Academic Fora

FULL PAPER PROCEEDING
Multidisciplinary Studies
Available online at www.academicfora.com

Full Paper Proceeding BESSH-2016, Vol. 114- Issue.2, 25-48

ISBN 978-969-670-259-7

BESSH-16
Decomposition Analysis Of Global Value Chain's Impact On Thai Economy

Mr. Punyawich Sessomboon*

Thammasat University, Thailand

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 32 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 tool 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.

Keywords— Decomposition Analysis, Global Value Chain, Comparative Advantage, Export-Led Growth, Panel Regression

Introduction

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. Correspond to the definition of export-led growth defined by Tang et al. (2015): export-led growth is a situation where a country growth follows from its ability to export.

Figure 1 illustrates the degree of trade openness(It can be calculated from summation of totals export and import divided by Gross Domestic Product (GDP)) for Thai economy in global value chain. This degree has increased about 50% from 86% in 1995 to 136% in 2011. From this reason, it claims that the participation of Thai producer and Thai economy are continuously connected to the global value chain for over a decade.

Even though, the participation of Thai producer and Thai economy in global value chain has increased over time; their net export does not improve like the improvement of their gross export (Net export equals to gross export minus gross import). Figure 2 clarifies that share of net export per GDP is explicitly lower than gross export's share in every year. For this reason it is still unable to completely conclude that the conventional export-led growth strategy can effectively apply to Thai economy since the quantitative measure of 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's components.

Actually, when one country exports to the others, the amount of gross export can be mainly decomposed into 3 categories—Domestic Value-Added in Gross Export (DVAING), Foreign Value-Added in Gross Export (FVAING) and Pure Double Counted in Gross Export (PDCING)—which should be also considered. Therefore, future policy formulation to enhance competitiveness and value added from global value chain participation are raised in this study.

*All correspondence related to this article should be directed to Punyawich Sessomboon from Thammasat University, Thailand
Email: punyawich.s@st.econ.tu.ac.th

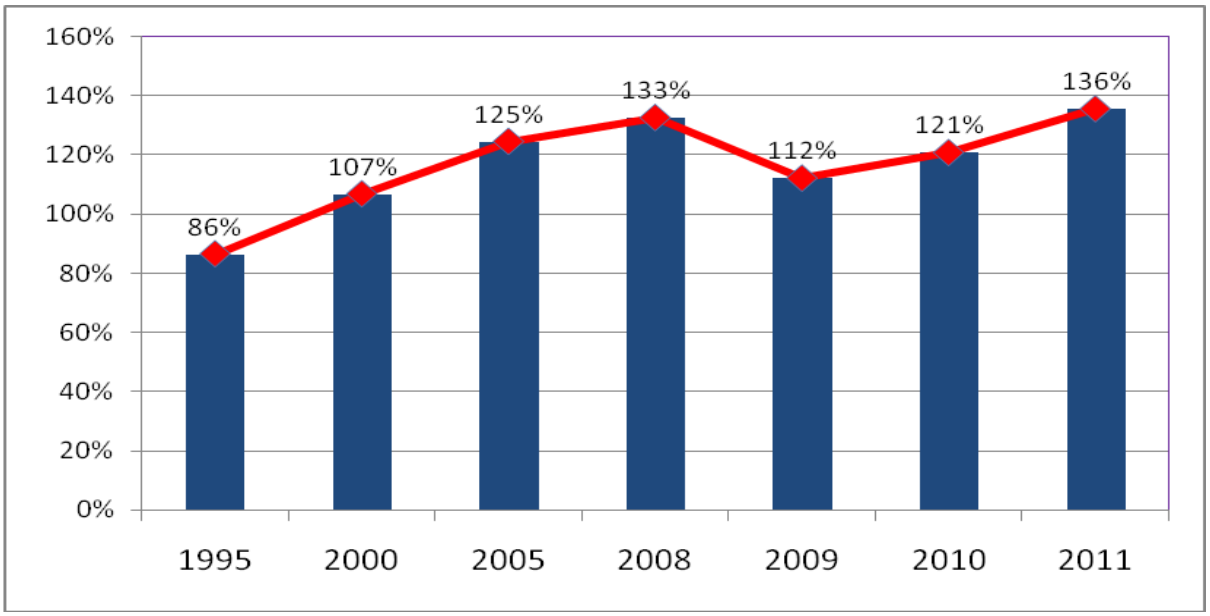

Figure1: Degree of Trade Openness for Thai Economy
Source: Author's calculation based on OECD

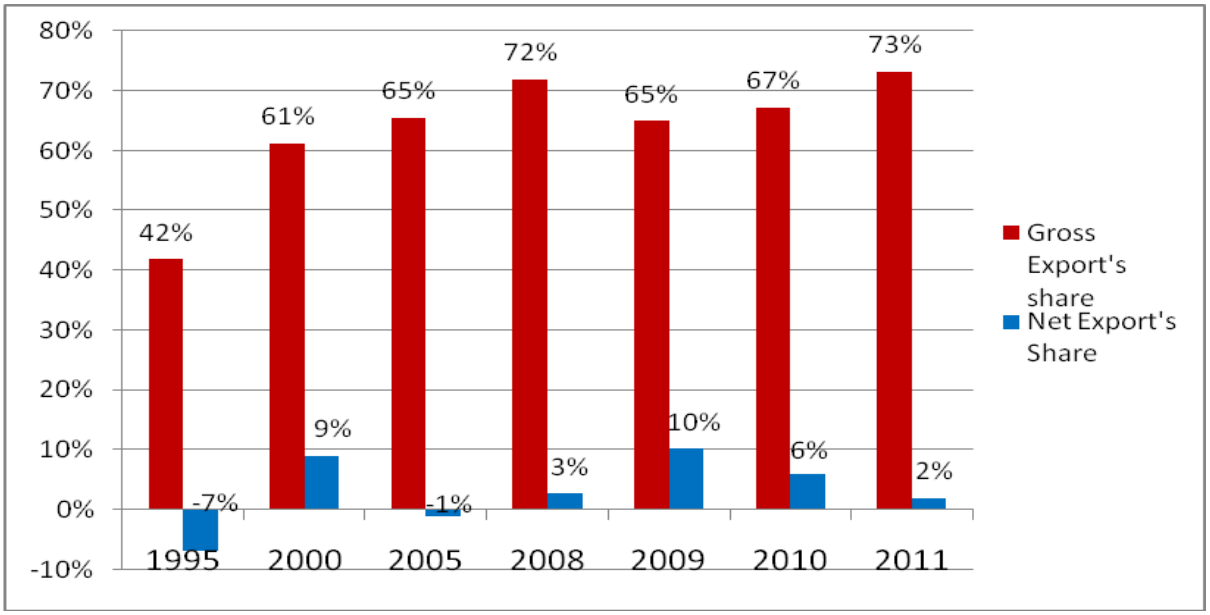

Figure 2: Share of Gross Export and Net Export to GDP for Thai Economy
Source: Author's calculation based on OECD

Objectives of the Study

- Decompose gross export of Thai industries based on Domestic Value-Added, Foreign Value-Added and Pure Double Counted in Gross Export in order to further analyze the export-led growth strategy in regression part.
- Compare the Revealed Comparative Advantage indices between conventional trade and new trade approaches of Thai industries in order to explore the better measurement of export ability in global value chain.
- Explore the linkage of Thai industries in 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 global value chain on Thai industries.
- To show empirical evidence of export-led growth strategy from regression model based on Domestic Value-Added, Foreign Value-added and Pure Double Counted in Gross Exports led-growth.

