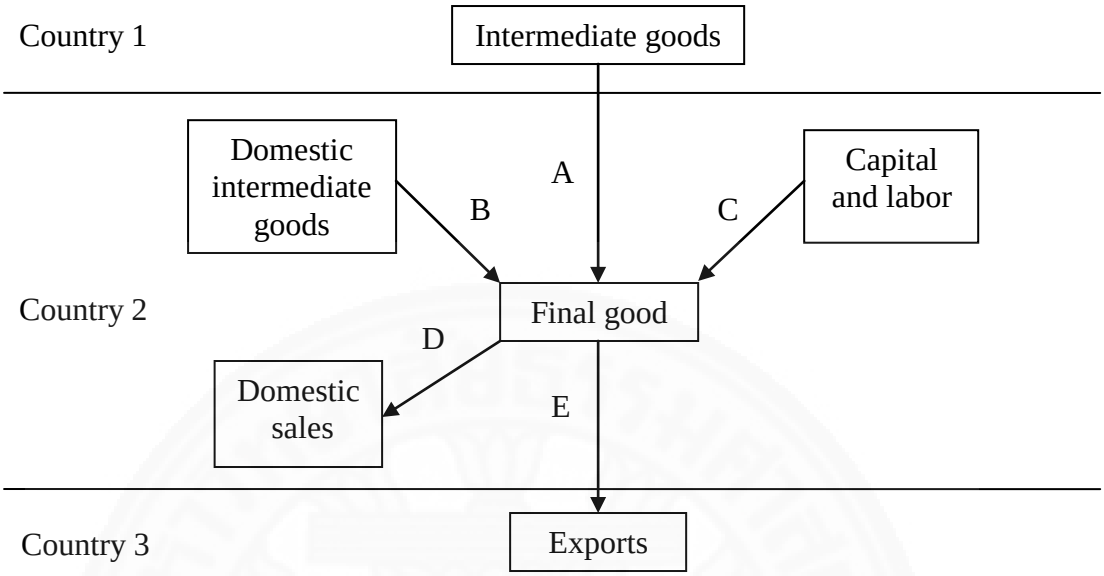
2.3 Concept of Vertical Specialization Chain

In the globalized world, a pattern of global trade is transformed to Vertical Specialization (VS) chain which can enhance the volume of global trade. Hummels et al. (2001) initially explored this phenomenon and named it as the VS chain. The VS chain clarified the specialization of each country in a particular stage that employs the imported intermediate input from other countries in global value chain to produce a country's export or the degree of linkage to global value chain.

Koopman et al. (2014) extended the idea of the VS chain and found that the VS value or imported content in a country's export consists of three things: foreign value-added in final goods export, foreign value-added in intermediate goods export, and double counted intermediate exports produced abroad. According to Figure 2.2, which illustrates the concept of VS chain, country 1 produces intermediate goods and exports to country 2. Then country 2 can employ the imported intermediate goods as one of its factors of production and combine it with its labor and capital (value-added), and domestic intermediate goods to produce larger amount of output. Finally, some of this output can be exported to country 3.

Figure 2.2

Concept of Vertical Specialization Chain



Source: Hummels et al. (2001)

The measurement of VS value for country k and sector i can be specified as follows:

$$VS_{ki} = \left(\frac{\text{imported intermediates}}{\text{gross output}} \right) \times \text{export} \quad (1)$$

$$= \left(\frac{\text{export}}{\text{gross output}} \right) \times \text{imported intermediates} \quad (2)$$

For country 2 sector i in Figure 2.1, its VS value (VS_{2i}) is equal to (A/(D+E))*E or (E/(D+E))*A.

In conclusion, the concept of VS chain contributes to two main issues; first, the volume of world trade can be increased by following the concept of VS chain (Hwang et al., 2011); second, a higher level of trade volume does not only depend on the conventional trade approach that stimulates the amount of gross exports but also depends on the concept of VS chain. However, the VS chain mentioned above has some weakness in which it measures only one way in explaining the participation of a

country in global value chain through employing intermediate use in producing a country's export. Moreover, based on the third objective of this study, the papers by Hummels et al. (2001) and Koopman et al. (2014) were used to clarify the exploration of Thai industries' linkage to the global value chain based on the degree of VS.

2.4 The Linkage of Industry in the Global Value Chain

The degree of an industry impact on upstream and downstream partners in the global value chain can be respectively measured by International Backward and Forward Multipliers which are quantified from an intermediate use of any industry among the global value chain (Puttanapong, 2015). Given that the International Backward Multiplier of a particular industry is 1.5, this means that a particular industry has to employ intermediate goods from other industries 1.5 units in the global value chain to produce its one unit of output. In contrast, 1.5 of International Forward Multiplier clarifies that when a particular industry produces one unit of output, its 1.5 unit of intermediate goods will be exported to the other industries in the global value chain.

Moreover, both the International Backward and Forward Multipliers can represent the position of any industry in the global value chain. Higher International Backward Multiplier means that a position of a particular industry in a country is close to the end of supply chain while higher International Forward Multiplier means that a position of an industry in the supply chain is close to the beginning of the process. Finally, this section supports the third objective of this study which is the exploration of Thai industries' impact on their downstream and upstream linkages in the global value chain based on International Forward as well as Backward Multipliers.

2.5 Export-led Growth Strategy

The final issue identified in this paper is related to the export-led growth strategy which originates from Romer (1990). The author explained the economic growth on the supply side of the economy by employing a production function using

the Cobb-Douglas model. Romer (1990) found that the economic growth is driven by growths of total factor productivity, labor, and capital. In order to make the production function more realistic, Chen (1999) examined some additional variables that explain economic growth, including the intermediate use as one of the explanatory variables in a production function from the previous model. Chen (1999) concluded that there is a positive relationship between all factors of production (total factor productivity, labor, capital and intermediate use) and economic growth. Sprout and Weaver (1993) extended the growth of Romer's model by analyzing the role of exports on economic growth in the simultaneous equation model. As a result, they found that exports can drive the economic growth at the same time the economic growth can stimulate the export growth. Lewer and Berg (2003) also explored the impact of exports on economic growth by employing export growth as one of the total factors of productivity in a production function, and they claimed that exports can provide a significant explanation for the economic growth. Finally, Hye et al. (2013) clarified that all three variables consisting of export, import and economic growth are interdependent.

Moreover, the export-led growth strategy can be explained from another method which is the demand side of the economy. Tang et al. (2015) constructed the export-led growth in the bivariate model which has only gross export as an explanatory variable, then they concluded that the export has a positive impact on economic growth. In addition, Wah (2004) constructed the export-led growth in a tri-variate model by employing gross export and domestic demand as explanatory variables to explain economic growth. The tri-variate model shows that both export and domestic demand can generate economic growth. By following the findings of Tang et al. (2015) and Wah (2004), the regression model based on export-led growth strategy on the demand side of the economy is created to identify the last objective of this study which aims to propose the economic policy for a better Thai export-led growth strategy.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter begins with a description of gross export accounting in the two-country one-sector model used for an explanation of the concept and measurement, and follows by the material proposed by Koopman et al. (2014) and the schematic diagram of the international production chain introduced by Baldwin and Lopez-Gonzalez (2015). In addition, the method of calculating conventional Revealed Comparative Advantage (RCA), new Revealed Comparative Advantage (NRCA) indices, Vertical Specialization index (VS index), International Forward as well as Backward Multipliers was constructed using these methods. Lastly, the regression analysis of Panel Fixed-Effect and Panel 2SLS Fixed Effect are explained in this chapter.

3.1 Theoretical Framework

Figure 3.1 illustrates the basic concept of trade in value-added by assuming that there are four steps of the value chain, including: raw material extraction, processing, manufacturing, final demand, and four participating countries (country A to country D). According to Figure 3.1, country A extracts raw material with the value of $2 then exports to country B, resulting in country B creating value-added of $24 in processing. After that, country B can further export the total output of $26, which includes double counted from country A ($2), to country C. In terms of a manufacturing process, country C can create value-added of $46 and export $72 which includes double counted from both countries A ($2) and B ($24) to country D. In this scenario, the amount of $72 becomes the final demand for country D.

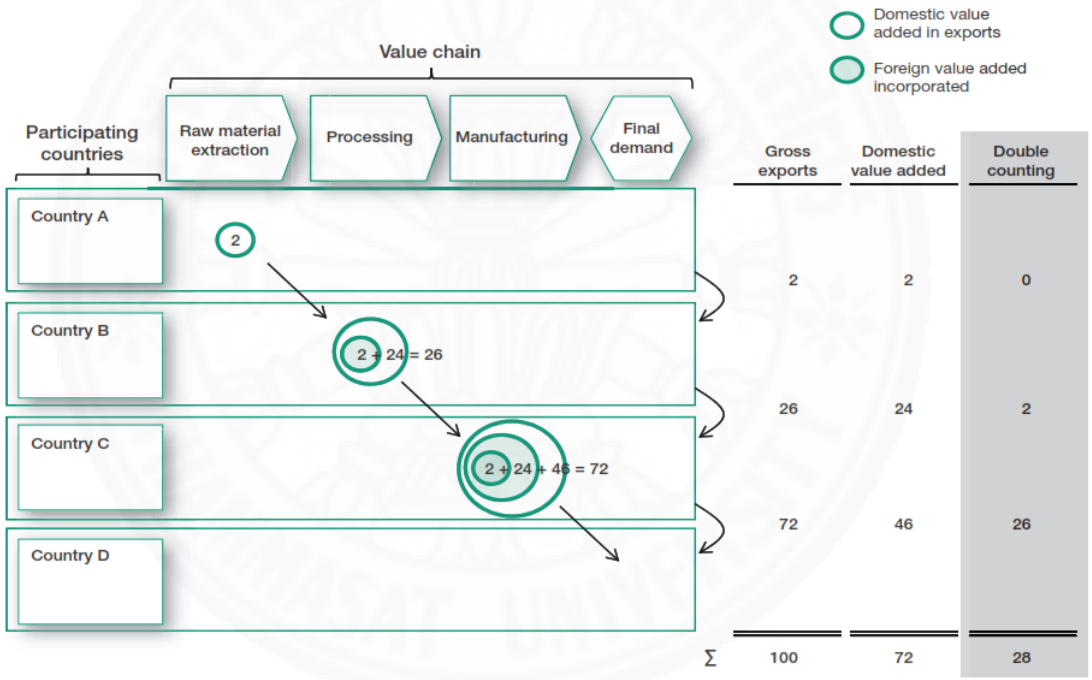
From this basic concept of trade in value-added explained above, the conventional trade approach concludes that the total amount of world export equals to $100 (the sum of $2, $26 and $72 from gross exports of country A to country C, respectively); however, measuring in this way can generate the misleading problem since $28 of total double counted is also included in the equation. In particular, the

double counting problem may lead to the over export value, resulting in distortion of economic growth.

Therefore, the amount of $72 of domestic value-added export (the sum of $2, $24 and $46 from domestic value-added export of country A to country C, respectively) is employed as a new approach in measuring the export value since it can provide more accurate measurement for export value and can diminish a misleading problem.

Figure 3.1

Basic Concept of Trade in Value-Added



Source: UNCTAD

3.1.1 Two-Country One-sector Model

3.1.1.1 Production Sharing and Trade in Value-Added

In order to simplify the explanation, this section focuses on the two-country one-sector model and discusses a general case of G-country N-sector in

section 3.1.2. The information in this section is associated with a model proposed by Koopman et al. (2014). In this model, it is assumed that there are two countries (a home country and a foreign country) in the world; each country has only one sector which produces a single product. The product in each sector can be directly consumed as final goods or indirectly used as an intermediate input. In addition, each country can export both intermediate and final goods to other countries. The gross output produced by country s (x_s) is classified as intermediate and final goods for both home and foreign countries. Thus, the gross output of country s (x_s) can be written as the following equation:

$$x_s = a_{ss}x_s + a_{sr}x_r + y_{ss} + y_{sr}, \quad r,s = 1,2 \tag{1}$$

According to the equation, y_{sr} is the final demand of country r which imports goods from country s while a_{sr} is the coefficient of input-output that describes one unit of intermediate goods in which country r imports from country s to produce the same unit of output in its own country. Hence, the total amount of intermediate goods which country r imports from country s is $a_{sr}x_r$.

In addition to the gross output of country s, the production of two countries can be shown by transforming equation (1) into a matrix form specified in Equation (2):

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} y_{11} + y_{12} \\ y_{21} + y_{22} \end{pmatrix} \tag{2}$$

After re-arranging equation (2), equation (3) is derived as follows:

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} I - a_{11} & -a_{12} \\ -a_{21} & I - a_{22} \end{pmatrix}^{-1} \begin{pmatrix} y_{11} + y_{12} \\ y_{21} + y_{22} \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} \tag{3}$$

Matrix B is Leontief inverse or the total requirement coefficients of input-output matrix. For example, if b_{11} is an amount of country 1's gross output that used to

produce an extra unit of final goods in its own country then this can contribute to domestic consumption and country 2' import. The other coefficients in matrix B can be similarly interpreted. The gross output of each country can be classified into different destinations by rewriting equation (3) as listed below:

$$\begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{pmatrix} = \begin{pmatrix} b_{11}y_{11} + b_{12}y_{21} & b_{11}y_{12} + b_{12}y_{22} \\ b_{21}y_{11} + b_{22}y_{21} & b_{21}y_{12} + b_{22}y_{22} \end{pmatrix} \quad (4)$$

The left-hand side of the equation (4) is the decomposition matrix of gross output which explains how gross output produced in a country absorbed by a variety of destinations. The summation of each row in equation (4) is the gross output of a country; for example, $x_{11}+x_{12}$ is equal to x_1 (gross output of country1). Correspondingly, the right-hand side of the equation (4) explains the classified gross output of each country; for example, x_{11} is classified into two parts. The first part, $b_{11}y_{11,}$ stands for gross output of country 1 that is used to produce final goods of country 1 that is consumed in the country. The second part, $b_{12}y_{21}$, stands for gross output of country 1 that is exported as intermediate goods; however, those intermediate goods is ultimately exported and returned home as part of country 1's imports from abroad (see the thick line in Figure 3.3, reimporting). Similarly, x_{12} can be classified into two parts; the first part, $b_{11}y_{12}$, stands for gross output of country 1 from the export of final goods that is consumed by country 2; the second part, $b_{12}y_{22,}$ stands for gross output of country 1 from the export of intermediate goods used by the country 2 to produce final goods for consumption.

In order to produce one unit of country 1's goods, producers have to use a_{11} unit of domestic intermediate goods and a_{21} unit of imported intermediate goods. Therefore, the ratio of value-added of an output for a particular sector within country 1 (the domestic value added in country 1) is $v_1=1-a_{11}-a_{21}$. Similarly, country 2's ratio of value-added to output for a sector is: $v_2=1-a_{12}-a_{22}$. As a result, v_1 and v_2 can be written in a 2×2 value-added coefficient matrix as follows:

$$V = \begin{pmatrix} v_1 & 0 \\ 0 & v_2 \end{pmatrix} \tag{5}$$

If the matrix V from equation (5) is multiplied by the Leontief inverse B from equation (4)**,** a 2×2 matrix of value-added share (VB) which is the measurement of value-added shares by a source of production is derived.

$$VB = \begin{pmatrix} v_1 b_{11} & v_1 b_{12} \\ v_2 b_{21} & v_2 b_{22} \end{pmatrix} \tag{6}$$

From the equation (6), v_1b_{11} and v_2b_{22} stand for domestic value-added shares of country 1 and country 2 respectively; whereas v_2b_{21} and v_1b_{12} stand for value-added shares of the same types of goods of a foreign country. Since the value-added comes from either domestic or foreign countries, the summation of a column has to be equal to one:

$$v_1 b_{11} + v_2 b_{21} = v_1 b_{12} + v_2 b_{22} = 1 \tag{7}$$

v_1x_1, the domestic value-added in gross output of country 1 (GDP of country 1), can be classified into two parts: $v_1x_1=v_1x_{11}+v_1x_{12}$ where v_1x_{11} is the domestic value-added absorbed at home, and v_1x_{12} is the value-added export from country 1 to country 2. When the equation (4) is substituted by the previous value-added export term (v_1x_{12}), then $v_1x_{12}=v_1b_{11}y_{12}+v_1b_{12}y_{22}$ is derived. Thus country 1's export of value added involves two components: country 1's value added embedded in its own export of final goods that is absorbed in country 2 ($v_1b_{11}y_{12}$), and country 1's value added in its exports of intermediate goods that is used by country 2 to produce final goods ($v_1b_{12}y_{22}$). As a result, the value-added export of countries 1 and 2 can be written as follows:

$$\left.\begin{aligned} VT_{12} \equiv v_1 x_{12} = v_1 b_{11} y_{12} + v_1 b_{12} y_{22} \\ VT_{21} \equiv v_2 x_{21} = v_2 b_{21} y_{11} + v_2 b_{22} y_{21} \end{aligned}\right\} \tag{8}$$

3.1.1.2 Accounting of Gross Exports

The gross export of country 1 which is the combination of final and intermediate goods exports can be written as the following equation:

$$e_{12} = y_{12} + a_{12}x_2 \tag{9}$$

By multiplying equation (9) with equation (7), equation (10) is derived as follows:

$$\begin{aligned} e_{12} &= \left(v_1 b_{11} + v_2 b_{21}\right)\left(y_{12} + a_{12}x_2\right) \\ &= v_1 b_{11} y_{12} + v_2 b_{21} y_{12} + v_1 b_{11} a_{12} x_2 + v_2 b_{21} a_{12} x_2 \\ &= v_1 b_{11} y_{12} + v_2 b_{21} y_{12} + v_1 b_{12} y_{22} + v_1 b_{12} y_{21} \\ &\quad + v_1 b_{12} a_{21} x_1 + v_2 b_{21} a_{12} x_2 \end{aligned} \tag{10}$$

Furthermore, the value of country 1's intermediate goods export and its value of double counted from a total 100 percent can be incorporated into an accounting equation. When combining equations (1) and (9) together, this generates $x_1=y_{11}+a_{11}x_1+e_{12}$ and $x_2=y_{22}+a_{22}x_2+e_{21,}$ which can be rearranged to get equation (11) as follows:

$$\left.\begin{aligned} x_1 &= \left(1-a_{11}\right)^{-1} y_{11} + \left(1-a_{11}\right)^{-1} e_{12} \\ x_2 &= \left(1-a_{22}\right)^{-1} y_{22} + \left(1-a_{22}\right)^{-1} e_{21} \end{aligned}\right\} \tag{11}$$

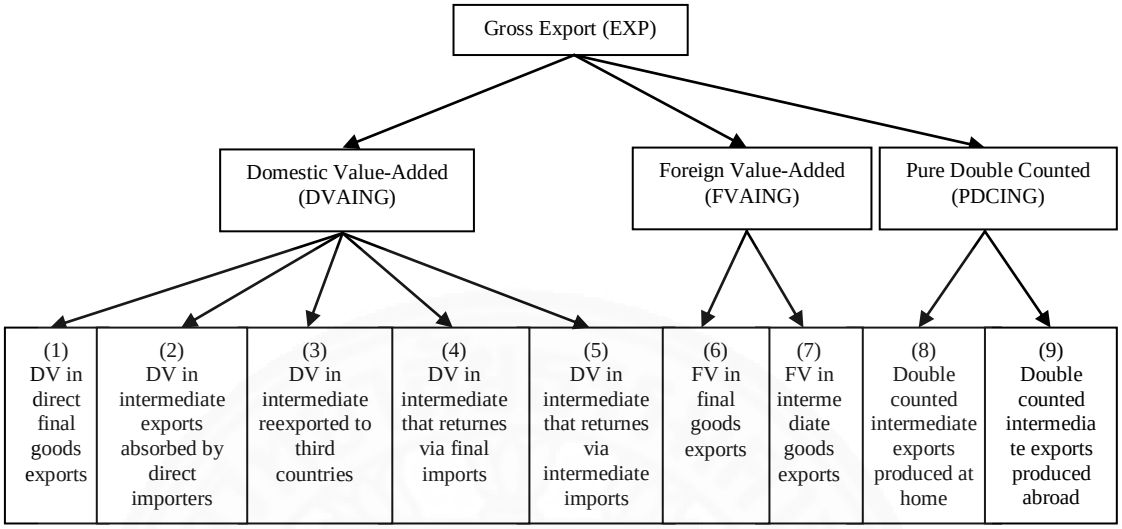
Substituting equation (11) into equation (10) yields equation (12) as follows:

$$\begin{aligned} e_{12} &= v_1 b_{11} e_{12} + v_2 b_{12} e_{12} = \left[v_1 b_{11} y_{12} + v_1 b_{12} y_{22}\right] \\ &\quad + \left[v_1 b_{12} y_{21} + v_1 b_{12} a_{21}\left(1-a_{11}\right)^{-1} y_{11}\right] + v_1 b_{12} a_{21}\left(1-a_{11}\right)^{-1} e_{12} \\ &\quad + \left[v_2 b_{21} y_{12} + v_2 b_{21} a_{12}\left(1-a_{22}\right)^{-1} y_{22}\right] + v_2 b_{21} a_{12}\left(1-a_{22}\right)^{-1} e_{21} \end{aligned} \tag{12}$$

All of the eight terms on the right-hand side of the equation (12) are gross export combinations of country 1 which corresponds to Figure 3.2 and 3.3 as listed below:

Figure 3.2

Decomposition Analysis of Gross Export



Source: Adapted from Koopman et at. (2014)

Note: DV (3) on Figure 3.2 only appears in a minimum number of the three country model, but does not appear in a two country model, of which will be discussed later in part of general case for G-country N-sector model.

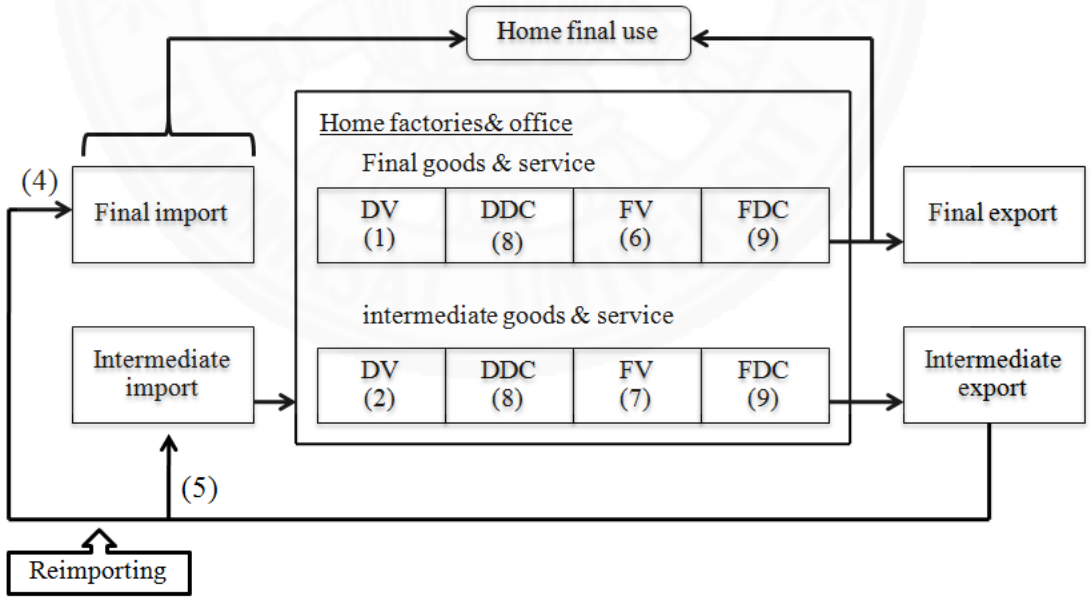
The first two terms, $v_1 b_{11} y_{12}$ and $v_1 b_{12} y_{22}$ ((1) and (2) in Figure 3.2), are defined as value-added exports of final and intermediate goods of country 1 respectively (they also correspond to the first equation in (8), VT_{12}). The third term, $v_1 b_{12} y_{21}$ ((4) in Figure 3.2), is the domestic value added in intermediate goods exports of country 1 of which is returned home as part of the final goods import. The fourth term, $v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} y_{11}$ ((5) in Figure 3.2), is domestic value-added in intermediate exports of country 1 that are returned home as part of the imports of intermediate goods used to produce final goods that are absorbed at a home country. Additionally, the fifth term, $v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} e_{12}$ ((8) in Figure 3.2), is a pure double counted term produced at home. This term only appears if both countries export intermediate goods. The sixth term, $v_2 b_{21} y_{12}$ ((6) in Figure 3.2), is the foreign value-added in final goods export of country 1. The seventh term, $v_2 b_{21} a_{12} \left(1 - a_{22}\right)^{-1} y_{22}$ ((7) in Figure 3.2), is

foreign value-added in intermediate goods exported out of the country 1. They both finally return to a foreign country and are consumed there. Lastly, the eighth term, $v_2 b_{21} a_{12} \left(1-a_{22}\right)^{-1} e_{21}$ ((9) in Figure 3.2), is another pure double counted term in country 1's gross exports being produced abroad. Similar to the fifth term, the eighth term only appears if both countries export intermediate goods. By using the same logic, the country 2's gross exports can be decomposed into eight terms as written below:

$$\begin{aligned} e_{21} &= v_1 b_{12} e_{21} + v_2 b_{22} e_{21} = \left[v_2 b_{22} y_{21} + v_2 b_{21} y_{11} \right] \\ &+ \left[v_2 b_{21} y_{12} + v_2 b_{21} a_{12} \left(1-a_{22}\right)^{-1} y_{22} \right] + v_2 b_{21} a_{12} \left(1-a_{22}\right)^{-1} e_{21} \\ &+ \left[v_1 b_{12} y_{21} + v_1 b_{12} a_{21} \left(1-a_{11}\right)^{-1} y_{11} \right] + v_1 b_{12} a_{21} \left(1-a_{11}\right)^{-1} e_{12} \end{aligned} \tag{13}$$

Figure 3.3

The Schematic Diagram of International Production Chain for Two- Country One-Sector Model



Source: Adapted from Baldwin and Lopez-Gonzalez (2015)

Note: DV is Domestic Value-Added DDC is Domestic Double Counted
FV is Foreign Value-Added FDC is Foreign Double Counted
(Number in parenthesis is corresponded to Figure 3.2's number)

3.1.1.3 Accounting of GDP

GDP in each country can be calculated from the sum of its value-added exports and domestic value-added consumed at home, as follows:

$$GDP_1 = v_1 x_1 = v_1\left(b_{11}y_{12} + b_{12}y_{22} + b_{12}y_{21} + b_{11}y_{11}\right)$$
$$= v_1\left\{b_{11}y_{12} + b_{12}y_{22} + \left[b_{12}y_{21} + b_{12}a_{21}\left(1-a_{11}\right)^{-1}y_{11}\right]\right\} + v_1\left(1-a_{11}\right)^{-1}y_{11} \quad (14)$$

$$GDP_2 = v_2 x_2 = v_2\left(b_{21}y_{11} + b_{22}y_{21} + b_{21}y_{12} + b_{22}y_{22}\right)$$
$$= v_2\left\{b_{21}y_{11} + b_{22}y_{21} + \left[b_{21}y_{12} + b_{21}a_{12}\left(1-a_{22}\right)^{-1}y_{22}\right]\right\} + v_2\left(1-a_{22}\right)^{-1}y_{22} \quad (15)$$

The last term in equations (14) and (15) are value-added produced and consumed at home which are not related to international trade; whereas, the first to the fourth terms in the bracket of each GDP equation are the same as first to fourth terms in equations (12) and (13). Finally, equation (16) shows that the summation of global GDP which always equals global final demand as follows:

$$GDP_1 + GDP_2 = v_1 x_1 + v_2 x_2 = \left(1-a_{11}-a_{21}\right)x_1 + \left(1-a_{12}-a_{22}\right)x_2$$
$$= x_1 - a_{11}x_1 - a_{12}x_2 + x_2 - a_{21}x_1 - a_{22}x_2 = y_1 + y_2 \quad (16)$$

3.1.2 General Case of G-Country and N-Sector Model

3.1.2.1 Production Sharing and Trade in Value-Added

The model can be used to generalize a case which involves G-country N- sector by using the same logic with the two-country one-sector model. Then the production of two countries and a trade system in equation (3) can be extended to equation (17).

