1-1-2016

A forecasting model for container throughput: empirical research for Laem Chabang Port, Thailand

Pitinoot Kotcharat

WORLD MARITIME UNIVERSITY
Malmö, Sweden

A FORECASTING MODEL FOR CONTAINER THROUGHPUT: EMPIRICAL RESEARCH FOR LAEM CHABANG PORT, THAILAND

By

PITINOOT KOTCHARAT
Kingdom of Thailand

A dissertation submitted to the World Maritime University in partial
Fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS

(PORT MANAGEMENT)

2016

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me

The contents of this dissertation reflect my own personal views, and not necessarily endorsed by the University.

(Signature): Pitinoot Katcharat

(Date): 19th September 2016

Supervised by: **Ilias Visvikis**

World Maritime University

Assessor: Daniel Moon

Institution/organization: World Maritime University

Co-assessor: Theodoros Syriopoulos

Institution/organization: University of the Aegean

ACKNOWLEDGEMENTS

Firstly, I am using this opportunity to express my gratitude to World Maritime University and British Petroleum Shipping Company for providing me with the fellowship.

Secondly, I would like to express my deepest appreciation to the Port Authority of Thailand to nominate me for this prestigious University, while providing me with an opportunity to expand my knowledge of the port management. My sincere appreciation also goes to my esteemed and distinguished supervisor, Professor Ilias Visvikis, who has the attitude and substance of a genius: he continually guides me and convincingly conveys a spirit of adventure in regard to research, and an excitement in regard to teaching. Without his guidance and persistent help this dissertation would not have been possible.

Thirdly, I would like to express my gratitude to everyone who supported me throughout the course of port management. I am thankful for their aspiring guidance, invaluable constructive criticism and friendly advice during my study period in Malmö, Sweden.
In addition, I would like to express my sincere thanks to Ms. Soontree Kimsawat for supporting me spiritually. My gratitude also goes to my classmates, Mr. Achmad Noor Riduansyah, Mr. Aditya Srivastav, Mr. Avinash Kumar, Mr. Ud Tuntivejakul, and Mr. Thet Wai, and my colleagues, Ms. Praew Ritthirungrat, and Palabodee Khanthong for supporting me during my dissertation work.

Finally, I express my sincere gratitude to my lovely parents, Mr. Chalor Kotcharat and Mrs. Parichat Kotcharat, my sister Ms. Parnnalin Kotcharat, and my friend Mr. Jose Alberto Solano Claustro, who have all devotedly supported me and shared my happiness.

Pitinoot Kotcharat
Malmo, 2016

ABSTRACT

Title of Dissertation: **A Forecasting Model for Container Throughput: Empirical Research for Laem Chabang Port, Thailand**

Degree: MSc

The Dissertation is a study on optimizing the forecast model of container throughput at Laem Chabang Port (LCP), and comparing the relationship of the container throughput with economic factors driven by demand of the country and economic factors driven by factors outside the country. A brief look is taken at present growth in world container trade and the trend of a mega size of vessels.

Over decade ports have to adjust themselves in order to accommodate the bigger size of vessels and the increase of world trade. Port expansion projects need to be engendered. The expansion projects at port are generally based on port traffic and cargo forecast. LCP which is the main international deep sea port in Thailand has been facing the same situation as other ports. The development project of LCP is initiated. In order to estimate the scope of the development project this paper is created to find the proper forecast model of container throughput at LCP. Undoubtedly, the growth of container throughput at a port is related to economic factors. In this paper, the economic factors are selected to generate the forecasting model. Pearson's correlation coefficient is applied to measure the correlation between each economic factor and container throughput. Regression method is used in the primary state to find the models. Autoregressive model and multiple regression with dummy variables are generated from regression method. Popularly statistical technics namely; main absolute error, root mean absolute error and mean absolute percentage error are performed to evaluate the predictive performance of each model. Eventually, the result illustrates that the autoregressive model with private investment index, employment volume and bunker oil price as its explanatory, gives the best precisely predictive performance

Key Words: Container throughput, forecast models, Laem Chabang Port, variable. regression, autoregressive model, statistical technics

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

ADF	Augmented Dickey-Fuller
APE	Absolute Percentage Error
ARIMA	Autoregressive Integrated Moving Average
ARMA	Autoregressive Moving Average
ASEAN	Association of Southeast Asian Nations
BLUE	Best Linear Unbiased Estimators
BUNKER_SIN	Bunker Price at Singapore
CAR_SALE	Volume of Car sales
CHN_T	Value of Trade between Thailand and China
CLRM	Classical Linear Regression Model
CONFRI	Container Freight Rate Index in Intra-Asia
CUSUM	Cumulative Sum Control Chart
ECM	Error Correction Model
ECT	Error Correction Term
EMPLOY	Number of Employment
ES	Exponential Smoothing
EXCHAGE_RATE	Exchange Rates
G_EXPEND	Government Expenditure
GDP	Gross Domestic Product
GNP	Gross National Product
GP	Genetic Programming
INDUSTRY_P	Industry Production Index
IRF	Impulse Response Function
JAP_T	Value of Trade between Thailand and Japan
LCP	Laem Chabang Port
LR	Linear Regression
MA	Moving Average

MACHINE	Value of Machine Sales
MAE	Mean Absolute Error
MD	Multiple regression with dummy variables
MOTORBIKE_SALE	Volume of Motorbike sales
MPAE	Mean Absolute Percentage Error
NN	Neural Networks
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
PAT	Port Authority of Thailand
PM	Pure multiple regression
PP	Phillip Perron
PRI_CON_ID	Private Consumption Index
PRI_IN_ID	Private Investment Index
RMSE	Root Mean Squared Error
RSS	Residual Sum Of Squares
S.E.	Standard Error
SARIMA	Seasonal Autoregressive Integrated Moving Average
TEU	Twenty Foot Equivalent Unit
UNCTAD	United Nations Conference on Trade and Development
USA_T	Value of Trade between Thailand and the United States
VAR	Vector Autoregressive
VECM	Vector Error Correction
WMA	Weight Moving Average

1. INTRODUCTION

In the era of globalization, trade barriers are being minimized to increase the world trade flow enabling people to consume products produced in other parts of the world. The maritime transport cost is the lowest compared to other modes of transportation. According to Cenek, Kean, Kvatch, and Jamieson (2012), sea transport is more cost effective than other modes of transport in the long distance. Their research shows that "every 1500 kilometers of a journey from Auckland to Dunedin, the ratio of costs in transporting a 20ft container was 1 (sea):1.7 (rail):2.8 (road)".