Scope of Study

This study will focus on export-led growth strategy which employs 2 methods: Panel Fixed-Effect and Panel Two Stage Least Square (2SLS) Fixed-Effect. For the data in empirical model, I will use panel data of Thai economy in 5 years: 2000, 2005, 2009, 2010 and 2011; the main source of data is OECD Inter-Country Input-Output Tables, 2015. The difference periods that mentioned above are also considered in order to monitor the structural change of Thai economy.

Review of Literature

Concept of Vertical Specialization Chain

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

The Linkage of Industry in Global Value Chain

The degree of a particular industry's impact on its upstream and downstream partners in global value chain can be respectively measured by International Backward and Forward Multipliers which are quantified from intermediates use of any industry among the global value chain (Puttanapong, 2015).

Decomposition Analysis of Gross Export

When any country exports goods and service to other countries, Koopman et al. (2012) prove that the amount of gross export can be decomposed into 9 categories: domestic value-added in direct final goods exports, domestic value-added in intermediate exports absorbed by direct importers, domestic value-added in intermediate reexported to 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 anddouble counted intermediate exports produced abroad. For the concept and lesson in calculating these 9 categories of gross export will be described in chapter 3 (Theoretical Framework and Research Methodology) of this study.

Theoretical Frameworkand Research Methodology

Theoretical Framework

Figure 3 illustrates the basic concept of trade in value-added by assuming that there are 4 steps of value chain—raw material extraction, processing, manufacturing and final demand—as well as 4 participating countries (country A to country D). Begin from country A extracts raw material $2 then exports to country B; country B can create value-added $24 in processing after that it can further export total output $26 which includes double counted from country A ($2) to country C; in manufacturing process, country C can also create value-added $46; finally, country C exports $72 which includes double counted from both country A ($2) and B ($24) to country D and this $72 becomes final demand for country D.

From this basic concept of trade in value-added explained above, the conventional trade approach concludes that total amount of world export equals to $100 (summation 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 included.

Therefore, $72 of Domestic Value-Added in Gross Export (summation of $2, $24 and $46 from domestic value-added of country A to country C, respectively) isemployed as a new approach in measuring export value since this new approach can provide more accurate measurement about export value and also handle with misleading problem.

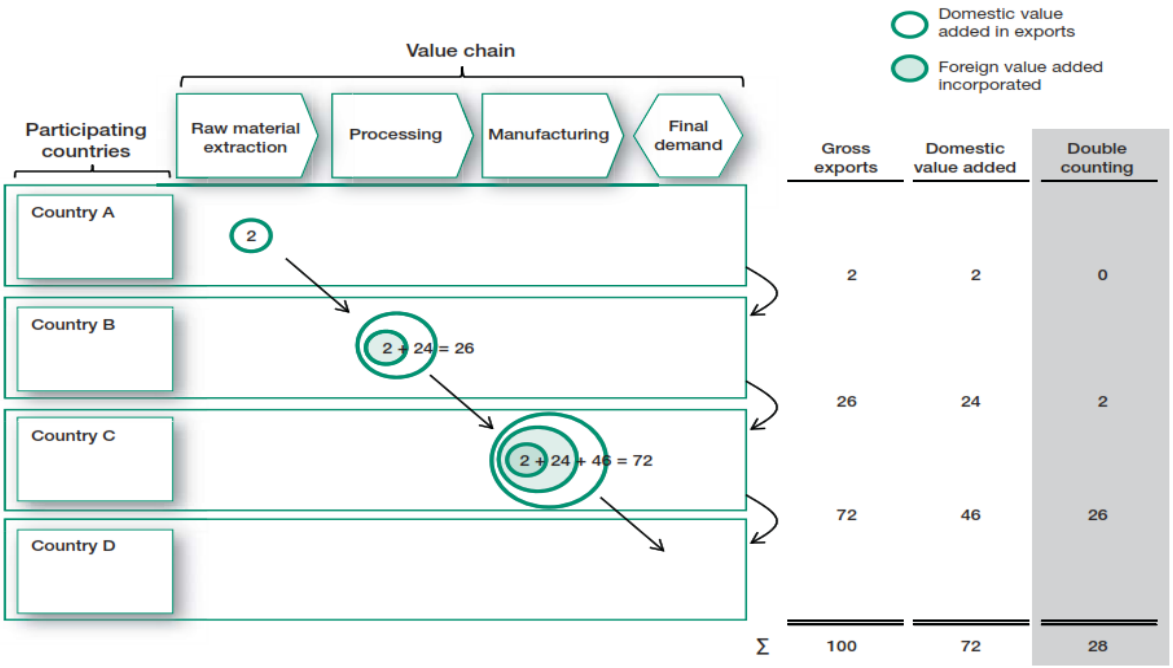

Figure 3: Basic Concept of Trade in Value-Added
Source: UNCTAD

Two Countries One sector Model

Production Sharing and Trade in Value-Added

In order to simplify the explanation, this study begins to explain about two countries one sector model. The general case of G countries N sectors will be talked later. The material here is mainly taken from Koopman et al. (2014). As I mentioned, the model assumes that there are two countries (home and foreign countries) in the world; each country has only one sector which produces single product. The product in each sector can be directly consumed as final goods or indirectly used as an intermediate input. Moreover, each country can also export both intermediate and final goods to other countries.

The gross output which is produced by country s (xs) will be classified to intermediate and final goods, at home and abroad. Thus, gross output of country s (xs) can be written as the following equation:

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

Where y_{sr} is the final demand of country r which imported from country s and a_{sr} is the coefficient of input-output that describes 1 unit of intermediate goods which country r import from country s to produce the same unit of output in its own country. Hence, total amount of intermediate goods which country r imported from country s is $a_{sr}x_r$.

In addition, the production of two countries can be shown by transforming equation (1) into matrix form in equation (2):

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

Rearrange equation (2), then we will get

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

Matrix B is Leontief inverse or total requirement coefficients of input-output matrix. For example, b_{11} is amount of country 1's gross output that used to produce extra unit of final good in its own country then contributed to domestic consumption and country 2' import. The other coefficients in matrix B can be similarly interpreted.