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} = \begin{bmatrix} I - A_{11} & -A_{12} & \cdots & -A_{1G} \\ -A_{21} & I - A_{22} & \cdots & -A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ -A_{G1} & -A_{G2} & \cdots & I - A_{GG} \end{bmatrix}^{-1} \begin{bmatrix} \sum_r^G Y_{1r} \\ \sum_r^G Y_{2r} \\ \vdots \\ \sum_r^G Y_{Gr} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \cdots & B_{1G} \\ B_{21} & B_{22} & \cdots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \cdots & B_{GG} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_G \end{bmatrix} \quad (17)$$

The gross output of each country can be classified into different destinations by rewriting the equation (17) as follows:

$$\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1G} \\ X_{21} & X_{22} & \cdots & X_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ X_{G1} & X_{G2} & \cdots & X_{GG} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \cdots & B_{1G} \\ B_{21} & B_{22} & \cdots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \cdots & B_{GG} \end{bmatrix} \begin{bmatrix} Y_{11} & Y_{12} & \cdots & Y_{1G} \\ Y_{21} & Y_{22} & \cdots & Y_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{G1} & Y_{G2} & \cdots & Y_{GG} \end{bmatrix} \quad (18)$$

The similar interpretation for the ratio of value-added to output for the G-country and N- sector model can be written as GN×GN matrix as follows:

$$\hat{V} = \begin{bmatrix} \hat{V}_1 & 0 & \cdots & 0 \\ 0 & \hat{V}_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \hat{V}_G \end{bmatrix} \quad (19)$$

If $\hat{V}$ from equation (19) is multiplied by the Leontief inverse B from equation (18)**,** this can yield a G×GN value-added share (VB) matrix which is the measurement of value-added shares by source of production as follows:

$$VB = \begin{bmatrix} V_1 B_{11} & V_1 B_{12} & \cdots & V_1 B_{1G} \\ V_2 B_{21} & V_2 B_{22} & \cdots & V_2 B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ V_G B_{G1} & V_G B_{G2} & \cdots & V_G B_{GG} \end{bmatrix} \quad (20)$$

Domestic value-added in gross output of country1 to country G can be extended from the two-country one-sector model in equation (8) as follows:

$$\begin{bmatrix} V_1B_{11} & V_1B_{12} & \cdots & V_1B_{1G} \\ V_2B_{21} & V_2B_{22} & \cdots & V_2B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ V_GB_{G1} & V_GB_{G2} & \cdots & V_GB_{GG} \end{bmatrix} \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1G} \\ X_{21} & X_{22} & \cdots & X_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ X_{G1} & X_{G2} & \cdots & X_{GG} \end{bmatrix}$$
$$= \begin{bmatrix} \hat{V}_1\sum_r^G B_{1r}Y_{r1} & \hat{V}_1\sum_r^G B_{1r}Y_{r2} & \cdots & \hat{V}_1\sum_r^G B_{1r}Y_{rG} \\ \hat{V}_2\sum_r^G B_{2r}Y_{r1} & \hat{V}_2\sum_r^G B_{2r}Y_{r2} & \cdots & \hat{V}_2\sum_r^G B_{2r}Y_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \hat{V}_G\sum_r^G B_{Gr}Y_{r1} & \hat{V}_G\sum_r^G B_{Gr}Y_{r2} & \cdots & \hat{V}_G\sum_r^G B_{Gr}Y_{rG} \end{bmatrix} \quad (21)$$

Each diagonal matrix in equation (21) is the domestic value-added that was absorbed at home and is similar to a logic in equation (6) of two-country one-sector model. Thus, the similar interpretation for value-added export in a general case of G-country and N- sector model can be also applied to the following off-diagonal matrix of this $GN \times G$ matrix in the equation (21) as follows:

$$VT_{sr} = \hat{V}_s X_{sr} = \hat{V}_s \sum_g^G B_{sg}Y_{gr} \quad (22)$$

The total value-added export to the world for any country can be written as follow:

$$VT_{s^*} = \sum_{r\neq s}^G VX_{sr} = V_s \sum_{r\neq s}^G \sum_{g=1}^G B_{sg}Y_{gr} \quad (23)$$

Furthermore, the equation (23) can be decomposed into three categories which clarify the destinations of value-added export of a country as follow:

$$VT_{s*} = V_s \sum_{r\neq s}^G B_{ss}Y_{sr} + V_s \sum_{r\neq s}^G B_{sr}Y_{rr} + V_s \sum_{r\neq s}^G \sum_{t\neq s,r}^G B_{sr}Y_{rt} \quad (24)$$

All of these three categories presented in the equation (24) can be clearly explained; the first category is the value-added embedded in the export of final goods that is absorbed abroad while the second category is the value-added in the export of intermediate goods that is used by a direct importer to produce final goods consumed by a direct importer. In addition to the first two categories, the third category is the value-added in the export of intermediate goods used by a direct importer to produce final good consumed by third countries (re-exported effect).

A comparison between G-country N-sector in the equation (24) and the two- country one-sector in the equation (8) yields a difference in terms of additional category. The equation (24) consists of re-exported or a third country effect that can be found in a minimum number of the three country model.

3.1.2.2 Accounting of Gross Exports

The gross export in a general case of G-country N-sector can be written as the following equation:

$$E_{s^*} = \sum_{r \neq s}^{G} E_{sr} = \sum_{r \neq s}^{G} \left(A_{sr} X_r + Y_{sr} \right) \tag{25}$$

Using the same logic with equation (10) to derive gross export combinations in a general case of G-country N-sector, gross export can initially be decomposed as the following equation:

$$\begin{aligned} uE_{s*} &= V_s B_{ss} E_{s^*} + \sum_{r \neq s}^{G} V_r B_{rs} E_{s^*} \\ &= VT_{s^*} + \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} X_s \right\} \\ &+ \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} X_r \right\} \end{aligned} \tag{26}$$

When rearranging gross output of any country with the equation, $X_s = Y_{ss} + A_{ss}X_s + E_{s^*}$, this can yield the following equation:

$$\left.\begin{aligned} X_s &= \left(I - A_{ss}\right)^{-1} Y_{ss} + \left(I - A_{ss}\right)^{-1} E_{s^*} \\ X_r &= \left(I - A_{rr}\right)^{-1} Y_{rr} + \left(I - A_{rr}\right)^{-1} E_{r^*} \end{aligned}\right\} \tag{27}$$

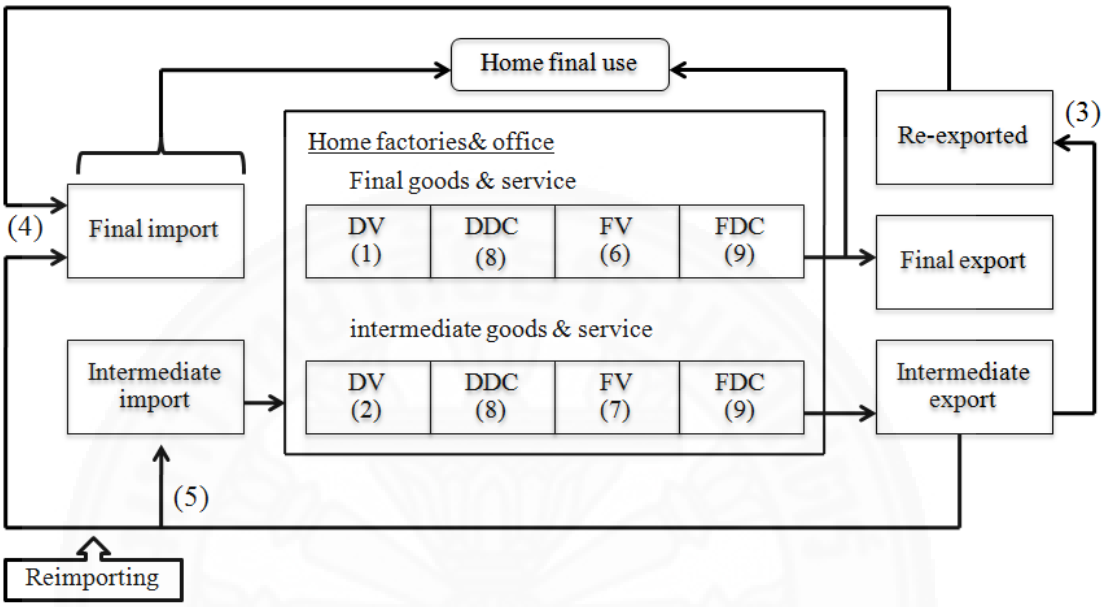
Replacing the equation (27) with the equation (26) and employing the equation (24) yield the final form of gross export (equation 28) which can be decomposed into nine categories (as shown in Figure 3.2 and 3.4).

$$\begin{aligned} uE_{s^*} = & \left\{ V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \right\} \\ & + \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \left(I - A_{ss}\right)^{-1} Y_{ss} \right\} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \left(I - A_{ss}\right)^{-1} E_{s^*} \\ & + \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} \left(I - A_{rr}\right)^{-1} Y_{rr} \right\} \\ & + \sum_{t \neq s}^{G} V_t B_{ts} A_{sr} \sum_{r \neq s}^{G} \left(I - A_{rr}\right)^{-1} E_{r^*} \end{aligned} \tag{28}$$

Note: third term in equation (28) can be illustrated as Domestic Value-added (DV) in intermediates re-exported to third countries which is number (3) in Figure 3.2

Figure 3.4

The Schematic Diagram of International Production Chain for G-Country N-Sector Model



Source: Adapted from Baldwin and Lopez-Gonzalez (2015)

Note: DV is Domestic Value-Added DDC is Domestic Double Counted
FV is Foreign Value-Added FDC is Foreign Double Counted
(Number in parenthesis is corresponded to Figure 3.2's number)

3.1.3 The Comparison between Conventional Revealed Comparative Advantage (RCA) and New Revealed Comparative Advantage (NRCA) Indices

One of the most interesting issues of the quantitative measurement of impact and gain from global value chain is the Revealed Comparative Advantage index (RCA) as shown in the conventional formula in equation (29). Conventional RCA is the measurement for the comparative advantage of a particular sector in a particular country in the world economy. Given that there are N commodities and G countries, the conventional RCA can be calculated using gross export value of goods i

in country r ($E_i^{r^*}$) per total export of country r ($\sum_{i=1}^{n} E_i^{r^*}$) then dividing by world export of good i ($\sum_{r}^{G} E_i^{r^*}$) per total world export ($\sum_{i}^{n}\sum_{r}^{G} E_i^{r^*}$).

$$TRCA_i^r = \frac{E_i^{r^*}}{\sum_{i=1}^{n} E_i^{r^*}} \Bigg/ \frac{\sum_{r}^{G} E_i^{r^*}}{\sum_{i}^{n}\sum_{r}^{G} E_i^{r^*}} \tag{29}$$

Koopman et al. (2014) proposed using a new method in measuring comparative advantage called New Revealed Comparative Advantage (NRCA). This NRCA can be calculated using the same formula as RCA uses, but it is required to change the variable from gross export to Domestic Value-Added in Gross Export (DVAING_i^r), which is the sum of the first to the fifth terms in Figure 3.2 or equivalent to the sum of the first five terms in the equation (28). As a result, equation (29) will be transformed to equation (30).

The reason NRCA should be considered using in the model instead of conventional RCA is because NRCA does not include Foreign Value-Added (FVAING) and Pure Double Counted (PDCING) in Gross Export, which is the sum of (6) to (9) terms in Figure 3.2 or equivalent to the sum of the sixth to the ninth terms in the equation (28). These two terms also do not reflect the ability of competition in the global value chain. For this reason, NRCA is employed in the equation (30) instead of conventional RCA.

$$NRCA_i^r = \frac{DVAING_i^r}{\sum_{i=1}^{n}\left(DVAING_i^r\right)} \Bigg/ \frac{\sum_{r}^{G}\left(DVAING_i^r\right)}{\sum_{i}^{n}\sum_{r}^{G}\left(DVAING_i^r\right)} \tag{30}$$

3.1.4 Linkage of Industry in Global Value Chain

3.1.4.1 Vertical Specialization (VS) Index

VS index[1] clarifies the degree of imported content in a country's export or the degree of linkage to global value chain which was introduced by Hummels et al. (2001). Koopman et al. (2014) explored the idea of VS index and found that VS index is the sum of foreign value-added in final goods exports, foreign value-added in intermediate goods exports and double counted intermediate exports produced abroad, which are shown as terms number (6), (7), and (9) respectively in Figure 3.2, divided by gross export. This can also be interpreted as the equivalent of the sum of the seventh to ninth terms in the equation (28) divided by gross export.

To simplify the explanation, VS index is the ratio of imported intermediate use[2] per gross export. For example, there are three countries in the global value chain, including, Lao PDR, Thailand as well as Singapore. Each of these countries has only one sector (see Figure 3.5). Lao PDR initially exports intermediate goods (empty bottle) with the value of $150 to Thailand. In this case, it can be decomposed into three categories: 1) foreign value-added in final goods exports or Laos labor cost embodied in Thai final goods exports with the value of $25, 2) foreign value-added in intermediate goods exports or Laos labor cost embodied in Thai intermediate goods export with the value of $25, and 3) double counted intermediate exports produced abroad or pure plastic produced in Lao PDR with the value of $100.

---

[1] Although, the word VS stands for Vertical Specialization; it does not mean a particular industry in particular country is good. In fact, higher VS index means local firms have to rely a lot on foreign market to produce their export; in contrast, for very low VS index, the industries can rely a lot on their own market to create exported product.

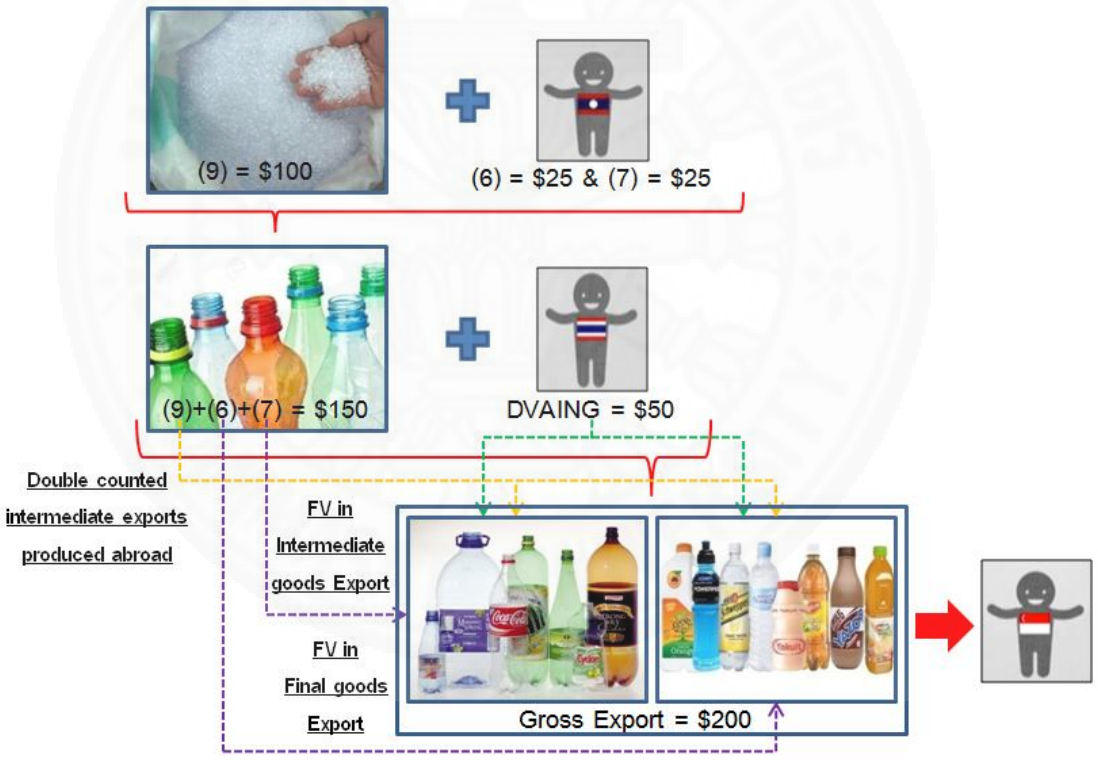
[2] Imported intermediate use is equal to the sum of foreign value-added in final goods exports, foreign value-added in intermediate goods exports, and double counted intermediate exports produced abroad.

Consequently, Thai producers can employ this $150 as an intermediate use (imported content by definition) to produce $200 of gross exports which are considered final goods (filled bottles) and intermediate goods (empty bottles) exports. Finally, this $200 of gross export is absorbed by Singapore as the final demand.

In conclusion, VS index of Thailand is equal to 0.75 (imported content, $150/gross export, $200). This implies that once Thai producers increase by one unit of their gross export, they have to employ the imported intermediate use from Lao PDR by 0.75 unit.

Figure 3.5

Concept of Vertical Specialization Index



Source: Adapted from Hummels et al. (2001)

Note: Number in parenthesis is corresponded to Figure 3.2's number

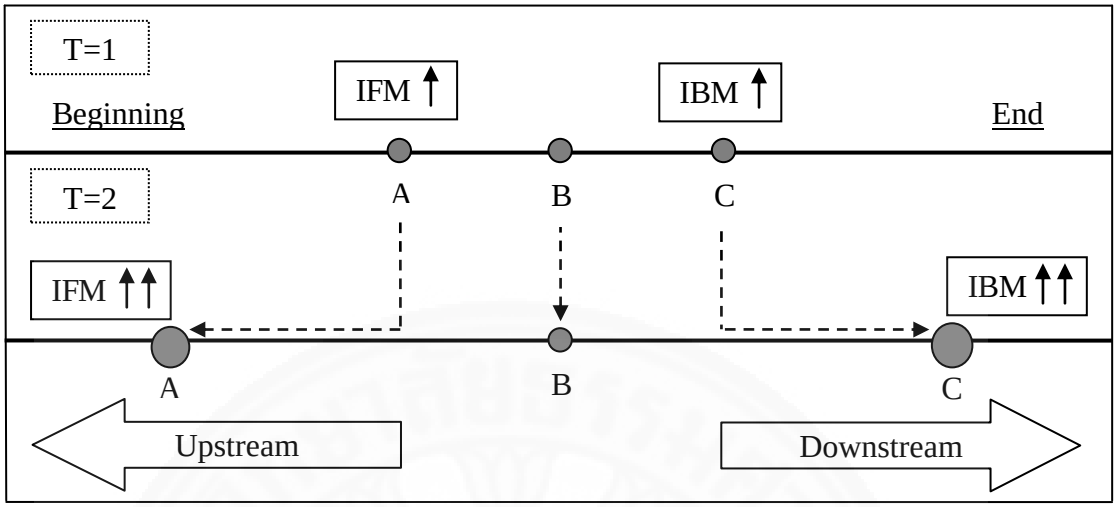
3.1.4.2 International Forward and Backward Multipliers

The International Forward and Backward Multipliers reveal the degree of a sector's impact on its downstream and upstream as well as its position in the global value chain. These multipliers can be calculated using the following five steps of matrix algebra based on OECD Inter-Country Input-Output (ICIO) Tables in 2015; the first step is to calculate matrix A which is the ratio of intermediate use of a particular sector per its gross output; the second step is to generate an identity matrix (matrix I) which has the same dimension as matrix A; the third step is to generate (I-A) matrix by using matrix A and I from the previous steps; the fourth step is to generate inverse matrix of (I-A); and the final step is to calculate total multipliers. Consequently, the sum of inverse (I-A) matrix along each row becomes the Total Forward Multiplier which represents the degree of downstream linkage while the sum of inverse (I-A) matrix along each column becomes the Total Backward Multiplier which represents the degree of upstream linkage. Although both Total Forward and Backward Multipliers can be classified into international and domestic terms, this study only focuses on the use of international terms: International Forward and Backward Multipliers.

Figure 3.6 demonstrates the International Forward and Backward Multipliers. Given that there are three industries in the Thai economy, at period T=1, industry C has the highest International Backward Multiplier (degree of upstream linkage is the highest), meaning that the position of industry C in the global value chain is close to the end of the process and International Backward Multiplier is increased in the next period T=2. In contrast, at period T=1, industry A has the highest International Forward Multiplier (degree of downstream linkage is the highest), meaning that the position of industry A in the global value chain is close to the beginning of the process and the degree of downstream linkage is increased in the next period T=2.

Figure 3.6

Downstream and Upstream Linkages



Source: Adapted from Inomata

Note: IFM is International Forward Multiplier
IBM is International Backward Multiplier

3.1.5 Regression Analysis Based on Export-led Growth Strategy

According to Tang et al. (2015), the source of growth equation in the bivariate model that represents the overall effect of export-led growth can be specified as follows:

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \varepsilon_{1it} \quad (31)$$

In order to identify the partial effect of export-led growth, this study explores three additional cases based on Figure 3.2 (Decomposition Analysis of Gross Export), consisting of: Domestic Value-Added in Gross Export-led Growth (DVAING-led Growth), Foreign Value-Added in Gross Export-led Growth (FVAING-led Growth) and Pure Double Counted in Gross Export-led Growth (PDCING-led Growth) as shown below:

Domestic Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \varepsilon_{2it} \quad (32)$$

Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \varepsilon_{3it} \quad (33)$$

Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \varepsilon_{4it} \quad (34)$$

Furthermore, the analysis of the previous bivariate model can be extended to the tri-variate one which includes domestic investment as an additional explanatory variable (Wha, 2004). Hence, the new source of growth equation can be specified as follows:

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{1it} \quad (35)$$

In order to examine the partial effect of export-led growth, equation (35) can be classified into three cases using a similar method in the bivariate model in equation (31) that involves Domestic Value-Added in Gross Export-led Growth (DVAING-led Growth), Foreign Value-Added in Gross Export-led Growth (FVAING-led Growth) and Pure Double Counted in Gross Export-led Growth (PDCING-led Growth) as stated in the equations (36) to (38).

Domestic Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{2it} \quad (36)$$

Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{3it} \quad (37)$$

Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{4it} \quad (38)$$

Lastly, the multivariate model is constructed using domestic investment and Vertical Specialization index (VS index) as additional explanatory variables. Hence, the new source of growth equation can be specified as follows:

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{1it} \quad (39)$$

In order to explore the partial effect of export-led growth, equation (39) can be classified into three cases using a similar method in the bivariate model in equations (31) and tri-variate model in equation (35) that involve Domestic Value-Added in Gross Export-led Growth (DVAING-led Growth), Foreign Value-Added in Gross Export-led Growth (FVAING-led Growth) and Pure Double Counted in Gross Export-led Growth (PDCING-led Growth) as indicated in the equations (40) to (42).

Domestic Value-Added in Gross Export-Led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{2it} \quad (40)$$

Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{3it} \quad (41)$$

Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{4it} \qquad (42)$$

Where;

LnY_{it} is growth rate of GDP of industry i at period t

$LnEXP_{it}$ is growth rate of Gross Export of industry i at period t

$LnDVAING_{it}$ is growth rate of Domestic Value-Added in Gross Export of industry i at period t

$LnFVAING_{it}$ is growth rate of Foreign Value-Added in Gross Export of industry i at period t

$LnPDCING_{it}$ is growth rate of Pure Double Counted in Gross Export of industry i at period t

$LnINVEST_{it}$ is growth rate of Domestic Investment of industry i at period t

$VSindex_{it}$ is Vertical Specialization index of industry i at period t

3.2 Research Methodology

In terms of research methodology, decomposition of gross exports for Thai industries is presented in section 3.2.1 and Section 3.2.2 clarifies the comparison of RCA and NRCA for Thai industries. The exploration for a linkage of Thai industries in the global value chain based on the degree of Vertical Specialization (VS index), the magnitudes of International Forward as well as Backward Multipliers is stated in section 3.2.3. Finally, the analysis of regression based on export-led growth strategies is illustrated in section 3.2.4.

3.2.1 Decomposition of Gross Export for Thai Industries

The source of data comes from Inter-Country Input-Output (ICIO) as of 2015 Tables issued by OECD. This dataset includes sixty-seven countries and thirty-two industries in 2000, 2005, 2009, 2010 and 2011. With this data, the impact of the global value chain on all thirty-two Thai industries can be further analyzed by employing a technique in decomposing gross export in section 3.1.2 (General Case of G-Country and N-Sector Model). This decomposition technique requires the use of a computer program to complete the analyzing process due to the large amount of data in ICIO Tables and the complexity of relevant formula. However, the decomposition of gross exports for all sixty-seven countries and thirty-two industries can be completely decomposed by applying the codes generated by Wang (2015) to R statistical program.

In reference to Accounting of Gross Export in G-Country N-Sector Model in section 3.1.2.2**,** the value of gross export can be decomposed into nine categories as addressed in a general case of G-country N-sector (see equation (28)). Moreover, this study groups the nine categories of gross exports of all thirty-two Thai industries in all five periods of time[3] into three main groups. The first group is Domestic Value-Added in Gross Export (DVAING) which is the sum of the first five terms in the equation (28) or equivalent to the sum of items number (1) to (5) in Figure 3.2. The second group is Foreign Value-Added in Gross Export (FVAING) which is the sum of the seventh and eighth terms in the equation (28) or equivalent to the sum of items number (6) and (7) in Figure 3.2. The last group is Pure Double Counted in Gross Export (PDCING) which is the sum of the sixth and ninth terms in the equation (28) or equivalent to the sum of items number (8) and (9) in Figure 3.2.

[3] Please see Appendix A.1 for all nine combinations of gross export of thirty-two Thai industries in 2000, 2005, 2009, 2010 and 2011.

3.2.2 The Comparison between Conventional Revealed Comparative Advantage (RCA) and New Revealed Comparative Advantage (NRCA) Indices for Thai Industries

There are two cases in comparing RCA with NRCA for all thirty-two Thai industries in all five periods of time; first, comparative advantage is increased as a result of the change from RCA to NRCA; second, comparative advantage is decreased as a result of the change from RCA to NRCA. Therefore, after the values of RCA and NRCA are generated for all thirty-two Thai industries in all five periods of time, they will be grouped into these two cases as mentioned above to examine the different results and to make a better economic policy in enhancing export performance as well as economic growth under the export-led growth strategy.

3.2.3 Linkage of Thai Industries in the Global Value Chain

3.2.3.1 Vertical Specialization Index (VS index) of Thai Industries

Based on Koopman et al. (2014), this study aims to decompose VS index of all thirty-two Thai industries in all five periods of time to explore the degree of linkage between Thai industries and global value chains across different periods of time and industries as well as to apply this degree of linkage to the global value chain with the export-led growth strategy.

3.2.3.2 International Forward and Backward Multipliers of Thai Industries

In this study, the International Forward and Backward Multipliers for all thirty-two Thai industries in all five periods of time are examined to explore the degree of downstream and upstream linkages of Thai industries in the global value chain across different periods of time and industries as well as to apply these International multipliers with the export-led growth strategy.

3.2.4 Regression Analysis Based on Export-led Growth Strategies

This section aims to answer two main questions; first is “How large is the impact of export on the growth of Thai economy?”; second, “Which combinations of gross export can generate the highest percentage change on the growth of Thai economy?”. These two questions can be answered by performing Panel Fixed-Effect and Panel 2SLS Fixed-Effect regressions explained in section 3.1.5 (Regression Analysis Based on Export-led Growth Strategy). Additionally, all signs within the export-led growth models are expected to be positive in according with the theory. Table 3.1 shows all possible results from the export-led growth strategy based on Panel Fixed-Effect and Panel 2SLS Fixed-Effect regressions.