According to the Review of Maritime Transport 2015 by UNCTAD, from 2000 to 2015, the increase of container trade was the highest compared to that of other types of maritime transportation. Ports are the place for the loading and unloading cargo. They play the necessary role to support maritime transportation and intensively support economy of the countries. In 2014, 132 percentage of gross domestic product (GDP) of Thailand was shared by trade[1] (the World Bank, 2015).

Over the decade, the trend of using larger container vessels has become obvious. Shipping companies believe that the voyage cost per twenty-foot equivalent unit (TEU)

1 Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product by exports of goods shares 69.3 per cent of GDP whereas import shares 62.7 per cent of GDP (the World Bank, 2016).

would be reduced by increasing the capacity of vessels. Greater economies of scale can be triggered by bigger vessel's sizes. As ports and terminals directly work on loading-unloading containers from ships, the growth of vessels' size come with the problem on transshipping a larger amount of containers in a short time in ports. The increase of port facilities and equipment, for instance, larger quay cranes, temporary warehouses, and large container yards are required to cope with the problem. Furthermore, ports intend to reduce congestion in order to attract more vessel calls. The congestion in ports can occur due to several reasons, for instance, inadequate port's equipment and land or inefficient logistics services in ports. According to the Report by OECD (2015), every 10 per cent of the increasing of port congestion lead to 0.7 per cent of the increase of maritime transport cost. In order to cope with the high amount of containers per ship and to reduce the congestion, port expansion plans are initiated. To evaluate the expanding size of a port and to estimate the investment budget, the forecast of container throughput is required to assist port decision makers in order to set the budget and the size of the expansion plans. Various previous empirical studies on the forecast of container throughput are present. These studies may use of forecasting methods such as autoregressive integrated moving average model (ARIMA), moving average (MA), weight moving average (WMA), linear regression (LR), exponential smoothing (ES), neural networks (NN), and hybrid models, amongst others. The available empirical studies reveal a relationship between container throughput volume and macroeconomic variable of a country: the population, GDP, gross national product (GNP), capital stock, labour force, international trade value, index of price, and industrial production index are such variables link with container throughput volume. Some empirical studies illustrate the relationship between container throughput and port facilities through terminal storage capacities, free trade area and berth length (Liu and Park, 2011). However, an important element to gain an accurate forecasting model is to select appropriate independent variables. Different port characteristics and countries are influenced by distinct variables (Jansen, 2014). For example, ports located on the main shipping routes are influenced by difference factors from ports located far from main shipping routes. Even through, in a case of the same factor, the strength of its impact is distinct depending on the characteristics of the port.

The aim of this research paper is to forecast container throughput in Laem Chabang Port (LCP). Over 80 per cent of international trade of Thailand shared by maritime transport (Kasikonthai, 2014) and the majority of cargo transported through LCP which is the main international deep sea port of Thailand. Since 2009, over 4.6 million containers have passed through the port, and the volume tends to increase ever year. LCP plays the essential role in order to support Thai economy. In this paper, the explanatory variable selected to predict container throughput at LCP are as follows; bunker oil price, employment volume, exchange rate, industry production index, private consumption index, private investment index, government expenditure, container freight rate, and bilateral trade value. The regression method is being chosen to evaluate the relationship between explanatory variables and the container throughput and to generate forecasting models.

1.1 Aim and Objectives

The commercial shipping industry has experienced the increasing size of vessels and this presents the port with a challenge in terms of infrastructure to accommodate larger vessels. Several ports are planning to upgrade their facilities. The LCP is the biggest international deep sea port of Thailand controlled by the Port Authority of Thailand (PAT). From 2007 to 2014, the average growth of container throughput was at four per cent. In order to cope with the situation of the larger size of vessels and prevent the congestion in port in the future, PAT has initiated to expand and develop the area and upgrade port's facilities at LCP. Based on the four per cent increase every year, the port planners predict that the container volume at LCP will exceed 75 per cent of the maximum capacity in 2025. However, the expansion project is required a long process and a long time for constructing. Furthermore, the planning would be made in three terms namely short term, medium term, and long term. The expansion projects at ports are generally based on port traffic and cargo forecasting. This can assist the port planners to make a decision on a limited investment budget, scope, and size of the expansion project, amongst others. As the average four per cent increase in the container, throughput is calculated by averaging an increasing amount of container each year which is an unreliable forecasting method. Therefore, this paper strives to find an appropriate forecasting model to predict container throughput of LCP in a short term.

1.2 Scope of the Dissertation

The proportion of container volume at LCP consists of transit containers[2], transshipment containers[3], and empty containers. Figure 1 demonstrates a share proportion of container throughput at LCP by three main types of containerization. As seen, between 2007-2014, the transit containers shared the biggest proportion of the container throughput at 75 per cent whereas transshipment and empty containers have averagely shared at 1 per cent and 25 per cent respectively.