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

$$V=\begin{pmatrix} v_1 & 0 \\ 0 & v_2 \end{pmatrix} \tag{4}$$

If we multiply matrix Vfrom equation (4)with the Leontief inverse B from equation (3)**,** it will be 2×2 matrix of value-added share (VB) which is the measurement of value-added shares by source of production.

$$VB=\begin{pmatrix} v_1b_{11} & v_1b_{12} \\ v_2b_{21} & v_2b_{22} \end{pmatrix} \tag{5}$$

From equation (5), v_1b_{11} and v_2b_{22} respectively stand for domestic value-added share of country 1 and country 2; whereas v_2b_{21} and v_1b_{12} stand for value added share of foreign country in the same goods. Since the value added comes from either domestic or foreign countries, the summation of column has to equal one:

$$v_1b_{11}+v_2b_{21}=v_1b_{12}+v_2b_{22}=1 \tag{6}$$

Accounting of Gross Exports

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

$$e_{12}=y_{12}+a_{12}x_2 \tag{7}$$

By multiplying equation (7) with equation (6), we will get

$$\begin{aligned} e_{12} &= (v_1b_{11}+v_2b_{21})(y_{12}+a_{12}x_2) \\ &= v_1b_{11}y_{12}+v_2b_{21}y_{12}+v_1b_{11}a_{12}x_2+v_2b_{21}a_{12}x_2 \\ &= v_1b_{11}y_{12}+v_2b_{21}y_{12}+v_1b_{12}y_{22}+v_1b_{12}y_{21} \\ &\quad +v_1b_{12}a_{21}x_1+v_2b_{21}a_{12}x_2 \end{aligned} \tag{8}$$

We can further calculate the value of country 1's intermediate goods export and also its value of double counted from total 100 percent through including them into accounting equation. Combining equations (1) and (7), we will get$x_1=y_{11}+a_{11}x_1+e_{12}$ and $x_2=y_{22}+a_{22}x_2+e_{21}$ after that rearrange them to get (9).

$$\left.\begin{aligned} x_1 &= (1-a_{11})^{-1}y_{11}+(1-a_{11})^{-1}e_{12} \\ x_2 &= (1-a_{22})^{-1}y_{22}+(1-a_{22})^{-1}e_{21} \end{aligned}\right\} \tag{9}$$

Substitute equation (9) into equation (8), it will be equation (10)

$$e_{12} = v_1 b_{11} e_{12} + v_2 b_{12} e_{12} = \left[v_1 b_{11} y_{12} + v_1 b_{12} y_{22} \right] + \left[v_1 b_{12} y_{21} + v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} y_{11} \right] + v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} e_{12} + \left[v_2 b_{21} y_{12} + v_2 b_{21} a_{12} \left(1 - a_{22}\right)^{-1} y_{22} \right] + v_2 b_{21} a_{12} \left(1 - a_{22}\right)^{-1} e_{21} \quad (10)$$

All of eight terms in the right hand side of equation (10) are gross export combinations of country 1 which correspond to figure 4 that can be explained in the next paragraph.

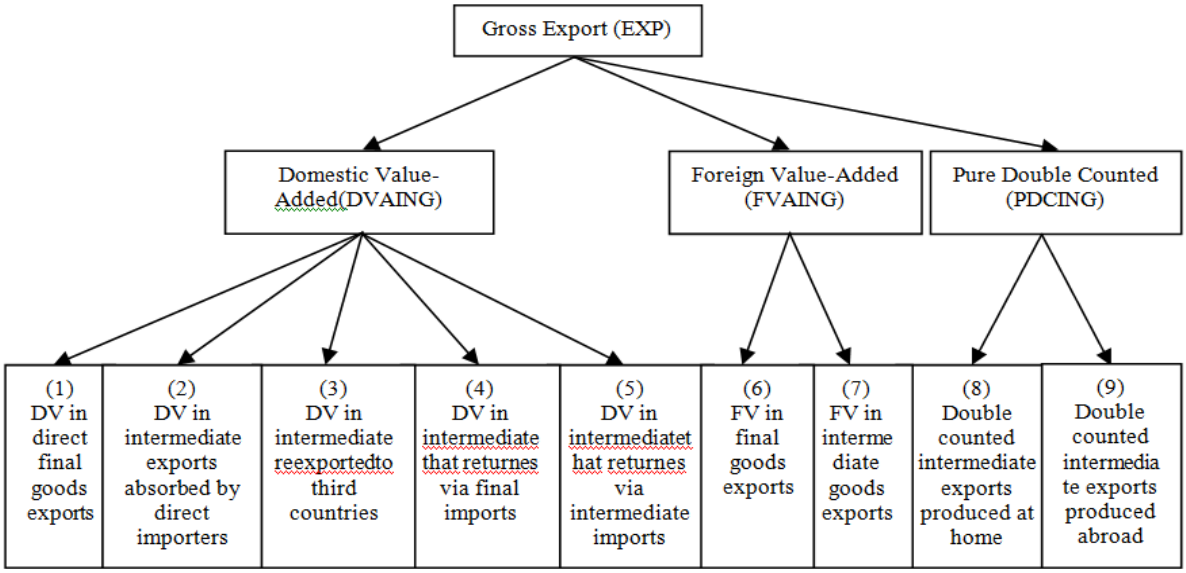

Figure.4: Decomposition Analysis of Gross Export

Note: number (3) in figure 4 will be only appeared in at least 3 countries model, not in 2 countries model that I will discuss later in part of general case for G countries N sectors model.

The first two terms, $v_1 b_{11} y_{12}$ and $v_1 b_{12} y_{22}$ ((1) and (2) in figure 4), are respectively value-added exports of final and intermediate goods of country 1. The third term, $v_1 b_{12} y_{21}$ ((4) in figure 4), is domestic value added in intermediate exports of country 1 that is returned at home as part of final goods' import. The fourth term, $v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} y_{11}$ ((5) in figure 4), is also domestic value-added in intermediate exports of country 1 that is returned at home as part of intermediate goods' import to produce final goods that are absorbed at home. The fifth term, $v_1 b_{12} a_{21} \left(1 - a_{11}\right)^{-1} e_{12}$ ((8) in figure 4), is a pure double counted term produced at home. This term will be appeared, if both countries export intermediate goods. The sixth term, $v_2 b_{21} y_{12}$ ((6) in figure 4), is foreign value added in final goods export of country 1; and the seventh term, $v_2 b_{21} a_{12} \left(1 - a_{22}\right)^{-1} y_{22}$ ((7) in figure 4), is foreign value added in intermediate export of country 1. They both finally return to the foreign country and are consumed there. The eighth term, $v_2 b_{21} a_{12} \left(1 - a_{22}\right)^{-1} e_{21}$ ((9) in figure 4), is another pure double counted term in country 1's gross exports which produced abroad. Similar to the fifth term, this eighth term will be appeared, if both countries export intermediate goods.