Furthermore, this study aims to analyze the effect of domestic investment as illustrated in both tri-variate and multivariate models in order to compare the different impacts between domestic investment-led growth and export-led growth strategies. In addition to the strategies, VS index was also applied to a multivariate model to examine the response of economic growth when the Thai economy has continuously participated in the global value chain. However, there is a need to test for the assumption of Classical Linear Regression Model (CLRM) using four tests in order to determine the consistency of parameters from regression results. These tests consist of:

1. Test for Multicollinearity by using Variance Inflation Factor (VIF)
2. Test and solve for Heteroskedasticity by using White’s Robust
3. Test for Endogeneity problem by using Huasman Specification Test
4. Test for Random-Effect/Fixed-Effect by using Huasman Test

Table 3.1

Export-led Growth Based on Panel Fixed-Effect and Panel 2SLS Fixed-Effect

Bivariate Model:		
Case	Parameter (the highest)	Conclusion
1st case	β_1(DVAING)	Policymaker should stimulate DVAING in order to generate a higher economic growth
2nd case	β_1(FVAING)	Policymaker should stimulate FVAING in order to generate a higher economic growth
3rd case	β_1(PDCING)	Policymaker should stimulate PDCING in order to generate a higher economic growth
Trivariate Model:		
Case	Parameter (the highest)	Conclusion
1st case	β_1(DVAING)	Policymaker should stimulate DVAING in order to generate a higher economic growth
2nd case	β_1(FVAING)	Policymaker should stimulate FVAING in order to generate a higher economic growth
3rd case	β_1(PDCING)	Policymaker should stimulate PDCING in order to generate a higher economic growth
Multivariate Model:		
Case	Parameter (the highest)	Conclusion
1st case	β_1(DVAING)	Policymaker should stimulate DVAING in order to generate a higher economic growth
2nd case	β_1(FVAING)	Policymaker should stimulate FVAING in order to generate a higher economic growth
3rd case	β_1(PDCING)	Policymaker should stimulate PDCING in order to generate a higher economic growth

Source: Author's own Table

CHAPTER 4

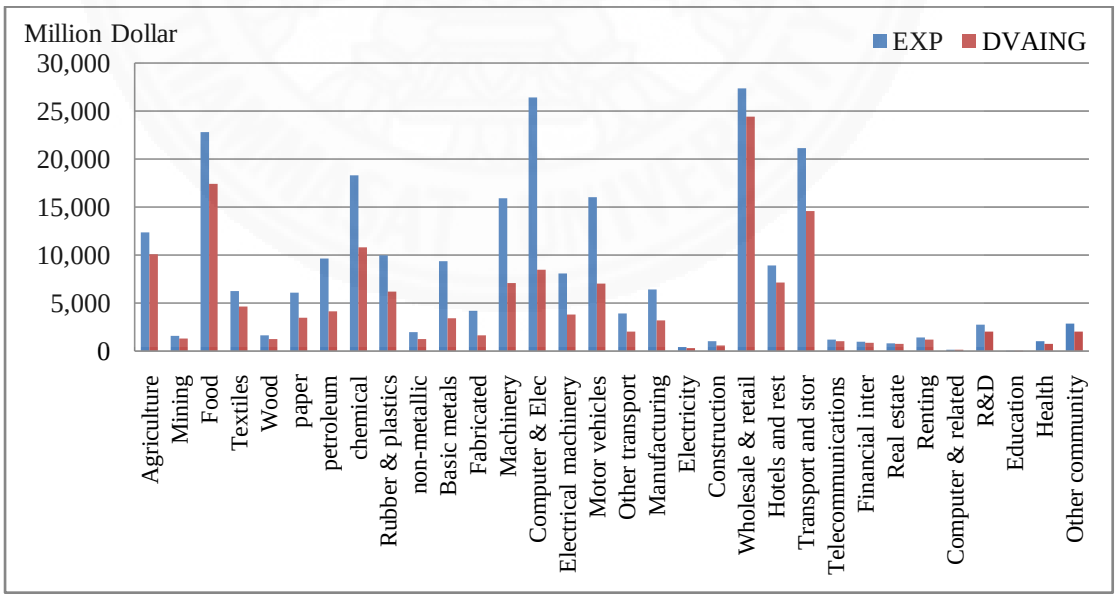
RESULTS AND DISCUSSION

4.1 Decomposition of Gross Export for Thai Industries

The results from decomposition of gross exports for Thai industries are based on Koopman et al. (2014). Figure 4.1 demonstrates the amounts of Domestic Value-Added in Gross Export (DVAING) and Gross Export (EXP) for all thirty-two Thai industries in 2011. According to Figure 4.1, it is obvious that computer, electronic and optical equipment industries have gross export values three times higher than their DVAING. Similarly, whole sale and retail trade and repairs industries have about the same gross export value as the previous industries do; however, in term of DVAING, these industries have explicitly higher value than computer, electronic and optical equipment industries do.

Figure 4.1

Gross Export and Domestic Value-Added in Gross Export of Thai Industries in 2011[1]



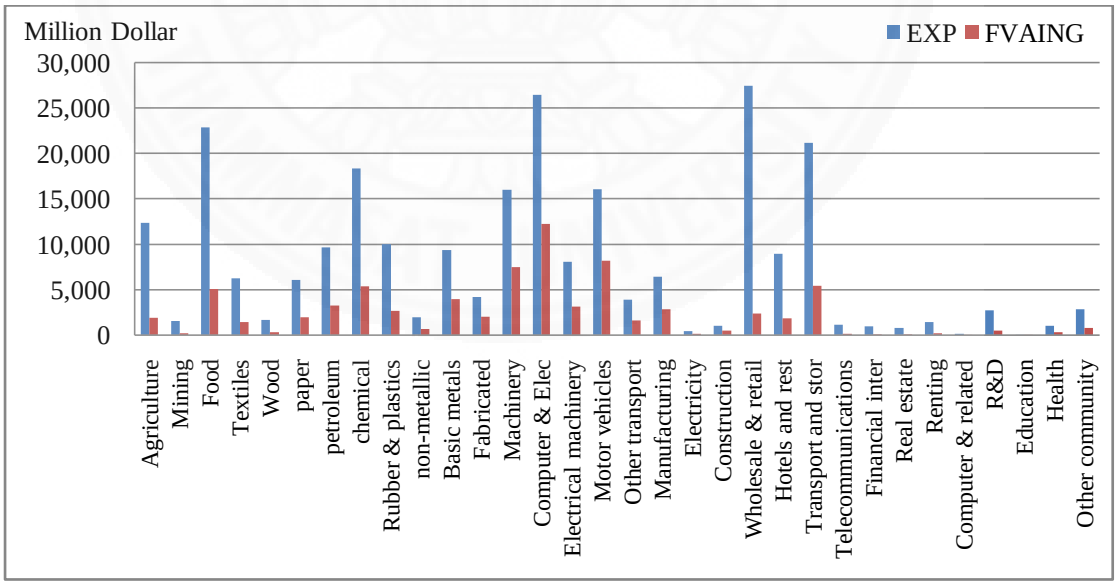
Source: Author's calculation based on Koopman et al. (2014)

[1] Please see Appendix B.1 for decomposition of DVAING in other years: 2000, 2005, 2009 and 2010.

In terms of Foreign Value-Added in Gross Export (FVAING) as stated in Figure 4.2 and Pure Double Counted in Gross Export (PDCING) as stated in Figure 4.3, these values are relatively high in computer, electronic and optical equipment industries, but are relatively low in whole sale and retail trade and repairs industries. It is apparent that having higher FVAING in such an industry means that a country employs higher value-added from foreign industries in a production process but creates less of its own domestic value-added. From Figure 3.2, PDCING can be divided into two parts: double counted intermediates exports produced at home (the eighth term) and double counted intermediates exports produced abroad (the ninth term). Having a larger amount of PDCING in such an industry means that a country uses more intermediate input from either domestic or international sources to produce gross export. Hence, with all of these reasons, the ability to export cannot be directly deduced by employing gross terms of export as this could result in misleading problems.

Figure 4.2

Gross Export and Foreign Value-Added in Gross Export of Thai Industries in 2011[2]

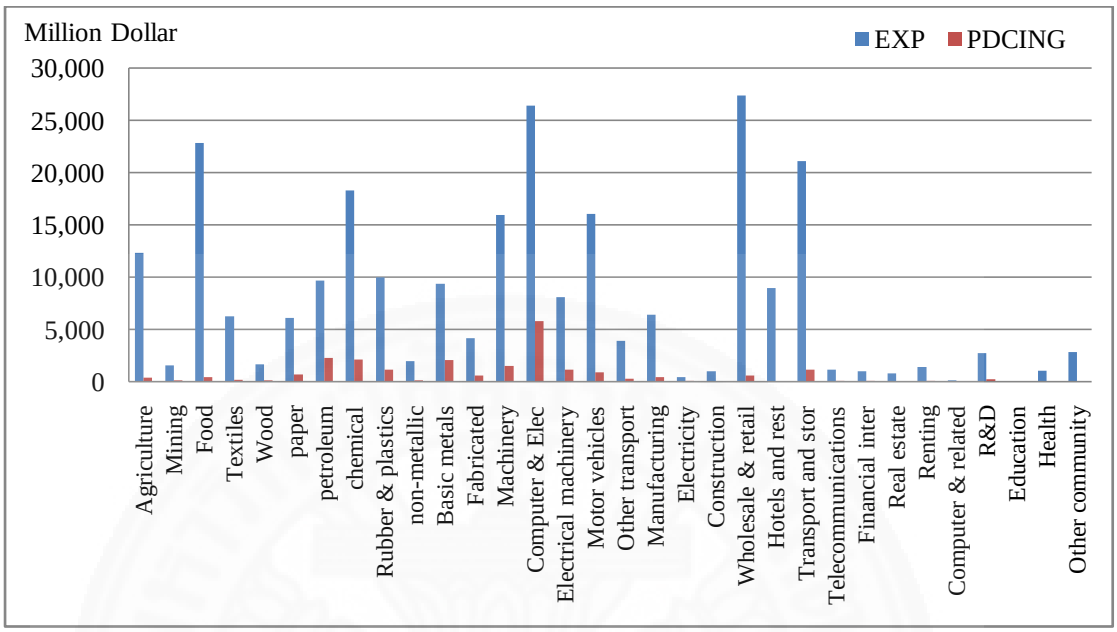


Source: Author's calculation based on Koopman et al. (2014)

[2] Please see Appendix B.2 for decomposition of FVAING in other years: 2000, 2005, 2009 and 2010.

Figure 4.3

Gross Export and Pure Double Counted in Gross Export of Thai Industries in 2011[3]



Source: Author's calculation based on Koopman et al. (2014)

Table 4.1 illustrates shares of gross export combinations of gross exports for all of the thirty-two Thai industries in 2011. According to the table, the real estate activities industry ranks the highest in DVAING share (95%), meaning that one unit of real estate activities' export can create 0.95 unit of DVAING. In addition, financial intermediation; education; wholesale and retail trade and repairs; post and telecommunications; mining and quarrying; renting of machinery and equipment; computer and related activities; agricultural, hunting, forestry and fishing; hotel and restaurants industries account for 80-90% of DVAING share, making them parts of the top ranking. On the contrary, computer, electronic and optical equipment industries which have the highest gross export value account for 32% of DVAING share, making these rank as the lowest in DVAING share.

In terms of FVAING and PDCING shares, the real estate activities industry accounts for 5% and 0% respectively, resulting in the lowest rank in both

[3] Please see Appendix B.3 for decomposition of PDCING in other years: 2000, 2005, 2009 and 2010.

shares. On the other hand, computer, electronic and optical equipment; basic metals; and fabricated metal products industries which rank the lowest in DVAING share rank the highest in FVAING and PDCING shares, implying that these industries could employ high foreign value-added as well as high double counted in order to produce one unit of their gross exports.

When applying the information from the table of the top seven exporting industries, in which data was collected in the past[4], this generates two main groups in accordance with DVAING share and VS index. The first group is the top seven exporting industries that have DVAING share higher than 50%[5], including, wholesale and retail trade and repairs (89%); food products, beverages and tobacco (76%); transport and storage (69%); and chemicals and chemical products (59%). The second group is the other top seven exporting industries that have DVAING share lower than 50%[6], including, machinery and equipment (44%); motor vehicles, trailers and semi-trailers (44%); and computer, electronic and optical equipment (32%).

Table 4.1

Share of Gross Export Combinations in 2011[7]

Industry	DVAING	FVAING	PDCING
Real estate activities	95%	5%	0%
Financial intermediation	90%	7%	3%
Education	89%	11%	0%
Wholesale & retail trade and repairs	89%	9%	2%
Post and telecommunications	88%	10%	2%

Source: Author's calculation based on Koopman et al. (2014)

[4] Please see Figure 1.3 for more details

[5] Their VS indices which indicate the degree of linkage to global value chain are lower than 50%

[6] Their VS indices which indicate the degree of linkage to global value chain are higher than 50%

[7] Please see Appendix B.4 for share of gross export combinations in other years: 2000, 2005, 2009 and 2010.

Table 4.1 (Continued)

Industry	DVAING	FVAING	PDCING
Mining and quarrying	83%	11%	6%
Renting of machinery and equipment	83%	14%	3%
Computer and related activities	83%	16%	2%
Agriculture, hunting, forestry and fishing	82%	15%	3%
Hotels and restaurants	80%	20%	0%
Wood and products of wood and cork	76%	19%	5%
Food products, beverages and tobacco	76%	22%	2%
R&D and other business activities	75%	17%	8%
Textiles, textile products, leather and footwear	74%	23%	3%
Other community, social and personal services	72%	27%	0%
Health and social work	70%	30%	0%
Transport and storage	69%	26%	5%
Electricity, gas and water supply	65%	27%	7%
Rubber and plastics products	62%	26%	11%
Other non-metallic mineral products	62%	32%	6%
Chemicals and chemical products	59%	29%	12%
Pulp, paper, paper products, printing and publishing	57%	32%	11%
Construction	54%	45%	1%
Other transport equipment	52%	41%	7%
Manufacturing and recycling	50%	44%	6%
Electrical machinery and apparatus	47%	39%	14%
Machinery and equipment	44%	47%	9%
Motor vehicles, trailers and semi-trailers	44%	51%	5%
Coke, refined petroleum products and nuclear fuel	43%	34%	23%
Fabricated metal products	39%	48%	13%
Basic metals	36%	42%	22%
Computer, electronic and optical equipment	32%	46%	22%

Source: Author's calculation based on Koopman et al. (2014)

4.2 The Comparison between Conventional Revealed Comparative Advantage (RCA) and New Revealed Comparative Advantage (NRCA) Indices for Thai Industries

As mentioned in section 3.2.2, there are two cases in a comparison between RCA and NRCA of Thai industries in the global value chain. In the first case, comparative advantage is increased due to a change from RCA to NRCA. These industries include agriculture, hunting, forestry and fishing; mining and quarrying; food products, beverages and tobacco; textiles, textile products, leather and footwear; wood, products of wood and cork; chemicals and chemical products; rubber and plastics products; other non-metallic mineral products; electricity, gas and water supply; wholesale and retail trade and repairs; hotels and restaurants; transport and storage; post and telecommunications; financial intermediation; real estate activities; renting of machinery and equipment; computer and related activity; R&D and other business activities; education; and other community, social and personal services.

For the second case, comparative advantage is decreased due to the change from RCA to NRCA. These industries include pulp, paper, paper products, printing and publishing; coke, refined petroleum products and nuclear fuel; basic metals; fabricated metal products; machinery and equipment; computer, electronic and optical equipment; electrical machinery and apparatus; motor vehicles, trailers and semi-trailers; other transport equipment; manufacturing and recycling; construction; and health and social work.

Coupled with the analysis from ADB (2015), the ability of export or competitiveness of Thai industries in the global value chain was measured using conventional RCA index. The results suggest that Thailand stimulate the top exporting industries such as computer, electronic and optical equipment; motor vehicles, trailers and semi-trailers; and machinery and equipment since these industries not only have high export value but also high competitiveness (reflected by conventional RCA index: 1.2971, 1.1755 and 1.1187 respectively). However, this research study suggests that drawing such a conclusion may not be completely accurate because the ability of export or competitiveness in global value chain in

those top exporting industries could be worse if it is measured by NRCA instead of conventional RCA (0.8791, 1.0254 and 0.8713 respectively). In addition, these industries cannot yield high DVAING values compared with their high gross export values.

Furthermore, the other top seven exporting industries that were mostly relied on the past information, including: wholesale and retail trade and repairs; food products, beverages and tobacco; transport and storage; and chemicals and chemical products seem better in terms of the ability to export or competitiveness in the global value chain with the use of NRCA measurement (from 1.0086, 2.4281, 1.1015 and 1.0184 to 1.2547, 2.9399, 1.2033 and 1.0875 respectively) because they can create high DVAING values compared with their gross export values.

Table 4.2

Comparison between Conventional RCA and New RCA of Thai Industries in 2011[8]

Industries	RCA	NRCA	Status
Agriculture, hunting, forestry and fishing	2.3724	2.8233	Increase
Mining and quarrying	0.0640	0.0710	Increase
Food products, beverages and tobacco	2.4281	2.9399	Increase
Textiles, textile products, leather and footwear	0.8496	1.0386	Increase
Wood, products of wood and cork	1.4403	1.7720	Increase
Pulp, paper, paper products, printing and publishing	1.6084	1.4634	Decrease
Coke, refined petroleum products and nuclear fuel	0.9248	0.8670	Decrease
Chemicals and chemical products	1.0184	1.0875	Increase
Rubber and plastics products	2.2423	2.5373	Increase
Other non-metallic mineral products	1.0490	1.0829	Increase
Basic metals	0.7248	0.5007	Decrease
Fabricated metal products	0.8996	0.6314	Decrease
Machinery and equipment	1.1187	0.8713	Decrease
Computer, electronic and optical equipment	1.2971	0.8791	Decrease
Electrical machinery and apparatus	1.2835	1.1391	Decrease

Source: Author's calculation based on Koopman et al. (2014) and OECD

[8] Please see Appendix B.5 for comparison of RCA and NRCA in other years: 2000, 2005, 2009 and 2010.

Table 4.2 (Continued)

Industries	RCA	NRCA	Status
Motor vehicles, trailers and semi-trailers	1.1755	1.0254	Decrease
Other transport equipment	0.5920	0.5670	Decrease
Manufacturing and recycling	1.3334	1.1084	Decrease
Electricity, gas and water supply	0.3194	0.3509	Increase
Construction	0.7128	0.6300	Decrease
Wholesale & retail trade and repairs	1.0086	1.2547	Increase
Hotels and restaurants	2.1892	2.5386	Increase
Transport and storage	1.1015	1.2033	Increase
Post and telecommunications	0.5986	0.7687	Increase
Financial intermediation	0.1268	0.1683	Increase
Real estate activities	0.9788	1.2276	Increase
Renting of machinery and equipment	0.8071	0.9675	Increase
Computer and related activities	0.0398	0.0512	Increase
R&D and other business activities	0.2826	0.3032	Increase
Education	0.0119	0.0140	Increase
Health and social work	4.0024	3.9557	Decrease
Other community, social and personal services	0.8754	0.9100	Increase

Source: Author's calculation based on Koopman et al. (2014) and OECD

4.3 Linkage of Thai Industries in Global Value Chain

4.3.1 Vertical Specialization Index (VS index) of Thai Industries

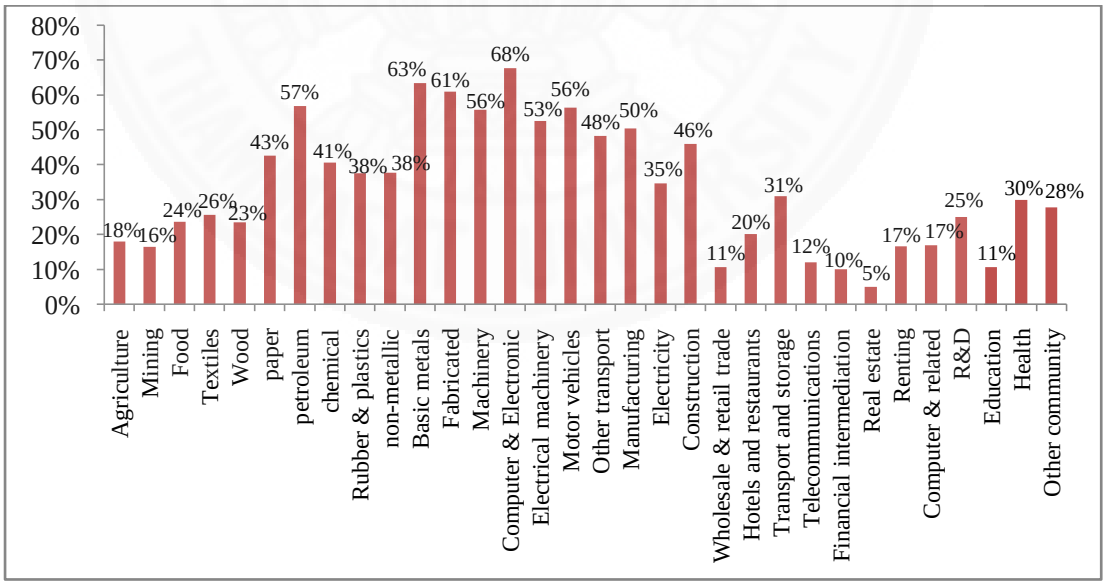
This study explores the linkage of Thai industries in the global value chain using Vertical Specialization index (VS index) which is the sum of foreign value-added in final goods export, foreign value-added in intermediate export, and double counted intermediates exports produced abroad (the sum of items number (6), (7) and (9) in Figure 3.2) divided by gross export. Figure 4.4 shows that computer, electronic and optical equipment industry yields the highest degree of linkage in global value chain (VS index is equal to 68%). This can be interpreted as these industries employ 0.68 unit of imported intermediate input from other countries in global value chain in order to export one unit. On the contrary, the real estate activities industry requires the lowest amount of imported content in export (VS index is equal to 5%), meaning that

the degree of linkage in the global value chain is the lowest in accordance with the Vertical Specialization index.

Additionally, the analysis of VS index can be incorporated into the top seven exporting industries, and categorized into two main groups. First, the top seven exporting industries in which DVAING share is lower than 50%, including, computer, electronic and optical equipment (68%); motor vehicles, trailers and semi-trailers (56%); and machinery and equipment (56%). These industries have higher VS index than another group because they have to significantly rely on the foreign market for exporting products. Second, the top seven exporting industries in which DVAING share is higher than 50%, including, wholesale and retail trade and repairs (11%); food products, beverages and tobacco (24%); transport and storage (31%); and chemicals and chemical products (41%). These industries have lower VS index compared with the first group because they rely heavily on their own markets for exporting products.

Figure 4.4

Vertical Specialization Index of Thai Industries in 2011[9]



Source: Author's calculation based on Koopman et al. (2014)

[9] Please see Appendix B.6 for decomposition of VS index in other years: 2000, 2005, 2009 and 2010.

4.3.2 International Forward and Backward Multipliers of Thai Industries

Figure 4.5 clarifies International Forward and Backward Multipliers of thirty-two Thai industries in 2011 which respectively represent the degree of a particular industry's impact on its downstream and upstream as well as its position in global value chain. According to the Figure 4.5, the upper-right and lower-left corners represent the longer and shorter distance of supply chain for Thai industries respectively. It is apparent that pulp, paper, paper products, printing and publishing; chemicals and chemical products; machinery and equipment; and basic metals industries are grouped in the upper-right corner, meaning that they have a longer supply chain difference compared to other Thai industries; whereas, real estate activities industry yields the shortest distance of the supply chain. This finding corresponds to the conclusion of the VS index that the industry has the lowest degree of linkage in the global value chain.

The upper-left and lower-right corners represent the higher degree of downstream and upstream linkages of industries in the global value chain. For example, a group of whole sale and retail trade and repair industry has the highest degree of downstream linkage (1.28), indicating that when the industry produces one unit of output then intermediate goods of 1.28 units are exported to the other industries within the global value chain. In contrast, a group of computer, electronic and optical equipment industry has the highest degree of upstream linkage (1.83), meaning that the industry has to employ 1.83 units of the intermediate goods from other industries within the global value chain to produce one unit of output.

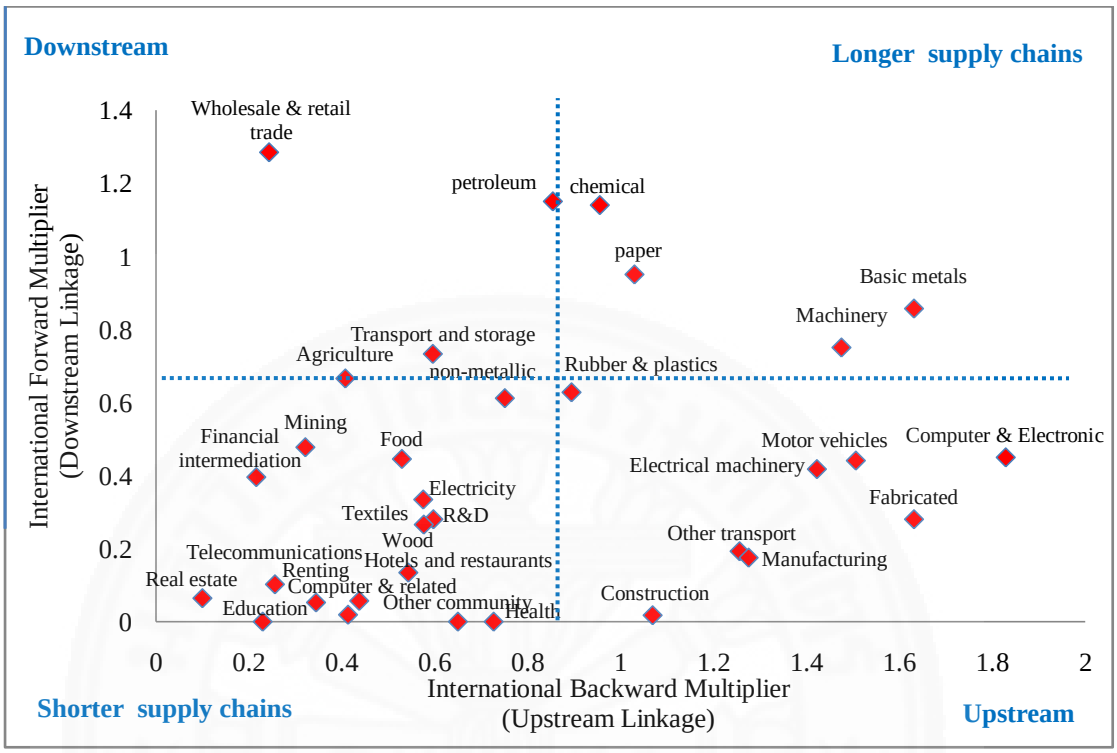
When combining International Multipliers with the top seven exporting industries, it provides two main findings. First, the top seven exporting industries in which DVAING share is lower than 50%, including: computer, electronic and optical equipment; and motor vehicles, trailers and semi-trailers. These industries are located at the lower-right corner in Figure 4.5, meaning that these industries have the highest impact on upstream linkage or their positions in the global value chain is close to the end of process compared with the other top seven exporting industries. Second, the top seven exporting industries in which DVAING share is higher than 50%, including: wholesale and retail trade and repairs; and transport and storage. These

industries are located at the upper-left corner in Figure 4.5, meaning that they have the highest impact on downstream linkage or their positions in the global value chain are close to the beginning of process compared with the other group of industries.

In addition, other three industries ranking in the top seven exporting industries are also categorized into two groups. First, machinery and equipment industry in which DVAING share is lower than 50% is located at the upper-right corner in Figure 4.5, meaning that the industry yields the longest distance in the supply chain compared with the other top seven exporting industries. Second, chemicals and chemical products industry in which DVAING share is higher than 50% is located at the upper-right corner in Figure 4.5 meaning that the industry yields the longest distance in the supply chain compared with the other top seven exporting industries. On the contrary, food products, beverages and tobacco industry in which DVAING share is higher than 50% is located at the lower-left corner in Figure 4.5 meaning that it yields the shortest distance in the supply chain compared with the other top seven exporting industries.

Figure 4.5

International Forward and Backward Multipliers of Thai Industries in 2011[10]



Source: Author's calculation based on OECD

Table 4.3 represents the VS index and the magnitude of International Forward as well as Backward Multipliers for all of the thirty-two Thai industries in 2011. From Table 4.3, computer, electronic and optical equipment; basic metals; and fabricated metal products industries rank the top three in terms of the highest VS index (68%, 63% and 61% respectively) compared with other Thai industries. Therefore, it can be concluded that these three industries mentioned have a production process that is highly integrated into the global value chain.

Moreover, International Forward and Backward Multipliers of all thirty-two Thai industries in 2011 are illustrated in Table 4.3. The information in the table suggests that the highest degree of International Forward Multiplier or the highest degree of downstream linkage involve a group of wholesale and retail trade and repair

[10] Please see Appendix B.7 for the degree of International Forward and Backward Multipliers in other years: 2000, 2005, 2009 and 2010.

industries, yielding 1.28; whereas, a group of computer, electronic and optical equipment industries ranks number one in terms of International Backward Multiplier or the degree of upstream linkage, yielding 1.82.

Table 4.3

VS index, International Forward and Backward Multipliers in 2011[11]

Industry	VS index	IFM	IBM
Computer, electronic and optical equipment	68%	0.4497	1.8288
Basic metals	63%	0.8568	1.6307
Fabricated metal products	61%	0.2807	1.6306
Coke, refined petroleum products and nuclear fuel	57%	1.15	0.854
Motor vehicles, trailers and semi-trailers	56%	0.4409	1.5063
Machinery and equipment	56%	0.7499	1.4753
Electrical machinery and apparatus	53%	0.4185	1.4224
Manufacturing and recycling	50%	0.1764	1.2755
Other transport equipment	48%	0.1928	1.2552
Construction	46%	0.0178	1.0688
Pulp, paper, paper products, printing and publishing	43%	0.9508	1.0293
Chemicals and chemical products	41%	1.1398	0.9551
Other non-metallic mineral products	38%	0.6126	0.7502
Rubber and plastics products	38%	0.6277	0.8944
Electricity, gas and water supply	35%	0.3353	0.5745
Transport and storage	31%	0.7325	0.5951
Health and social work	30%	0.0009	0.7265
Other community, social and personal services	28%	0.0001	0.6489
Textiles, textile products, leather and food wear	26%	0.2812	0.5962
R&D and other business activities	25%	0.2667	0.5761
Food products, beverage and tobacco	24%	0.4454	0.5288
Wood, products of wood and cork	23%	0.1345	0.5426

Source: Author's calculation based on Koopman et al. (2014) and OECD (2015)

[11] Please see Appendix B.8 for VS index, International Forward and Backward Multipliers in other years: 2000, 2005, 2009 and 2010.

