Export Performance, Comparative Advantage and Factors Determining Comparative Advantage of Manufacturing Industries in Thailand

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Abstract

The manufacturing industry sector of Thailand is one of the main elements which promote the economy of the country. Since the export of the manufacturing industry in Thailand covers more than 90% of total export, it is crucially important to address the export performance of the manufacturing industry in Thailand. The objective of this study is to analyze the export performance and the factors determining the comparative advantage of the manufacturing industry in Thailand during 1990-2010. The methods to analyze the export performance of the manufacturing industry are adapted from UNESCAP in 2007. The logistic analysis is used to determine the direction of trade. In order to determine factors influencing the export of the manufacturing industry, the Vector Error Correction Model is used to establish the long-run and short-run relationship among variables. The results indicate that many product groups performed well in the world market while some products dropped over the past decade. The logistic regression suggests that manufacturing industry exported labor intensive goods in the early 1990s, and there was a transition to export capital intensive goods in the late 2000s. The factors influencing the export of the manufacturing industry also show that the export of manufacturing in Thailand depends greatly on the incomes of trading partners. The real effective exchange rate and production capacity have significant effects on the export of the manufacturing industry in Thailand in the short-run.

Key words: Export performance, Comparative Advantage, Vector Error Correction Model

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I. Introduction

Thailand, like many countries in the world, heavily depends on trade. The exports and imports of Thailand share around 70% and 60% of GDP in the present year. The country shifted from import substitution in the 1970s to export promotion in the 1980s, since then trade has extensively contributed to economic growth. The manufacturing industry of Thailand is the most important sector to move the economy of the country forward. Since the export of the manufacturing industry in Thailand covers more than 90% of total export and its market share of in the world market is around 1.2% in the present year. Therefore, it is vitally important to study the export performance of the manufacturing industry in Thailand during the 1990s and 2000s when it was in the high-growth period.

The export of the manufacturing industry in Thailand is the key element that brought the country out of the Asian Financial Crisis in 1997. After the crisis, the manufacturing industry recovered faster than the Thai government had predicted. For that reason, many studies attempt to explain which factors shifted Thailand out of the crisis such as Athukorala and Suphachalasai (2004) and Vimolsiri (2010). Those authors applied factors such as trade performance, total factor productivity, and fiscal and monetary policy to explain the recovery of economy after the crisis. One conclusion from previous studies is that the crucial factor that pulled Thailand out of the crisis is the export performance. The excellent export performance of the manufacturing industry has also raised many questions regarding the factors explaining the export performance of the manufacturing industry in Thailand.

Consequently, the objective of this study is to analyze the export performance of the manufacturing industry during 1990-2010. Another objective is to analyze the factors determining the comparative advantage of the manufacturing industry in Thailand. This study attempts to address the questions as following: what is the export performance of the manufacturing industry during the 1990s and 2000s, which product groups of the manufacturing in Thailand had a strong or weak performance, how the transition of comparative advantage of the product groups of the manufacturing industry increased or decreased, and which factors determined the comparative advantage of the manufacturing industry.

This study analyzes the manufacturing industry in Thailand at the aggregate and product group level. The product group level is the three digits level regarding the classification of the International Standard Industry Classification (ISIC). Analyzing the export performance can assist the country to better address its strength and weakness of its export in the world market. Policy makers can create appropriate trade policies to improve the competitiveness of international trade if they better understand the situation of trade in the country and the world market. The results of this analysis also can be a lesson for other countries to learn from the experience of the manufacturing industry in Thailand.

II. Review of Literatures

The modern theory of international trade was introduced by David Ricardo in the early nineteen century. The concept of his theory is the comparative advantage which states that “the competitive of an industry depends not only on its productivity relative to foreign industry, but also on the domestic wage rate relative to foreign wage rate" (Appleyard & Field, 2001). However, the Ricardo's model has some restricted assumptions. Balassa (1965) applied the concept of comparative advantage to develop the Revealed Comparative Advantage index (RCA). The country estimates the RCA index in order to check the strength and weakness of industry in term of export. Then they can promote competitive sectors and support noncompetitive sectors.

The weakness of RCA is that the index cannot compare among industries or countries. Many authors attempted to find the alternated indexes to overcome this problem; nevertheless, those indexes could not fulfill the constraint of the RCA index. Yu, Cai and Leung (2008) derived the Normalized Revealed Comparative Advantage (NRCA) from RCA in order to make the index comparable among industries and over period of times. They estimated and compared the NRCA and RCA index of the United States mainland with Hawaii and foreign countries. They concluded that NRCA is more consistent and more reflects the real situation of the United States trade than the RCA index.

The next question regarding the comparative advantage is what factors influence the comparative advantage of a nation. The basic explanation is a factor intensity of the country. The theory of factor intensity and comparative advantage was developed by Heckscher and Ohlin in 1930s. Two countries and two factors, capital (K) and labor (L), are the main assumptions of this model. The country will export the commodity whose production requires the intensive use of the nation's relatively abundance and cheap factor and import goods whose production requires the intensive use of the nation's relatively scarce and expensive factor (Salvatore, 2007).

The theory of Heckscher-Ohlin (H-O) has been applied in many empirical studies. Leontief (1956) used the input-outputs table to estimate the factor requirement for the export and import of the United States. The rich capital country like the United States should export capital-intensive goods and import labor-intensive goods. However, the result was surprising that the United States mostly exported labor-intensive goods and imported capital-intensive goods. This result is known as "Leontief's Paradox." However, the Leontief Paradox was rejected by many authors. Harkness and Kyle (1975) studied the factors influencing the United States' comparative advantage. They used the multi-factors regression to explain the net export of the United States. They found that the United States exported skilled labor intensive goods and import capital and unskilled labor intensive goods. Branson and Monoyios (1977) reconfirmed the studies of Harkeness and Kyle.

The studies on factors determining comparative advantage of the manufacturing industry are hardly existent in Thailand. Athukorala and Suphachalasai (2004) analyzed trade performance and factors determining the export of Thailand after the Asian Financial Crisis. They applied the factors such as the real effective exchange rate, world trade volume, and capacities utilization to explain the export. Jiranyakul and Brahmasrene (2002) analyzed factors determining the export and import of Thailand with major trading partners. Their results show that the real income and bilateral real exchange rates are crucial determinants of export and import between Thailand and its major trading partners. Vimolsiri (2010) studied the economic performance after the Asian financial crisis. Her study covers the impacts of the crisis in 1997 on all economic sectors which included agriculture sectors, service sectors and industry sectors. In addition, she also explains the policies that the Thai government had implemented to stimulate the economy during the crisis.