General Case of G Countries and N Sectors Model

Production Sharing and Trade in Value-Added

Now, we can extend the model to a general case which involves G countries N sectors by using the same logic with two countries one sector model. Then the production of two countries and trade system in equation (3) will be extended to equation (11)

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

The similar interpretation for the ratio of value added to output for G countries and N sectors model can be written as GN×GN matrix as follow:

$$\hat{V} = \begin{bmatrix} \hat{V}_1 & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \hat{V}_2 & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \hat{V}_G \end{bmatrix} \tag{12}$$

If we multiply $\hat{V}$ from equation (12)with the Leontief inverse B from equation (11)**,** it will be G×GN value-added share (VB) matrix which is the measurement of value-added shares by source of production, as follow:

$$VB = \begin{bmatrix} V_1B_{11} & V_1B_{12} & \cdots & V_1B_{1G} \\ V_2B_{21} & V_2B_{22} & \cdots & V_2B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ V_GB_{G1} & V_GB_{G2} & \cdots & V_GB_{GG} \end{bmatrix} \tag{13}$$

Domestic value-added in gross output of country1 to country G can be written as follow:

$$\begin{bmatrix} V_1B_{11} & V_1B_{12} & \cdots & V_1B_{1G} \\ V_2B_{21} & V_2B_{22} & \cdots & V_2B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ V_GB_{G1} & V_GB_{G2} & \cdots & V_GB_{GG} \end{bmatrix} \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1G} \\ X_{21} & X_{22} & \cdots & X_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ X_{G1} & X_{G2} & \cdots & X_{GG} \end{bmatrix}$$

$$= \begin{bmatrix} \hat{V}_1\sum_r^G B_{1r}Y_{r1} & \hat{V}_1\sum_r^G B_{1r}Y_{r2} & \cdots & \hat{V}_1\sum_r^G B_{1r}Y_{rG} \\ \hat{V}_2\sum_r^G B_{2r}Y_{r1} & \hat{V}_2\sum_r^G B_{2r}Y_{r2} & \cdots & \hat{V}_2\sum_r^G B_{2r}Y_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \hat{V}_G\sum_r^G B_{Gr}Y_{r1} & \hat{V}_G\sum_r^G B_{Gr}Y_{r2} & \cdots & \hat{V}_G\sum_r^G B_{Gr}Y_{rG} \end{bmatrix} \tag{14}$$

Each diagonal matrix in equation (14) is the domestic value-added that absorbed at home which is similar logic with equation (5) of two countries one sector model. Thus, the similar interpretation for value-added export in general case of G countries and N sectors model can be also applied through following the off-diagonal matrix of this $GN \times G$ matrix in equation (14) as follow:

$$VT_{sr} = \hat{V}_s X_{sr} = \hat{V}_s \sum_{g}^{G} B_{sg} Y_{gr} \tag{15}$$

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

$$VT_{s^*} = \sum_{r \neq s}^{G} VX_{sr} = V_s \sum_{r \neq s}^{G} \sum_{g=1}^{G} B_{sg} Y_{gr} \tag{16}$$

We can further decompose equation (16) into 3 categories which clarify the destinations of value-added export of a particular country as follow:

$$VT_{s*} = V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \tag{17}$$

All 3 categories in equation (17) can be clearly explained: 1st and 2nd categories are, respectively, value added embedded in its own export of final goods that is absorbed abroad and value added in its exports of intermediate goods that is used by direct importer to produce final goods consumed by direct importer; the last term is value added in its exports of intermediate goods that is used by direct importer to produce final good consumed by third countries (reexported effect).

Accounting of Gross Exports

The gross export in general case of G countries N sectors can be written as following equation:

$$E_{s^*} = \sum_{r \neq s}^{G} E_{sr} = \sum_{r \neq s}^{G} \left(A_{sr} X_r + Y_{sr} \right) \tag{18}$$

Using the same logic with equation (8) to derive gross export combinations in general case of G countries N sectors, then we can initially decompose gross export as following equation:

$$\begin{aligned} uE_{s*} &= V_s B_{ss} E_{s^*} + \sum_{r \neq s}^{G} V_r B_{rs} E_{s^*} \\ &= VT_{s^*} + \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} X_s \right\} \\ &\quad + \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} X_r \right\} \end{aligned} \tag{19}$$

By rearranging gross output of any country, $X_s = Y_{ss} + A_{ss} X_s + E_{s^*}$ then we will get

$$\left.\begin{aligned} X_s &= \left(I - A_{ss} \right)^{-1} Y_{ss} + \left(I - A_{ss} \right)^{-1} E_{s^*} \\ X_r &= \left(I - A_{rr} \right)^{-1} Y_{rr} + \left(I - A_{rr} \right)^{-1} E_{r^*} \end{aligned}\right\} \tag{20}$$

Substitute equation (20) into equation (19) and also employ equation (17); then it will be the final form of gross export (equation 21) which decomposed into nine categories and also corresponded to figure 4.

$$
\begin{aligned}
uE_{s^*} = & \left\{ V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \right\} \\
& + \left\{ V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \left(I - A_{ss} \right)^{-1} Y_{ss} \right\} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \left(I - A_{ss} \right)^{-1} E_{s^*} \\
& + \left\{ \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} A_{sr} \left(I - A_{rr} \right)^{-1} Y_{rr} \right\} \\
& + \sum_{t \neq s}^{G} V_t B_{ts} A_{sr} \sum_{r \neq s}^{G} \left(I - A_{rr} \right)^{-1} E_{r^*}
\end{aligned} \tag{21}
$$

Note: third term in equation (21) can be illustrated as Domestic Value-added (DV) in intermediates reexported to third countries which is number (3) in figure 4.

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

One of the most interesting issues of the quantitative measure of impact and gain from global value chain is the Revealed Comparative Advantage index (RCA) which has the conventional formula in equation (22). Conventional RCA is the measurement for the comparative advantage of a particular sector in a particular country to world economy. Assuming that there are N commodities and G countries, the conventional RCA can be calculated through 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 divided by world export of good i ($\sum_{r}^{G} E_i^{r^*}$) per total world export ($\sum_{i}^{n} \sum_{r}^{G} E_i^{r^*}$).

$$
TRCA_i^r = \frac{E_i^{r^*}}{\sum_{i=1}^{n} E_i^{r^*}} \Bigg/ \frac{\sum_{r}^{G} E_i^{r^*}}{\sum_{i}^{n} \sum_{r}^{G} E_i^{r^*}} \tag{22}
$$

Koopman et al. (2014) suggested a new method in measuring comparative advantage which calls New Revealed Comparative Advantage (NRCA). This NRCA can be calculated through employing the same formula as RCA, just change the variable from gross export to Domestic Value-Added in Gross Export (DVAING_i^r) which is the summation of (1) to (5) terms in figure 4 or equivalent to summation of 1st to 5th terms in equation (21); then equation (22) will be changed to equation (23).

The reason why we should employ NRCA instead of conventional RCA is that NRCA does not include Foreign Value-Added (FVAING) and Pure Double Counted (PDCING) in Gross Export—the summation of (6) to (9) terms in figure 4 or equivalent to summation of 6th to 9th terms in equation (21)—since these 2 terms do not reflect the ability of competition in the global value chain. From this reason,NRCA is employed in equation (23) instead of conventional RCA.

$$
NRCA_i^r = \frac{DVAING_i^r}{\sum_{i=1}^{n} \left(DVAING_i^r \right)} \Bigg/ \frac{\sum_{r}^{G} \left(DVAING_i^r \right)}{\sum_{i}^{n} \sum_{r}^{G} \left(DVAING_i^r \right)} \tag{23}
$$

Linkage of Industry in Global Value Chain

Vertical Specialization Index

This VS index clarifies the degree of imported content in a country's export or the degree of linkage to global value chain which originated by Hummels et al. (2001). Koopman et al. (2014) extended the idea of this VS index then they can explore that this VS index is actually the summation of number 6 (foreign value-added in final goods exports), 7 (foreign value-added in intermediate goods exports) and 9 (double counted intermediate exports produced abroad) in figure 4 divided by gross export; or equivalent to the summation of 7^{th} to 9^{th} terms in equation (21) divided by gross export.