Table 4.3 (Continued)

Industry	VS index	IFM	IBM
Hotels and restaurants	20%	0.0575	0.4371
Agriculture, hunting, forestry and fishing	18%	0.6659	0.4069
Computer and related activity	17%	0.0203	0.4126
Renting of machinery and equipment	17%	0.0525	0.3445
Mining and quarrying	16%	0.4783	0.3211
Post and telecommunications	12%	0.1024	0.2557
Wholesale & retail trade and repair	11%	1.2851	0.2425
Education	11%	0.0002	0.2294
Financial intermediation	10%	0.3956	0.2159
Real estate activities	5%	0.0641	0.0997

Source: Author's calculation based on Koopman et al. (2014) and OECD (2015)

4.4 Regression Analysis Based on Export-led Growth Strategy

4.4.1 Test for the Assumption of Classical Linear Regression Model (CLRM)

The result of testing CLRM assumption indicates that all violations from these assumptions do not exist. The acceptance of the result for a fixed-effect model is shown in Table 4.4

Table 4.4

Test for CLRM Assumption

(1) Bivariate Model				
	Model1	Model2	Model3	Model4
Multicollinearlity (Mean VIF)	-	-	-	-
Heteroskedasticity	Robust	Robust	Robust	Robust
Endogeneity	NO	NO	NO	NO
Random-Effect/Fixed Effect	FE	FE	FE	FE

Table 4.4 (Continued)

(2) Trivariate Model				
	Model1	Model2	Model3	Model4
Multicollinearlity (Mean VIF)	1.33	1.25	1.45	1.18
Heteroskedasticity	Robust	Robust	Robust	Robust
Endogeneity	NO	NO	NO	NO
Random-Effect/Fixed Effect	FE	FE	FE	FE
(3) Multivariate Model				
	Model1	Model2	Model3	Model4
Multicollinearlity (Mean VIF)	1.51	1.42	1.84	1.75
Heteroskedasticity	Robust	Robust	Robust	Robust
Endogeneity	NO	NO	NO	NO
Random-Effect/Fixed Effect	FE	FE	FE	FE

Source: Author's calculation

4.4.2 Panel Fixed-Effect Regression

The result from Panel Fixed-Effect regression is clarified in Table 4.5. There are three models involved in the regression. First, with a bivariate model, the findings show that the overall effect of export-led growth in accordance with the gross terms of export has a positive impact on economic growth (0.6475%), meaning that if producers increase their exports by 1%, then economic growth is raised by 0.6475%. Moreover, the partial effect from Domestic Value-Added in Gross Export contributes to the highest impact on economic growth (0.6653%) compared to other gross export combinations, including, Foreign Value-Added in Gross Export (0.5835%) and Pure Double Counted in Gross Export (0.5309%).

Second, a trivariate model is used to clarify that among those gross export combinations, Domestic Value-Added in Gross Export can provide the highest impact on economic growth (0.6205%) compared to Foreign Value-Added (0.5492%) and

Pure Double Counted in Gross Export (0.4957%). In addition, this tri-variate model is used to examine the effect of domestic investment on economic growth. The finding shows that domestic investment can also generate economic growth for 0.1104% but it has less impact on economic growth than gross export (0.6060%).

Third, a multivariate model is used to clarify the new source of a growth equation that includes Vertical Specialization index as an additional explanatory variable. The findings suggest that there are three conclusive issues; the first issue is associated with Domestic Value-Added in Gross Export which can generate the highest impact on economic growth again (0.5869%) compared to Foreign Value-Added in Gross Export (0.5625%) and Pure Double Counted in Gross Export (0.5140%); the second issue is associated with domestic investment which can also positively affect economic growth (0.1031%) but still has less impact than gross export (0.5880%); and the last issue is associated with model 2. The results from the last issue shows that the Domestic Value-Added in Gross Export tend to have the higher degree of linkage in the global value chain (reflected by VS index) and can positively affect economic growth (1.91), meaning that when participation of producers in the global value chain increases by one unit then economic growth is raised by 1.91%. Subsequently, findings from the use of models 3 and 4, which stimulate Foreign Value-Added and Pure Double Counted in Gross Exports, show that VS indices have a negative impact on the economic growth though it is not significant. This finding implies that producers have to significantly rely on foreign markets that can hamper the economic growth.

Table 4.5

Panel Fixed-Effect Regression

(1) Bivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.6475			
	(0.0560)***			
LOG_DVAING		0.6653		
		(0.0625)***		
LOG_FVAING			0.5835	
			(0.0422)***	

Table 4.5 (Continued)

(1) Bivariate Model				
	Model1	Model2	Model3	Model4
LOG_PDCING				0.5309
				(0.0371)***
CONST	3.5347	3.6611	4.9456	5.9988
	(0.4239)***	(0.4484)***	(0.2520)***	(0.1674)***
R-squared	0.0796	0.1110	0.2520	0.0214
F(1,31)	133.38	116.98	191.18	204.76
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145
(2) Trivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.6060			
	(0.0568)***			
LOG_DVAING		0.6205		
		(0.0626)***		
LOG_FVAING			0.5492	
			(0.0430)***	
LOG_PDCING				0.4957
				(0.0388)***
LOG_INVEST	0.1104	0.1203	0.0950	0.1021
	(0.0452)**	(0.0455)**	(0.0423)**	(0.0427)**
CONST	3.3068	3.3910	4.6836	5.6071
	(0.3777)***	(0.3987)***	(0.2503)***	(0.2400)***
R-squared	0.0795	0.1074	0.0309	0.0339
F(2,31)	93.78	82.08	119.16	105.31
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145
(3) Multivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.5880			
	(0.0634)***			
LOG_DVAING		0.5869		
		(0.0629)***		
LOG_FVAING			0.5625	
			(0.0568)***	
LOG_PDCING				0.5140
				(0.0578)***
LOG_INVEST	0.1031	0.1008	0.0989	0.1061
	(0.0472)**	(0.0469)**	(0.0441)**	(0.0437)**
VS_INDEX	0.8306	1.9112	-0.5606	-0.7536
	(0.7814)	(0.7035)**	(0.8430)	(0.9766)
CONST	3.2280	3.3910	4.7539	5.7394
	(0.3240)***	(0.3987)***	(0.1977)***	(0.1804)***

Table 4.5 (Continued)

(3) Multivariate Model				
	Model1	Model2	Model3	Model4
R-squared	0.0578	0.0531	0.0401	0.0479
F(3,31)	130.18	132.61	133.02	134.42
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Source: Author's calculation

Note: ***, ** and * are significant at 1%, 5% and 10% respectively; number in parenthesis is Robust Standard Error and dependent variable is LOG_GDP.

4.4.3 Panel 2SLS Fixed-Effect Regression

According to the export-led growth model, the findings imply that exports can have an impact on the economic growth and that the export growth may also be generated by the economic growth. Thus, this simultaneous effect can lead to an endogeneity problem (Sprout and Weaver, 1993 & Wizarat and Lau, 2013). In order to prevent such a problem, this study employs the panel 2SLS Fixed-Effect regression. The results from Panel 2SLS Fixed-Effect regression[12] for bivariate, tri-variate and multivariate models are similar to the results from Panel Fixed-Effect regression in which Domestic Value-Added in Gross Export has the strongest impact on the economic growth compared to Foreign Value-Added and Pure Double Counted in Gross Export. Similarly, domestic investment can generate economic growth but still has a lesser impact than gross export as illustrated in Table 4.6. However, since the endogeneity problem does not exist in the three models (see Table 4.4: test for

[12] Instrument Variables (IVs) in this study were selected following two main criterions (see Appendix B.9). First (weak instruments test), IVs have to be strongly correlated with the endogenous variable; second (over identification test), IVs do not have to correlate with the error term of the structural equation. Therefore, in this study, NRCA, IBM and IFM of any industry are selected as instrument variables of gross export as well as its combinations.

CLRM assumption); therefore, this study can be concluded that the regression results are solely based on the Panel Fixed-Effect regression.

Table 4.6

Panel 2SLS Fixed-Effect Regression

(1) Bivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.7561			
	(0.0781)***			
LOG_DVAING		0.8626		
		(0.1216)***		
LOG_FVAING			0.6187	
			(0.0468)***	
LOG_PDCING				0.5539
				(0.0524)***
CONST	2.7140	2.2465	4.7354	5.8948
	(0.5616)***	(0.8033)***	(0.3622)***	(0.3795)***
R-squared	0.0796	0.1110	0.0270	0.0214
Wald chi2(1)	93.63	50.30	174.29	111.71
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145
(2) Trivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.6978			
	(0.0841)***			
LOG_DVAING		0.7997		
		(0.1164)***		
LOG_FVAING			0.5704	
			(0.0442)***	
LOG_PDCING				0.5050
				(0.0431)***
LOG_INVEST	0.0865	0.0776	0.0883	0.0991
	(0.0425)**	(0.0406)*	(0.0336)***	(0.0455)***
CONST	2.7298	2.3159	4.5897	5.5814
	(0.6091)***	(0.7321)***	(0.4121)***	(0.3863)***
R-squared	0.0802	0.1105	0.0306	0.0333
Wald chi2(2)	108.91	113.04	253.61	273.17
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Table 4.6 (Continued)

(3) Multivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.7344			
	(0.1676)***			
LOG_DVAING		0.7383		
		(0.2173)***		
LOG_FVAING			0.7298	
			(0.1947)***	
LOG_PDCING				0.6360
				(0.2106)***
LOG_INVEST	0.0813	0.0777	0.0716	0.0850
	(0.0463)*	(0.0443)*	(0.0380)*	(0.0470)*
VS_INDEX	-0.3032	1.0146	-2.3292	-2.1601
	(1.5078)	(1.5295)	(2.1991)	(2.5625)
CONST	2.5696	2.4505	4.4212	5.7444
	(0.8247)***	(1.2105)**	(0.5950)***	(0.4270)***
R-squared	0.0880	0.0824	0.0677	0.0668
Wald chi2(3)	202.78	202.16	145.55	215.95
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Source: Author's calculation

Note: ***, ** and * are significant at 1%, 5% and 10% respectively; number in parenthesis is Robust Standard Error and dependent variable is LOG_GDP.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion and Policy implication

To conclude, this study explores four main issues. First, the decomposition analysis of Thailand's gross export that can be grouped into three major categories: Domestic Value-Added in Gross Export (DVAING), Foreign Value-Added in Gross Export (FVAING) and Pure Double Counted in Gross Export (PDCING). Interestingly, computer, electronic and optical equipment; motor vehicles, trailers and semi-trailers; and machinery and equipment ranking in the top seven of exporting industries, which were significantly relied on the past information, tend to be in accurately measured given that DVAING is used instead of gross export. It is apparent that DVAING share of these industries associated with the gross export in 2011 are 32%, 44% and 44% respectively as they have to heavily rely on other countries' value-added (FVAING) and an intermediate use (PDCING) to produce their gross export. In contrast, wholesale and retail trade and repair; food products, beverages and tobacco; transport and storage; and chemicals and chemical products ranking in the top seven exporting industries are explicitly different in term of DVAING share associated with gross export, resulting in 89%, 76%, 69% and 59% respectively in 2011. This implies that the industries have to significantly rely on their own markets to create high DVAING share. As a consequence, export performance should not be deduced by employing gross export because it can possibly generate the misleading problem (over export value) and then distorts the ability of export as well as the economic growth.

The second issue is the comparison between conventional Revealed Comparative Advantage (RCA) and New Revealed Comparative Advantage (NRCA) indices. The comparison suggests that NRCA provide more accuracy in measuring export ability or competitiveness of a particular industry in a particular country in the world economy. This study classifies the results in 2011 into two groups. For the first group, the comparative advantage is increased as a result of the change from RCA to

NRCA. These industries include agriculture, hunting, forestry and fishing; mining and quarrying; food products, beverages and tobacco; textiles, textile products, leather and footwear; wood, product of wood and cork; chemicals and chemical products; rubber and plastics products; other non-metallic mineral products; electricity, gas and water supply; wholesale and retail trade and repairs; hotels and restaurants; transport and storage; post and telecommunications; financial intermediation; real estate activities; renting of machinery and equipment; computer and related activity; R&D and other business activities; education; and other community, social and personal services. For the second group, the comparative advantage is decreased as a result of the change from RCA to NRCA. These industries in this group include pulp, paper, paper products, printing and publishing; coke, refined petroleum products and nuclear fuel; basic metals; fabricated metal products; machinery and equipment; computer, electronic and optical equipment; electrical machinery and apparatus; motor vehicles, trailers and semi-trailers; other transport equipment; manufacturing and recycling; construction; and health and social work.

Coupled with the analysis from ADB (2015), it is suggested that Thailand stimulate the industries that have large export value and the high conventional RCA indices such as the industries in computer, electronic and optical equipment; motor vehicles, trailers and semi-trailers; and machinery and equipment since they do not only have a large amount of gross export but also have high competitiveness (their conventional RCA indices in 2011 are 1.2971, 1.1755 and 1.1187 respectively). However, this study proves that such suggestions can distort the economic policy because once re-computed RCA or NRCA is used to measure export ability or competitiveness in the global value chain instead of using conventional RCA, export ability or competitiveness of those top exporting industries as mentioned earlier can become worse (their NRCA indices in 2011 are 0.8791, 1.0254 and 0.8713 respectively) since they cannot create high DVAING values compared with their high gross export values. Thus, the policymakers should support the other top exporting industries which can create high DVAING values compared with their gross export values such as the industries in wholesale and retail trade and repairs; food products, beverages and tobacco; transport and storage; and chemicals and chemical products because their export ability or competitiveness in the global value chain tend to be

better in terms of re-computed RCA or NRCA (their NRCA indices in 2011 are 1.2547, 2.9399, 1.2033 and 1.0875 respectively).

The third issue is relevant to the exploration of Vertical Specialization index (VS index), International Forward Multiplier (IFM), and International Backward Multiplier (IBM) that represent the degree of linkage and the impact on the downstream and upstream of Thai industries in the global value chain respectively. The study finds that in 2011,the analysis of VS index can be incorporated into the top seven exporting industries, and categorized into two main groups. First, the top seven exporting industries in which DVAING share is lower than 50%, including, computer, electronic and optical equipment (68%); motor vehicles, trailers and semi-trailers (56%); and machinery and equipment (56%). These industries have to import a large amount of intermediate use from foreign markets to produce their large amount of exports. Second, the top seven exporting industries in which DVAING share is higher than 50%, including wholesale and retail trade and repairs (11%); food products, beverages and tobacco (24%); transport and storage (31%); and chemicals and chemical products (41%). These industries have a lower VS index compared with the first group because they have to employ a large amount of intermediate input from their own market in order to produce the large gross of exports.

Furthermore, when International Multipliers is incorporate into the top seven exporting industries, which were reliedon heavily in the past, this provides two main contributions. First, the top seven exporting industries in which DVAING share is lower than 50%, including: computer, electronic and optical equipment; motor vehicles, and trailers and semi-trailers rank the top in terms of IBM, meaning that these industries have the highest impact on upstream linkage or their positions in global value chain are close to the end of the supply chain. Second, the top seven exporting industries that have DVAING share higher than 50%, including: wholesale and retail trade and repairs; and transport and storage rank at the top in terms of IFM, meaning that these industries have the highest impact on downstream linkage or their positions in the global value chain are close to the beginning of the supply chain.Accordingly, the current study suggests that policymakers encourage the use of DVAING for the top seven exporting industries located near the end of the supply chain (high IBM) in order to support the better export-led growth strategy in the

industries such as computer, electronic and optical equipment; and motor vehicles, trailers and semi-trailers. It is also shown that these industries still gain a lower DVAING share compared with other top seven exporting industries located near the beginning of the supply chain (high IFM), including: wholesale and retail trade and repairs; and transport and storage.

The final issue is the regression analysis based on the export-led growth strategy which can lead to the conclusive results which are as follows. The findings of this study suggest that policymakers should stimulate the industries and/or sectors that have high DVAING[1] rather than only concentrating on high gross export value. For example, wholesale and retail trade and repairs; food products, beverage and tobacco; transport and storage; chemicals and chemical products; and agriculture, hunting, forestry and fishing[2] (see Figure 4.1: Gross Export and Domestic Value-Added in Gross Export of Thai Industries). Moreover, this study has shown that industries and/or sectors which gain benefit from high DVAING per unit of gross export should be supported since one unit increase of their exports can generate a greater margin of DVAING; for instance, real estate activities; financial intermediation; education; wholesale and retail trade and repairs; post and telecommunications; mining and quarrying; renting of machinery and equipment; computer and related activities; agricultural, hunting, forestry and fishing; and hotel and restaurants of which can gain over 80% of DVAING per unit (see Table 4.1: Share of Gross Export Combinations).

[1] See Appendix C.1 for comparison between the top rank of gross export and DVAING in 2000, 2005, 2009, 2010 and 2011.

[2] Summation of DVAING of these five products is higher than 50% from total DVAING of Thai industries in every year.

5.2 Limitation

In reference to the database from the OECD Inter-Country Input-Output (ICIO) Tables, 2015; there has been a limited number of time periods (the database contains only seven years) for all thirty-four Thai industries. For this reason, a time series model cannot be constructed to examine the dynamic impact of global value chain on Thai economy. Therefore, this dynamic impact of the global value chain on the Thai economy becomes the limitation of this study.

5.3 Recommendation for future research

Following this study, there are three main recommendations for future research. First, the future research should provide methods for increasing Domestic Value-Added in the Gross Export of Thai industries since this study concludes that any industry should stimulate its Domestic Value-Added in Gross Export in order to generate a higher GDP growth but does not suggest the way to do this. Second, the future research should answer the following question: how can Thai labor gain the benefit from participating in global value chain? In order to claim the benefit of the global value chain on Thai economy. Finally, the future research should classify the impact of a particular industry on its downstream and upstream positions in the global value chain through employing Structural Path Analysis (SPA) in order to examine the different source of destination among global value chain.

REFERENCES

Books

Baltagi, B. (2008). *Econometric analysis of panel data*: John Wiley & Sons.

Breisinger, C., Thomas, M., & Thurlow, J. (2009). *Social accounting matrices and multiplier analysis: An introduction with exercises* (Vol. 5): Intl Food Policy Res Inst.

Cheng, M. K. C., Rehman, S., Seneviratne, M. D., & Zhang, S. (2015). *Reaping the Benefits from Global Value Chains*: International Monetary Fund.

Elms, D. K., & Low, P. (2013). *Global value chains in a changing world*: World Trade Organization Geneva.

Greene, W. H. (2003). *Econometric analysis*: Pearson Education India.

Heij, C., De Boer, P., Franses, P. H., Kloek, T., & Van Dijk, H. K. (2004). *Econometric methods with applications in business and economics*: OUP Oxford.

Kowalski, P., ., & et al. *Participation of Developing Countries in Global Value Chains*: OECD Publishing.

Wooldridge, J. (2015). *Introductory econometrics: A modern approach*: Nelson Education.

Articles

ADB (2015). Thailand: Industrialization and Economic Catch-Up. *Asian Development Bank*.

Alfaro, L., Antràs, P., Chor, D., & Conconi, P. (2015). Internalizing Global Value Chains: A Firm-Level Analysis: National Bureau of Economic Research.

Baldwin, R., & Lopez-Gonzalez, J. (2015). Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. *The World Economy, 38*(11), 1682-1721.

Biwott, K., Moyi, D., & Khainga, D. (2013). Trade liberalization and economic growth: the role of regulatory policies. *Journal of World Economic Research, 2*(3), 45-57.

Boz, E., Bussière, M., & Marsilli, C. (2015). Recent slowdown in global trade: Cyclical or structural? *The Global Trade Slowdown: A New Normal?*, 55.

Brakman, S., & Van Marrewijk, C. (2016). A closer look at revealed comparative advantage: Gross-versus value-added trade flows. *Papers in Regional Science*.

Chatterji, M., Mohan, S., & Dastidiar, S. G. (2014). Relationship between trade openness and economic growth of India: a time series analysis. *Journal of Academic Research in Economics, 6*(1), 45-69.

Chen, B.-L. (1999). Trade openness and economic growth: evidence in East Asia and Latin America. *Journal of Economic Integration*, 265-295.

Daumal, M., & Özyurt, S. (2010). The impact of international trade flows on economic growth in Brazilian states. *Review of Economics and Institutions, 2*(1).

De Mello, L. R. (1999). Foreign direct investment-led growth: evidence from time series and panel data. *Oxford economic papers, 51*(1), 133-151.

Defourny, J., & Thorbecke, E. (1984). Structural Path Analysis and Multiplier Decomposition within a Social Accounting Matrix Framework. *The Economic Journal, 94*(373), 111-136. doi: 10.2307/2232220

Di Mauro, F., Plamper, H., & Stehrer, R. (2013). Global value chains: a case for Europe to cheer up. *CompNet Policy Brief, 3*, 2013.

Dietzenbacher, E., Los, B., Stehrer, R., Timmer, M., & De Vries, G. (2013). The construction of world input–output tables in the WIOD project. *Economic Systems Research, 25*(1), 71-98.

Drukker, D. M. (2011). *Estimating and interpreting structural equation models in Stata 12.* Paper presented at the Stata Conference, Chicago.

Gereffi, G., & Frederick, S. (2010). The global apparel value chain, trade and the crisis: challenges and opportunities for developing countries. *World Bank Policy Research Working Paper Series, Vol*.

Guerra, A.-I., & Sancho, F. (2011). Revisiting the original Ghosh model: can it be made more plausible? *Economic Systems Research, 23*(3), 319-328.

Hu, B., & McAleer, M. (2004). Input–output structure and growth in China. *Mathematics and Computers in Simulation, 64*(1), 193-202.

Hummels, D., Ishii, J., & Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics, 54*(1), 75-96.

Hummels, D. L., Rapoport, D., & Yi, K.-M. (1998). Vertical specialization and the changing nature of world trade. *Economic Policy Review, 4*(2).

Hwang, Y. S., Song, J., & Kim, S. E. (2011). Vertical Specialization and Trade Growth in Northeast Asia. *China & World Economy, 19*(2), 109-126. doi: 10.1111/j.1749-124X.2011.01238.x

Hye, Q. M. A., Wizarat, S., & Lau, W.-Y. (2013). Trade-led growth hypothesis: An empirical analysis of South Asian countries. *Economic Modelling, 35*, 654-660.

Jimenez, G. H., & Razmi, A. (2013). Can Asia sustain an export-led growth strategy in the aftermath of the global crisis? Exploring a neglected aspect. *Journal of Asian Economics, 29*, 45-61.

Johnson, R. C. (2014). Five facts about value-added exports and implications for macroeconomics and trade research. *The Journal of Economic Perspectives, 28*(2), 119-142.

Johnson, R. C., & Noguera, G. (2012). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics, 86*(2), 224-236.

Jorgenson, D. W., & Stiroh, K. J. (2000). US economic growth at the industry level. *The American Economic Review, 90*(2), 161-167.

Kohpaiboon, A. (2009). Vertical and horizontal FDI technology spillovers: Evidence from Thai manufacturing. *ERIA Discussion Paper, 8*.

Koopman, R., Wang, Z., & Wei, S.-J. (2012). Tracing value-added and double counting in gross exports: National Bureau of Economic Research.

Koopman, R., Wang, Z., & Wei, S.-J. (2014). Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review, 104*(2), 459-494.

Kyophilavong, P. (2011). Will trade liberalization in least developed countries help during the crisis? : evidence from the Lao People's Democratic Republic. *Trade-led growth : a sound strategy for Asia*, 259-279.

Lea, R. (2014). The OECD-WTO "trade in value-added" research: a break-through in analysing world trade. *Arbuthnot Banking Group, 17*.

Levchenko, A. A., Lewis, L. T., & Tesar, L. L. (2010). The collapse of international trade during the 2008–09 crisis: in search of the smoking gun. *IMF Economic review, 58*(2), 214-253.

Lewer, J. J., & Berg, H. V. d. (2003). How large is international trade's effect on economic growth? *Journal of Economic Surveys, 17*(3), 363-396.

Los, B., Timmer, M. P., & Vries, G. J. (2015). How global are global value chains? A new approach to measure international fragmentation. *Journal of Regional Science, 55*(1), 66-92.

Manresa, A., & Sancho Pifarré, F. (2012). Leontief versus Ghosh: two faces of the same coin. *Economia Aplicada*.

Marelli, E., & Signorelli, M. (2011). China and India: Openness, trade and effects on economic growth. *The European Journal of Comparative Economics, 8*(1), 129.

McKibbin, W. J., & Stoeckel, A. (2010). The Global Financial Crisis: Causes and Consequences*. *Asian Economic Papers, 9*(1), 54-86.

Oosterhaven, J. (2012). Adding supply-driven consumption makes the Ghosh model even more implausible. *Economic Systems Research, 24*(1), 101-111.

Pula, G., & Peltonen, T. A. (2009). Has emerging Asia decoupled? An analysis of production and trade linkages using the Asian international input-output table: European Central Bank.

Puttanapong, N. (2015). Tracing and Quantifying Thailand's Linkages to the Global Supply Chain: the Modification of World Input-Output Database (WIOD) and the Applications of Leontief Multiplier and Structural Path Analysis. *Singapore Economic Review Conference*.

Puttanapong, N. (2016). Tracing Thailand's Linkages to Global Supply Chain: Applications of World Input-Output Database (WIOD) and Structural Path Analysis. *International Journal of Applied Business and Economic Research,* 14(1), 411-438.

Romer, P. (1989). Endogenous technological change: National Bureau of Economic Research.

Saito, M., Ruta, M., & Turunen, J. (2013). Trade Interconnectedness: The World with Global Value Chains. *IMF Policy Paper*.

Tahir, M., & Azid, T. (2015). The relationship between international trade openness and economic growth in the developing economies: Some new dimensions. *Journal of Chinese Economic and Foreign Trade Studies, 8*(2), 123-139.

Tang, C. F., Lai, Y. W., & Ozturk, I. (2015). How stable is the export-led growth hypothesis? Evidence from Asia's Four Little Dragons. *Economic Modelling, 44*, 229-235.

Timmer, M. P., Erumban, A. A., Los, B., Stehrer, R., & de Vries, G. J. (2014). Slicing up global value chains. *The Journal of Economic Perspectives, 28*(2), 99-118.

Ulaşan, B. (2015). Trade openness and economic growth: panel evidence. *Applied Economics Letters, 22*(2), 163-167.

Vogiatzoglou, K. (2012). Vertical Specialization and Export Performance in Electronics: A Cross-Country Analysis. *International Economic Journal, 26*(1), 109-139.

Wang, Z., Wei, S.-J., & Zhu, K. (2013). Quantifying international production sharing at the bilateral and sector levels: National Bureau of Economic Research.

Weaver, J. H. (1993). Exports and economic growth in a simultaneous equations model. *The Journal of Developing Areas, 27*(3), 289-306.

Yamamoto, S. (2014). Transmission of US financial and trade shocks to Asian economies: Implications for spillover of the 2007–2009 US financial crisis. *The North American Journal of Economics and Finance, 27*, 88-103.

Yew Wah, L. (2004). The role of domestic demand in the economic growth of Malaysia: a cointegration analysis. *International Economic Journal, 18*(3), 337-352.