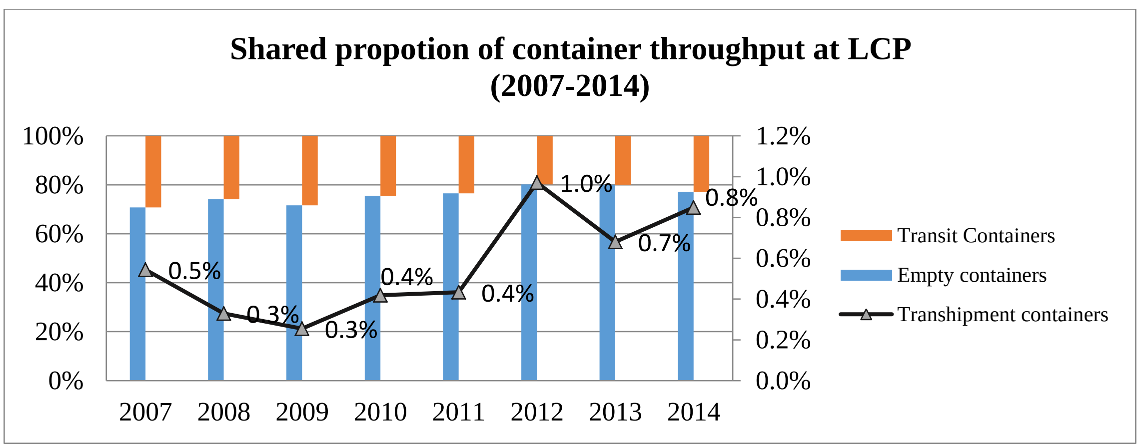


Figure 1 : Shared proportion of container throughput at LCP (2007-2014)

[2] Transit containers are the container conveyed from ports by rail or road for consuming in hinterland or transporting to a third country. For further definition of transit is indicated in chapter 2.

3 Transshipment containers are containers remained inside ports until they are shifted to another vessel. For further definition of transshipment is indicated in chapter 2.

Source: Adapted from “Unpublished data file” by PAT,2015

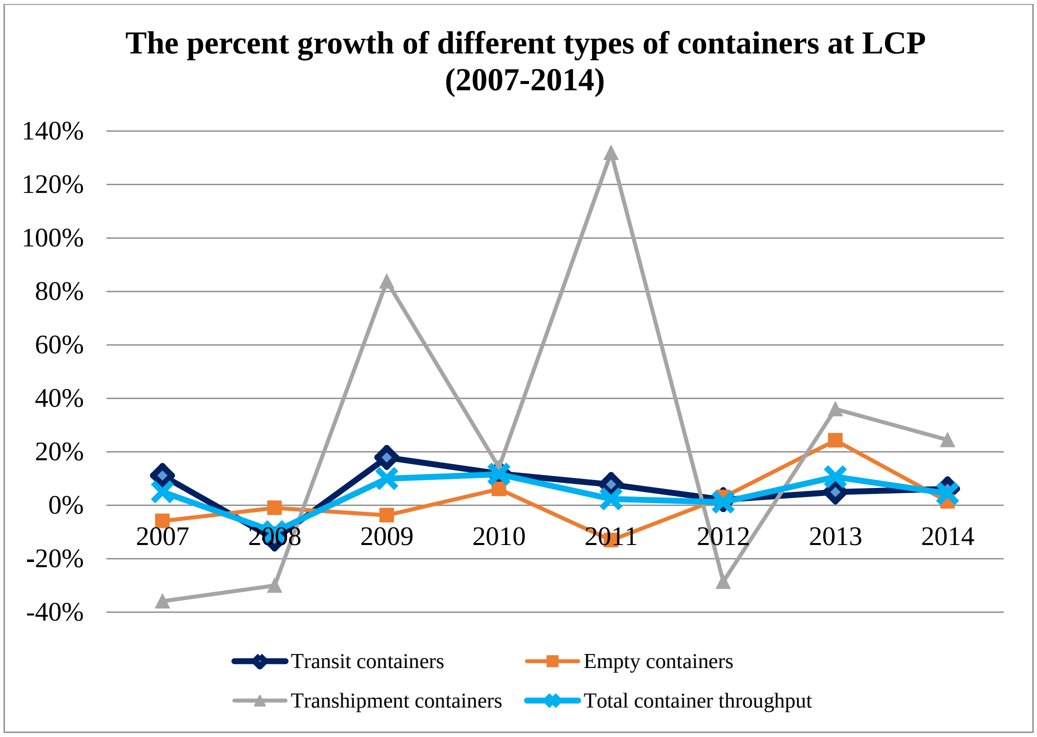


Figure 2 : The per cent growth of different types of containers at LCP (2007-2014)

Source: Adapted from “Unpublished data file” by PAT,2015

Figure 2 illustrates the movement of different types of containers during 2007-2014. Transit containers move closely with total container throughput whereas transshipment containers and empty containers move quietly uncorrelated with total container throughput. The types of containers have different characteristic and the reaction from economic factors in distinct ways. For instance, empty containers are generally determined similarly with non-empty container but in some factor e.g. trade imbalance is more influential to empty containers than non-empty containers (Diaz, Talley, and Tulpule,2011). As the recommendation of De Langen (2012) cited in Jemsan (2014), “it is more suitable to establish models to suit with one type of cargo”. Therefore, the forecast should be made for a particular type of cargo in order to discover the most efficient forecasting model and prevent any bias of the model. The movement of transit containers is the most closely related to total container throughput compared with the other two types of containers and it shares nearly 80 per cent of total container throughput. Therefore, this paper focuses on forecasting transit containers throughput at LCP to represent the total throughput at LCP by using the historical data in monthly from 2009-2013. The forecast model will be generated through the autoregressive model and multiple regression model. The monthly historical data of economic factors namely bunker oil price, employment volume, exchange rate, industry production index, private consumption index, private Investment index, government expenditure, container freight rate, and the bilateral trade value during 2009-2013 are to be used as explanatory variables in order to predict a dependent variable (volume of transit container throughput at LCP).

1.3 Research Questions

The aim of this paper is to answer the following statement questions:

- Are containers throughput of LCP more correlated with internal macroeconomic factors of a country e.g. employment volume, industry production index, private consumption index rather than external factors such as bunker oil price, container freight rate, and exchange rate?
- Can container throughput of LCP be forecasted and modeled well by using economic factors as the explanatory variables in an econometric model?

1.4 Structure of the Dissertation

This dissertation will determine the concept of Jansen (2014) on "each type of port should focus on different variables" by comparing the relationship of container throughput of transit port with factors related to activities inside country and factors related to market outside the country. The correlation between each independent variable and container throughput will be examined before proceeding model. An evaluation of the outcome of the models will be made before state the final forecasting model.