International Forward and Backward Multipliers

The International Forward and Backward Multipliers respectively reveal us about the degree of a particular sector's impact on its downstream and upstream as well as the position in global value chain.

These multipliers can be calculated through following 5 steps of matrix algebra based on OECD Inter-Country Input-Output (ICIO) tables, 2015. First step is to calculate matrix A which is the ratios of intermediate use of a particular sector per gross output of its own sector. Second step is to generate identity matrix (matrix I) which has the same dimension as matrix A. Third step is to generate (I-A) matrix by using matrix A and I from first and second steps. Fourth step is to generate inverse matrix of (I-A). Final step is to calculate total multipliers; the summation of inverse (I-A) matrix along each row becomes the Total Forward Multiplier which represents the degree of downstream linkage while the summation of inverse (I-A) matrix along each column becomes the Total Backward Multiplier which represents the degree of upstream linkage.

In addition, both Total Forward and Backward Multipliers can be classified into international and domestic terms; in this study, we will focus only on international terms which are International Forward and Backward Multipliers.

Regression Analysis Based on Export-led Growth Strategy

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

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \varepsilon_{1it} \quad (24)$$

In order to see the partial effect of export-led growth; this study explores additional 3 cases based on figure 4 (Decomposition Analysis of Gross Export) which are 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 follow:

- Domestic Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \varepsilon_{2it} \quad (25)$$

- Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \varepsilon_{3it} \quad (26)$$

- Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \varepsilon_{4it} \quad (27)$$

In addition, the analysis of previous bivariate model can be extended to trivariate one which includes domestic investment as an additional explanatory variable (Yew Wha, 2004). So, the new source of growth equation can be specified as follow:

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{1it} \quad (28)$$

In order to see the partial effect of export-led growth; equation (28) can be classified into 3 cases using similar method with bivariate model in equation (24) that are 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 follow:

- Domestic Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{2it} \quad (29)$$

- Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{3it} \quad (30)$$

- Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \varepsilon_{4it} \quad (31)$$

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

$$LnY_{it} = \beta_0 + \beta_1 LnEXP_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{1it} \quad (32)$$

In order to see the partial effect of export-led growth; equation (32) can be classified into 3 cases using similar method with bivariate model in equations (24) and trivariate model in equation (28) that are 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 follow:

- Domestic Value-Added in Gross Export-Led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnDVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{2it} \quad (33)$$

- Foreign Value-Added in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnFVAING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{3it} \quad (34)$$

- Pure Double Counted in Gross Export-led Growth:

$$LnY_{it} = \beta_0 + \beta_1 LnPDCING_{it} + \beta_2 LnINVEST_{it} + \beta_3 VSindex_{it} + \varepsilon_{4it} \quad (35)$$

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

Research Methodology

Decomposition of Gross Export for Thai Industries

The source of data comes from Inter-Country Input-Output (ICIO) tables, 2015 which shared by OECD. 67 countries (include Thailand) and 32 industries in 2000, 2005, 2009, 2010 and 2011 are included in these ICIO tables.

For this reason, we can further analyze the impact of global value chain on all 32 Thai industries through employing technique in decomposing gross export in (General Case of G Countries and N Sectors Model).

As I mentioned in (Accounting of Gross Export in G Countries N Sectors Model)**,** value of gross export can be decomposed into 9 categories in general case of G countries N sectors (see equation 21) which can explain how the real world work. Moreover, this study will group all 9 categories of gross export of all 32 Thai industries in all 5 periods into 3 main groups. First group is Domestic Value-Added in Gross Export (DVAING) which is the summation of 1^{st} to 5^{th} terms in equation (21) or equivalent to the summation of number (1) to (5) in figure 4. Second group is Foreign Value-Added in Gross Export (FVAING) which is the summation of 7^{th} and 8^{th} terms in equation (21) or equivalent to the summation of number (6) and (7) in figure 4. Last group is Pure Double Counted in Gross Export (PDCING) which is the summation of 6^{th} and 9^{th} terms in equation (21) or equivalent to the summation of number (8) and (9) in figure 4.

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

There are 2 cases in comparing RCA and NRCA for all 32 Thai industries in all 5 periods. First, comparative advantage is increased since we change from RCA to NRCA. Second, comparative advantage is decreased since we change from RCA to NRCA.

Linkage of Thai Industries in Global Value Chain

Vertical Specialization Index (VS index) of Thai Industries

From the explanation about concept in calculating VS index based on Koopman et al. (2014) that I mentioned, this study will decompose VS index of all 32 Thai industries in all 5 periods to explore the degree of Thai industries' linkage with global value chain during different periods and industries.

International Forward and Backward Multipliers of Thai Industries

In this study, the International Forward and Backward Multipliers for all 32 Thai industries in all 5 periods will be stated to explore the degree of downstream and upstream linkage as well as position of Thai industries in global value chain.

Regression Analysis Based on Export-led Growth Strategies

This issue aims to answer 2 main questions. First, "How large is the impact of export on growth of Thai economy?"; second, "Which combinations of gross export can generate the highest percentage change on growth of Thai economy?". These 2 questions can be answered through employing Panel Fixed-Effect and Panel 2SLS Fixed-Effect regressions that are explained in section Regression Analysis Based on Export-led Growth Strategy.

We expect all signs within the export-led growth models to be positive that will be corresponded to the theory. Table 1 explores all possible result from export-led growth strategy based on Panel Fixed-Effect and Panel 2SLS Fixed-Effect regressions.

Table1:

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

Bivariate Model:		
Case	Parameter (the highest)	Conclusion
1^{st} case	$\beta_1(\text{DVAING})$	Producers should stimulate DVAING in order to led economic growth
2^{nd} case	$\beta_1(\text{FVAING})$	Producers should stimulate FVAING in order to led economic growth

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

Results and Discussion

Decomposition of Gross Export for Thai Industries

Figure 5 clarifies the amounts of Domestic Value-Added in Gross Export (DVAING) and Gross Export (EXP) for all 32 Thai industries in 2011. We can explore that computer, electronic and optical equipment industries have gross export value about 3 times higher than their Domestic Value-Added in Gross Export. Whole sale & retail trade and repairs industries have gross export value about the same with the previous industries' gross export value; however in term of Domestic Value-Added in Gross Export, they have explicitly higher than the former industries' value.