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http://www.nesdb.go.th

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APPENDICES

APPENDIX A

Gross Export Combinations of Thai industries

Appendix A.1: Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2000, 2005, 2009, 2010 and 2011

Table A.1

Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2011

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Agriculture, hunting, forestry and fishing	3,175.61	5,272.37	1,618.36	14.44	11.13	700.14	1,161.17	365.90	9.73
Mining and quarrying	75.38	759.94	437.66	2.70	5.60	14.85	148.62	89.52	3.11
Food product, beverages and tobacco	11,049.73	5,147.04	1,199.19	10.07	7.24	3,426.92	1,596.16	380.25	8.96
Textiles, textile products, leather and footwear	3,255.44	875.76	495.96	2.35	1.92	1,122.47	301.10	174.10	2.24

Source: Koopman et al. (2014)

Table A.1 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Wood, products of wood and cork	73.41	908.61	254.51	1.98	2.12	22.55	278.61	80.66	2.25
Pulp, paper, paper products, printing and publishing	695.74	1,933.81	815.69	8.61	11.20	514.99	1,433.89	628.41	16.66
Coke, refined petroleum products and nuclear fuel	1,073.32	1,401.74	1,625.65	21.82	24.86	1,412.52	1,840.50	2,225.24	15.00
Chemicals and chemical products	2,057.33	5,791.12	2,921.50	23.57	28.40	1,408.14	3,952.25	2,070.90	34.82
Rubber and plastics products	792.61	3,588.05	1,789.07	15.10	12.76	477.44	2,153.70	1,113.62	18.94
Other non-metallic mineral products	105.60	924.02	172.79	1.33	1.76	63.97	559.50	108.22	2.35
Basic metals	138.92	2,131.71	1,095.95	12.46	23.53	239.66	3,675.63	2,000.53	26.32
Fabricated metal products	206.62	1,074.28	334.24	3.24	3.18	321.57	1,674.33	540.03	7.83
Machinery and equipment	3,763.90	2,157.44	1,108.61	11.76	9.64	4,723.93	2,706.55	1,442.72	18.46
Computer, Electronic and optical equipment	3,297.94	2,527.11	2,615.41	13.43	7.21	6,918.93	5,271.51	5,691.62	62.13
Electrical machinery and apparatus	1,332.61	1,478.40	980.48	9.78	7.12	1,473.57	1,632.46	1,122.38	15.41
Motor vehicles, trailers and semi-trailers	4,603.52	1,747.32	633.14	16.02	7.30	5,920.35	2,253.67	858.11	15.83

Source: Koopman et al. (2014)

Table A.1 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Other transport equipment	1,075.24	646.98	285.79	3.49	1.66	999.61	599.46	275.85	3.66
Manufacturing and recycling	1,990.00	800.85	377.00	1.95	1.95	2,023.96	813.54	392.93	4.47
Electricity, gas and water supply	93.29	119.93	53.32	0.62	0.69	49.41	63.31	29.39	0.45
Construction	444.36	79.54	10.44	0.11	0.14	377.20	67.58	9.25	0.28
Wholesale & retail trade and repairs	10,876.49	9,046.87	4,443.01	36.87	34.56	1,298.93	1,075.96	546.68	25.12
Hotels and restaurants	7,136.67	0	0	0	0	1,796.05	0	0	0
Transport and storage	7,880.46	4,210.15	2,430.28	26.54	25.24	3,528.34	1,879.76	1,125.06	18.63
Post and telecommunications	406.74	418.68	179.87	0.98	1.20	55.62	57.16	25.10	0.81
Financial intermediation	191.29	437.10	221.46	1.23	1.02	21.54	48.79	25.74	1.06
Real estate activities	702.06	17.84	3.95	0.04	0.06	37.02	0.94	0.22	0.03
Renting of machinery and equipment	580.74	373.33	198.49	0.73	0.73	116.11	74.50	40.25	0.62
Computer and related activity	41.35	41.12	7.49	0.08	0.09	8.47	8.42	1.59	0.08
R&D and other business activities	112.58	1,258.86	656.06	1.83	2.00	37.76	420.56	224.14	3.52
Education	3.63	0	0	0	0	0.43	0	0	0
Health and social work	709.05	0	0	0	0	303.66	0	0	0
Other community, social and personal services	1,956.12	49.74	28.14	0.05	0.08	753.25	19.14	10.95	0.13

Source: Koopman et al. (2014)

Table A.2

Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2010

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_ INTrex	RDV_ FIN	RDV_ INT	FVA_FIN	FVA_INT	FDC	DDC
Agriculture, hunting, forestry and fishing	2,009.73	3,379.91	1,338.60	15.88	14.11	393.66	661.47	270.33	8.49
Mining and quarrying	48.38	591.59	333.15	2.03	3.63	8.02	97.60	57.06	1.95
Food product, beverages and tobacco	9,328.87	4,212.90	987.99	7.97	6.11	2,637.22	1,190.86	285.34	6.94
Textiles, textile products, leather and footwear	3,094.76	862.59	517.18	2.89	2.67	921.43	256.13	157.05	2.41
Wood, products of wood and cork	50.29	790.01	230.55	1.94	2.64	13.81	216.68	65.48	2.19
Pulp, paper, paper products, printing and publishing	407.74	1,082.18	487.63	5.79	9.45	260.11	691.96	326.42	11.33
Coke, refined petroleum products and nuclear fuel	985.17	1,398.20	1,238.21	15.50	18.85	1,074.51	1,521.44	1,403.46	10.96
Chemicals and chemical products	1,654.45	4,670.15	2,374.48	18.08	24.70	966.29	2,720.01	1,434.76	26.22
Rubber and plastics products	661.84	3,100.36	1,535.04	11.51	11.81	355.69	1,660.56	851.61	15.77
Other non-metallic mineral products	115.87	1,125.86	164.21	1.46	1.49	55.78	542.07	81.63	2.41

Source: Koopman et al. (2014)

Table A.2 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Basic metals	123.55	2,435.79	1,368.92	13.25	28.21	170.34	3,357.63	1,986.87	30.19
Fabricated metal products	193.77	1,159.02	348.43	3.10	3.58	246.54	1,476.54	460.53	8.32
Machinery and equipment	3,528.58	2,050.70	1,078.22	9.68	9.48	3,378.15	1,962.14	1,067.49	16.46
Computer, Electronic and optical equipment	3,458.56	2,687.37	2,981.30	11.01	7.73	6,185.49	4,780.91	5,505.71	64.27
Electrical machinery and apparatus	1,194.19	1,429.70	1,046.02	10.43	9.76	1,201.45	1,437.97	1,092.12	18.90
Motor vehicles, trailers and semi-trailers	5,540.56	1,977.69	711.85	20.44	10.22	5,799.66	2,077.25	792.81	21.63
Other transport equipment	898.48	545.97	249.12	4.22	1.79	628.96	381.01	182.39	3.72
Manufacturing and recycling	1,929.18	926.44	362.38	1.81	1.99	1,415.66	679.10	272.52	4.19
Electricity, gas and water supply	118.71	138.19	37.94	0.12	0.24	48.81	56.60	16.05	0.21
Construction	473.98	85.75	11.04	0.10	0.15	327.33	59.28	7.94	0.30
Wholesale & retail trade and repairs	9,470.83	7,698.88	3,976.42	30.97	32.39	990.80	802.24	428.20	22.80
Hotels and restaurants	5,378.49	0	0	0	0	1,208.02	0	0	0
Transport and storage	6,726.64	4,012.52	2,331.34	23.24	25.33	2,617.46	1,556.44	937.70	17.27
Post and telecommunications	358.63	318.51	153.83	1.09	1.52	42.96	38.11	18.89	0.82
Financial intermediation	212.82	223.57	35.32	0.15	0.23	22.03	23.08	3.78	0.20

Source: Koopman et al. (2014)

Table A.2 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Real estate activities	542.17	15.86	3.55	0.03	0.04	24.75	0.72	0.17	0.02
Renting of machinery and equipment	422.40	361.80	191.16	0.51	0.61	75.03	64.13	34.39	0.56
Computer and related activity	5.77	17.67	2.12	0.01	0.01	1.02	3.13	0.38	0.02
R&D and other business activities	106.60	1,131.81	578.52	1.29	1.76	32.63	345.50	180.11	3.60
Education	3.20	0	0	0	0	0.34	0	0	0
Health and social work	657.09	0	0	0	0	247.15	0	0	0
Other community, social and personal services	1,504.59	60.34	33.29	0.05	0.08	488.16	19.56	10.91	0.14

Source: Koopman et al. (2014)

Table A.3

Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2009

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Agriculture, hunting, forestry and fishing	1,286.56	2,188.01	850.85	8.61	8.61	231.87	394.04	157.62	4.85
Mining and quarrying	32.38	670.57	287.51	1.37	2.78	5.19	106.93	47.58	1.57
Food product, beverages and tobacco	8,329.33	3,687.68	770.25	4.72	3.98	2,261.22	1,001.01	212.88	4.81
Textiles, textile products, leather and footwear	2,788.09	750.16	418.24	1.68	1.70	750.06	201.29	114.38	1.62
Wood, products of wood and cork	40.18	597.99	167.55	1.08	1.63	10.22	151.99	43.85	1.39
Pulp, paper, paper products, printing and publishing	343.58	870.99	444.30	4.35	8.03	202.82	514.80	273.71	8.06
Coke, refined petroleum products and nuclear fuel	953.33	1,297.06	730.66	6.39	8.48	1,023.78	1,390.03	810.03	6.08
Chemicals and chemical products	1,317.93	3,636.90	1,711.19	10.37	15.55	647.13	1,780.69	865.60	15.39
Rubber and plastics products	577.83	2,434.01	1,082.29	6.64	7.99	265.03	1,113.26	510.53	9.30
Other non-metallic mineral products	95.15	891.00	156.18	0.87	1.53	42.73	399.99	72.19	1.91
Basic metals	69.05	2,336.81	1,155.87	7.70	21.28	78.49	2,657.11	1,374.12	24.94

Source: Koopman et al. (2014)

Table A.3 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Fabricated metal products	246.27	1,492.11	325.72	2.45	3.41	264.93	1,609.03	363.11	9.55
Machinery and equipment	2,722.40	1,525.46	714.17	5.07	6.38	2,417.12	1,353.93	654.10	10.56
Computer, Electronic and optical equipment	2,924.87	2,295.40	2,505.73	7.90	6.14	4,774.71	3,726.31	4,216.47	50.39
Electrical machinery and apparatus	971.81	1,136.47	729.83	5.48	6.63	889.68	1,040.58	690.70	12.68
Motor vehicles, trailers and semi-trailers	3,925.04	1,350.60	436.20	7.90	5.46	3,352.71	1,156.11	390.03	9.92
Other transport equipment	827.10	540.18	239.69	1.76	1.26	583.43	379.44	174.50	2.41
Manufacturing and recycling	1,834.02	722.66	299.63	0.98	1.21	1,152.09	453.60	191.71	2.80
Electricity, gas and water supply	114.40	138.32	37.63	0.10	0.20	46.52	56.03	15.72	0.20
Construction	507.36	93.17	10.25	0.08	0.12	315.03	57.92	6.59	0.27
Wholesale & retail trade and repairs	7,905.80	6,256.39	3,013.12	17.16	21.22	775.32	611.33	302.99	15.31
Hotels and restaurants	4,159.12	0	0	0	0	909.16	0	0	0
Transport and storage	6,032.33	3,914.80	2,245.79	19.99	23.32	2,212.25	1,431.72	849.09	15.36
Post and telecommunications	295.51	344.91	143.90	0.38	0.53	34.32	39.99	16.94	0.40
Financial intermediation	147.00	168.25	24.14	0.09	0.15	14.41	16.45	2.44	0.12
Real estate activities	479.49	12.74	5.80	0.04	0.05	21.11	0.56	0.26	0.02

Source: Koopman et al. (2014)

Table A.3 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Renting of machinery and equipment	308.82	343.45	127.08	0.32	0.39	50.51	56.09	21.05	0.38
Computer and related activity	8.66	18.04	8.78	0.04	0.06	1.41	2.94	1.46	0.05
R&D and other business activities	104.07	969.89	535.55	1.40	1.93	29.54	274.41	154.60	2.89
Education	2.72	0	0	0	0	0.28	0	0	0
Health and social work	630.42	0	0	0	0	202.51	0	0	0
Other community, social and personal services	1190.07	45.05	12.75	0.02	0.03	357.48	13.53	3.86	0.06

Source: Koopman et al. (2014)

Table A.4

Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2005

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Agriculture, hunting, forestry and fishing	322.95	525.16	198.45	2.00	1.48	66.68	108.36	41.96	0.98
Mining and quarrying	54.34	622.59	439.40	3.52	7.59	9.56	109.25	80.14	3.07
Food product, beverages and tobacco	5,186.59	2,210.44	514.64	4.23	2.75	1,493.07	636.27	151.10	3.11
Textiles, textile products, leather and footwear	2,905.48	895.27	530.30	2.06	1.97	977.87	300.31	181.59	2.25
Wood, products of wood and cork	53.45	868.19	277.75	1.87	2.13	17.76	288.13	94.69	2.19
Pulp, paper, paper products, printing and publishing	131.15	331.73	170.91	1.61	2.67	82.54	208.78	111.83	2.47
Coke, refined petroleum products and nuclear fuel	368.40	529.37	266.74	3.71	4.49	534.45	767.50	404.21	3.37
Chemicals and chemical products	784.78	2,182.14	1,392.03	11.47	16.02	505.08	1,400.83	926.76	14.89
Rubber and plastics products	555.90	2,373.84	1,090.02	8.05	7.91	333.01	1,418.59	672.81	11.41
Other non-metallic mineral products	80.60	688.09	136.52	1.00	1.21	46.42	396.08	80.96	1.59

Source: Koopman et al. (2014)

Table A.4 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Basic metals	18.97	780.48	469.05	6.03	8.01	24.58	1,007.51	638.75	6.99
Fabricated metal products	121.76	732.00	200.47	2.06	2.22	143.64	862.78	246.64	3.68
Machinery and equipment	1,804.96	1,011.92	520.52	6.38	5.79	1,950.41	1,092.44	585.30	8.01
Computer, Electronic and optical equipment	2,107.28	1,370.82	1,593.22	5.42	3.50	3,491.23	2,259.58	2,709.55	26.37
Electrical machinery and apparatus	775.65	899.07	710.70	6.84	6.21	815.03	944.12	773.07	11.40
Motor vehicles, trailers and semi-trailers	2,552.65	906.74	393.20	7.19	3.87	2,686.72	955.90	431.78	7.43
Other transport equipment	400.39	223.23	96.48	1.72	1.05	310.02	172.78	77.79	1.13
Manufacturing and recycling	1,263.99	439.20	120.19	0.68	0.65	997.29	345.83	97.68	1.39
Electricity, gas and water supply	87.84	120.74	53.14	0.45	0.57	45.24	61.97	28.30	0.38
Construction	244.91	40.22	4.94	0.05	0.06	193.12	31.75	4.06	0.13
Wholesale & retail trade and repairs	5,782.59	4,067.95	2,171.45	15.11	15.52	589.99	413.43	227.31	10.02
Hotels and restaurants	2,336.69	0	0	0	0	534.36	0	0	0
Transport and storage	3,804.21	2,808.97	1,956.33	18.31	19.92	1,650.39	1,214.96	874.36	12.45
Post and telecommunications	181.55	195.77	92.08	0.28	0.34	21.00	22.60	10.80	0.22
Financial intermediation	65.14	68.24	15.62	0.07	0.10	6.50	6.80	1.60	0.06
Real estate activities	300.43	11.79	4.97	0.02	0.02	12.84	0.50	0.22	0.01

Source: Koopman et al. (2014)

Table A.4 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Renting of machinery and equipment	173.44	161.19	73.61	0.23	0.24	27.36	25.37	11.77	0.19
Computer and related activity	19.04	19.77	8.96	0.03	0.03	3.08	3.19	1.48	0.03
R&D and other business activities	52.44	667.65	347.35	0.86	1.06	14.87	189.00	99.88	1.50
Education	1.55	0	0	0	0	0.16	0	0	0
Health and social work	435.51	0	0	0	0	171.22	0	0	0
Other community, social and personal services	725.79	24.19	15.48	0.024	0.03	227.76	7.58	4.89	0.04

Source: Koopman et al. (2014)

Table A.5

Nine Combinations of Gross Export of Thirty-Two Thai Industries in 2000

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Agriculture, hunting, forestry and fishing	195.43	288.44	92.27	0.69	0.54	29.70	43.81	14.31	0.38
Mining and quarrying	29.90	201.22	135.36	0.82	1.33	3.63	24.33	16.85	0.67
Food product, beverages and tobacco	4,371.45	1,727.73	362.70	2.93	1.57	937.77	370.50	79.27	1.70
Textiles, textile products, leather and footwear	2,695.29	889.75	395.79	1.29	0.95	747.39	245.58	111.89	1.32
Wood, products of wood and cork	51.10	668.97	166.97	0.81	0.60	11.72	153.23	39.06	0.95
Pulp, paper, paper products, printing and publishing	89.73	279.95	116.73	0.72	0.76	42.76	133.24	56.87	0.75
Coke, refined petroleum products and nuclear fuel	190.28	391.92	221.16	2.47	2.48	165.69	340.63	198.91	1.57
Chemicals and chemical products	374.45	1,081.35	612.88	4.49	4.69	211.87	610.80	355.74	4.84
Rubber and plastics products	300.47	1,195.42	487.96	2.49	2.20	143.20	567.52	238.57	3.29
Other non-metallic mineral products	61.20	533.34	86.91	0.44	0.41	25.30	220.20	36.86	0.61

Source: Koopman et al. (2014)

Table A.5 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Basic metals	13.42	522.16	291.00	2.22	2.57	9.72	375.25	218.95	2.51
Fabricated metal products	78.80	473.03	130.19	0.91	0.80	64.55	386.15	110.63	1.54
Machinery and equipment	902.44	577.41	252.01	2.00	1.66	789.52	503.64	227.48	2.61
Computer, Electronic and optical equipment	1,813.72	1,207.32	1,154.64	4.17	2.28	2,818.86	1,860.97	1,845.55	16.45
Electrical machinery and apparatus	600.29	545.28	328.95	3.16	2.30	707.26	641.78	401.23	5.56
Motor vehicles, trailers and semi-trailers	749.37	269.73	172.55	1.02	0.60	795.54	286.12	186.71	1.49
Other transport equipment	25.68	19.04	13.98	0.20	0.14	20.55	15.21	11.57	0.11
Manufacturing and recycling	1,050.67	334.69	80.63	0.35	0.27	532.50	169.06	42.04	0.59
Electricity, gas and water supply	66.97	105.48	40.08	0.12	0.23	19.50	30.56	11.97	0.15
Construction	223.63	35.87	3.40	0.03	0.03	124.52	19.98	1.96	0.07
Wholesale & retail trade and repairs	4,314.95	2,715.54	1,207.41	6.54	5.12	399.67	250.40	114.47	4.55
Hotels and restaurants	2,258.12	0	0	0	0	389.07	0	0	0
Transport and storage	2,971.72	1,897.23	1,216.35	10.69	9.37	995.17	633.64	417.93	6.50
Post and telecommunications	78.79	103.05	38.55	0.12	0.14	5.36	6.99	2.66	0.09
Financial intermediation	49.87	62.48	23.91	0.05	0.06	3.30	4.13	1.60	0.04
Real estate activities	268.55	7.60	2.65	0.01	0.01	6.79	0.19	0.07	0.00

Source: Koopman et al. (2014)

Table A.5 (Continued)

IND	EXP								
	DVAING					FVAING		PDCING	
	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	FVA_FIN	FVA_INT	FDC	DDC
Renting of machinery and equipment	166.84	69.32	22.98	0.05	0.05	26.41	10.96	3.67	0.04
Computer and related activity	43.59	42.64	6.63	0.05	0.05	6.43	6.28	1.00	0.04
R&D and other business activities	9.33	160.66	93.06	0.14	0.16	2.18	37.42	21.94	0.22
Education	1.43	0	0	0	0	0.08	0	0	0
Health and social work	492.79	0	0	0	0	142	0	0	0
Other community, social and personal services	667.24	14.83	8.74	0.01	0.01	227.80	5.05	3.01	0.02

Source: Koopman et al. (2014)

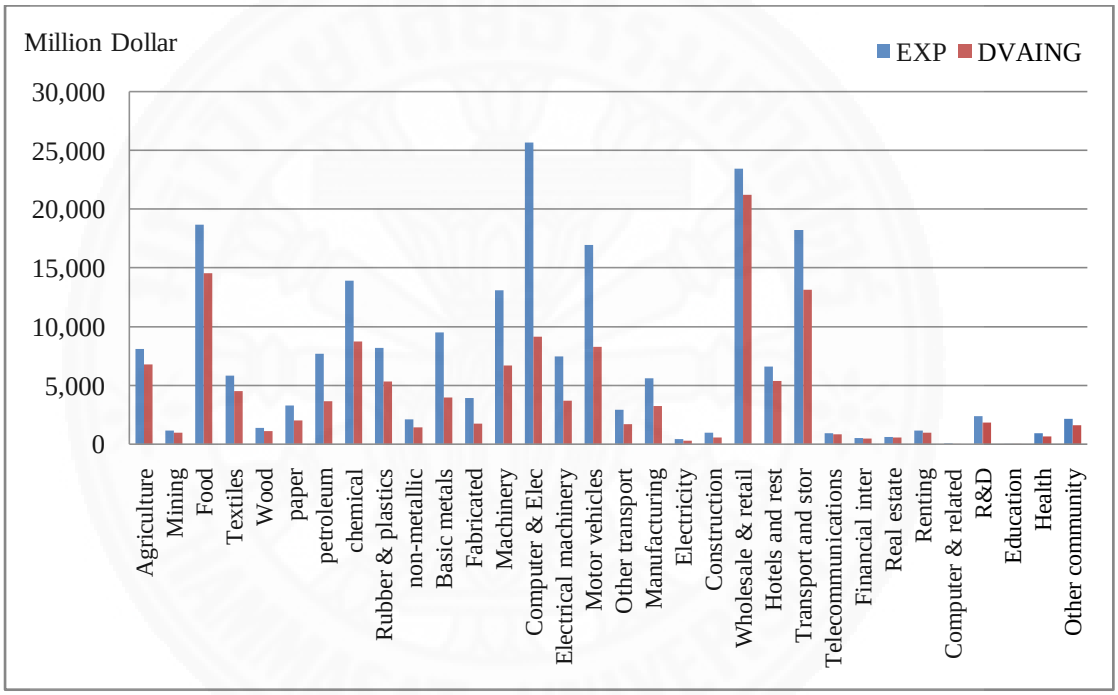
APPENDIX B

Decomposition Analysis of Global Value Chain

Appendix B.1: Decomposition of Domestic Value-Added in Gross Export in 2000, 2005, 2009 and 2010

Figure B.1

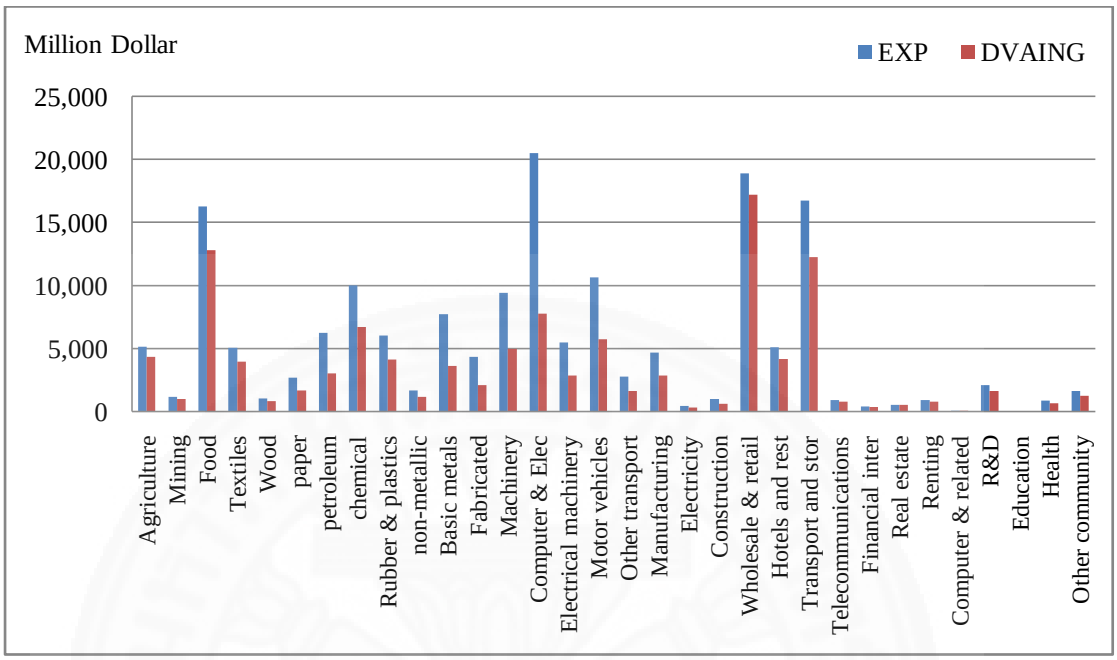
Domestic Value-Added in Gross Export in 2010



Source: Author's calculation based on Koopman et al. (2014)

Figure B.2

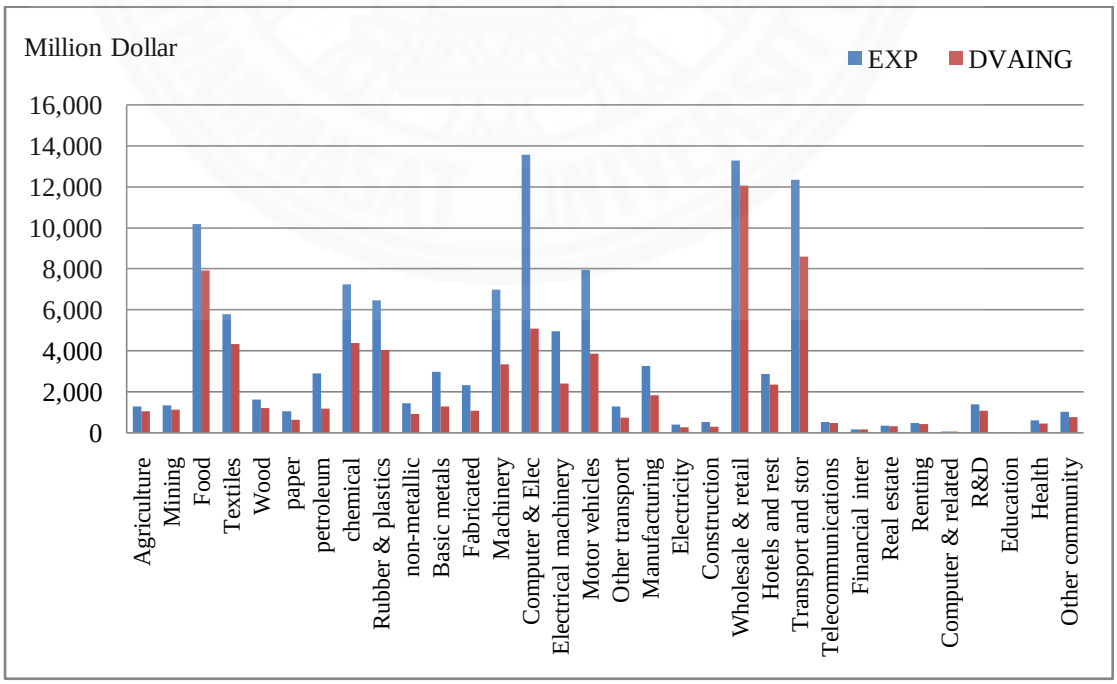
Domestic Value-Added in Gross Export in 2009



Source: Author's calculation based on Koopman et al. (2014)

Figure B.3

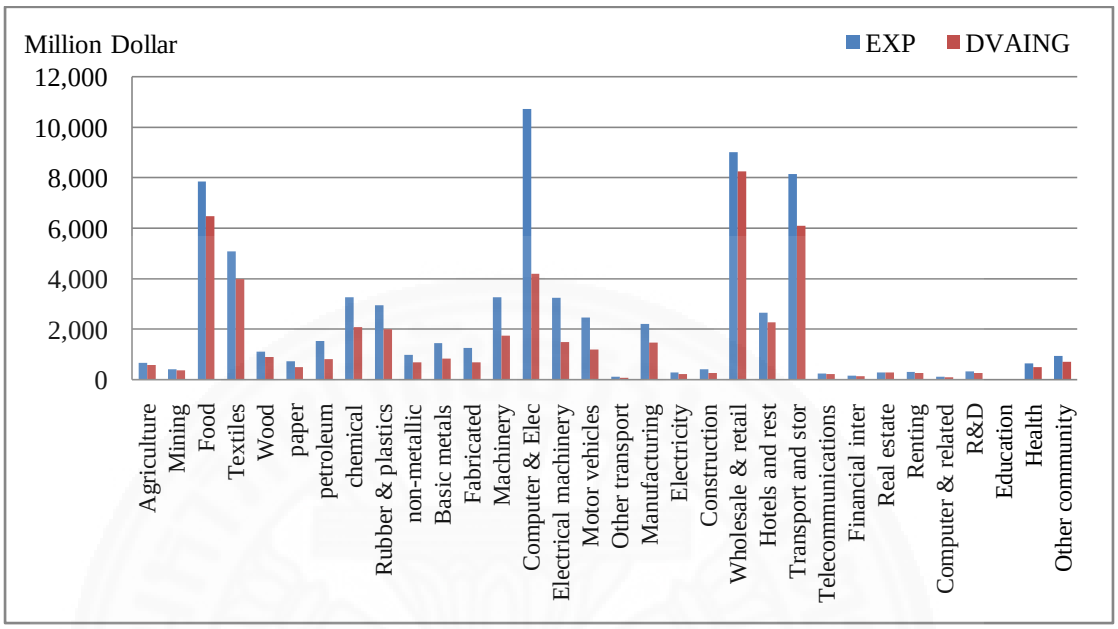
Domestic Value-Added in Gross Export in 2005



Source: Author's calculation based on Koopman et al. (2014)