The structure of the dissertation consists of 6 chapters, as follows:

Chapter 1 explains the overview of maritime transport and port and introducing the objective of the dissertation. Also, the methodology and scope of the dissertation and research questions are included.

Chapter 2 defines the role, type and characteristic of ports and briefly explains the background of LCP. A literature review of the relationship between container volume and economic factors will be included in this chapter. In addition, several forecasting methods will be introduced.

Chapter 3 analyzes economic explanatory variables and their influences to the container throughput. In this chapter, Pearson's correlation coefficient is performed in order to determine the correlation between container throughput and each independent variable. Furthermore, to forecast the container throughput, regression method is used. The methodology process is described in this chapter.

Chapter 4 describes the result of the methodology. Two types of forecasting model namely autoregressive model and multiple regression with dummy variable model are found in this chapter.

Chapter 5 evaluates the performances of the models by using mathematical technic e.g. standard error and R square. In this chapter, an appraisal of the predictive performance of the forecasting models is also evaluated It also analyzes a comparison of predictive performance of multiple regression with and without dummy variables before summarizing the best accurate forecasting model.

Chapter 6 concludes the outcome of the dissertation. It includes the limitation of the research and suggestions for further research.

1.5 Overview Process of Discovering a Forecasting Model

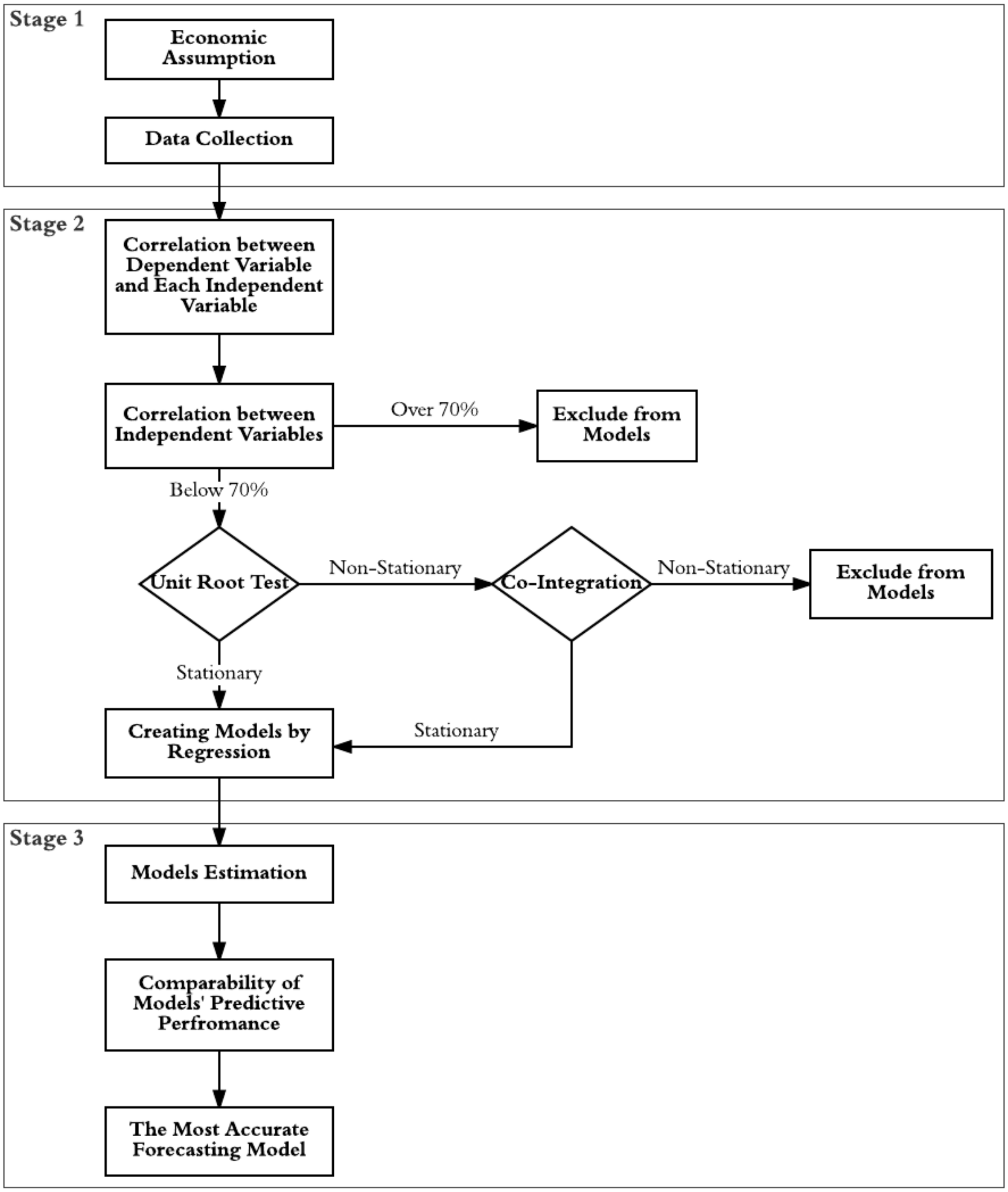


Figure 3 : Overview process of discovering forecasting model

Source: Author

Figure 3 illustrates a 3 stage map to determine the most accurate forecasting model for container throughput by using economic data as explanatory variables . At the first stage, of “Economic assumption”, the aim is to hypothesise the strength of the relationship of each economic factor which affect the volume of container throughput. Next, the data collection should be made. The second stage is creating a model by using quantitative method e.g. Pearson’s correlation coefficient, Unit root test, regression method. Furthermore, in this stage, the strength of the relationship between each explanatory variable and container throughput can be evaluated. The models generated from the second stage shall comparably estimate their accuracy and predictive performance in the third stage before arriving at the best forecasting model.