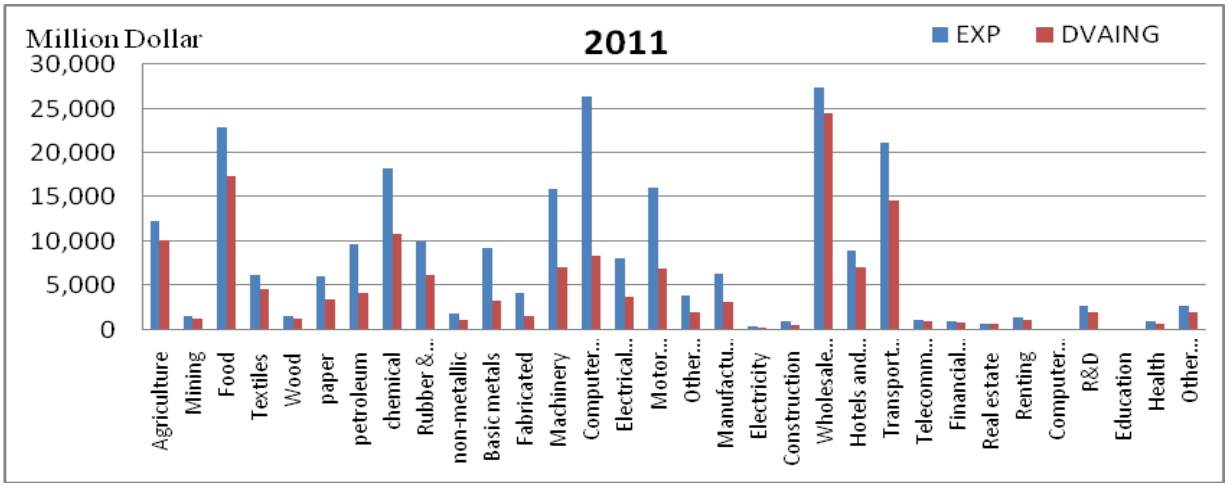

Figure 5: Gross Export and Domestic Value-Added in Gross Export of Thai Industries

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

In contrast, Foreign Value-Added in Gross Export (see figure 6) and Pure Double Counted in Gross Export (see figure 7) are relatively high in computer, electronic and optical equipment industries; but are relatively low in whole sale & retail trade and repairs industries.

Higher Foreign Value-Added in Gross Export means that production process of a particular industry employs higher value-added of foreign industries but creates less amount of its own domestic value-added.

From figure 4, we know that pure double counted term can be divided into 2 parts: double counted intermediates exports produced at home (eighth term) and double counted intermediates exports produced abroad (ninth term). More amount of double counted in gross export means that a particular industry use more intermediate input from either domestic or international sources to produce gross export.

From all reasons mentioned above, we cannot directly deduce export ability by gross term of export since it can generate misleading problem.

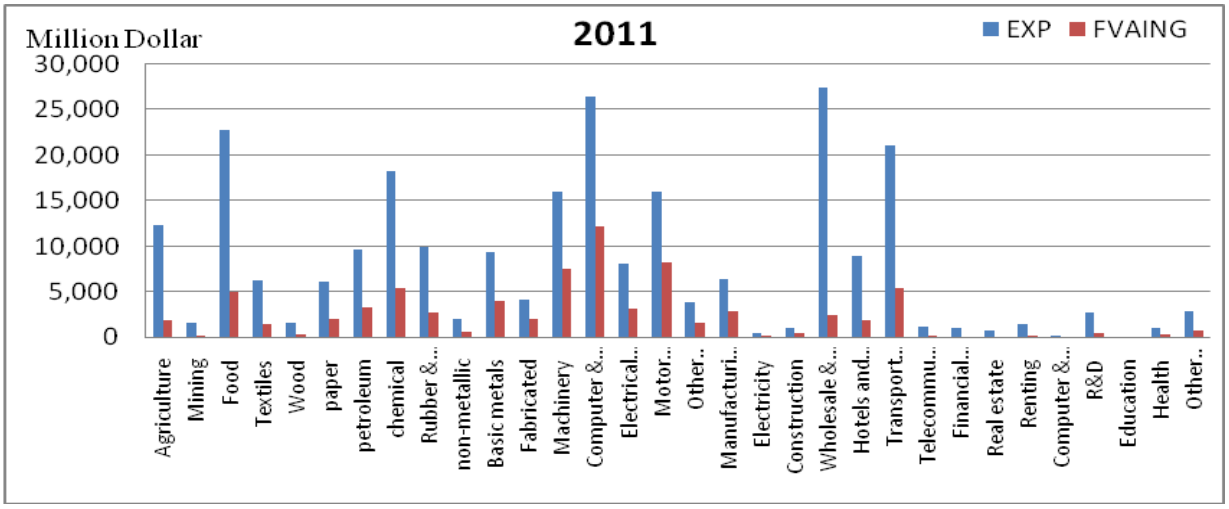

Figure 6: Gross Export and Foreign Value-Added in Gross Export of Thai Industries
Source: Author's calculation based on Koopman et al. (2014)

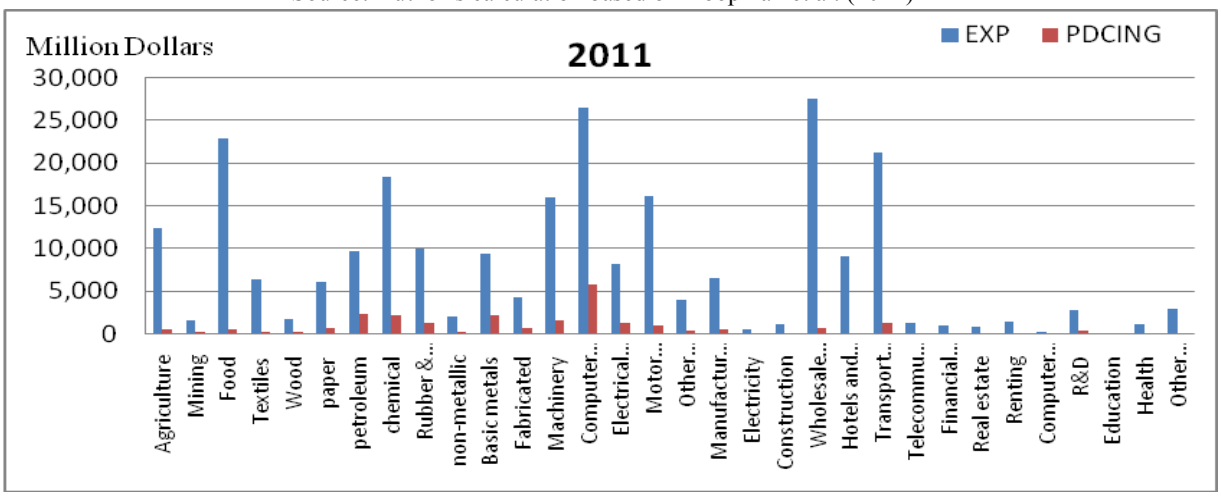

Figure 7: Gross Export and Pure Double Counted in Gross Export of Thai Industries
Source: Author's calculation based on Koopman et al. (2014)

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

As I mentioned in topic above, there are 2 cases in comparing RCA and NRCA of Thai industries in the global value chain. First case, comparative advantage is increased since we change from RCA to NRCA: 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 & 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.

Second case, comparative advantage is decreased since we change from RCA to NRCA: 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; health and social work.

Table 2:
Comparison between Conventional RCA and New RCA of Thai Industries
2011

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
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

Linkage of Thai Industries in Global Value Chain

Vertical Specialization Index (VS index) of Thai Industries

Figure 8 illustrates that computer, electronic and optical equipment have the highest degree of linkage to global value chain (VS index equals to 68%). The interpretation is that these industries employ 0.68 unit of imported intermediate input from other countries in global value chain in order to export 1 unit. Compared with real estate activities, they require the lowest imported content in export (VS index equals to 5%) which means the degree of linkage to global value chain is the lowest by definition of Vertical Specialization index.