Figure B.4

Domestic Value-Added in Gross Export in 2000

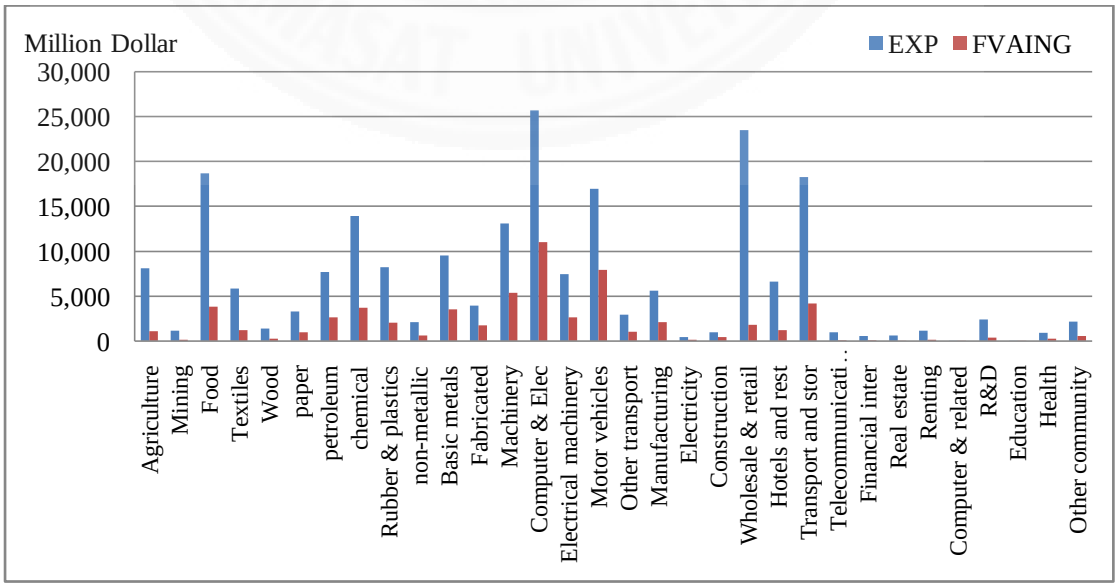


Source: Author's calculation based on Koopman et al. (2014)

Appendix B.2: Decomposition of Foreign Value-Added in Gross Export in 2000, 2005, 2009 and 2010

Figure B.5

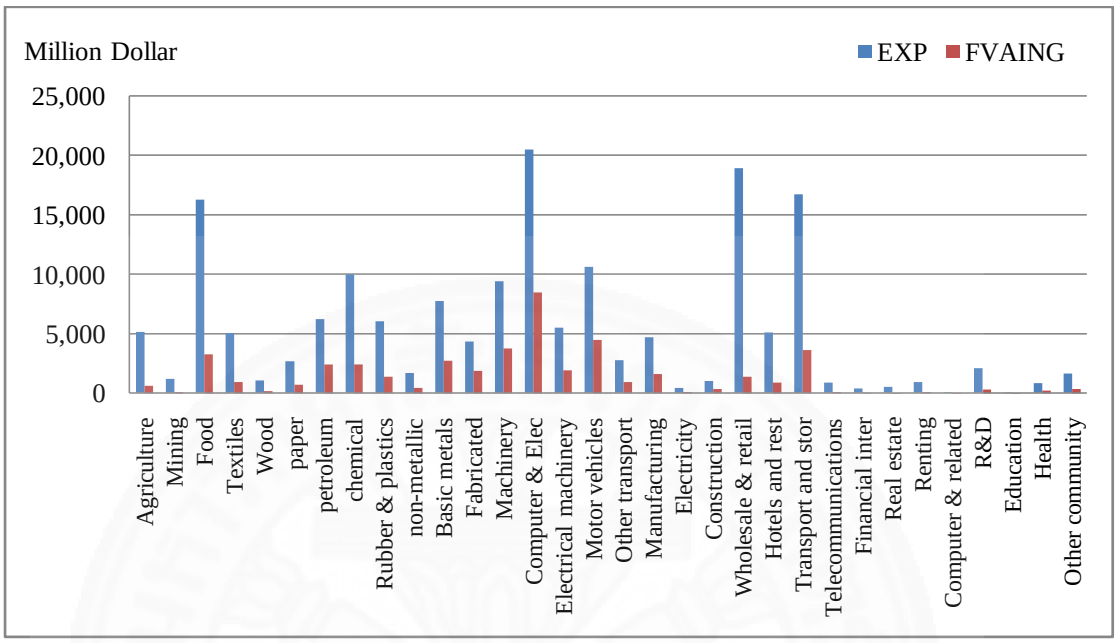
Foreign Value-Added in Gross Export in 2010



Source: Author's calculation based on Koopman et al. (2014)

Figure B.6

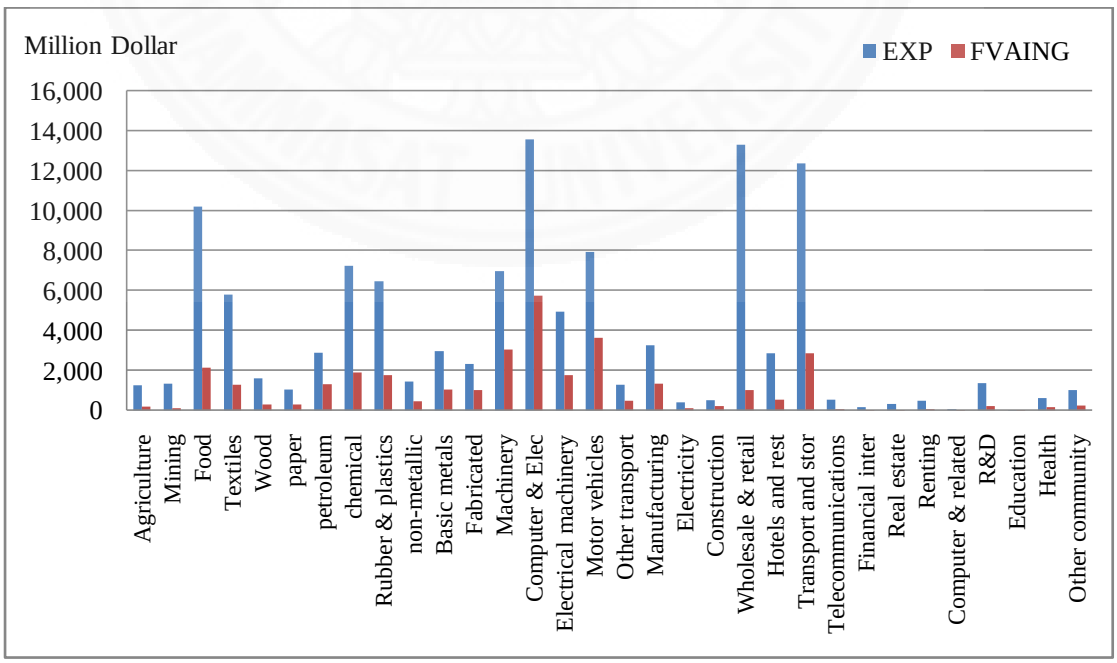
Foreign Value-Added in Gross Export in 2009



Source: Author's calculation based on Koopman et al. (2014)

Figure B.7

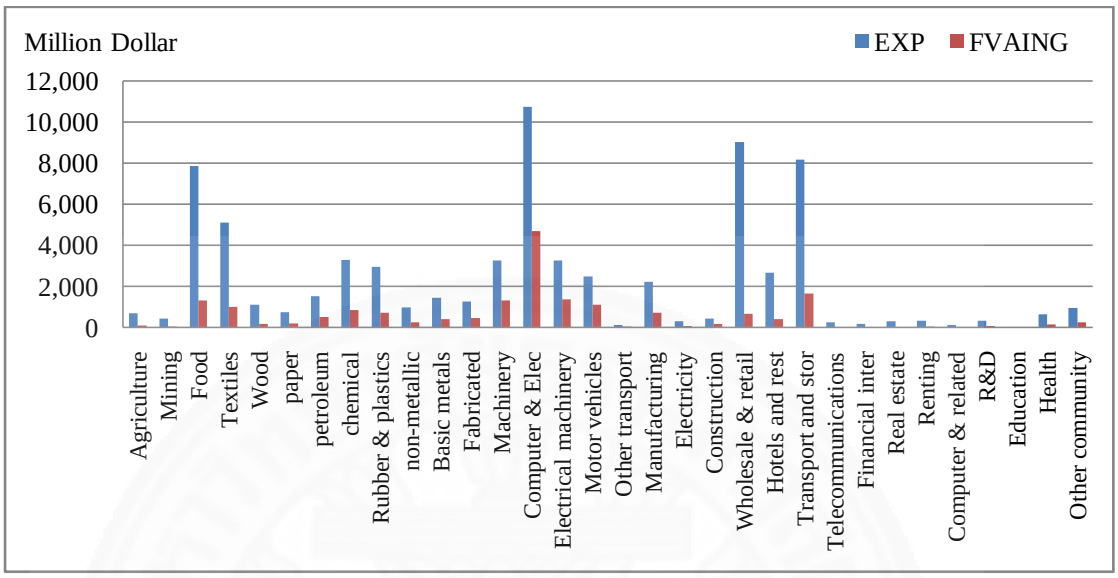
Foreign Value-Added in Gross Export in 2005



Source: Author's calculation based on Koopman et al. (2014)

Figure B.8

Foreign Value-Added in Gross Export in 2000

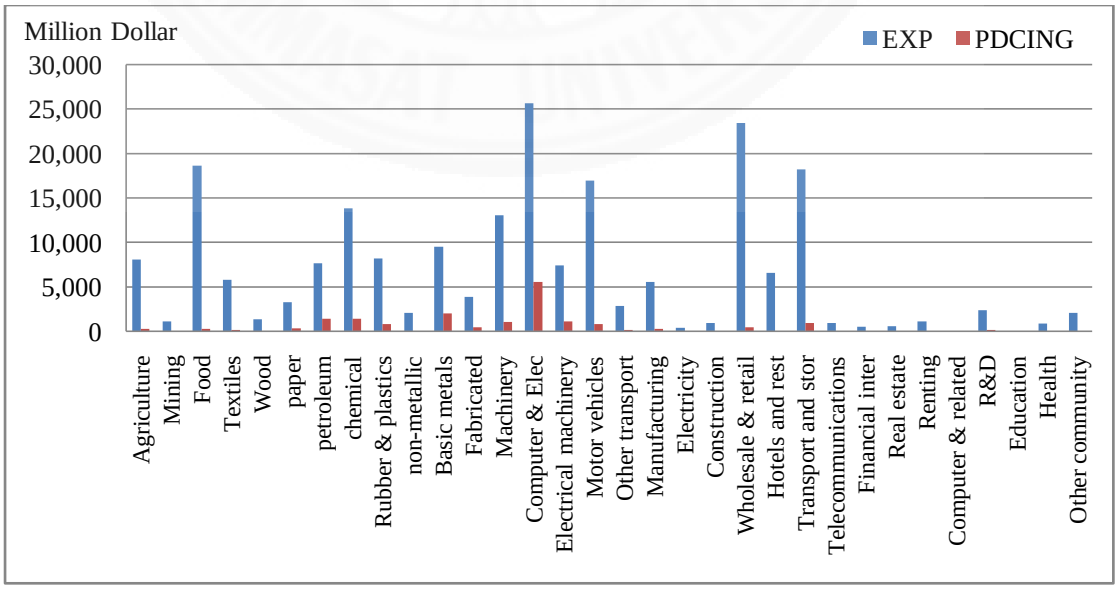


Source: Author's calculation based on Koopman et al. (2014)

Appendix B.3: Decomposition of Pure Double Counted in Gross Export in 2000, 2005, 2009 and 2010

Figure B.9

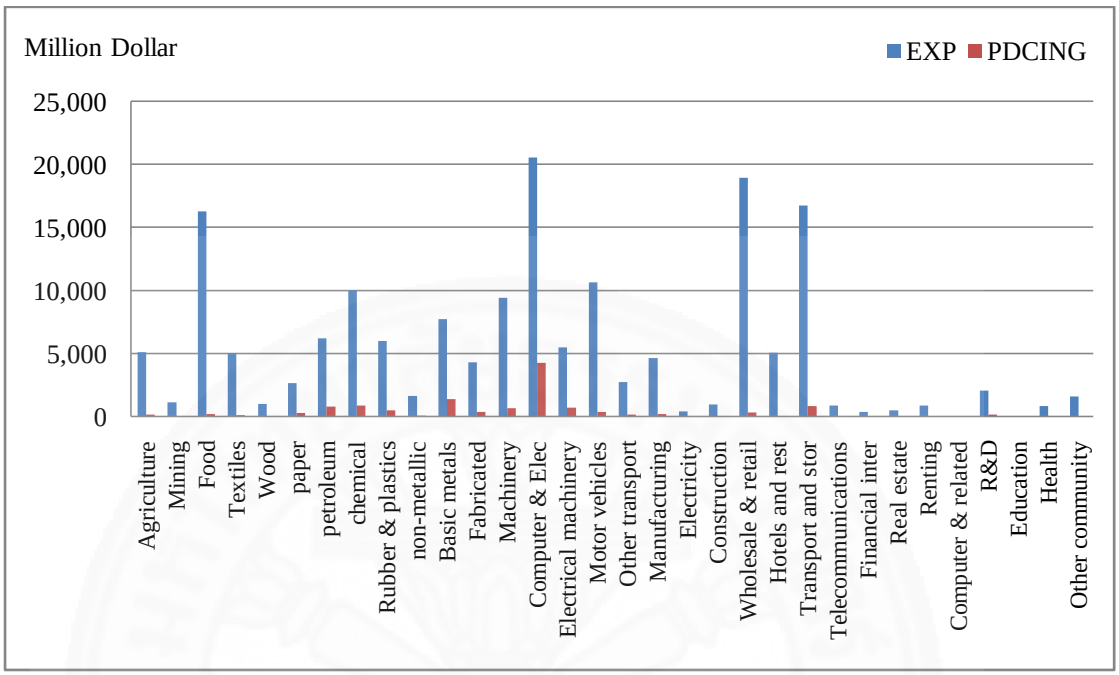
Pure Double Counted in Gross Export in 2010



Source: Author's calculation based on Koopman et al. (2014)

Figure B.10

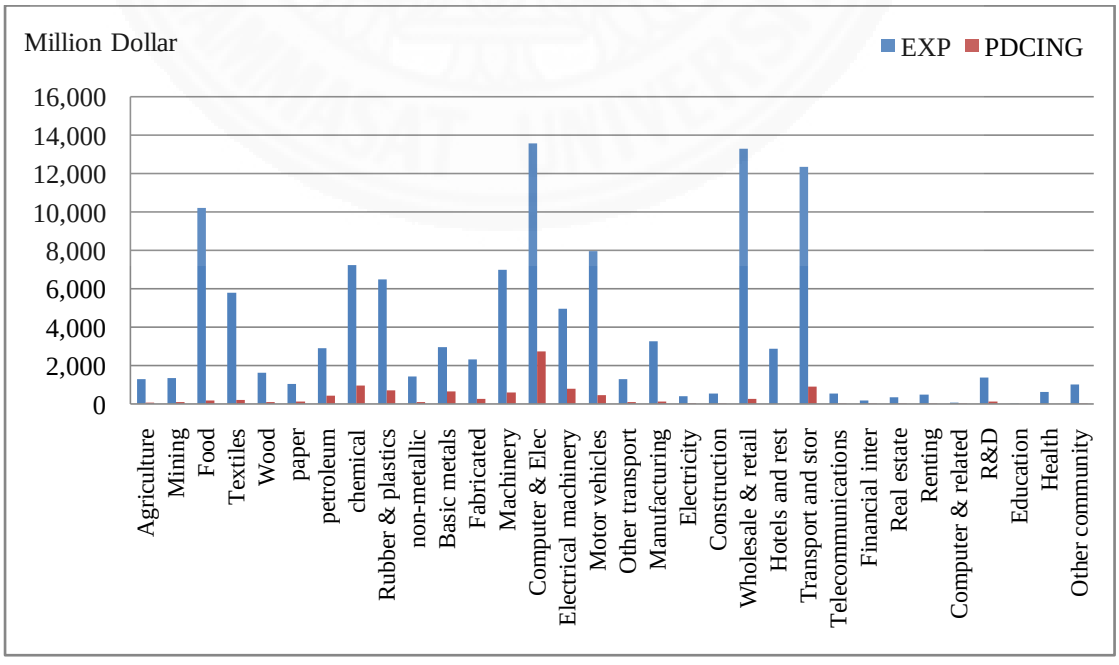
Pure Double Counted in Gross Export in 2009



Source: Author's calculation based on Koopman et al. (2014)

Figure B.11

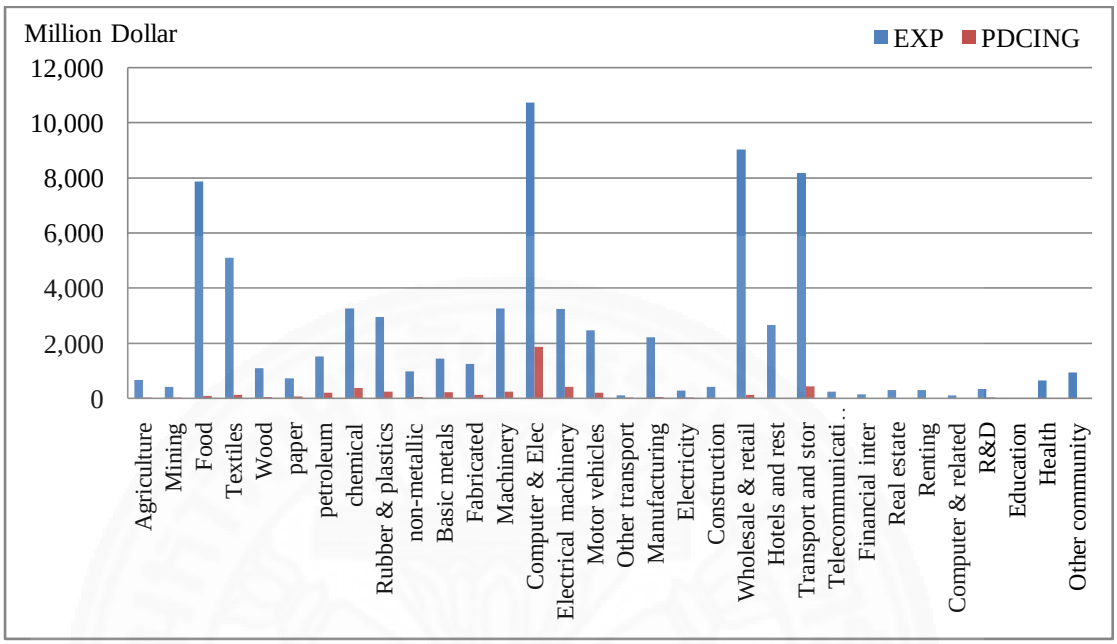
Pure Double Counted in Gross Export in 2005



Source: Author's calculation based on Koopman et al. (2014)

Figure B.12

Pure Double Counted in Gross Export in 2000



Source: Author's calculation based on Koopman et al. (2014)

Appendix B.4: Share of Gross Export Combinations in 2000, 2005, 2009 and 2010

Share of Domestic Value-Added in Gross Export (DVAING share) in 2010, 2009, 2005 and 2000 for the top seven exporting industries, including, computer, electronic and optical equipment; machinery and equipment; motor vehicles, trailers and semi-trailers are explicitly low. Whereas, other top seven exporting industries that are whole sale and retail trade and repairs; food products, beverages and tobacco; transport and storage; and chemicals and chemical products have a higher DVAING share compared with the former industries' shares.

In contrast, Foreign Value-Added in Gross Export share (FVAING share) and Pure Double Counted in Gross Export share (PDCING share) for the top seven exporting industries are relatively high in computer, electronic and optical equipment; machinery and equipment; and motor vehicles, trailers and semi-trailers but are relatively low in whole sale and retail trade and repairs; food products, beverages and tobacco; transport and storage; and chemicals and chemical products.

Table B.1

Gross Export Combinations in 2010

Industry	DVAING	FVAING	PDCING
Real estate activities	96%	4%	0%
Financial intermediation	91%	9%	1%
Education	90%	10%	0%
Wholesale & retail trade and repairs	90%	8%	2%
Post and telecommunications	89%	9%	2%
Mining and quarrying	86%	9%	5%
Computer and related activities	85%	14%	1%
Renting of machinery and equipment	85%	12%	3%
Agriculture, hunting, forestry and fishing	84%	13%	3%
Hotels and restaurants	82%	18%	0%
Wood, products of wood and cork	78%	17%	5%
Food products, beverages and tobacco	78%	21%	2%
Textiles, textile products, leather and footwear	77%	20%	3%
R&D and other business activities	76%	16%	8%
Other community, social and personal services	75%	24%	1%
Health and social work	73%	27%	0%
Transport and storage	72%	23%	5%
Electricity, gas and water supply	71%	25%	4%
Other non-metallic mineral products	67%	29%	4%
Rubber and plastics products	65%	25%	11%
Chemicals and chemical products	63%	27%	11%
Pulp, paper, paper products, printing and publishing	61%	29%	10%
Construction	59%	40%	1%
Other transport equipment	59%	35%	6%
Manufacturing and recycling	58%	37%	5%
Machinery and equipment	51%	41%	8%
Electrical machinery and apparatus	50%	35%	15%
Motor vehicles, trailers and semi-trailers	49%	46%	5%
Coke, refined petroleum products and nuclear fuel	48%	34%	18%
Fabricated metal products	44%	44%	12%
Basic metals	42%	37%	21%
Computer, electronic and optical equipment	36%	43%	22%

Source: Author's calculation based on Koopman et al. (2014)

Table B.2

Gross Export Combinations in 2009

Industry	DVAING	FVAING	PDCING
Real estate activities	96%	4%	0%
Financial intermediation	91%	8%	1%
Wholesale & retail trade and repairs	91%	7%	2%
Education	91%	9%	0%
Post and telecommunications	90%	8%	2%
Mining and quarrying	86%	10%	4%
Renting of machinery and equipment	86%	12%	2%
Computer and related activities	86%	10%	4%
Agriculture, hunting, forestry and fishing	85%	12%	3%
Hotels and restaurants	82%	18%	0%
Wood, products of wood and cork	80%	16%	4%
Textiles, textile products, leather and footwear	79%	19%	2%
Food products, beverages and tobacco	79%	20%	1%
R&D and other business activities	78%	15%	8%
Other community, social and personal services	77%	23%	0%
Health and social work	76%	24%	0%
Transport and storage	73%	22%	5%
Electricity, gas and water supply	71%	25%	4%
Other non-metallic mineral products	69%	27%	4%
Rubber and plastics products	68%	23%	9%
Chemicals, chemical products	67%	24%	9%
Pulp, paper, paper products, printing and nuclear fuel	63%	27%	11%
Construction	62%	38%	1%
Manufacturing and recycling	61%	34%	4%
Other transport equipment	59%	35%	6%
Motor vehicles, trailers and semi-trailers	54%	42%	4%
Machinery and equipment	53%	40%	7%
Electrical machinery and apparatus	52%	35%	13%
Coke, refined petroleum products and nuclear fuel	48%	39%	13%
Fabricated metal products	48%	43%	9%
Basic metals	46%	35%	18%
Computer, electronic and optical equipment	38%	41%	21%

Source: Author's calculation based on Koopman et al. (2014)

Table B.3

Gross Export Combinations in 2005

Industry	DVAING	FVAING	PDCING
Real estate activities	96%	4%	0%
Financial intermediation	91%	8%	1%
Wholesale & retail trade and repairs	91%	8%	2%
Education	91%	9%	0%
Post and telecommunications	90%	8%	2%
Renting of machinery and equipment	86%	11%	3%
Computer and related activities	86%	11%	3%
Mining and quarrying	85%	9%	6%
Agriculture, hunting, forestry and fishing	83%	14%	3%
Hotels and restaurants	81%	19%	0%
R&D and other business activities	78%	15%	7%
Food products, beverages and tobacco	78%	21%	2%
Other community, social and personal service	76%	23%	0%
Wood, products of wood and cork	75%	19%	6%
Textiles, textile products, leather and footwear	75%	22%	3%
Health and social work	72%	28%	0%
Transport and storage	70%	23%	7%
Electricity, gas and water supply	66%	27%	7%
Other non-metallic mineral products	63%	31%	6%
Rubber and plastics products	62%	27%	11%
Pulp, paper, paper products, printing and publishing	61%	28%	11%
Chemicals and chemical products	61%	26%	13%
Other transport equipment	56%	38%	6%
Construction	56%	43%	1%
Manufacturing and recycling	56%	41%	3%
Motor vehicles, trailers and semi-trailers	49%	46%	6%
Electrical machinery and apparatus	49%	36%	16%
Machinery and equipment	48%	44%	8%
Fabricated metal products	46%	43%	11%
Basic metals	43%	35%	22%
Coke, refined petroleum products and nuclear fuel	41%	45%	14%
Computer, electronic and optical equipment	37%	42%	20%

Source: Author’s calculation based on Koopman et al. (2014)

Table B.4

Gross Export Combinations in 2000

Industry	DVAING	FVAING	PDCING
Real estate activities	98%	2%	0%
Education	95%	5%	0%
Financial intermediation	94%	5%	1%
Post and telecommunications	94%	5%	1%
Wholesale & retail trade and repair	91%	7%	1%
Mining and quarrying	89%	7%	4%
Computer & related activities	87%	12%	1%
Agriculture, hunting, forestry and fishing	87%	11%	2%
Renting of machinery and equipment	86%	12%	1%
Hotels and restaurants	85%	15%	0%
Food products, beverages and tobacco	82%	17%	1%
Wood, products of wood and cork	81%	15%	4%
R&D and other business activities	81%	12%	7%
Textiles, textile products, leather and footwear	78%	20%	2%
Health and social work	78%	22%	0%
Electricity, gas and water supply	77%	18%	4%
Transport and storage	75%	20%	5%
Other community, social and personal service	75%	25%	0%
Other non-metallic mineral products	71%	25%	4%
Pulp, paper, paper products, printing and publishing	68%	24%	8%
Rubber and plastics products	68%	24%	8%
Manufacturing and recycling	66%	32%	2%
Construction	64%	35%	0%
Chemicals and chemical products	64%	25%	11%
Basic metals	58%	27%	15%
Other transport equipment	55%	34%	11%
Fabricated metal products	55%	36%	9%
Coke, refined petroleum products and nuclear fuel	53%	33%	13%
Machinery and equipment	53%	40%	7%
Motor vehicles, trailers and semi-trailers	48%	44%	8%
Electrical machinery and apparatus	46%	42%	13%
Computer, electronic and optical equipment	39%	44%	17%

Source: Author’s calculation based on Koopman et al. (2014)

Appendix B.5: Comparison between RCA and NRCA in 2000, 2005, 2009 and 2010

When export ability or competitiveness of thirty-two Thai industries is measured by using NRCA instead of conventional RCA in 2010, 2009, 2005 and 2000; it can be classified into 3 groups. The first group indicates the industries that have a higher competitiveness after measured by NRCA index. The second group involves the industries that have a lower competitiveness after measured by NRCA index. The third group includes the industries that their competitiveness are not changed after measured by NRCA index.