The previous studies provide different arguments and conclusions; however, they agree that the export of the manufacturing industry is one of the main factors that enable the Thai economy to recover quickly from the crisis. According to previous research studies, it is important to analyze the export performance and explain the factors influencing export performance of the manufacturing industry in Thailand both before and after the crisis. The uniqueness of this research is that it applies the logistic analysis to examine the direction of trade of the manufacturing industry in Thailand. In addition, different factors and approaches are used to explain the factors determining export of the manufacturing industry in Thailand.

III. Methodology

The methods to analyze export performance of the manufacturing industry are explained in the beginning of this section. The export performance indicators are mainly adapted from UNESCAP in 2007. The factors determining the export of the manufacturing industry is ascertained at the end of this section.

3.1 Export Performance

This section includes indicators which reveal changes in the commodity structure of export. They are also relevant for formulation of development strategies, as they reflect directly or indirectly the competitive ability of a country or region's economic sectors or activities. The indices covered in this section are the export share, market power index, and normalized revealed comparative advantage.

3.1.1 Export Share *(EXS)*

EXS measures extent diversification of exports across sectoral categories. It defines as the value of sectoral export divided by total exports of a given economy which is expressed by

$$EXS_{i,t} = \frac{EX_{i,t}}{\sum_{i=1}^{n} EX_{i,t}} \times 100 \qquad (1)$$

where $EXS_{i,t}$ is the export share of industry *i* at time *t*, $EX_{i,t}$ is the export of industry *i* at time *t*. The value of *EXS* is ranging from 0 to 100%. The more percentage of *EXS* is the greater importance of the product *i* in the export profile of the country.

3.1.2 Market Power Index *(MPI)*

MPI measures an indirect international market power, evaluated through a country's share of world markets in selected export categories. It defines as a share of total exports of a given product from the country under study in total world exports of the same product which is expressed by

$$MPI_{i,t}=\frac{EX_{i,t}}{EX_{i,t}^{w}} \times 100 \qquad (2)$$

where $EX_{i,t}^{w}$ is total export of industry *i* at time *t* in the world market, $EX_{i,t}$ is the export of industry *i* at time *t*. *MPI* takes values between 0 to 100%, with the higher value indicating the greater market power of industry.

3.1.3 Growth of Export *(GEX)*

GEX measures the movement of industry. It is defined as an annual compound percentage change in the value of exports of one industry between two periods, which is expressed by

$$GEX_{i,t} = \frac{EX_{i,t} - EX_{i,t-1}}{EX_{i,t-1}} \times 100 \qquad (3)$$

where $EX_{i,t}$ is the export of industry *i* at time *t*, $GEX_{i,t}$ is the growth rate of export of industry *i* at time *t*. GEX takes value from -100 (if trade ceases) to $+\infty$. The value zero means trade does not change.

3.1.4 Normalized Revealed Comparative Advantage *(NRCA)*

The NRCA measures the degree of deviation of a country's actual export from its comparative advantage neutral level in term of its relative scale with respect to the world export market and thus provides the a proper indication underlying comparative advantage (Yu, Cai, and Leung, 2008). The key derivation of NRCA is from Revealed Comparative Advantage (RCA) at neutral point (RCA=1). Under the situation of RCA at neutral point, country d export industry *i*, $\widehat{EX}_i^d$, equal to $\sum_{i=1}^{n} EX_i^d \times EX_i^w / \sum_{i=1}^{n} EX_i^w$, where EX_i^d is the export of industry *i* from country *d*, EX_i^w is the export of industry *i* from the world *w*, $\sum_{i=1}^{n} EX_i^d$ is total export of country *d*, $\sum_{i=1}^{n} EX_i^w$ is total export of the world. Country d is actual export industry *i* in the real world, EX_i^d, would normally different from $\widehat{EX}_i^d$ and the different can be stated as

$$\Delta EX_i^d = EX_i^d - \widehat{EX}_i^d = EX_i^d - \frac{\sum_{i=1}^{n} EX_i^d \times EX_i^w}{\sum_{i=1}^{n} EX_i^w} \quad (4)$$

Normalizing (4) by the world export, $\sum_{i=1}^{n} EX_i^w$, then NRCA is expressed as

$$NRCA_i = \frac{EX_i^d}{\sum_{i=1}^{n} EX_i^w} - \frac{\sum_{i=1}^{n} EX_i^d \times EX_i^w}{\sum_{i=1}^{n} EX_i^w \times \sum_{i=1}^{n} EX_i^w} \quad (5)$$

$NRCA_i > 0$ ($NRCA_i < 0$) indicates that a county actually export commodity *i* is higher (lower) than its comparative advantage neutral level (RCA = 1), signifying that the country has comparative advantage (disadvantage) in commodity *i*. The greater the $NRCA_i$ score is, the stronger of comparative advantage would be. For example, $NRCA_1$ = 0.01 and $NRCA_2$ = 0.005 means that the relative strength of commodity 1 is two times its comparative advantage of commodity 2.

3.2 Factors determining comparative advantage of the manufacturing industry

This section discusses the method to analyze the factors determining comparative advantage of the manufacturing industry. The manufacturing industry is analyzed in two levels, manufacturing at sub-group level and at aggregate levels.

3.2.1 Factors determining comparative advantage at industry group level

This section analyzes the factors determining the comparative advantage of the manufacturing industry at industry group level (three digits level). Branson and Monoyios (1977) had predicted the direction of trade regarding the factor intensity of industry. They justified two-factor model to the multi-factors model. In the multi-factors model, capital, skilled labor and unskilled labor are the main factors to explain the direction of trade and comparative advantage. Stern and Maskus (1981) use multi-factors model to explain the structure of the United States foreign trade during 1958-76. Derived from both studies, the model is defined by

$$NX_i = f(K_i, USKL_i, SKL_i) \quad (6)$$

where the linear function is

$$NX_i = \alpha_0 + \alpha_1 K_i + \alpha_2 USKL_i + \alpha_3 SKL_i + u_i \quad (7)$$

NX_i is net export, export minus import, of industry *i*. K_i is total net fixed asset as a proxy of capital of industry *i*. $USKL_i$ and SKL_i are unskilled labor and skilled labor of industry *i* respectively. $USKL_i$ is unskilled labor where it is the numbers of operative labor of industry *i*. The operative labor refers to persons who were directly engaged in the production process or other related activities and received regular pay in terms of wages or salaries. SKL_i is a skilled labor of industry *i* where it is defined as labor other than operative labor, they are administrative technical and clerical workers such as salaried managers and directors, laboratory and research workers, clerks, typists, book-keepers and administrative supervisors, salesmen and the like. The sign of the coefficient of independent variables shows a direction of trade. For example, if the coefficient $\alpha_1$in the equation (6) is positive, then the manufacturing industry exports the capital intensive; in other words, they are the comparative advantages. On the other hand, if the coefficient α_1 is negative, then the manufacturing industry imports the capital intensive goods; in other words, they are the comparative disadvantages. The explanation of the sign of α_2 and α_3 is the same as the sign of α_1.