1.6 The Contribution of the Dissertation

This dissertation will make contributions to the port field. Even though there are several studies on forecasting container throughput, up to now there has been no particular study on the forecasting model of container throughput at LCP. Nowadays, a proper quantitative method to predict the future volume of container throughput has been lacking. Hence, he forecasting model derived in this dissertation will benefit Port planners at LCP in the future, and the over-investment of projects could be avoided.

Furthermore, studies concerning a comparison of different methods are (rich)??? and GDP is the most popular variable used to contribute forecasting model in the aforesaid studies. However, only a few studies have concentrated on an appraisal of proper explanatory variables from different relevant factors before generating a model. Therefore, dissertation will set to make a scientific contribution to the existing limited literature concerning the proper explanatory variables.

2. LITERATURE REVIEW

2.1 Definition of port

Port or portal has been known as a gateway to a town or city since the Roman era. The Romans built fortresses in order to protect themselves from enemies. All those who came across a fortress were considered as enemies. The passage was built in the mid of a fortress to allow transport and people passing through (Sorgenfrei, 2013). Regarding the definition given by UN-Glossary cited in Sorgenfrei (2013), a port is “an area with facilities for vessels to moor and load or unload cargo or to disembark or embark passenger”. A similar definition is given by other literature, for instance, in Roa, Peña, Amante and Goretti (2013), they identify ports as “ the areas that are attached to a sea, ocean or river by connecting waterway and are essentially considered as entities”. Mayer (1988) defines ports as “the places where there is the interchange of cargo and passenger traffic among vessels, and between vessels and overland carriers or sites alongshore”. To summarize, ports are the nodes interface connected to maritime transport and other modes of transport serving as a place to interchange cargo and passengers. After cargos are loaded at ports, they can be transported to the hinterland such as, logistics areas, industrial areas, agricultural areas or metropolitan areas.

2.2 Roles of ports

Ports have major impacts on the economy of the country. Most of them are positive effects whereas some are negative. The positive effects are mostly related to the escalating economic growth and GDP in countries. In Singapore, the land located of the busiest transshipment port in the world, in 2015 was 7 per cent of its GDP and was contributed from the Port of Singapore Authority (Fabbri, 2015). In terms of employment, ports create indirect and direct jobs, and one of the main points is the increase of demand for employment derived from related activities and industries. Furthermore, several innovations, research and development are initiated from ports. Nonetheless, various negative effects still exist. Mainly the negative consequences are environment effects and traffic congestion (Merk, 2013). Even through some negative effects of countries are caused by ports, they are still playing an essential role in order to stimulate the economy, and they act as the linkage gates between distinct continents. Ports play an essential role in term of transporting freight and people in a maritime field. Technical facilities, superstructures and infrastructures are provided to load and unload services for general or specialized cargos from different types of ship. Also, nowadays many ports are improving their roles. They not only act as the loading-unloading point , but also provide the distinct indirect-direct value added services. For instance, in the port of Rotterdam in 2007, roughly 10 per cent of the regional GDP was shared by value added from the port and in the same year, the value added to Le Havre/Rouen port generated more than 21 per cent of regional GDP (Merk, 2013). In Japan, which is known as a country with a long coastline of 18,486 miles (29,751 km) length, along its coast 1,100 ports and harbours are located (Alderton, 2008). 21 ports of the total ports are major international trade ports such as Yokohama Port, Tokyo Port, Kobe Port and Osaka Port. These port areas were developed to be used for related logistics activities namely; distribution centre, industry zone and energy supply base, commercial trading centre, and maritime leisure base (Alderton, 2008).

2.3 Characteristics and types of port

Ports can be classified into three major groups – by function, by type of cargo and by geography.

2.3.1 Function

Transshipment Port: Sorgenfrei (2013) defines a transshipment port as a port where the majority of total cargo traffic in the ports are transshipment cargos. Transshipment cargo is cargo which is being transferred from one ship to another ship. Transshipment cargo is not permitted to be conveyed out of port by rail or road. It has to remain inside the port until it is loaded onto another vessel. Regularly, each hub port is a transshipment port. The transshipment port is mostly massive in size, located on the main shipping routes and acts as hub port in the region. It is mainly called at by mega vessels. The transshipment port provides several advantages for shipping lines. As aforementioned on the trend of bigger size of ships, a transshipment port is a proper option for shipping lines in order to reduce a significant amount of long-haul trade without decreasing the connectivity with small ports and also reducing unbalanced global trade. The examples of transshipment ports are Singapore Port, Hong Kong Port and Busan Port.

Transit Port: The word "Transit" means across. A transit port is a port where the majority of its total throughput is transit cargo. Sorgenfrei (2013) defines transit cargo as: "For the cargo which its bill of landing shows the destination at the port but during the journey of the cargo the wholesaler sells the cargo to somebody in other lands. This cargo can be declared as transit cargo". Hence, transit cargo is the cargo which is conveyed from ports by rail or road and be transported across the country to a third country. The main difference between transit cargo and transshipment cargo is the volume of cargo counted in a port statistic. For transit cargo, it is counted only one time in term of port throughput. The statement of Song (2016) defined that the transit cargo can be cargo remaining inside the country or crossed to a third country by land transport.

Therefore, transit volume is directly related to a country's industry and hinterland activities. The transit port appeared in this paper refers from the definition of transit port by Song (2016).

Gateway port: A gateway port is a port which acts as the gate to the world. Mostly, in a remote country where there is only one major port, the port can be called the gateway port as it offers a link between the country and the world. In this case, the port acts as a transit port or import-export port. The container throughput is directly influenced by consumption in the country and hinterland activities. However, a gateway port can act as a hub port by collecting cargos from small neighbor ports (Sorgenfrei,2013). In this paper gateway port means the same as a transit port.