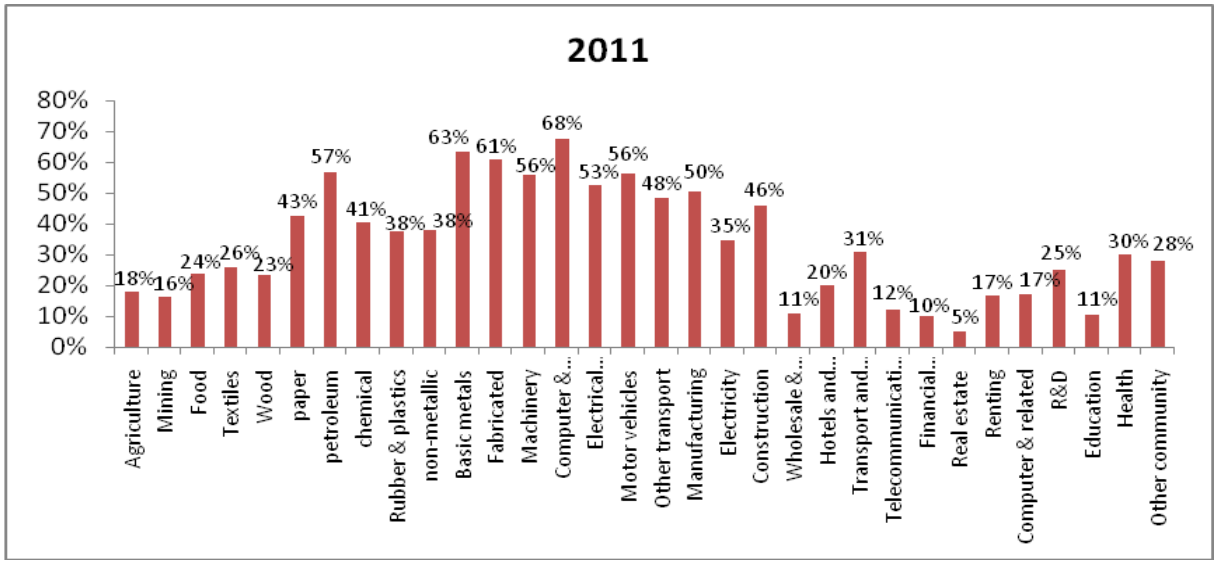

*Figure 8:*Vertical Specialization Index of Thai Industries
Source: Author's calculation based on Koopman et al. (2014)

International Forward and Backward Multipliers of Thai Industries

Figure 9 clarifies International Forward and Backward Multipliers of 32 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.

The positive blue line represents balance for the degree of International Forward and Backward Multipliers and also represents the distance of supply chain. As a result, pulp, paper, paper products, printing and publishing reveals the balance between degree of downstream and upstream linkage which means they exports intermediate goods as equal as amount of imported intermediate goods. In addition, real estate activities that also has nearly balance between degree of downstream and upstream linkages explores the shortest supply chain (correspond to conclusion of VS index that is these industries has the lowest degree of linkage to global value chain).

Negative blue line represents the degree of downstream and upstream linkages for any industry in global value chain. For example, computer, electronic and optical equipment industries have the highest degree of upstream linkage (1.83) which means they have to employ the intermediate goods from other industries 1.83 unit in the global value chain to produce their 1 unit of output. In contrast, whole sale & retail trade and repair industries have the highest degree of downstream linkage (1.28) that means when they produce 1 unit of output then intermediate goods 1.28 unit will be exported to the other industries in global value chain.

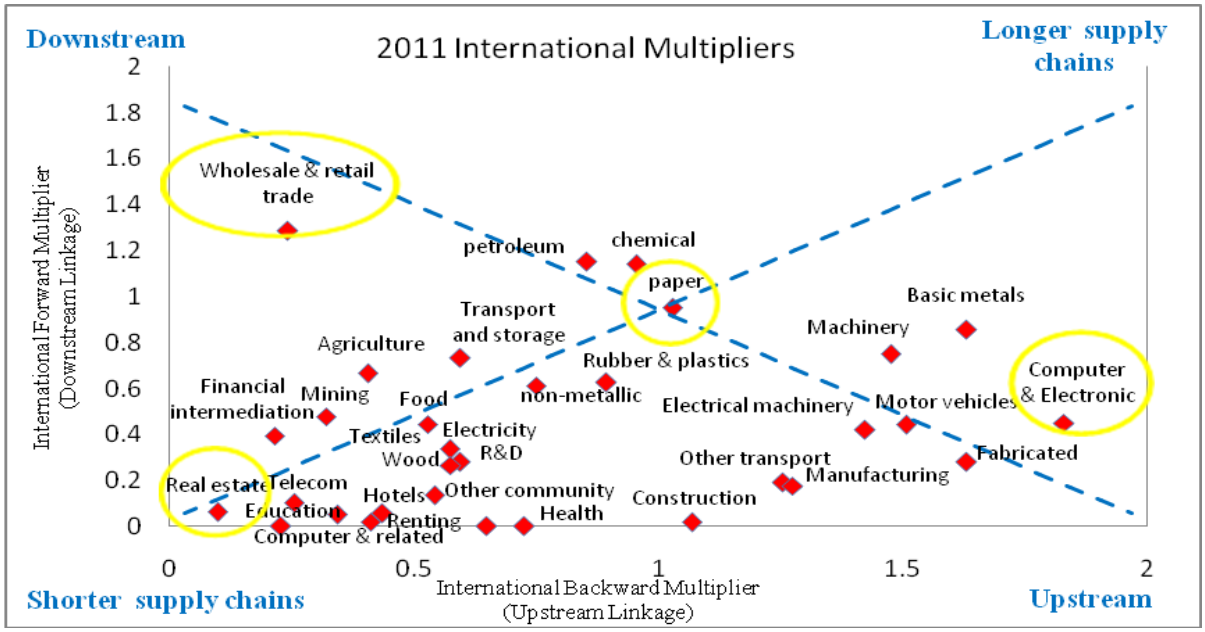

Figure 9: International Forward and Backward Multipliers of Thai Industries
Source: Author's calculation based OECD

Regression Analysis Based on Export-led Growth Strategy

Panel Fixed-Effect Regression

The result from Panel Fixed-Effect regression is clarified in table 3. There are 3 models; first, bivariate model explores that the overall effect of export-led growth following gross term of export has positive impact on economic growth (0.6475%). Meaning that if producers increase their export 1%, then economic growth will be raised 0.6475%. Moreover, the partial effect from Domestic Value-Added in Gross Export clarifies the highest impact on economic growth (0.6653%) compared to other gross export combinations—Foreign Value-Added in Gross Export (0.5835%) and Pure Double Counted in Gross Export (0.5309%).

Second, trivariate model clarifies that among those gross export combinations; again, 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 trivariate model examines the effect of domestic investment on economic growth; as a result, domestic investment can also generate economic growth for 0.1104% but has less impact than gross export (0.6060%).