Harkness and Kyle (1975) and Stern and Maskus (1981) argued with model (6) that cannot be used as a basis for analyzing the determinant of a country net export. Model (6) did not say that, across industries, either the relative or absolute share of net exports is monotonically increasing with the capital-labor ratio, ceteris paribus. In other words, there is no theory saying that the industry with high capital-labor ratio (K/L) will have higher net export surplus. Furthermore, the export also depends on the demand side, and model (6) has ignored it. The multi factor proportion model can predict only the direction but not the volume of trade. Therefore, the net export (NX) considers only the industry as a net exporter or net importer, ignoring absolute or relative dimension. The net export *(NX_i)* in the previous model (6) becomes one if industry *i* is a net exporter, and zero if industry *i* is a net importer. Therefore, the logitic analysis is used to estimate the direction of trade. In both studies, the factors determining the comparative advantage are set in a linear function as

$$Y_i = \alpha + \beta X_i + \varepsilon_i \tag{8}$$

where Y_i is a binary dependent variable ($Y_i = 1$ if NX_i is positive and $Y_i = 0$ if NX_i is negative) and X_i is a characteristic of industry *i*. β is a vector of parameters and ε_i is the error term. The logistic analysis is that the logarithm of the odds of an industry being a net exporter is linear in independent variables. The characteristics of industry, X_i, in this model are the capital-labor ratios (*KL*), share of skilled labor to total labor (*SE*). The total net fixed asset of industry *i* is a proxy of the capital. In this section, the skilled labor is defined as in previous section. Therefore, the share of skilled labor (*SE*) is a ratio of skilled labors to total labor.

The sign of the coefficient of independent variables shows the direction of trade regarding factor intensities industry. A positive sign of the coefficient of the capital-labor ratio is interpreted that the manufacturing industry has been capital intensive in exporting goods; conversely, the negative sign of the coefficient shows that the manufacturing industry has been labor intensive in exporting goods. A positive sign of a coefficient of skilled labor to the total labor ratio means the manufacturing industry has exported skilled labor intensive goods and vice versa in the case of a negative sign of a coefficient. In the manufacturing census in 2007, the operative labor can be classified into two groups, skilled operative and unskilled operative labor. In order to check the direction of trade of manufacturing industry in Thailand whether it exports low skilled labor, the variable *MSE* is formed. *MSE* is the ratio of operative skilled labor plus skilled labor divided by total.

3.2.2 Factors determining the export of the manufacturing industry

The study of factors determining the export of the manufacturing industry indirectly explains the comparative advantage. In order to determine the factors influencing the export of the manufacturing industry, it is necessary to review the factors affecting the export from previous studies. The neoclassic economic theory emphasized the role of the real effective exchange rate on export. The appreciation or depreciation of a particular country's currency exhibits the loss or gain of export's competitiveness

(Edwards, 1989). Other factors influencing the export are the income of trading partners and production capacity, which reflect the demand and supply capacity. Goldstein and Khan (1978) derived the export function from the export demand function and the export supply function. The main factors determining the export are the export price, price of competing goods, production capacity, and income of trading partners. The empirical studies of factors influencing the export have been studied in many countries. Athukorala and Suphachalasai (2004) studied factors determining the export performance of Thailand in the post crisis period. The real effective exchange rate is one of the main factors in their model. Based on previous studies, the factors determining the export of the manufacturing industry in Thailand can be formed as follows:

$$EX_t = f(GDP_t, REER_t, PC_t,) \tag{7}$$

Deriving from (7), the linear function is specified as following:

$$lnEX_t = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnREER_t + \beta_3 lnPC_t + \varepsilon_t \tag{8}$$

where *ln* is natural logarithm, EX_t is real export of the manufacturing industry at time *t*, the real export of the manufacturing industry is calculated by dividing the value of export of the manufacturing industry with export price; GDP_t is real weighted average of GDP of the 22 trading partners at time *t*; $REER_t$ is real effective exchange rate at time *t;* and PC_t is production capacity of the manufacturing industry at time *t*.

GDP_t is the weighted average of real GDP of 22 trading partners. The selection of 22 trading partners is consistent with the estimation of real effective exchange rate. The real GDP of trading partners *i* is weighted by overall trade volume with Thailand. The theory suggests that when the income of trading partners increases, they tend to consume more, and then the exporting country can improve their export. Therefore, the expected sign of coefficient β_1 is positive.

Real effective exchange rate is a weighted average of exchange rates of home and foreign currencies, with the weight for each foreign country equal to its share in trade. When the effective exchange rate increases, the export of the country tends to decrease since the export product is more expensive from the perspective of foreign countries. Therefore, the expected sign of the coefficient of β_2 is negative.

The export supply function is determined by the supply capacity regarding the study of Goldstein and Khan in 1978. The manufacturing production capacity is estimated by

$$PC_t = \frac{Q_t}{CU_t} \times 100 \tag{9}$$

where PC_t is the manufacturing industry production capacity at time *t*; CU_t is capacity utilization rate at time *t*; and Q_t is production quantity of manufacturing industry at time *t* (Bank of Thailand, 2011). The higher rate of production capacity the more output has been produced. Therefore, the expected sign of coefficient of β_3 is positive.

All of data in model (8) are time-series data covering a quarterly data during 1995-2010. The problem in time-series data is that they are often non-stationary or containing unit roots. If series are non-stationary, the result of regression often leads to a spurious regression. In order to use non-stationary data series, Vector Autoregressive Regression (VAR) is applied if the variables are not co-integrated and the Vector Error Correction Model (VECM) is applied if the variables are co-integrated. The Johansen (1995) approach is applied in this paper.

There are five steps to estimate the VECM by using the Johansen (1995) approach. The first step is to test order of integration. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) are used to test the unit root. The second step is determining the lag length since it can influence the result of the model. The lag length is determined by using five different information criterions such as Likelihood Ratio (LR), Final Prediction Error Criteria (FPC), Akaike Information Criterion (AIC), Hannan-Quinn Information Criteria (HIQC) and Schwarz Criterion (SC). The third step is to choose the appropriate model with respect to whether it includes the intercept and/or a trend in the long-run model and the short-run model. The forth step is to find the cointegration among variables. The idea behind the co-integration test is that two or more variables can be stable for long run equilibrium relationships even though series data may drift apart in the short-run. If a co-integration relationship is found, all variables are co-integrated and they move closely together over time. The final step is to test for weak exogeneity. Therefore, when the number of cointegrating vectors has been determined, the testing for weak exogeneity should be observed.