Hub port and feeder port: A hub-and-spoke follows the concept of a wheel, as seen in figure 4. The hub port acts as the central transshipment port of a region; it collects cargo from small neighbor ports and ports nearby in order to serve the bigger size of ships and reduce imbalanced trade. Cargos from different feeder ports nearby are loaded at the hub port and are prepared to be transshipped to other countries. Nowadays, this concept can help shipping line to reduce its logistics cost (Sorgenfrei, 2013). However, it is necessary for hub port to provide fast turnaround time for vessel and high efficient and quality services to its customers. In the Association of Southeast Asian Nations (ASEAN) region, the Singapore port acts as a hub port. It collects cargos from small ports nearby, for instance, LCP in Thailand, Tanjung Perak Port and Tanjung Priok Port in Indonesia.

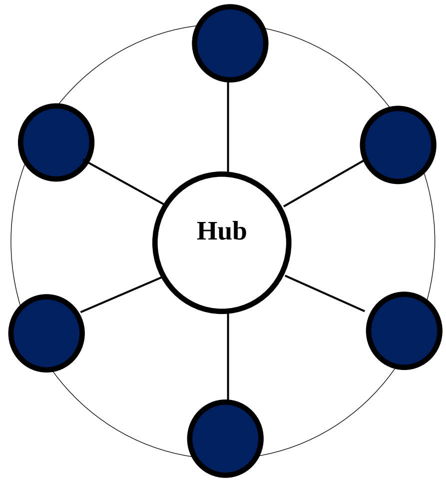


Figure 4 : Hub-and-Spoke

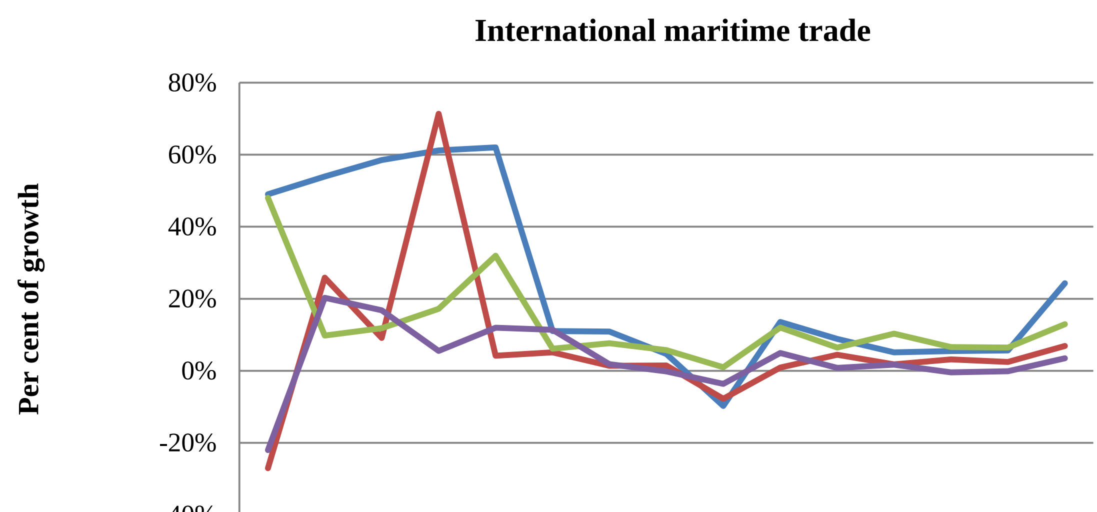
Source: Author

2.3.2 Type of cargo

Specialized Port: A specialized port is dedicated for one type or few specific cargos. For instance, the general cargo port is the port where above 50 per cent of a port's total throughput are shared by general cargo likewise Ro-Ro port, ferry port, passenger port, container port and cruise port (Sorgenfrei, 2013).

Container Port: Containerization was introduced in April 1956. The first full container was loaded in the Port of Newark, New Jersey, USA (Sorgenfrei, 2013). Prior to this, the aim of the container was to carry cargo with low requirements on the physical handling, for instance, textile and shoes. As time passes by, special containers were needed and developed, e.g. tank container and reefer container. As the cost of maritime transport is the lowest among all modes of transportation, several companies have shifted from other modes of transport to maritime transport, e.g. FloraHolland and Seagate. FloraHolland is a Dutch compnay well known for being the biggest exporter of flowers. In order to lower its transport cost, the company switched its mode of transport from air to sea and consequently, the transport cost to Europe was reduced by 40 per cent (Kostiner,2012).

Similarly, Seagate, a Hard Disk manufacturer, increased 75 per cent from 10 per cent of its product to transport by sea and rail which lead to a reduced 50 per cent of company's logistics cost (Mackey, 2014). From 1985-2014 (as shown in Figure 5), container trade growth was the highest at 24 per cent compared to that of other cargo, e.g. other dry cargo, five major cargo and oil and gas with their per cent growth at 7 per cent, 13 per cent and 3 per cent, respectively. A container port is a port where containers represent a minimum 50 per cent of cargo handling volume at a port. As the amount of container trade has increased dramatically, container ports have also evolved in the same way. In many ports, the share of container volumes tremendously raise, e.g. in 2010, the share of total throughput by the container at the port of Busan, Hong Kong and Port Klang stood at 90 per cent, 75 per cent and 85 per cent respectively (Sorgenfrei, 2013).



	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total _Avg
Container	49%	54%	59%	61%	62%	11%	11%	5%	-10%	14%	9%	5%	5%	6%	24%
Other dry cargo	-27%	26%	9%	71%	4%	5%	1%	1%	-8%	1%	4%	2%	3%	2%	7%
Five major bulks	48%	10%	12%	17%	32%	6%	8%	6%	1%	12%	6%	10%	7%	6%	13%
Oil and gas	-22%	20%	17%	6%	12%	11%	2%	0%	-4%	5%	1%	2%	0%	0%	3%

Figure 5 : International maritime trade , 1985-2014

Source: Adapted from "Review of maritime transport 2015" by United Nations Conference on Trade and Development (UNCTAD), 2015

Multipurpose Port: A multipurpose port or a universal port is different from a specialized port. It is not dedicated to one or a few types of cargo, but the port can handle various types of cargo. Equipment and infrastructures are provided to deliver flexible services for different types of cargos and vessels. The size of a multipurpose port can be small or large like Rotterdam Port and it is normally situated in remote countries where only one port is located to provide a broad range of services (Sorgenfrei, 2013).