Third, multivariate model clarifies the new source of growth equation that includes Vertical Specialization index as an additional explanatory variable. As a result, there are 3 conclusive issues. First issue, Domestic Value-Added in Gross Export 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%); second issue, domestic investment can also positively affect economic growth (0.1031%) but still has less impact than gross export (0.5880%); last issue, model2 explores that higher degree of linkage to global value chain (VS index) can positively affect economic growth (1.91)—participation of producers in global value chain increases 1 unit then economic growth will be raised 1.91%.

Table 3:
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)***	
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)***
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

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

Panel 2SLS Fixed-Effect Regression

Following export-led growth model, not only export can affect economic growth but economic growth may also generate export growth. Thus, this simultaneity effect can lead to the endogeneity problem (Sprout and Weaver, 1993

& Wizarat and Lau, 2013).In order to prevent this problem, this study can employ panel 2SLS Fixed-Effect regression.

The results from Panel 2SLS Fixed-Effect regression (Instrument Variables (IVs) in this study are selected following 2 main criterions. First, IVs have to be strongly correlated with endogenous variable; second, IVs have not to correlate with error term of structural equation. Therefore, in this study, Size, NRCA, IBM and IFM of any industry are selected as instrument variables of gross export as well as its combination) for bivariate, trivariate and multivariate models are similar to the previous regression's results (results from Panel Fixed-Effect regression) that are Domestic Value-Added in Gross Export has the strongest impact on economic growth compared to Foreign Value-Added and Pure Double Counted in Gross Export as well as domestic investment can also generate economic growth but still has less impact than gross export as illustrated in table 4.

Table 4:
Panel 2SLS Fixed-Effect Regression

(1) Bivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.7493			
	(0.0733)***			
LOG_DVAING		0.8425		
		(0.0818)***		
LOG_FVAING			0.6141	
			(0.0462)***	
LOG_PDCING				0.5590
				(0.0378)***
CONST	2.7654	2.3904	4.763	5.8716
	(0.5581)***	(0.6103)***	(0.4431)***	(0.3876)***
R-squared	0.0796	0.1110	0.0270	0.0214
Wald chi2(1)	104.28	106.07	176.46	218.45
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145
(2) Trivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.6917			
	(0.0725)***			
LOG_DVAING		0.7791		
		(0.0978)***		
LOG_FVAING			0.5663	
			(0.0545)***	
LOG_PDCING				0.5115

				(0.0405)***
LOG_INVEST	0.0881	0.0825	0.0896	0.0970
	(0.0478)*	(0.0454)*	(0.0534)*	(0.0487)**
CONST	2.7685	2.4398	4.6079	5.5637
	(0.5269)***	(0.7015)***	(0.4148)***	(0.4471)***
R-squared	0.0802	0.1103	0.0306	0.0329
Wald chi2(2)	148.42	89.32	213.18	271.61
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145
(3) Multivariate Model				
	Model1	Model2	Model3	Model4
LOG_EXP	0.7184315			
	(0.1576)***			
LOG_DVAING		0.7179		
		(0.1192)***		
LOG_FVAING			0.6883	
			(0.1344)***	
LOG_PDCING				0.6426
				(0.1559)***
LOG_INVEST	0.0837	0.0808	0.0784	0.0838
	(0.0487)*	(0.0480)*	(0.0378)**	(0.0371)**
VS_INDEX	-0.1788	1.1354	-1.8906	-2.2363
	(1.4935)	(1.0152)	(1.6050)	(2.0893)
CONST	2.6419	2.5450	4.5037	5.7447
	(0.8513)***	(0.6310)***	(0.4556)***	(0.3857)***
R-squared	0.0848	0.0786	0.0610	0.0677
Wald chi2(3)	207.36	335.56	338.09	135.21
Prob > F	0.0000	0.0000	0.0000	0.0000
Obs	160	160	160	145

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

Conclusions and Recommendations

Conclusion and Policy implication

This study explores 4 main issues. First is decomposition analysis of Thailand's gross export that lastly can be grouped into 3 main categories: Domestic Value-Added, Foreign Value-Added and Pure Double Counted in Gross Export. Surprisingly, computer, electronic and optical equipment industries that have the highest export volume turn to be worse after measured their value through using Domestic Value-Added in Gross Export. In contrast, wholesale & retail trade and repair industries that have about the same amount of gross export with previous industries are explicitly difference in term of Domestic Value-Added in Gross Export. Therefore, we cannot directly deduce ability to export by employing gross term of export which can generate the misleading problem.

Second is the comparison between conventional RCA and NRCA of Thailand; as a result, NRCA can provide more accuracy in measuring comparative advantage. This study classifies the result into 2 groups. First group, comparative advantage is increased since we change from RCA to NRCA: 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 & 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. Second group, comparative advantage is decreased since we change from RCA to NRCA: 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; health and social work.

Third is the exploration of Vertical Specialization index and International Forward as well as Backward Multipliers of Thailand that respectively clarify the degree of linkage and the position of Thai industries in global value chain. As a result, computer, electronic and optical equipment industries have the highest degree of linkage to global value chain (VS index equals to 68%) as well as the highest degree of upstream linkage in global value chain (the highest degree of International Backward Multiplier); whereas, wholesale & retail trade and repair become the top one in term of downstream linkage in global value chain (the highest degree of International Forward Multiplier) but their degree of linkage to global value chain are still low (VS index is only 11%).

Final issue is regression analysis based on export-led growth strategy which finally can lead to the conclusive results as follow. The policy makers should stimulate the industries that have high Domestic Value-Added in Gross Export rather than gross export in order to generate higher economic growth. For example, wholesale & retail trade and repairs; food products, beverage and tobacco; transport and storage; chemicals and chemical products; agriculture, hunting, forestry and fishing (Summation of Domestic Value-Added in Gross Export of these five products is higher than 50% from total DVAING of Thai industries) (see figure 5: Gross Export and Domestic Value-Added in Gross Export of Thai Industries). Moreover, industries which gain benefit from high Domestic Value-Added in Gross Export per unit should be also stimulate to export; since 1 unit increasing of their exports can generate big margin of Domestic Value-Added in Gross Export. Such as, real estate activities; financial intermediation; education; wholesale & 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 that can gain over 80% of Domestic Value-Added in Gross Export per unit.

Limitation

Based on database from OECD Inter-Country Input-Output (ICIO) tables, 2015; there has limited number of time period (only 7 years) for all 34 Thai industries. From this reason, we are still unable to construct time series model to examine the dynamic impact of global value chain on Thai economy. Therefore, this dynamic impact of global value chain on Thai economy becomes the limitation in this study.

Recommendation for Future Research

Following this study, there are 3 main recommendations for future research. First, the future research should provide methods in stimulating Domestic Value-Added in Gross Export of Thai industries since this study just conclude 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 global value chain on Thai economy.

Third, the future research should classify the impact of a particular industry on its downstream and upstream in global value chain through employing Structural Path Analysis (SPA) in order to examine the different source of destination among global value chain.

References

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

Defourny, J., & Thorbecke, E. (1984). Structural path analysis and multiplier decomposition within a social accounting matrix framework. *The Economic Journal, 94*(373), 111-136.

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.

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.

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

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.

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.

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.

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.

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*.

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*.

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.

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