3.3 Data

This study covers the manufacturing industry in Thailand at the product group level and at the aggregate level. The manufacturing industry in Thailand is classified based on International Standard Industry Classification (ISIC). The ISIC classifies the industry into Section, Division, Group and Class. The industry is divided into 17 sections, and manufacturing is in Section D. Section D includes 23 divisions and 61 groups of industry. The export data covers 57 groups of industry from manufacturing of processing and preservation of meat, fish, fruit, vegetables, oils and fats (151) to manufacturing of not classified elsewhere in other groups (369). Trade data are obtained from World Integrated Trade Solution (WITS).

The main source of data of characteristics of the manufacturing industry is from the National Statistics Office (NSO) of Thailand. The data of the manufacturing at the industry and firm level are taken from manufacturing industry censuses in the years 1997 and 2007. The manufacturing industry censuses cover 54 and 56 groups of industry in the year 1997 and 2007 respectively. The manufacturing industry census is conducted every ten years; nevertheless, the NSO has rescheduled the census to be conducted every five years. The new census is expected to be carried out in the year 2012. The manufacturing industry census covers the operation of firms from 1st January to 31st December of the preceding year. For example, the industry census in 2007 covered the operation of firms from 1st January to 31st December 2006. The time series data used in model (15) are obtained from various sources. The data of the export of the manufacturing industry are obtained from WITS. Real GDP of trading partners are taken from CD ROM of International Financial Statistic in 2011. The real effective exchange rate and capacity utilization and quantity of manufacturing industry are collected from the website of the Bank of Thailand.

IV. Results and discussions

The results of export performance are discussed in the beginning of this section. Export performance covers the indicators such as export share, market power index, growth of export, RCA and NRCA. The end of this section investigates the factors determining the RCA and discusses the results.

4.1 Export Performance

4.1.1 Export Share

The top five export share of the Thai manufacturing industry is explained in this section. Table 1 shows the percentage of major export products during 1991-1995, 1996-00, 2001-05, and 2006-10. The top major export product groups share around 40% of the total export of the manufacturing industry. The export of processing and preservation of meat, fish, fruit, vegetables, oils and fats (151) is in the top major export product groups during 1991-1995; however, the trend of its share is decreasing over time. After 1995, the number one major export of the manufacturing industry is the manufacture of office equipment and machinery (300) which accounts for 10.55-14.75% of total export of manufacturing industry. The second top ten major exports is the manufacture of electronic valves and tubes and other electronic components (321). The manufacture of motor vehicle (341) is remarkable group as it has moved from out of the top five during 1990-2005 to the third position of export share of the manufacturing industry during 2006-2010.

Table 1. Top five export share

	Top five 1991-1995		Top five 1996-2000		Top five 2001-2005		Top five 2006-2010	
Rank	Product	%	Product	%	Product	%	Product	%
1	151	13.45%	300	14.75%	300	11.70%	300	10.55%
2	181	9.71%	151	10.26%	321	9.18%	321	6.72%
3	300	9.10%	321	9.05%	151	7.94%	341	6.52%
4	369	7.74%	181	5.18%	241	5.20%	151	6.29%
5	321	6.16%	153	4.90%	323	4.82%	241	6.12%

Source: Author's calculation, 2011

4.1.2 Market Power Index

The top five of the market power index or share of export product in the world market of manufacturing products is demonstrated in table 2. The manufacture of grain mill products, starches and starch products, and prepared animal feeds (153) has strong market power in the world market which accounts for 10.12% to 19.09% in the world market. The export of processing and preservation of meat, fish, fruit, vegetables, oils and fats (151) shares around 3-6% of the world market, although it is number one in the major export product. Other product groups have small power in the world market.

Table 2. Top five products on Market Power Index

	Top five 1991-1995		Top five 1996-2000		Top five 2001-2005		Top five 2006-2010	
Rank	Product	%	Product	%	Product	%	Product	%
1	153	19.09%	153	11.36%	153	10.12%	153	12.46%
2	192	7.01%	151	3.80%	151	3.32%	251	4.41%
3	369	6.97%	191	3.25%	243	3.00%	243	4.18%
4	191	6.42%	300	2.72%	251	2.72%	300	4.03%
5	151	6.39%	369	2.68%	300	2.45%	359	3.25%

Source: Author's calculation, 2011

4.1.3 Growth of Export

This section shows the export's growth of potential product groups. The selection of potential groups is based on the significant of the product groups in term of export share, market power index, and RCA. Therefore, this section mainly focuses on product groups 151, 153, 300, 321, and 323, which are major export and high market share in the world market products. The discussion also focus on the product groups which have RCA changing from lower than unity (noncompetitive) to more than unity (competitive) such as product groups 241, 281, 291, 341, and 343. The export of manufacturing products grew on average at 20.89% per year during 1991-1995 (see table 3). The impact of the Asian Financial Crisis reduced the export of manufacturing to have negative growth in 1998. Out of 57 manufacturing products group 39 product groups have a severe situation in facing negative growth in 1998. After the crisis, the export of manufacturing rapidly rebounded to positive growth during 2001-2010. The manufacture of office equipment and machinery (300) dropped the export growth from 29.95% to 9.27% after the crisis. The growth rate of export of manufacture of motor vehicles (341) and manufacture of parts and accessories for motor vehicles (343) has average growth around 38.10% and 37.89% per year during 1991-2010. The government of Thailand implemented policies to promote motor vehicle sector during early 1990s, since then this sector shifted from import oriented to export oriented in 1996.