Table B.5

Comparison between RCA and NRCA in 2010

Industry	RCA	NRCA	Status
Agriculture, hunting, forestry and fishing	1.9616	2.3363	Increase
Mining and quarrying	0.0830	0.0933	Increase
Food products, beverages and tobacco	2.1447	2.5858	Increase
Textiles, textile products, leather and footwear	1.4304	1.8181	Increase
Wood, products of wood and cork	1.2738	1.5692	Increase
Pulp, paper, paper products, printing and publishing	0.8192	0.7514	Decrease
Coke, refined petroleum products and nuclear fuel	0.9190	0.9713	Increase
Chemicals and chemical products	0.8194	0.8916	Increase
Rubber and plastics products	2.1528	2.4195	Increase
Other non-metallic mineral products	1.3582	1.4699	Increase
Basic metals	0.9345	0.7249	Decrease
Fabricated metal products	0.9848	0.7373	Decrease
Machinery and equipment	1.0490	0.8951	Decrease
Computer, electronic and optical equipment	1.7554	1.1626	Decrease
Electrical machinery and apparatus	1.4776	1.3047	Decrease
Motor vehicles, trailers and semi-trailers	1.2559	1.1574	Decrease
Other transport equipment	0.4634	0.4797	Increase
Manufacturing and recycling	1.3488	1.2887	Decrease
Electricity, gas and water supply	0.2789	0.3082	Increase
Construction	0.8453	0.7783	Decrease

Source: Author’s calculation based on Koopman et al. (2014) and OECD

Table B.5 (Continued)

Industry	RCA	NRCA	Status
Wholesale & retail trade and repairs	1.0346	1.2773	Increase
Hotels and restaurants	1.6556	1.9044	Increase
Transport and storage	0.9993	1.0877	Increase
Post and telecommunications	0.5464	0.7045	Increase
Financial intermediation	0.0624	0.0806	Increase
Real estate activities	0.7193	0.8806	Increase
Renting of machinery and equipment	0.6588	0.7825	Increase
Computer and related activities	0.0106	0.0135	Increase
R&D and other business activities	0.2465	0.2600	Increase
Education	0.0088	0.0102	Increase
Health and social work	3.4050	3.3720	Decrease
Other community, social and personal services	0.6463	0.6751	Increase

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.6

Comparison between RCA and NRCA in 2009

Industry	RCA	NRCA	Status
Agriculture, hunting, forestry and fishing	0.4073	0.4508	Increase
Mining and quarrying	0.0037	0.0023	Decrease
Food products, beverages and tobacco	2.4206	2.3480	Decrease
Textiles, textile products, leather and footwear	0.8148	1.0407	Increase
Wood, products of wood and cork	0.0558	0.0879	Increase
Pulp, paper, paper products, printing and publishing	0.3371	0.5000	Increase
Coke, refined petroleum products and nuclear fuel	0.5537	1.5740	Increase
Chemicals and chemical products	0.3340	0.4183	Increase
Rubber and plastics products	0.5979	0.6912	Increase
Other non-metallic mineral products	0.2517	0.2269	Decrease
Basic metals	0.0605	0.0866	Increase
Fabricated metal products	0.5943	0.5959	Increase
Machinery and equipment	1.5998	1.9353	Increase
Computer, electronic and optical equipment	3.3776	2.8850	Decrease
Electrical machinery and apparatus	1.6952	1.5785	Decrease
Motor vehicles, trailers and semi-trailers	1.5699	3.5643	Increase
Other transport equipment	0.8208	0.9124	Increase

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.6 (Continued)

Industry	RCA	NRCA	Status
Manufacturing and recycling	1.4149	2.3651	Increase
Electricity, gas and water supply	1.8049	0.2612	Decrease
Construction	3.4129	1.8705	Decrease
Wholesale & retail trade and repairs	0.2628	0.2533	Decrease
Hotels and restaurants	1.6505	1.8818	Increase
Transport and storage	1.5270	1.0569	Decrease
Post and telecommunications	0.0535	0.1456	Increase
Financial intermediation	0.0338	0.0143	Decrease
Real estate activities	0.1797	0.2017	Increase
Renting of machinery and equipment	0.2458	0.2546	Increase
Computer and related activities	0.0031	0.0053	Increase
R&D and other business activities	0.0210	0.0255	Increase
Education	0.0045	0.0062	Increase
Health and social work	4.9093	6.8951	Increase
Other community, social and personal services	0.8825	1.0256	Increase

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.7

Comparison between RCA and NRCA in 2005

Industry	RCA	NRCA	Status
Agriculture, hunting, forestry and fishing	1.0513	1.5725	Increase
Mining and quarrying	0.0557	0.2612	Increase
Food products, beverages and tobacco	0.7634	0.6694	Decrease
Textiles, textile products, leather and footwear	0.2503	0.3053	Increase
Wood, products of wood and cork	0.7471	1.5246	Increase
Pulp, paper, paper products, printing and publishing	1.4375	1.4977	Increase
Coke, refined petroleum products and nuclear fuel	0.5920	1.8482	Increase
Chemicals and chemical products	1.0973	1.7445	Increase
Rubber and plastics products	2.4329	3.4195	Increase
Other non-metallic mineral products	1.1719	1.2153	Increase
Basic metals	2.1504	2.2299	Increase
Fabricated metal products	2.4031	0.9050	Decrease
Machinery and equipment	1.1706	0.6202	Decrease

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.7 (Continued)

Industry	RCA	NRCA	Status
Computer, electronic and optical equipment	3.0059	1.4750	Decrease
Electrical machinery and apparatus	2.9875	1.9091	Decrease
Motor vehicles, trailers and semi-trailers	1.0820	0.8523	Decrease
Other transport equipment	0.6888	0.5091	Decrease
Manufacturing and recycling	0.9305	0.3830	Decrease
Electricity, gas and water supply	0.2223	0.3199	Increase
Construction	0.3383	0.1855	Decrease
Wholesale & retail trade and repairs	0.2118	1.1569	Increase
Hotels and restaurants	0	0	Unchange
Transport and storage	0.4778	1.5767	Increase
Post and telecommunications	0.1268	0.2483	Increase
Financial intermediation	0.0106	0.0173	Increase
Real estate activities	0.0044	0.0335	Increase
Renting of machinery and equipment	0.1625	0.2743	Increase
Computer and related activities	0.0103	0.0311	Increase
R&D and other business activities	0.3041	0.2302	Decrease
Education	0	0	Unchange
Health and social work	0	0	Unchange
Other community, social and personal services	0.0433	0.0209	Decrease

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.8

Comparison between RCA and NRCA in 2000

Industry	RCA	NRCA	Status
Agriculture, hunting, forestry and fishing	1.1346	0.6765	Decrease
Mining and quarrying	0.3947	0.8359	Increase
Food products, beverages and tobacco	1.1525	0.6305	Decrease
Textiles, textile products, leather and footwear	0.4692	0.4561	Decrease
Wood, products of wood and cork	2.1913	2.2161	Increase
Pulp, paper, paper products, printing and publishing	0.6307	0.9948	Increase
Coke, refined petroleum products and nuclear fuel	1.3018	1.7439	Increase
Chemicals and chemical products	1.6924	2.4079	Increase
Rubber and plastics products	4.0764	3.6571	Decrease

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.8 (Continued)

Industry	RCA	NRCA	Status
Other non-metallic mineral products	0.9607	1.0551	Increase
Basic metals	1.5293	2.2170	Increase
Fabricated metal products	1.0118	0.9984	Decrease
Machinery and equipment	1.0388	0.8903	Decrease
Computer, electronic and optical equipment	0.3507	0.3106	Decrease
Electrical machinery and apparatus	2.4487	2.0284	Decrease
Motor vehicles, trailers and semi-trailers	1.0408	0.5699	Decrease
Other transport equipment	0.5744	0.3118	Decrease
Manufacturing and recycling	0.2991	0.2804	Decrease
Electricity, gas and water supply	1.6267	1.7626	Increase
Construction	0.0817	0.0939	Increase
Wholesale & retail trade and repairs	1.1911	1.0387	Decrease
Hotels and restaurants	0	0	Unchange
Transport and storage	1.9761	1.9883	Increase
Post and telecommunications	0.3193	0.3208	Increase
Financial intermediation	0.0230	0.0313	Increase
Real estate activities	0.0442	0.0337	Decrease
Renting of machinery and equipment	0.3621	0.3459	Decrease
Computer and related activities	0.0311	0.0348	Increase
R&D and other business activities	0.1869	0.2463	Increase
Education	0	0	Unchange
Health and social work	0	0	Unchange
Other community, social and personal services	0.0136	0.0195	Increase

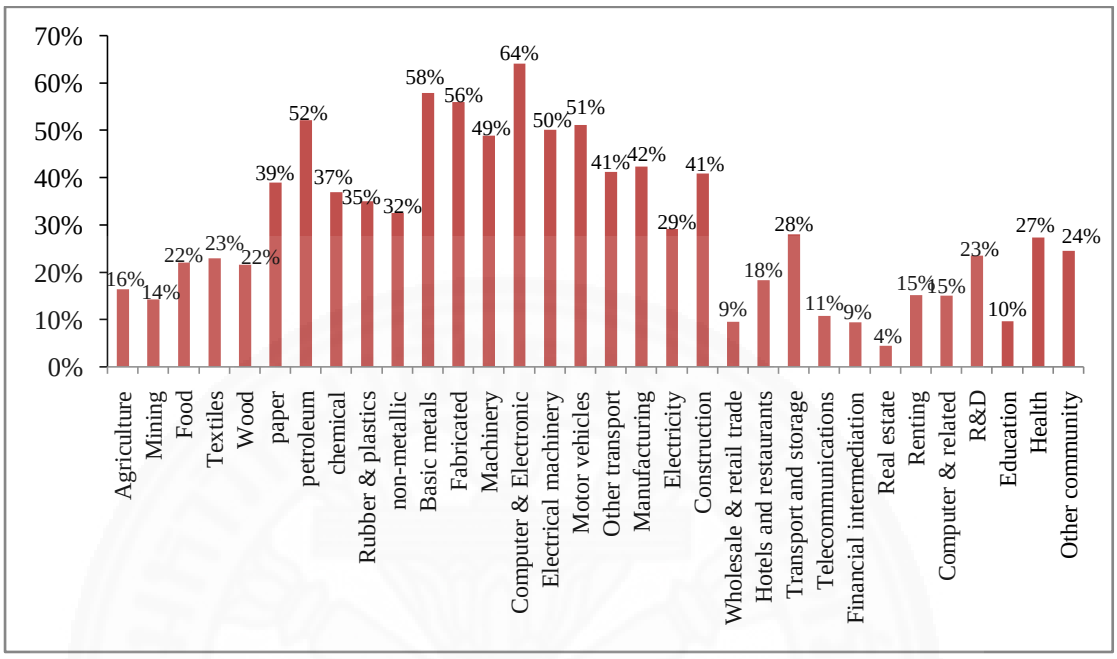
Source: Author’s calculation based on Koopman et al. (2014) and OECD

Appendix B.6: Decomposition of VS index in 2000, 2005, 2009 and 2010

The results of VS index in 2010, 2009, 2005 and 2000 provide the same thing with the result in 2011 in which computer, electronic and optical equipment; machinery and equipment; and motor vehicles, trailers and semi-trailers have the highest degree of linkage to global value chain compared with other top seven exporting industries which have DVAING share higher than 50% (wholesale and retail trade and repairs; food products, beverages and tobacco; transport and storage; chemicals and chemical products).

Figure B.13

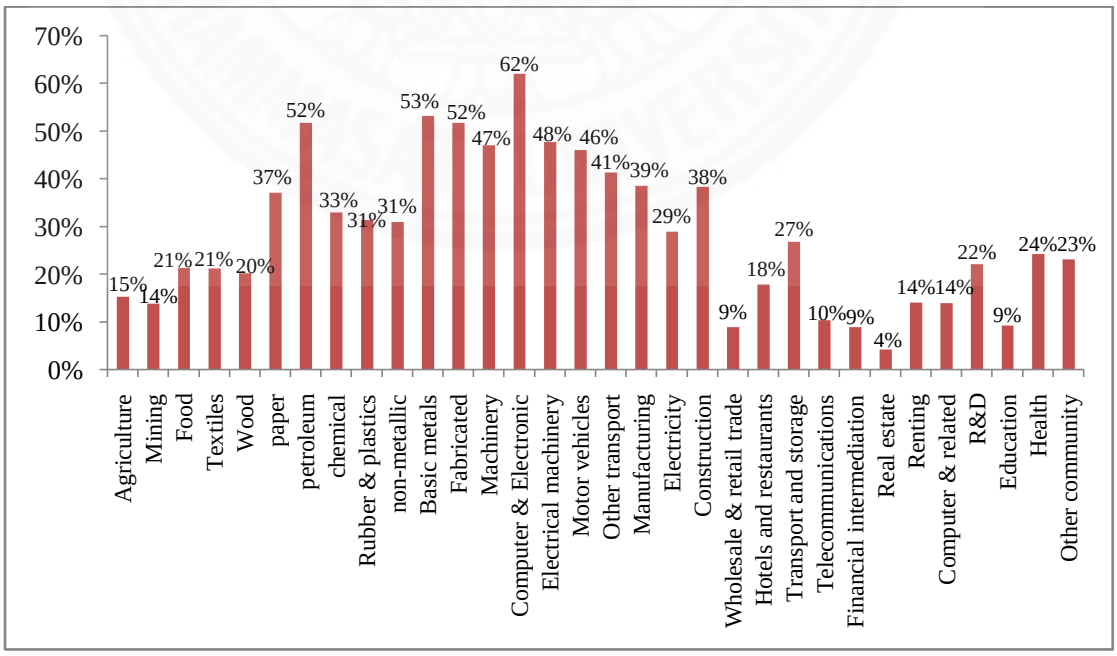
VS index in 2010



Source: Author's calculation based on Koopman et al. (2014)

Figure B.14

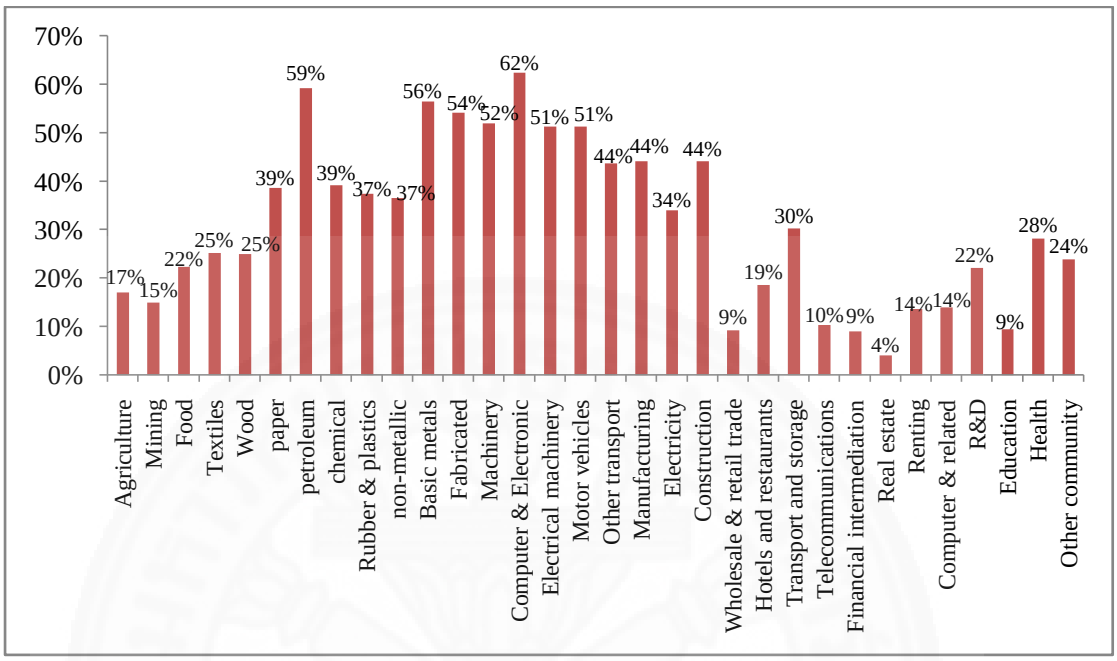
VS index in 2009



Source: Author's calculation based on Koopman et al. (2014)

Figure B.15

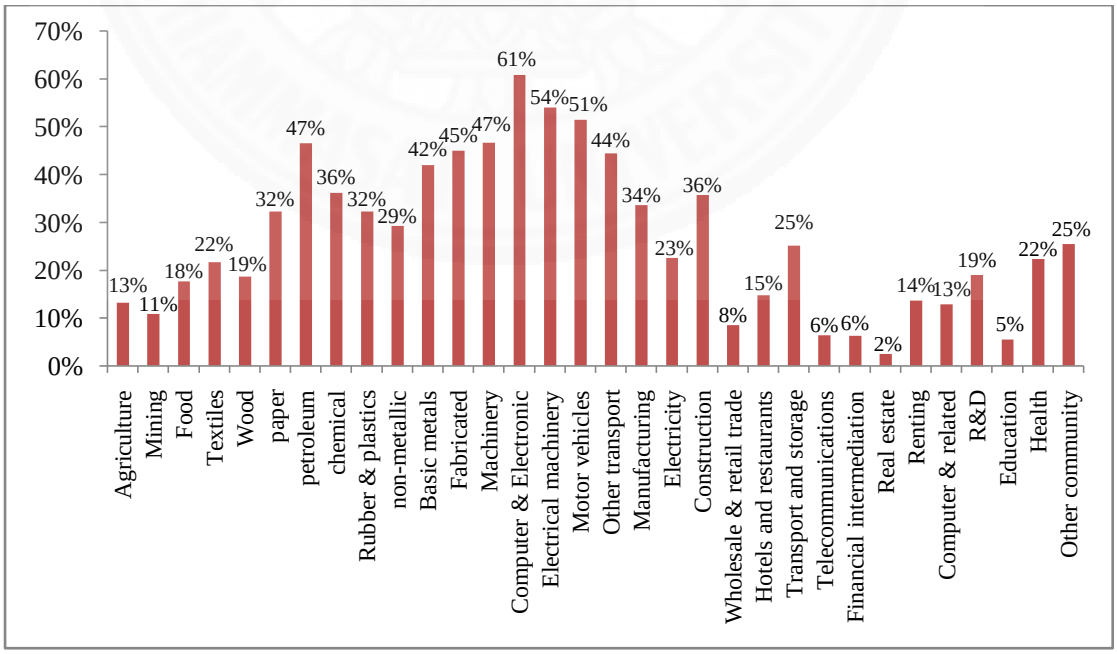
VS index in 2005



Source: Author's calculation based on Koopman et al. (2014)

Figure B.16

VS index in 2000



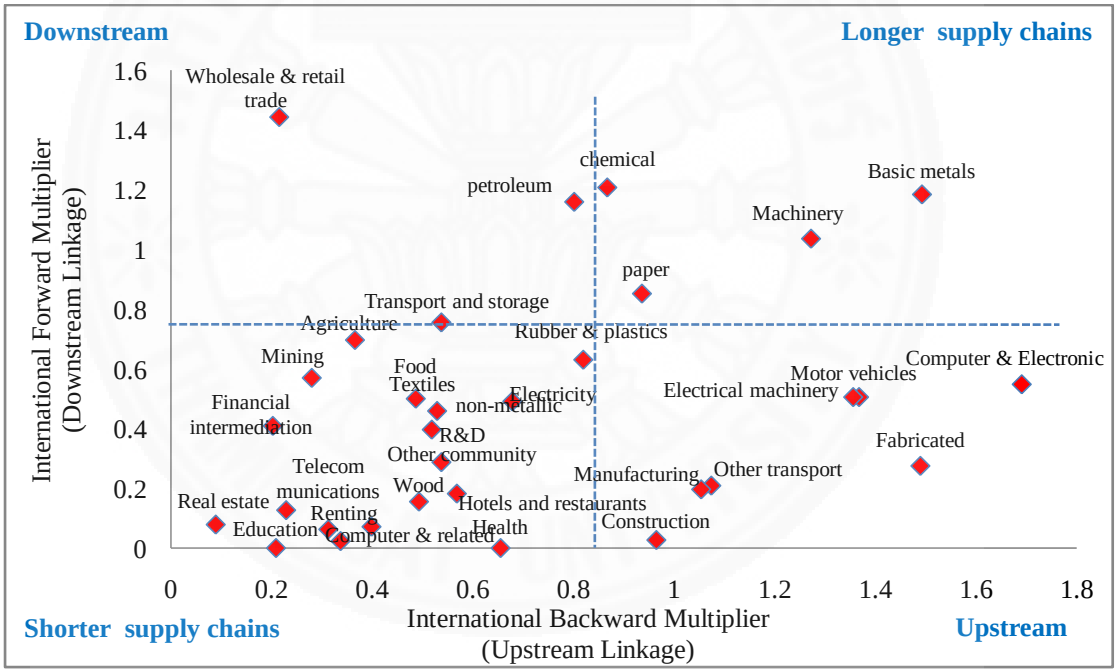
Source: Author's calculation based on Koopman et al. (2014)

Appendix B.7: the degree of International Forward and Backward Multipliers in 2000, 2005, 2009 and 2010

This study explores that actually the positions of the top seven exporting industries in global value chain have not been significantly changed. Computer, electronic and optical equipment; motor vehicles, trailers and semi-trailers are still located at nearly the end of supply chain; whereas, wholesale and retail trade and repairs; transport and storage are still located at the beginning of supply chain during 2000 and 2010.

Figure B.17

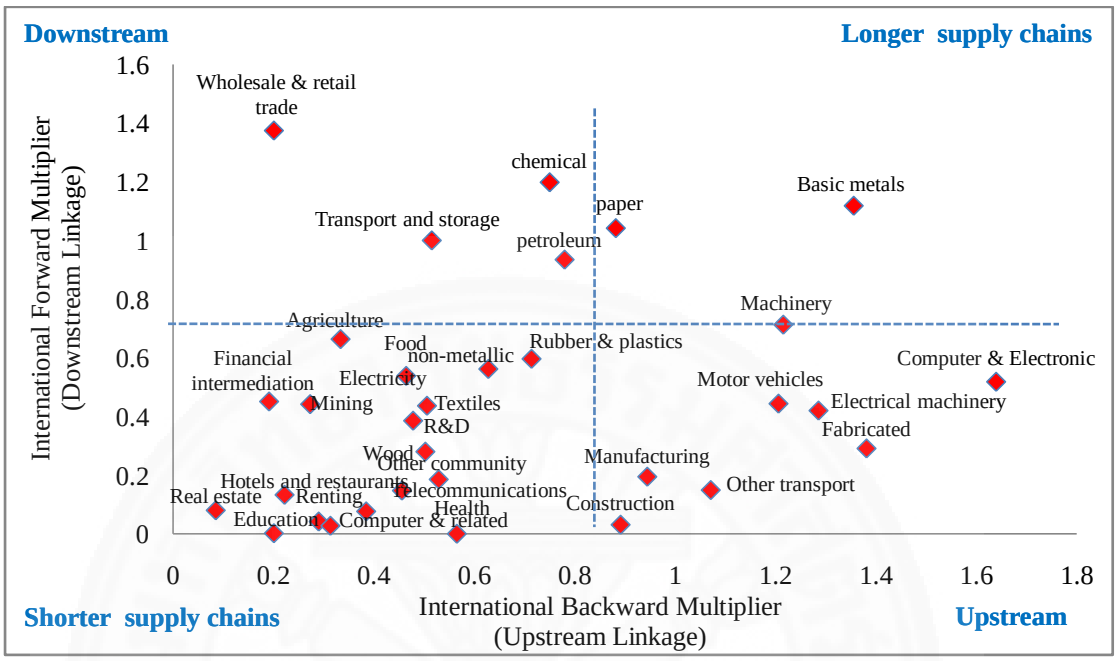
The Degree of International Forward and Backward Multipliers in 2010



Source: Author's calculation based OECD

Figure B.18

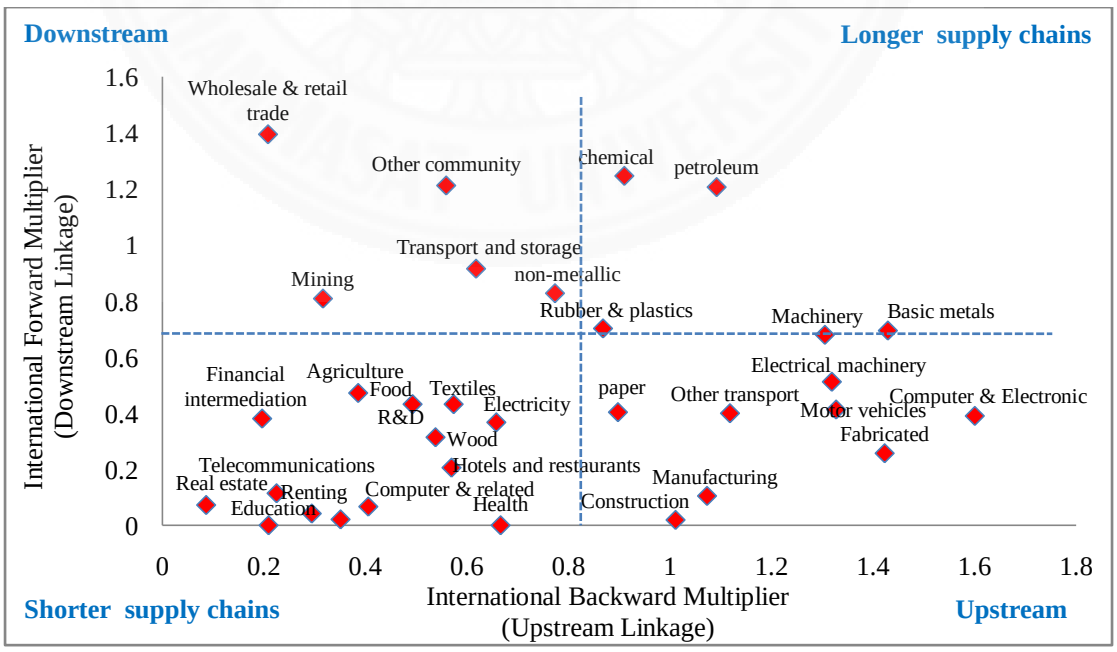
The Degree of International Forward and Backward Multipliers in 2009



Source: Author's calculation based OECD

Figure B.19

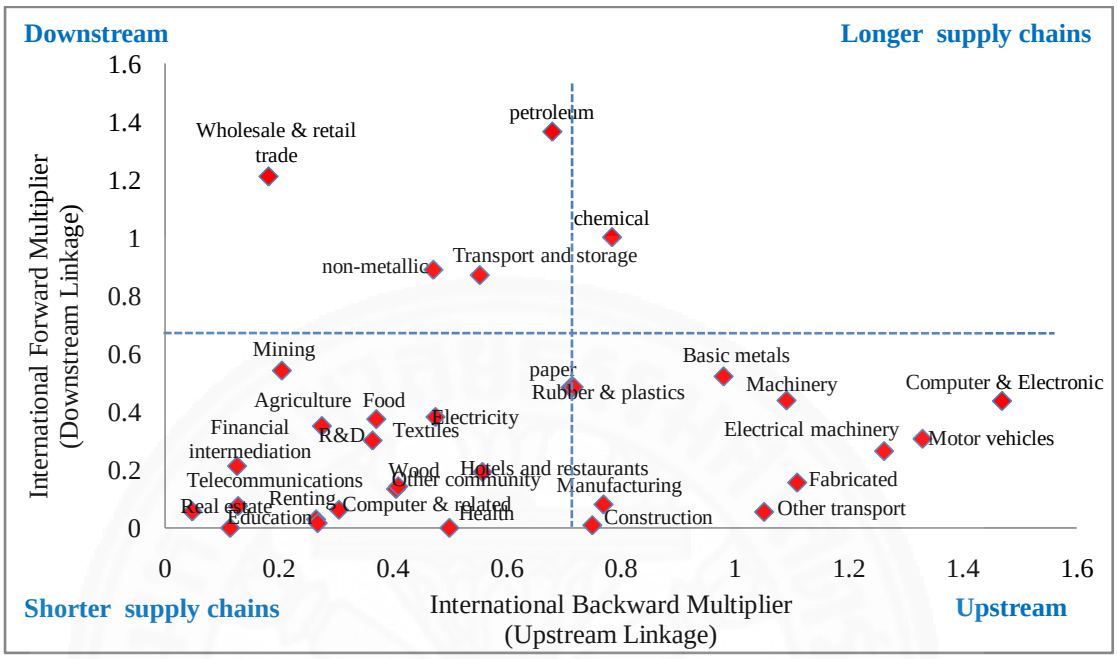
The Degree of International Forward and Backward Multipliers in 2005



Source: Author's calculation based OECD

Figure B.20

The Degree of International Forward and Backward Multipliers in 2000



Source: Author's calculation based OECD

Appendix B.8: VS index, International Forward and Backward Multipliers in 2000, 2005, 2009 and 2010

Table B.9

VS index, International Forward and Backward Multipliers in 2010

Industry	VS index	IFM	IBM
Computer, electronic and optical equipment	64%	0.5491	1.6909
Basic metals	58%	1.1835	1.4924
Fabricated metal products	56%	0.276	1.4892
Coke, refined petroleum products and nuclear fuel	52%	1.1597	0.8011
Motor vehicles, trailers and semi-trailers	51%	0.5055	1.3555
Electrical machinery and apparatus	50%	0.5064	1.3671
Machinery and equipment	49%	1.0363	1.2722
Manufacturing and recycling	42%	0.1977	1.0537

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.9 (Continued)

Industry	VS index	IFM	IBM
Other transport equipment	41%	0.2093	1.0741
Construction	41%	0.0274	0.9644
Pulp, paper, paper products, printing and publishing	39%	0.8521	0.9361
Chemicals and chemical products	37%	1.2067	0.8674
Rubber and plastics products	35%	0.6305	0.8197
Other non-metallic mineral products	32%	0.4919	0.6787
Electricity, gas and water supply	29%	0.3971	0.5183
Transport and storage	28%	0.7565	0.5373
Health and social work	27%	0.0001	0.6549
Other community, social and personal services	24%	0.1828	0.568
R&D and other business activities	23%	0.2875	0.5371
Textiles, textile products, leather and food wear	23%	0.459	0.5295
Food products, beverage and tobacco	22%	0.5012	0.4865
Wood, products of wood and cork	22%	0.1566	0.4931
Hotels and restaurants	18%	0.0714	0.3985
Agriculture, hunting, forestry and fishing	16%	0.697	0.3656
Renting of machinery and equipment	15%	0.0625	0.3133
Computer and related activity	15%	0.0241	0.3372
Mining and quarrying	14%	0.5706	0.2802
Post and telecommunications	11%	0.1283	0.2289
Education	10%	0.0011	0.2085
Wholesale & retail trade and repairs	9%	1.4433	0.2153
Financial intermediation	9%	0.4094	0.2027
Real estate activities	4%	0.079	0.089