2.3.3 Geographic

Sea Port: A seaport is a port located at the international water or located close to open sea. It is mainly called by ocean vessels. Even though some ports are located nearby the open sea, they do not have a number of calls from ocean vessels, therefore; it cannot be named as a seaport. Likewise, if some ports are located far from the open sea but have a call from an ocean vessel, they can be considered as a seaport. For instance, the Port of Hamburg in Germany due to its geography should be called a river port, but the port is accessed by ocean vessels. Therefore it can be considered as a seaport (Roa, Peña, Amante and Goretti, 2013).

Deep Water Port: A deep water port is the sub-category of a seaport, but the depth of the water is taken into consideration in this term. The depth of water is correlated with the size of vessels. The bigger vessels require the deeper depth of water to access the ports Nowadays, the largest size of the vessel is 18,000 TEU which requires a minimum 16 meters of water’s depth. Even though there is no specific declaration of how deep a water port is in terms of meters, Roa, Peña, Amante and Goretti (2013) implied that ports with their draft exceed 13.72 meters are considered as deep seaports.

River Port: A river port is a port that is located far from the open sea and usually not located in the mouth or estuary region. Moreover, the river port is normally inaccessible and called by ocean vessels (Roa, Peña, Amante and Goretti, 2013).

2.4 Background of Laem Chabang Port

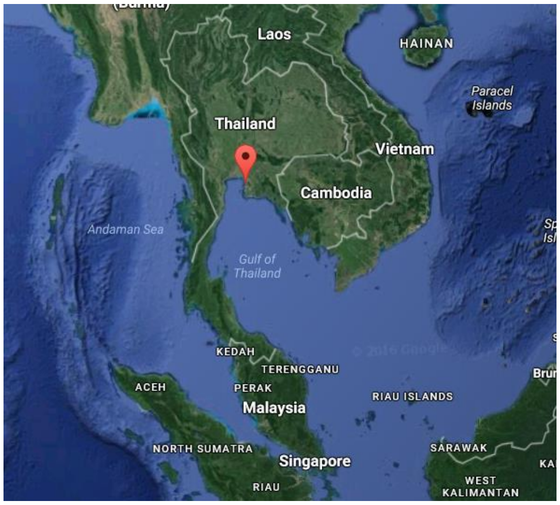


Figure 6: Geographical location of Laem Chabang Port

Source : Author

Laem Chabang Port (LCP) is the main international deep sea port of Thailand. It is located in eastern part of Thailand in Chon Buri province as shown in figure 6. The port area covers 2,572 acres. The port offers various services such as Ro-Ro terminal, cruise terminal, general cargo terminal, and multipurpose terminal but the majority of its total throughput is containers. Therefore it can be considered as a container port. According to the Port Reform Toolkit (2007), the characteristic of a landlord port is the port combination between public and private. In the landlord port model, the port authority acts as a regulatory body, whereas private companies are in charge of its operations. LCP is regulated by the Port Authority of Thailand (PAT). LCP consists of two phases. The first phase and second phase are composed of 14 container ports. The maximum capacity of first and second phases is 11 million TEU/year. The water depth in Phase 1 is -14 meters and in phase two is -16 meters. From 2007 to 2014, container throughput at the port increased approximately by 4 per cent. Figure 7 illustrates the growth of container throughput at LCP. In 2009, the container throughput at the port dropped sharply by 13 per cent as a consequence of global financial crisis which not only impacted on world economic growth but also the shipping industry. A year after, the growth container throughput recovered by soaring to 18 per cent.

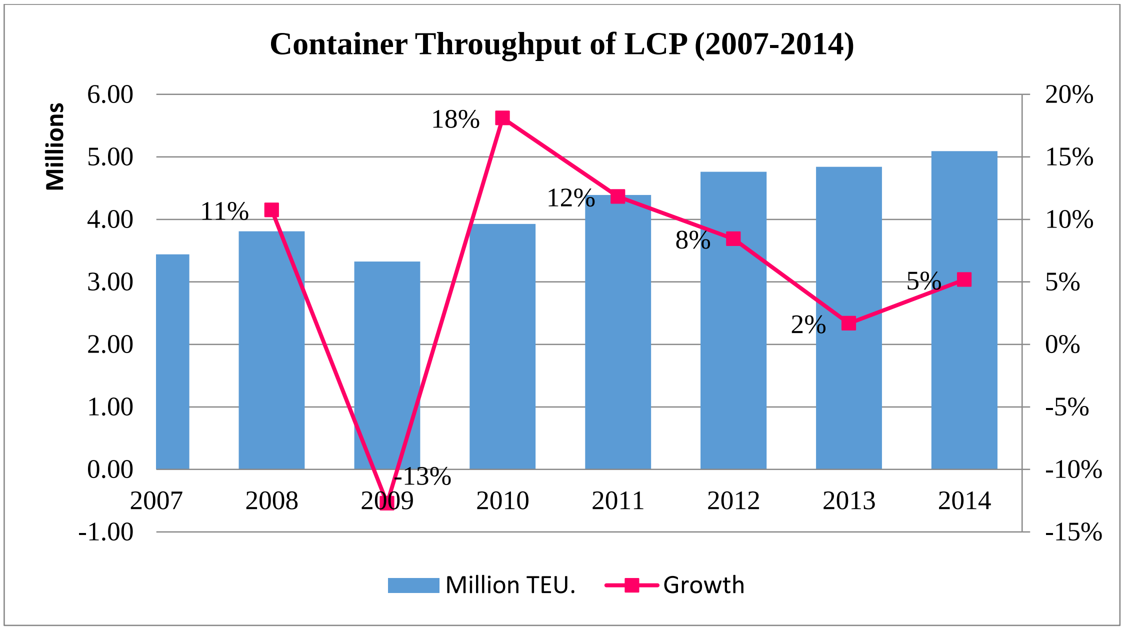
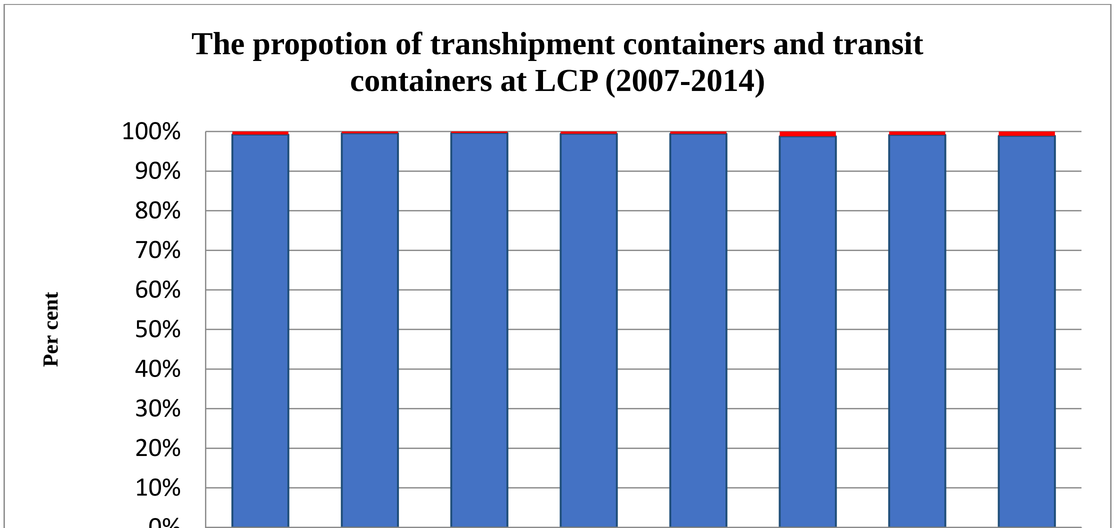