Table 3. Average growth of export of manufacturing industry

Code/Year	1991-95	1996-00	2001-05	2006-10	1991-10
Manufacturing	20.89%	4.66%	10.21%	13.37%	12.28%
151	13.82%	0.46%	2.80%	11.54%	7.16%
153	13.16%	-1.97%	9.31%	19.89%	10.10%
241	42.65%	34.87%	19.63%	12.99%	27.54%
281	11.06%	3.90%	26.19%	30.66%	17.95%
291	33.70%	4.78%	17.65%	17.30%	18.36%
300	29.95%	9.27%	6.44%	8.49%	13.54%
321	30.13%	15.55%	3.38%	7.11%	14.04%
323	24.49%	4.70%	10.24%	2.21%	10.41%
341	27.97%	73.31%	26.35%	24.77%	38.10%
343	68.04%	30.83%	35.50%	17.20%	37.89%

Source: Author's calculation, 2011

4.1.4 Normalized Reveal Comparative Advantage

The result of NRAC from the equation (5) provide a small number; however, it is recommended to multiply the NRCA by 10,000 (Yu, Cai, and Leung, 2008). The highest rank of NRCA is processing and preservation of meat, fish, fruit, vegetables, oils and fats (151) during 1991-1995. The NRCA of processing and preservation of meat, fish, fruit, vegetables, oils and fats (151) has three times strength of the NRCA of manufacture of office, accounting and computing machinery (300). However, the rank of product (151) and (300) is reversed during 2006-2010. The highest rank of NRCA is manufacture of office, accounting and computing machinery (300) and it is two times strength of the manufacturing of processing and preservation of meat, fish, fruit, vegetables, oils and fats (151). The NRCA of the manufacture of wearing apparel, except fur apparel drop over time. The NRCA of manufacture of rubber (251) has impressively moved from outside the top ten during 1991-2000 to the fifth rank during 2006-2010.

Table 4. Top ten highest NRCA

	Top ten 1991-1995		Top ten 1996-2000		Top ten 2001-2005		Top ten 2006-2010	
Rank	Product	NRCA	Product	NRCA	Product	NRCA	Product	NRCA
1	151	13.845	300	9.819	300	7.167	300	9.772
2	181	9.854	151	8.363	151	6.137	153	5.561
3	369	8.211	153	5.209	321	5.218	151	4.971
4	153	7.269	321	4.375	153	4.020	321	4.207
5	300	4.930	369	3.103	323	2.754	251	2.971
6	192	3.885	181	2.828	369	2.158	369	2.085
7	323	2.980	323	2.686	251	1.407	154	1.414
8	321	2.976	311	1.731	311	1.295	323	1.286
9	154	2.644	154	1.608	154	1.190	293	1.047
10	191	1.889	192	1.268	181	1.092	319	0.907

Source: Author’s calculation, 2011

In order to capture the trend of comparative advantage during 1990-2010, NRCA of the manufacturing industry is classified into seven groups (see table A.1 in Appendix). Group A contains products achieving comparative advantage status (NRCA>0), which exhibited an increased during 1991-2010. The main products in this group are mainly capital intensive products except for manufacture of rubber products (251) and manufacture of transport equipment (359). Group B contains products achieving comparative advantage (NRCA>0), but the trend of NRCA in this group is decreased. The main products in this group are labor intensive products such as production, processing and preservation of meat (151), manufacture of grain mill products (153), manufacture of food products (154) and spinning, weaving and finishing of textiles (171). The trend of manufacture of processing and preservation of meat, fish, fruit and vegetable and the like (151) and manufacture grain mill products (153) has decreased despite a strong comparative advantage. Group C contains products achieving comparative advantage during 1991-05 and becomes comparative disadvantage during 2006-2010. The main products of this group are manufacture of other textiles, manufacture of knitted and crocheted products (173), manufacture of wearing apparel, except fur apparel (181), tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness (191), and manufacture of footwear (192).

Group D is a group of products having NRCA lower than zero, but the trend of products in this group is increasing. There are 12 products in this group. The manufacture of motor vehicles (341) and manufacture of parts and accessories for motor vehicle (343) has demonstrated a remarkable increase in NRCA. Group E contains products having NRCA lower than zero, but the trend is decreasing over time. There are nine products in this group including the manufacture of tobacco products (160), the manufacture of paper and paper part products (210), the manufacture of electric lamps and lighting equipment (315), the manufacture of television and radio transmitters (322), and the manufacture of bodies (coachwork) for motor vehicles and manufacture of trailers and semi-trailers (342). Notice that main products in this group are natural resource products. Group F contains products having NRCA lower than zero and their trend is constant.

Group G contains products in which NRCA changes from lower than zero during 1990-05 to higher than zero during 2006-10. This group is comprised of five products, which are the manufacture of products of wood, cork, straw and plaiting materials (202), publishing (221), the manufacture of basic chemicals (241), the manufacture of structural metal products, tanks, reservoirs and steam generator (281) and the manufacture of optical instruments and photographic equipment (332).

4.2 Factors determining comparative advantage and export of the manufacturing industry

This section demonstrates the results of the factors determining comparative advantage of the manufacturing industry in Thailand. The logistic regression is applied to analyze the factors determining comparative advantage. The times series analysis is also used to find factor determine the export of the manufacturing industry.

4.2.1 Factors determining the comparative advantage

The multi-factors model (9) was regressed by using OLS for two years, 1996 and 2006. In 1996, the results of model (9) show the coefficient of capital is negatively significant at the 5% level and the coefficient of labor is positively significant at the 1% level. The manufacturing industry is exporting labor intensive goods and importing capital intensive goods. In addition, the coefficient of unskilled labor is positively significant at the 1% level while the coefficient of skilled labor is insignificant in the model which means that the manufacturing industry in Thailand is actually exporting unskilled labor intensive goods.

In 2006, the coefficient of labor is negatively significant at the 10% level. This means the manufacturing industry is exporting labor intensive goods. The coefficient of capital is negative but not significant, so it is not obvious that the manufacturing industry is an importer of capital intensive goods in 2006. The coefficient of unskilled labor is significant at the 10% level while the coefficient of skilled labor is negatively insignificant. Therefore, the manufacturing industry exports unskilled labor.

Table 8. Summary of statistics results of model (9)

Year	K	L	USKL	SKL	N	R^2
1996	-0.481	0.562			54	0.281
	(0.233)**	(0.142)***				
	-0.469		0.614	0.139	54	0.283
	(0.248)***		(0.191)***	(1.441)		
2006	-0.260	0.353			56	0.067
	(0.027)	(0.181)*				
	-0.131		0.721	-3.550	56	0.087
	(0.255)		(0.392)*	(3.697)		

Note: figures in parenthesis are standard errors

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

The net export was replaced by the binary variable (1 is the net exporter, and 0 is the net importer). The logistic regression results are shown in table 9. The signs of coefficient of the capital-labor ratio are negative in 1996 and 2006, but they are not significant in any year. The coefficients of the ratio of skilled labor to total labor are negatively significant in both years. This means the manufacturing industry is an exporter of unskilled labor intensive goods. In 2006, the data allow for classifying labor into two levels, skilled labor (SE) and medium skilled labor (MSE). Equation (14) was regressed again with SE and MSE; however, the coefficient of the medium skilled labor ratio is not significant.