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.10

VS index, International Forward and Backward Multipliers in 2009

Industry	VS index	IFM	IBM
Computer, electronic and optical equipment	62%	0.5179	1.6394
Basic metals	53%	1.1181	1.356

Source: Author's calculation based on Koopman et al. (2014) and OECD

Table B.10 (Continued)

Industry	VS index	IFM	IBM
Fabricated metal products	52%	0.291	1.3807
Coke, refined petroleum products and nuclear fuel	52%	0.935	0.7795
Electrical machinery and apparatus	48%	0.4212	1.2851
Machinery and equipment	47%	0.7134	1.2152
Motor vehicles, trailers and semi-trailers	46%	0.4435	1.2056
Other transport equipment	41%	0.1499	1.0707
Manufacturing and recycling	39%	0.1942	0.9445
Construction	38%	0.0325	0.8914
Pulp, paper, paper products, printing and publishing	37%	1.0423	0.8814
Chemicals and chemical products	33%	1.1987	0.7498
Rubber and plastics products	31%	0.5957	0.714
Other non-metallic mineral products	31%	0.5616	0.6277
Electricity, gas and water supply	29%	0.4364	0.5057
Transport and storage	27%	1.0001	0.5151
Health and social work	24%	0.0005	0.5653
Other community, social and personal services	23%	0.186	0.5287
R&D and other business activities	22%	0.2807	0.5024
Food products, beverage and tobacco	21%	0.5384	0.4636
Textiles, textile products, leather and food wear	21%	0.3863	0.4781
Wood, products of wood and cork	20%	0.1478	0.456
Hotels and restaurants	18%	0.0775	0.384
Agriculture, hunting, forestry and fishing	15%	0.664	0.3334
Renting of machinery and equipment	14%	0.0428	0.2902
Computer and related activity	14%	0.0276	0.3133
Mining and quarrying	14%	0.4418	0.2727
Post and telecommunications	10%	0.1327	0.2218
Education	9%	0.0017	0.2005
Wholesale & retail trade and repairs	9%	1.3743	0.2011
Financial intermediation	9%	0.4508	0.1914
Real estate activities	4%	0.081	0.0853

Source: Author’s calculation based on Koopman et al. (2014) and OECD

Table B.11

VS index, International Forward and Backward Multipliers in 2005

Industry	VS index	IFM	IBM
Computer, electronic and optical equipment	62%	0.3913	1.6005
Coke, refined petroleum products and nuclear fuel	59%	1.2076	1.0916
Basic metals	56%	0.6952	1.4294
Fabricated metal products	54%	0.2569	1.4223
Machinery and equipment	52%	0.6795	1.3053
Motor vehicles, trailers and semi-trailers	51%	0.4128	1.3266
Electrical machinery and apparatus	51%	0.5128	1.3185
Manufacturing and recycling	44%	0.1054	1.0731
Construction	44%	0.0198	1.0107
Other transport equipment	44%	0.4002	1.1178
Chemicals and chemical products	39%	1.2462	0.91
Pulp, paper, paper products, printing and publishing	39%	0.4049	0.8972
Rubber and plastics products	37%	0.7032	0.8681
Other non-metallic mineral products	37%	0.8289	0.7729
Electricity, gas and water supply	34%	0.3679	0.6579
Transport and storage	30%	0.9149	0.6177
Health and social work	28%	0.0002	0.6662
Textiles, textile products, leather and food wear	25%	0.4323	0.5737
Wood, products of wood and cork	25%	0.2063	0.569
Other community, social and personal services	24%	1.2117	0.5592
Food products, beverage and tobacco	22%	0.4319	0.4923
R&D and other business activities	22%	0.3141	0.5379
Hotels and restaurants	19%	0.0673	0.4056
Agriculture, hunting, forestry and fishing	17%	0.4731	0.3853
Mining and quarrying	15%	0.8096	0.3163
Computer and related activity	14%	0.0214	0.3507
Renting of machinery and equipment	14%	0.0436	0.2937
Post and telecommunications	10%	0.1141	0.2246
Education	9%	0.0012	0.2087
Wholesale & retail trade and repairs	9%	1.3955	0.2079
Financial intermediation	9%	0.3821	0.1962
Real estate activities	4%	0.0731	0.0855

Source: Author’s calculation based on Koopman et al. (2014) and OECD

Table B.12

VS index, International Forward and Backward Multipliers in 2000

Industry	VS index	IFM	IBM
Computer, electronic and optical equipment	61%	0.437	1.4687
Electrical machinery and apparatus	54%	0.3069	1.3287
Motor vehicles, trailers and semi-trailers	51%	0.2653	1.2614
Machinery and equipment	47%	0.4385	1.0902
Coke, refined petroleum products and nuclear fuel	47%	1.3637	0.679
Fabricated metal products	45%	0.1554	1.1093
Other transport equipment	44%	0.0546	1.0514
Basic metals	42%	0.5223	0.98
Chemicals and chemical products	36%	1.0013	0.7843
Construction	36%	0.009	0.7495
Manufacturing and recycling	34%	0.0808	0.7695
Rubber and plastics products	32%	0.4844	0.7171
Pulp, paper, paper products, printing and publishing	32%	0.4822	0.7112
Other non-metallic mineral products	29%	0.8696	0.5525
Other community, social and personal services	25%	0.1929	0.5566
Transport and storage	25%	0.8891	0.4707
Electricity, gas and water supply	23%	0.3018	0.3642
Health and social work	22%	0.0001	0.4988
Textiles, textile products, leather and food wear	22%	0.3824	0.4748
R&D and other business activities	19%	0.1425	0.4085
Wood, products of wood and cork	19%	0.1347	0.4048
Food products, beverage and tobacco	18%	0.3749	0.3708
Hotels and restaurants	15%	0.0633	0.305
Renting of machinery and equipment	14%	0.0301	0.265
Agriculture, hunting, forestry and fishing	13%	0.3512	0.2747
Computer and related activity	13%	0.0169	0.2678
Mining and quarrying	11%	0.5422	0.2049
Wholesale & retail trade and repairs	8%	1.2096	0.1816
Post and telecommunications	6%	0.0757	0.128
Financial intermediation	6%	0.2127	0.1264
Education	5%	0.0007	0.1143
Real estate activities	2%	0.0561	0.0473

Source: Author's calculation based on Koopman et al. (2014) and OECD

Appendix B.9: Instrument Variables (IVs) estimation

This study employs 2 main criterions in choosing the appropriate IVs. First is weak instruments test, once the result from Huasman test suggests that using 2SLS method can provide a better measurement compared with simple OLS; then this first criterion in choosing instrument variables to explain the endogenous variable (s) is valid. Second is overidentification test that proposes to examine the relationship between IVs and error term of structural equation. If this relationship is not occurred, then selected IVs can be adopted because they will provide a consistency of parameter estimation.

In this study, gross export and its combinations—DVAING, FVAING and PDCING—are suspected to be an endogenous variable; thus they should be solved by using Instrument Variables (IVs) technique following 2 main criterions mentioned before. Based on Sprout and Weaver (1993) & Wizarat and Lau (2013); NRCA of any industries are initially selected as instrument variables. In addition, the variables which represent position of industries—IFM and IBM—are also chosen as additional instrument variables in this study.

1. Bivariate Model

1.1 Weak Instruments Test

Structural equations

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \varepsilon_{1it} \quad (1)$$

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \varepsilon_{2it} \quad (2)$$

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \varepsilon_{3it} \quad (3)$$

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \varepsilon_{4it} \quad (4)$$

1st stage regression

$$LnEXP_{it} = \beta_0 + \beta_1 NRCA_{it} + \beta_2 IFM_{it} + \beta_3 IBM_{it} + e_{1it} \quad (1.1)$$
$$LnDVAING_{it} = \beta_0 + \beta_1 NRCA_{it} + \beta_2 IFM_{it} + \beta_3 IBM_{it} + e_{2it} \quad (2.1)$$
$$LnFVAING_{it} = \beta_0 + \beta_1 NRCA_{it} + \beta_2 IFM_{it} + \beta_3 IBM_{it} + e_{3it} \quad (3.1)$$
$$LnPDCING_{it} = \beta_0 + \beta_1 NRCA_{it} + \beta_2 IFM_{it} + \beta_3 IBM_{it} + e_{4it} \quad (4.1)$$

The results from estimating 1st stage equation above (see Table B.13) suggests to reject the null hypothesis that instruments are weak (H_0:β_1=β_2=β_3=0). Hence the selected instruments ($NRCA_{it}$, IFM_{it} and IBM_{it}) are strong enough to explain the endogenous variable (EXP_{it}, $DVAING_{it}$, $FVAING_{it}$ and $PDCING_{it}$).

1.2 Over Identification Test

The results from Table B.13 accept the null hypothesis that there has no relationship between IVs and error term of structural equations (H_0:$E(Z_{it},U_{it})$=0). Therefore, those 3 variables mentioned before are selected as appropriate instrument variables.

Table B.13

1st Stage Regression in Bivariate Model

	EQ (1.1)	EQ (2.1)	EQ (3.1)	EQ (4.1)
NRCA	0.1272	0.1319	0.1447	0.1910
	(0.0611)**	(0.0620)**	(0.0662)**	(0.0872)**
IFM	1.3290	1.3421	1.3129	1.7597
	(0.6451)**	(0.6502)**	(0.6325)**	(0.6095)***
IBM	2.3888	1.8009	3.4653	3.5564
	(0.3302)***	(0.3343)***	(0.3838)***	(0.3679)***
CONST	5.1876	5.1958	2.8380	0.8959
	(0.4495)***	(0.4493)***	(0.5033)***	(0.4616)*

Table B.13 (Continued)

	EQ (1.1)	EQ (2.1)	EQ (3.1)	EQ (4.1)
H_0:$\beta_1=\beta_2=\beta_3=0$	Reject	Reject	Reject	Reject
H_0:$E(Z_{it},U_{it})=0$	Accept	Accept	Accept	Accept
R-squared	0.4238	0.3451	0.5719	0.6587
Wald chi2(3)	86.42	52.84	108.89	154.60
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Source: Author's calculation

Note: ***, ** and * are significant at 1%, 5% and 10% respectively; number in parenthesis is Robust Standard Error; Z_{it} stands for instrument variables and U_{it} stands for error terms in structure equation.

2. Trivariate Model

2.1 Weak Instruments Test

Structural equations

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{1it} \quad (5)$$
$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{2it} \quad (6)$$
$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{3it} \quad (7)$$
$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{4it} \quad (8)$$

1st stage regression

$$LnEXP_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 NRCA_{it} + \beta_3 IFM_{it} + \beta_4 IBM_{it} + e_{1it} \quad (5.1)$$
$$LnDVAING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 NRCA_{it} + \beta_3 IFM_{it} + \beta_4 IBM_{it} + e_{2it} \quad (6.1)$$
$$LnFVAING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 NRCA_{it} + \beta_3 IFM_{it} + \beta_4 IBM_{it} + e_{3it} \quad (7.1)$$
$$LnPDCING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 NRCA_{it} + \beta_3 IFM_{it} + \beta_4 IBM_{it} + e_{4it} \quad (8.1)$$

The results from estimating 1st stage equation above (see Table B.14) suggests to reject the null hypothesis that instruments are weak (H_0:β_2=β_3=β_4=0). Hence the selected instruments ($NRCA_{it}$, IFM_{it} and IBM_{it}) are strong enough to explain the endogenous variable (EXP_{it}, $DVAING_{it}$, $FVAING_{it}$ and $PDCING_{it}$).

2.2 Over Identification Test

The results from Table B.14 accept the null hypothesis that there has no relationship between IVs and error term of structural equations (H_0:$E(Z_{it},U_{it})$=0). Therefore, those 3 variables mentioned before are selected as appropriate instrument variables.

Table B.14

1st Stage Regression in Trivariate Model

	Model1	Model2	Model3	Model4
LOG_INVEST	0.1293	0.1324	0.1488	0.0943
	(0.0657)**	(0.0662)**	(0.0762)*	(0.0784)
NRCA	0.1269	0.1316	0.1449	0.1831
	(0.0590)**	(0.0599)**	(0.0634)**	(0.0878)**
IFM	1.2648	1.2762	1.2383	1.7064
	(0.6296)**	(0.6345)**	(0.6138)**	(0.6156)***
IBM	2.0197	1.4227	3.0376	3.3346
	(0.3192)***	(0.3233)***	(0.3620)***	(0.4409)***
CONST	4.8379	4.8379	2.4376	0.5823
	(0.5089)***	(0.5097)***	(0.5700)***	(0.3758)
H_0:$\beta_2=\beta_3=\beta_4=0$	Reject	Reject	Reject	Reject
H_0:$E(Z_{it},U_{it})=0$	Accept	Accept	Accept	Accept
R-squared	0.4580	0.3838	0.6018	0.6494
Wald chi2(4)	102.05	63.03	134.56	213.50
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Source: Author's calculation

Note: ***, ** and * are significant at 1%, 5% and 10% respectively; number in parenthesis is Robust Standard Error; Z_{it} stands for instrument variables and U_{it} stands for error terms in structure equation.

3. Multivariate Model

3.1 Weak Instruments Test

Structural equations

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{1it} \quad (9)$$
$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{2it} \quad (10)$$
$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{3it} \quad (11)$$
$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{4it} \quad (12)$$

1st stage regression

$$LnEXP_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 VSindex_{it} + \beta_3 NRCA_{it} + \beta_4 IFM_{it} + \beta_5 IBM_{it} + e_{1it} \quad (9.1)$$
$$LnDVAING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 VSindex_{it} + \beta_3 NRCA_{it} + \beta_4 IFM_{it} + \beta_5 IBM_{it} + e_{2it} \quad (10.1)$$
$$LnFVAING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 VSindex_{it} + \beta_3 NRCA_{it} + \beta_4 IFM_{it} + \beta_5 IBM_{it} + e_{3it} \quad (11.1)$$
$$LnPDCING_{it} = \beta_0 + \beta_1 INVEST_{it} + \beta_2 VSindex_{it} + \beta_3 NRCA_{it} + \beta_4 IFM_{it} + \beta_5 IBM_{it} + e_{4it} \quad (12.1)$$

The results from estimating 1st stage equation above (see Table B.15) suggests to reject the null hypothesis that instruments are weak (H_0:β_3=β_4=β_5=0). Hence the selected instruments ($NRCA_{it}$, IFM_{it} and IBM_{it}) are strong enough to explain the endogenous variable (EXP_{it}, $DVAING_{it}$, $FVAING_{it}$ and $PDCING_{it}$).

3.2 Over Identification Test

The results from Table B.15 accept hypothesis that there has no relationship between IVs and error term of structural equations (H_0:$E(Z_{it},U_{it})$=0). Therefore, those 3 variables mentioned before are selected as appropriate instrument variables.

Table B.15

1st Stage Regression in Multivariate Model

	Model1	Model2	Model3	Model4
LOG_INVEST	0.1324	0.1366	0.1480	0.0942
	(0.0645)**	(0.0651)**	(0.0747)**	(0.0789)
VS_INDEX	-3.6393	-4.8972	0.7667	2.8784
	(5.3820)	(5.3027)	(4.9902)	(4.8883)
NRCA	0.1246	0.1287	0.1445	0.1845
	(0.0580)**	(0.0587)**	(0.0633)**	(0.0880)**
IFM	1.2406	1.2468	1.2360	1.7112
	(0.6178)**	(0.6191)**	(0.6152)**	(0.6187)***
IBM	3.2675	3.0976	2.7825	2.3420
	(1.9343)*	(1.9107)	(1.7820)	(1.7473)
CONST	5.0611	5.1392	2.3901	0.3985
	(0.6492)***	(0.6523)***	(0.6942)***	(0.4927)
H_0:$\beta_3=\beta_4=\beta_5=\beta_6=0$	Reject	Reject	Reject	Reject
H_0:$E(Z_{it},U_{it})=0$	Accept	Accept	Accept	Accept
R-squared	0.4582	0.3905	0.6024	0.6516
Wald chi2(5)	95.24	57.71	137.94	232.14
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

Source: Author's calculation

Note: ***, ** and * are significant at 1%, 5% and 10% respectively; number in parenthesis is Robust Standard Error; Z_{it} stands for instrument variables and U_{it} stands for error terms in structure equation.

APPENDIX C

Appendix C.1: Rank of Gross Export and Domestic Value Added in Gross Export

Table C.1

Comparison between the Top Rank of EXP and DVAING in 2011

Industry	EXP	Industry	DVAING
Wholesale & retail trade and repairs	27,392	Wholesale & retail trade and repairs	24,438
Computer, electronic and optical equipment	26,411	Food products, beverage and tobacco	17,413
Food products, beverage and tobacco	22,830	Transport and storage	14,573
Transport and storage	21,126	Chemicals and chemical products	10,822
Chemicals and chemical products	18,301	Agriculture, hunting, forestry and fishing	10,092
Motor vehicles, trailers and semi-trailers	16,054	Computer, electronic and optical equipment	8,461
Machinery and equipment	15,943	Hotels and restaurants	7,137
Agriculture, hunting, forestry and fishing	12,340	Machinery and equipment	7,051
Rubber and plastics products	9,965	Motor vehicles, trailers and semi-	7,007
Coke, refined petroleum products and nuclear fuel	9,643	Rubber and plastics products	6,198
Basic metals	9,344	Textiles, textile products, leather and food wear	4,631
Hotels and restaurants	8,933	Coke, refined petroleum products and nuclear fuel	4,147
Electrical machinery and apparatus	8,053	Electrical machinery and apparatus	3,808
Manufacturing and recycling	6,407	Pulp, paper, paper products, printing and publishing	3,465
Textiles, textile products, leather and food wear	6,231	Basic metals	3,403
Pulp, paper, paper products, printing and publishing	6,060	Manufacturing and recycling	3,172
Fabricated metal products	4,166	Other community, social and personal services	2,034
Other transport equipment	3,890	R&D and other business activities	2,031
Other community, social and personal services	2,818	Other transport equipment	2,013
R&D and other business activities	2,718	Fabricated metal products	1,622
Other non-metallic mineral products	1,940	Mining and quarrying	1,281
Wood, products of wood and cork	1,625	Wood, products of wood and cork	1,241
Mining and quarrying	1,538	Other non-metallic mineral products	1,206
Renting of machinery and equipment	1,386	Renting of machinery and equipment	1,154
Post and telecommunications	1,146	Post and telecommunications	1,007
Health and social work	1,013	Financial intermediation	852
Construction	989	Real estate activities	724
Financial intermediation	950	Health and social work	709
Real estate activities	762	Construction	535
Electricity, gas and water supply	410	Electricity, gas and water supply	268
Computer and related activity	109	Computer and related activity	90
Education	4	Education	4

Source: Koopman et al. (2014)

Table C.2

Comparison between the Top Rank of EXP and DVAING in 2010

Industry	EXP	Industry	DVAING
Computer, electronic and optical equipment	25,682	Wholesale & retail trade and repairs	21,210
Wholesale & retail trade and repairs	23,454	Food products, beverage and tobacco	14,544
Food products, beverage and tobacco	18,664	Transport and storage	13,119
Transport and storage	18,248	Computer, electronic and optical equipment	9,146
Motor vehicles, trailers and semi-trailers	16,952	Chemicals and chemical products	8,742
Chemicals and chemical products	13,889	Motor vehicles, trailers and semi-trailers	8,261
Machinery and equipment	13,101	Agriculture, hunting, forestry and fishing	6,758
Basic metals	9,515	Machinery and equipment	6,677
Rubber and plastics products	8,204	Hotels and restaurants	5,378
Agriculture, hunting, forestry and fishing	8,092	Rubber and plastics products	5,321
Coke, refined petroleum products and nuclear fuel	7,666	Textiles, textile products, leather and food wear	4,480
Electrical machinery and apparatus	7,441	Basic metals	3,970
Hotels and restaurants	6,587	Electrical machinery and apparatus	3,690
Textiles, textile products, leather and food wear	5,817	Coke, refined petroleum products and nuclear fuel	3,656
Manufacturing and recycling	5,593	Manufacturing and recycling	3,222
Fabricated metal products	3,900	Pulp, paper, paper products, printing and publishing	1,993
Pulp, paper, paper products, printing and publishing	3,283	R&D and other business activities	1,820
Other transport equipment	2,896	Fabricated metal products	1,708
R&D and other business activities	2,382	Other transport equipment	1,700
Other community, social and personal services	2,117	Other community, social and personal services	1,598
Other non-metallic mineral products	2,091	Other non-metallic mineral products	1,409
Wood, products of wood and cork	1,374	Wood, products of wood and cork	1,075
Renting of machinery and equipment	1,151	Mining and quarrying	979
Mining and quarrying	1,143	Renting of machinery and equipment	976
Construction	966	Post and telecommunications	834
Post and telecommunications	934	Health and social work	657
Health and social work	904	Construction	571
Real estate activities	587	Real estate activities	562
Financial intermediation	521	Financial intermediation	472
Electricity, gas and water supply	417	Electricity, gas and water supply	295
Computer and related activity	30	Computer and related activity	26
Education	4	Education	3

Source: Koopman et al. (2014)

Table C.3

Comparison between the Top Rank of EXP and DVAING in 2009

Industry	EXP	Industry	DVAING
Computer, electronic and optical equipment	20,508	Wholesale & retail trade and repairs	17,214
Wholesale & retail trade and repairs	18,919	Food products, beverage and tobacco	12,796
Transport and storage	16,745	Transport and storage	12,236
Food products, beverage and tobacco	16,276	Computer, electronic and optical equipment	7,740
Motor vehicles, trailers and semi-trailers	10,634	Chemicals and chemical products	6,692
Chemicals and chemical products	10,001	Motor vehicles, trailers and semi-trailers	5,725
Machinery and equipment	9,409	Machinery and equipment	4,973
Basic metals	7,725	Agriculture, hunting, forestry and fishing	4,343
Coke, refined petroleum products and nuclear fuel	6,226	Hotels and restaurants	4,159
Rubber and plastics products	6,007	Rubber and plastics products	4,109
Electrical machinery and apparatus	5,484	Textiles, textile products, leather and food wear	3,960
Agriculture, hunting, forestry and fishing	5,131	Basic metals	3,591
Hotels and restaurants	5,068	Coke, refined petroleum products and nuclear fuel	2,996
Textiles, textile products, leather and food wear	5,027	Manufacturing and recycling	2,858
Manufacturing and recycling	4,659	Electrical machinery and apparatus	2,850
Fabricated metal products	4,317	Fabricated metal products	2,070
Other transport equipment	2,750	Pulp, paper, paper products, printing and publishing	1,671
Pulp, paper, paper products, printing and publishing	2,671	R&D and other business activities	1,613
R&D and other business activities	2,074	Other transport equipment	1,610
Other non-metallic mineral products	1,662	Other community, social and personal	1,248
Other community, social and personal	1,623	Other non-metallic mineral products	1,145
Mining and quarrying	1,156	Mining and quarrying	995
Wood, products of wood and cork	1,016	Wood, products of wood and cork	808
Construction	991	Post and telecommunications	785
Renting of machinery and equipment	908	Renting of machinery and equipment	780
Post and telecommunications	877	Health and social work	630
Health and social work	833	Construction	611
Real estate activities	520	Real estate activities	498
Electricity, gas and water supply	409	Financial intermediation	340
Financial intermediation	373	Electricity, gas and water supply	291
Computer and related activity	41	Computer and related activity	36
Education	3	Education	3

Source: Koopman et al. (2014)

Table C.4
Comparison between the Top Rank of EXP and DVAING in 2005

Industry	EXP	Industry	DVAING
Computer, electronic and optical equipment	13,567	Wholesale & retail trade and repairs	12,053
Wholesale & retail trade and repairs	13,293	Transport and storage	8,608
Transport and storage	12,360	Food products, beverage and tobacco	7,919
Food products, beverage and tobacco	10,202	Computer, electronic and optical equipment	5,080
Motor vehicles, trailers and semi-trailers	7,945	Chemicals and chemical products	4,386
Chemicals and chemical products	7,234	Textiles, textile products, leather and food wear	4,335
Machinery and equipment	6,986	Rubber and plastics products	4,036
Rubber and plastics products	6,472	Motor vehicles, trailers and semi-trailers	3,864
Textiles, textile products, leather and food wear	5,797	Machinery and equipment	3,350
Electrical machinery and apparatus	4,942	Electrical machinery and apparatus	2,398
Manufacturing and recycling	3,267	Hotels and restaurants	2,337
Basic metals	2,960	Manufacturing and recycling	1,825
Coke, refined petroleum products and nuclear fuel	2,882	Basic metals	1,283
Hotels and restaurants	2,871	Wood, products of wood and cork	1,203
Fabricated metal products	2,315	Coke, refined petroleum products and nuclear fuel	1,173
Wood, products of wood and cork	1,606	Mining and quarrying	1,127
Other non-metallic mineral products	1,432	R&D and other business activities	1,069
R&D and other business activities	1,375	Fabricated metal products	1,059
Mining and quarrying	1,329	Agriculture, hunting, forestry and fishing	1,050
Other transport equipment	1,285	Other non-metallic mineral products	907
Agriculture, hunting, forestry and fishing	1,268	Other community, social and personal	766
Pulp, paper, paper products, printing and publishing	1,044	Other transport equipment	723
Other community, social and personal	1,006	Pulp, paper, paper products, printing and publishing	638
Health and social work	607	Post and telecommunications	470
Post and telecommunications	525	Health and social work	436
Construction	519	Renting of machinery and equipment	409
Renting of machinery and equipment	473	Real estate activities	317
Electricity, gas and water supply	399	Construction	290
Real estate activities	331	Electricity, gas and water supply	263
Financial intermediation	164	Financial intermediation	149
Computer and related activity	56	Computer and related activity	48
Education	2	Education	2

Source: Koopman et al. (2014)

Table C.5

Comparison between the Top Rank of EXP and DVAING in 2000

Industry	EXP	Industry	DVAING
Computer, electronic and optical equipment	10,724	Wholesale & retail trade and repairs	8,250
Wholesale & retail trade and repairs	9,019	Food products, beverage and tobacco	6,466
Transport and storage	8,159	Transport and storage	6,105
Food products, beverage and tobacco	7,856	Computer, electronic and optical equipment	4,182
Textiles, textile products, leather and food wear	5,089	Textiles, textile products, leather and food wear	3,983
Chemicals and chemical products	3,261	Hotels and restaurants	2,258
Machinery and equipment	3,259	Chemicals and chemical products	2,078
Electrical machinery and apparatus	3,236	Rubber and plastics products	1,989
Rubber and plastics products	2,941	Machinery and equipment	1,736
Hotels and restaurants	2,647	Electrical machinery and apparatus	1,480
Motor vehicles, trailers and semi-trailers	2,463	Manufacturing and recycling	1,467
Manufacturing and recycling	2,211	Motor vehicles, trailers and semi-trailers	1,193
Coke, refined petroleum products and nuclear fuel	1,515	Wood, products of wood and cork	888
Basic metals	1,438	Basic metals	831
Fabricated metal products	1,247	Coke, refined petroleum products and nuclear fuel	808
Wood, products of wood and cork	1,093	Other community, social and personal	691
Other non-metallic mineral products	965	Fabricated metal products	684
Other community, social and personal	927	Other non-metallic mineral products	682
Pulp, paper, paper products, printing and publishing	721	Agriculture, hunting, forestry and fishing	577
Agriculture, hunting, forestry and fishing	666	Health and social work	493
Health and social work	635	Pulp, paper, paper products, printing and publishing	488
Mining and quarrying	414	Mining and quarrying	369
Construction	409	Real estate activities	279
R&D and other business activities	325	R&D and other business activities	263
Renting of machinery and equipment	300	Construction	263
Real estate activities	286	Renting of machinery and equipment	259
Electricity, gas and water supply	275	Post and telecommunications	221
Post and telecommunications	236	Electricity, gas and water supply	213
Financial intermediation	145	Financial intermediation	136
Computer and related activity	107	Computer and related activity	93
Other transport equipment	106	Other transport equipment	59
Education	2	Education	1

Source: Koopman et al. (2014)

BIOGRAPHY

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Publications

Sessomboon, P. (2016). Decomposition Analysis of Global Value Chain's Impact on Thai Economy. *BESSH International Academic Conference Proceedings March 26-27, 2016 in Tokyo, Japan, 25-48.*

Awards	January 8, 2015: Setthathat Competition 2014 (arranged by Bank of Thailand) Honorable Mention