Table 9. Summary statistics result of equation (14)

Year	KL	SE	MSE	N	Pseudo R^2
1996	-0.518	-15.098		54	0.173
	(-0.802)	(6.171)**			
2006	-0.017	-25.974		56	0.214
	(0.222)	(8.537)***			
	-0.009	-24.512	-2.322	56	0.222
	(0.224)	(8.591)***	(3.032)		

Note: figures in parenthesis are standard errors
* p<0.10, ** p<0.05, *** p < 0.01

From the results in tables 8 and 9 it can be concluded that the manufacturing industry of Thailand has a comparative advantage in labor intensive goods and a comparative disadvantage in capital intensive goods in 1996. Although the manufacturing industry has a comparative advantage in labor intensive goods, it is a medium and unskilled labor not skilled labor. The result is obvious since the labor-intensive goods play an important role in the share of export of and comparative advantage manufacturing industry. For example, the product groups (300) and (151) are the first and the second highest major of export of manufacturing industry during 1996-2000 (see table 1). In addition, the product groups (151) and (153) have a very high comparative advantage during 1996-2000. The absolute value of a coefficient of capital in model (8) becomes smaller in 2006. Furthermore, the absolute coefficient of the capital-labor ratio in 2006 is smaller than it is in 1996. From this result, the manufacturing industry is in the transition process of moving from a labor-intensive industry to a capital intensive industry. The evidence can be supported by the result of the previous section. The capital-intensive industries play more important roles in the exports in the present year. The industry in group G (table A.2 in appendix A) such as publishing (221) manufacture of basic chemical (241), and manufacture of structural products (281), and this group has a comparative advantage in the present year.

4.2.2 Factors determining the export of the manufacturing industry

Following five steps of the VECM approach, each series variables are tested by ADF and PP. According the ADF test, the variables are not stationary at the level except $lnREER$, although including constant and time trend (see table A.2 in Appendix). The results of PP test confirm the result of ADF test. Then the first difference in the stationary process is employed to all series variables. The results of ADF and PP test show that all variables are stationary at the first difference (see table A.3 in Appendix). In other words, they are integrated at degree one, I (1). If all series are integrated in the same order, i.e. I (1), the cointegration may exist. The statistic of lag length criterion of LR, FPE, and AIC suggests that the appropriate lag length in the level is four (see table A. 4 in Appendix). However, in the VECM the lag is reduced to two, because the variables are in first difference. The appropriated model is case three where there is an intercept and trend in CE and no trend in VAR. The next stage is to test cointegration (see table A.5 and A.6 in Appendix). The maximum eigen value and trace statistic shows that the null hypothesis of no rank (r = 0) is rejected. Thus, the appropriate rank is one. After determining the number of the lag and the rank (number of cointegration), all variables are employed VECM model. The result presents the factor determining the export of manufacturing industry. The cointegration equation expresses as long run relationship among variables and shows as follows:

$$lnEX = 3.566lnGDP - 0.967lnREER + 0.182lnPC - 26.738 \quad (10)$$
$$(0.384)^{***} \qquad (0.340)^{***} \qquad (0.164)$$

The coefficients of variables are interpreted as long run elasticity. The coefficient of $lnGDP$ is positively significant at the 1% level. In the long run, it can be expected that 1% increase of GDP of trading partners will increase the export of manufacturing of Thailand for 3.566%. This means the income of trading partners of Thailand is an important factor to determine the export of manufacturing of Thailand. The coefficient of $lnREER$ is negatively significant at the 1% level. Therefore, 1% decrease (increase) in real effective exchange rate will increase (decrease) the export of the manufacture industry in Thailand about 0.967%. In other words, the depreciation (appreciation) of value of Baht against the value of trading partners' currencies will increase (decrease) the export of the manufacturing industry in the long-run. The long-run coefficient of production capacity is not statistically significant.

Table 6. Summary results from the VECMs

	$\Delta lnEX$	$\Delta lnGDP$	$\Delta lnREER$	$\Delta lnPC$
$\hat{\alpha}$	-0.434 (0.060)***	-0.003 (0.007)	-0.296 (0.036)***	-0.322 (0.056)***
$\Delta lnEX_{t-1}$				0.218 (0.116)*
$\Delta lnEX_{t-2}$			0.163 (0.074)***	0.271(0.117)***
$\Delta lnGDP_{t-1}$	3.157 (1.312)***	0.449 (0.149)***		
$\Delta lnREER_{t-1}$	0.678 (0.331)***		-0.316 (0.185)***	
$\Delta lnPC_{t-1}$	0.615 (0.214)***	0.059 (0.025)***		
D_1	-0.058 (0.021)***			
D_3	0.044 (0.024)*			
Df	-0.252 (0.051)***		-0.227 (0.028)***	-0.245 (0.045)***
Adjusted R^2	0.622		0.602	0.487
S.E. equation	0.048		0.027	0.042

Note: figures in parenthesis are standard errors
* p<0.10, ** p<0.05, *** p < 0.01

The short-run relationship among variables is shown in table 6. The short-run models included exogenous variables in order to investigate the impact of the shocks to the system. The Asian Financial Crisis (Df) is dummy variable where it is 1 after the crisis (3rd quarter of 1997) and 0 otherwise. The seasonal adjustments for quarterly data are D_1, D_2 and D_3. The $\hat{\alpha}$ determines the single period response of the dependent variable to its deviation from the equilibrium. The efficient of speed of adjustment of $\Delta lnGDP$ is statistically insignificant. The $lnGDP$ is weak exogenous, so the short-run equation of $\Delta lnGDP$ can be dropped from a system.

Consider the short-run equation of $\Delta lnEX$, the adjustment coefficient, $\hat{\alpha}$, is negatively significant at the 1% level. The negative error correction coefficient (-0.426) indicate that $\Delta lnEX_t$ falls ($lnEX_t$ falls or $\Delta lnEX_t$ is negative) when there is a positive cointegrating equation ($lnEX - 3.566lnGDP + 0.967lnREER + 0.182lnPC + 26.738 > 0$). The speed of adjustment of export in the short-run indicates that export disequilibrium is corrected to a speed of approximately 43.4% per quarter. The coefficients of $\Delta lnGDP$ and $\Delta lnREER$ are positively significant at 1% level in the first lag. The coefficient of real effective exchange rate is opposite from the expectation. The coefficient of $\Delta lnCU$ is positively but not significant.

The Asian Financial Crisis has negative impact to the export, real effective exchange rate and production capacity. The short-run equation of $\Delta lnREER$ is affected export at second lag and real effective exchange rate at first lag. The short run equation of $\Delta lnPC$ has a positive relationship with export of manufacturing industry at first and second lag.

4.3 Discussions

The study provides the results of the export performance of the manufacture industry in Thailand. The export of the manufacturing industry is dominated by the labor-intensive product's groups as can be seen in tables 1 and 2. However, the role of capital intensive goods has become more important in recent years since the share of product groups 241 and 341 moves from out of the top ten in the during 1991-1995 to the fifth and the third during 2006-2010, respectively. Although the country faced the Asian Financial Crisis, it has had a slight impact on the export of manufacturing industry in Thailand. Major trading partners like Japan and the United States did not endure any impacts from the crisis in 1997; therefore, the growth of export of the manufacturing industry performs well as its growth rate is 10-13% per year during 2000-2010. The NRCA index of manufacturing industry shows strong comparative advantage in the labor-intensive goods, but the trend is decreasing overtime. On the other hand, the capital intensive goods contain a strong comparative advantage, especially product groups D and G (see table A. 1 in Appendix), which include manufacture of parts and accessories for motor vehicle and manufacture of general purpose machinery.

In order to find the factors determining the comparative advantage two approaches are used in this paper. The first approach applies the logistic regression to predict the direction of trade. The results show that the manufacturing industry in Thailand is an exporter of labor intensive goods where it is medium and low skilled labor. The result also indicates that Thailand is an importer of capital intensive manufacturing goods. In line with the results of NRCA, it can be concluded that manufacturing industry in Thailand has relatively comparative advantage in medium skilled labor intensive goods and has a relatively comparative disadvantage in capital and skilled labor intensive goods during 1990s. The turning point came after the country had recovered from the crisis in 1997, the country exports many manufacturing industry goods which contains a lot of export of capital intensive goods.

The pattern of comparative advantage and export of the manufacturing industry in Thailand is moving from labor intensive goods to capital intensive goods as explained in the flying geese paradigm and product life cycle. Akamatsu (1962) explained the flying geese paradigm of East Asia based on dynamic comparative advantage. The leader of flying geese is Japan. The second tiers of nations are South Korea, Taiwan, Singapore and Hong Kong and the third tier of nations are Thailand, Malaysia, the Philippines and Indonesia. Japan, Taiwan, and Korea are good examples in this pattern of development. In the early stage of economic development, garment and textile industries were important sectors in their economies. Later, they became diversified into more advanced technology such as electronics, steel, and automobile industries. The same pattern can be explained for the export of the manufacturing industry of Thailand. In early 1990s, the export of manufacturing is dominated by labor intensive industries such as the foods processing industry and textile industry. However, during 2000-2007 the export of motor vehicle and electronic has increased rapidly. The product life cycle is also support the pattern of trade of the manufacturing industry in Thailand. There are five stages of the product life cycle: introduction, growth, maturity, saturation and decline (Vernon, 1966). The export share and market share of many labor intensive manufacturing goods are in a declining stage because the increasing of labor cost reduces their competitiveness. On the other hand, many capital intensive goods are in a growth stage.

The long-run relationship among variables which include the export of the manufacturing industry, income of trading partner, real effective exchange rate and capacity utilization is presented in equations (9). The coefficients of $lnGDP$ and $lnREER$ are statistically significant at 1% level and the signs are correct. The result is obvious since the export of the manufacturing industry in Thailand depend on income of trading partners, especially Japan and the United States. The bilateral trade between Thailand and Japan and between Thailand and the United States covers 40-50% of total trade during 1990-2010. The coefficient of production capacity is statically insignificant in the long-run which means production capacity does not affect the export of manufacturing industry in the long-run. Thus, the demand (trading partner income) is more important than supply (production capacity) to the export of the manufacturing industry over the long term.

The short-run relationships among variables are presented in table 6. The discussion is focused on the factor determining the export of the manufacturing in the short-run. The capacity utilization and income of trading partners have positive impact on the export of manufacturing in the short term. However, the real effective exchange rate has positive effect to the export in the short-run which is not consistent to expectation and previous studies. Athukorala and Suphachalasai (2004) calculated of real exchange rate in term of Baht per US dollar based on ten trading partners and whole sale price index. They found the real exchange rate has a positive impact on the export of the manufacturing industry in the short-run and the long-run. Jiranyankul and Brahmasrene (2002) analyzed factors determining the trade between Thailand and major trading partners including Japan, the United States and Singapore. The bilateral real effective exchange rate was estimated in term of Baht per trading partner's currency for the example Baht per Yen. The results show the positive relationship between real effective exchange rate and the export. Remember the real effective exchange rate in this paper is in terms of foreign currency to Baht, thus the corrected sign of the coefficient is negative.

The possible explanation of the positive relationship between the real effective exchange rate and export of the manufacturing industry in the short-run is the Foreign Direct Investment (FDI) especially FDI from Japan. FDI from Japan covers around 40-60% of total investment in the manufacturing industry. Most of FDI from Japan in Thailand intends to export their products to the third countries. In the short-run, if the Thai's Baht appreciates, it may not impact the export of the manufacturing industry since they already have the order from other countries. In other words, Japanese firms gradually adjust to the fluctuation of exchange rate. The disadvantage of real effective exchange rate is based on the weight of 22 trading partners' currencies while the actual receipt from the export are using only three currencies such as USD (80%), Yen (10%), and Euro (5%). Therefore, the real effective exchange is not adjust well in the short run.

V. Conclusion and Policies Implication

The study analyzes the export performance of the manufacturing industry during 1990 to 2010 and identifies the factors influencing trade performance. It found that many groups of industries performed well in the world market. The results of the comparative advantage suggests that the manufacturing industry exported labor intensive goods in the early 1990s and it was in a transition to export capital intensive goods in the 2000s. The incomes of trading partners also have significant effects on the export of the manufacturing industry in Thailand over the long term. The real effective exchange rate is negatively significant in the long-run while it is positively significant in the short term. The capacity utilization has satisfied the expected sign in the short-run. Based on the results of this study, the policies implication can be drawn as follows:

The industry groups which are comparative disadvantage, especially labor intensive goods, should consider diversifying their investment to the locations where they have lower labor cost. For example, labor-intensive products can move their location to neighboring countries such as Cambodia, Laos, and Myanmar. Another possible option is to import labor from neighboring countries; however, this may be a trade off with the employment of domestic labor.

The manufacturing industry in Thailand should concentrate more on capital intensive goods, but they need more investment in machinery and technology. In order to do that the Thai government should promote domestic and foreign investment. It also suggests that labor requires more training which is necessary to improve the skills of labor in line with enhancement of capital. The skills of labor should meet the requirement of firms which means the firms should coordinate with the training institutes in other to match labor to appropriate work in the firms.

Diversifying the export to many other trading partners is another policy that the Thai government should consider since the export of the manufacturing industry in Thailand relies much on Japan and the United States. Trade negotiations and bilateral trade agreement should be considered as one alternative way to diversify trading partners. The stability of the exchange rate is a requirement for the exporters and importers of the manufacturing industry to reduce their risk.

The results of the study show that the manufacturing industry in Thailand is shifting from exporting labor intensive goods to exporting capital intensive goods, leading to the question of what factors influence the transition process. Foreign direct investment is one factor that has supported the export of the manufacturing industry in Thailand for many decades. Therefore, it is considerably interesting to study the role of FDI on export of the manufacturing industry in Thailand. Another factor that may impact on the export of manufacturing industry in Thailand is the role of productivity. Therefore, the investigation of impact of productivity on the manufacturing industry should be observed.

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Appendix

Table A.1 NRCA index and its trend during 1990-2010

NRCA > 0		NRCA < 0	
Code	Description	Code	Description
	Group A increase (1990-2010)		**Group D increase (1990-2010)**
243	Manufacture of man-made fibers	152	Manufacture of dairy products
251	Manufacture of rubber products	160	Manufacture of tobacco products
269	Manufacture of non-metallic mineral products not…	182	Dressing and dyeing of fur; manufacture of articles of fur
293	Manufacture of domestic appliances n.e.c.	201	Sawmilling and planning of wood
300	Manufacture of office, accounting and computing…	272	Manufacture of basic precious and non-ferrous metals
311	Manufacture of electric motors, generators and…	289	Manufacture of other fabricated metal products…
319	Manufacture of other electrical equipment n.e.c.	291	Manufacture of general purpose machinery
321	Manufacture of electronic valves and tubes…	292	Manufacture of special purpose machinery
359	Manufacture of transport equipment n.e.c.	312	Manufacture of electricity distribution…
		341	Manufacture of motor vehicles
	Group B decrease (1990-2010)	343	Manufacture of parts and accessories for motor vehicles…
151	Production, processing and preservation of meat…	353	Manufacture of aircraft and spacecraft
153	Manufacture of grain mill products, starches…		
154	Manufacture of other food products		**Group E decrease (1990-2010)**
171	Spinning, weaving and finishing of textiles	155	Manufacture of beverages
323	Manufacture of television and radio receivers, sound…	210	Manufacture of paper and paper products
333	Manufacture of watches and clocks	222	Printing and service activities related to printing
369	Manufacturing n.e.c.	231	Manufacture of coke oven products
		232	Manufacture of refined petroleum products
	Group C decrease from >0 (1990-05) to <0 (2006-10)	242	Manufacture of other chemical products
172	Manufacture of other textiles	322	Manufacture of television and radio transmitters…
173	Manufacture of knitted and crocheted fabrics and articles	351	Building and repairing of ships and boats
181	Manufacture of wearing apparel, except fur apparel	352	Manufacture of railway and tramway locomotives and…
191	Tanning and dressing of leather; manufacture of luggage…		
192	Manufacture of footwear		**Group F constant (1990-2010)**

252	Manufacture of plastic products	233	Processing of nuclear fuel
313	Manufacture of insulated wire and cable	261	Manufacture of glass and glass products
315	Manufacture of electric lamp and lighting equipment	271	Manufacture of basic iron and steel
342	Manufacture of bodies (coachwork) for motor vehicles…	314	Manufacture of accumulators, primary cells and…
361	Manufacture of furniture	331	Manufacture of medical appliances and instrument…
			Group G increase from <0 (1990-05) to >0 (2006-10)
		202	Manufacture of products of wood, cork, straw…
		221	Publishing
		241	Manufacture of basic chemicals
		281	Manufacture of structural metal products, tanks…
		332	Manufacture of optical instruments and photographic…

Note …for more details please see table A. 1

Table A.2 ADF and PP statistics at the level

	ADF				PP			
Variable	Constant without trend	Constant with trend	None	Lag	Constant without trend	Constant with trend	None	Bandwidth
lnex	-0.181	-2.937	1.247	0, 1, 0	-0.273	-2.423	1.186	4, 5, 4
lngdp	-1.352	-2.408	3.108	1, 1, 1	-1.418	-1.756	5.661	3, 3, 3
lnreer	-2.922**	-2.704	-0.679	8, 8, 8	-1.881	-1.423	-0.241	7, 8, 10
lnpc	0.185	-1.194	1.069	1, 3, 1	0.486	-0.961	-1.401	3, 5, 2
5% critical value	-2.908	-3.483	-1.946		-2.908	-3.483	-1.946	
1% critical value	-3.538	-4.113	-2.602		-3.538	-4.113	-2.602	

* p<0.10, ** p<0.05, *** p<0.01

Table A.3 ADF and PP test at the first difference

	ADF				PP			
Variable	Constant without trend	Constant with trend	None	Lag	Constant without trend	Constant with trend	None	Bandwidth
Δlnex	-6.778***	-6.869**	-6.706***	0, 0, 0	-6.712***	-6.807***	-6.666***	7, 8, 6
Δlngdp	-4.427***	-4.541***	-2.924***	0, 0, 0	-4.490***	-4.554***	-2.831***	2, 3, 2
Δlnreer	-6.112**	-4.966***	-6.152***	2, 7, 2	-5.908***	-8.410***	-5.985***	24, 36, 24
Δlnpc	-5.742***	-5.337***	-5.636***	0, 2, 0	-5.543***	-6.852***	-5.491***	8, 14, 7
5% critical value	-2.909	-3.481	-1.946		-2.909	-3.481	-1.946	
1% critical value	-3.540	-4.113	-2.602		-3.540	-4.113	-2.602	

* p<0.10, ** p<0.05, *** p<0.01

Table A.4 Selection lag order criteria

Lag	LL	LR	FPE	AIC	HIQC	SBIC
0	312.965	NA	5.73E-10	-9.931	-9.227	-9.656
1	594.975	477.984	7.00E-14	-18.948	-17.680*	-18.453*
2	613.470	28.839*	6.56e-14*	-19.033	-17.202	-18.318
3	629.820	23.278	6.73E-14	-19.044	-16.650	-18.110
4	643.769	17.968	7.69E-14	-18.975	-16.017	-17.821

Endogenous: lnex lngdp lnreer lnpc

Exogenous: c d1 d2 d3 df

Table A.5 Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.678	87.118	47.856	0.000
At most 1	0.170	17.972	29.797	0.568
At most 2	0.101	6.578	15.494	0.627
At most 3	0.001	0.050	3.841	0.822

Trace test indicates 1 cointegrating eqn (s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

A.6 Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.678	69.147	27.584	0.000
At most 1	0.170	11.394	21.132	0.608
At most 2	0.101	6.528	14.265	0.547
At most 3	0.001	0.050	3.841	0.822

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values