Figure 7: Container Throughput at Laem Chanbang Port 2007-2014

Source: Adapted from "Unpublished data file" by PAT,2015

LCP is a transit port (import-export port). Regarding the geographical location of the port, it is not located on a main shipping route. Most ship calls are feeder ships from Singapore. Therefore, the majority of containers in LCP are transit containers. The majority of cargos are consumed within the country and are used in the hinterland. Figure 8 illustrates the per cent share of transit and transshipment containers at LCP between 2007-2014. During this period, the average number of transshipment containers was less than 1 per cent of transit container.



	2007	2008	2009	2010	2011	2012	2013	2014
Transshipment	0.8%	0.4%	0.4%	0.6%	0.6%	1.2%	0.8%	1.1%
Transit	99.2%	99.6%	99.6%	99.4%	99.4%	98.8%	99.2%	98.9%

Note: empty containers are uncounted.

Figure 8 : Comparison of transit and transshipment containers at LCP

Source: Adapted from “Unpublished data file” by PAT,2015

2.5 Forecasting

As the majority of world merchandise trade are transported by ships, ports act as the essential connecting door between land and sea. Accoridng to the review of maritime transport by UNCTAD (2015), the estimate growth of seaborne container trend in 2015 was 32.06% at 9,204 billion of ton-mile (Figure 9). Forecasting a future number of container throughputs is popularly utilized in order to anticipate the required investment for expansion of the port.

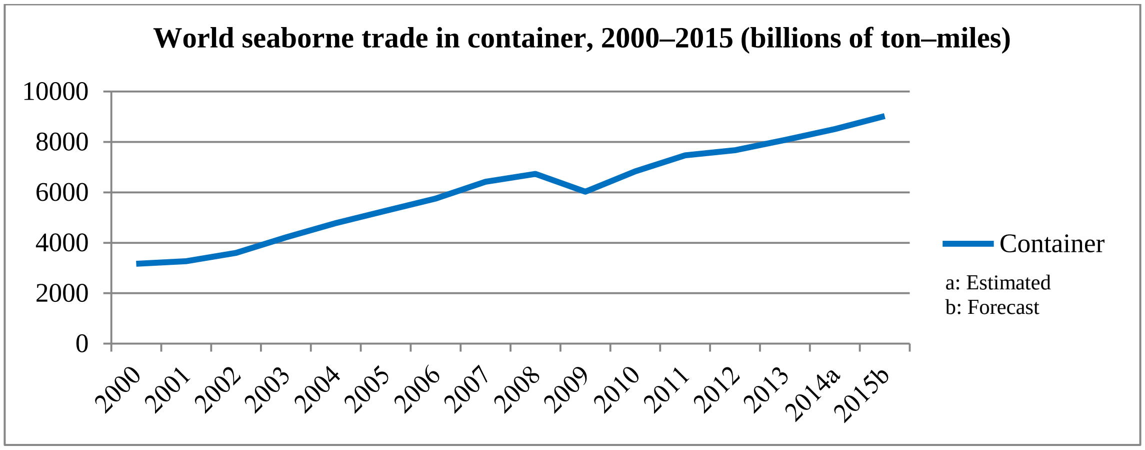


Figure 9 : World seaborne trade in container, 2000-2015

Source: Adapted from "Review of maritime transport 2015" by United Nations Conference on Trade and Development (UNCTAD),2015

Empirical shreds of evidence illustrate that a short-term forecast of container volume covering a period of one year offers a better accuracy than long-term forecasts in terms of monitoring the changes in seasonal patterns and business cycles. Nevertheless, a long-term forecasting is more widespread to predict container throughput, and is mainly used to estimate the port investment (Peng and Wu Chu, 2009). Several models are used in order to predict container volume, for instance, regression model, neural network, and grey forecasting model.

2.5.1 Neural Network

Neural Network (NN) is a type of cause-and-effect model based on the structure of the human brain (Lam, Seabrooke, and Hui, 2004) and commonly used for river flow forecasting, steam water temperature, and traffic flow (Gosasang, Chandraprakaikul, and Kiattisin, 2011). The model is composed of various components. Figure 10 below shows the example of the NN model. There are three layers: the input layer, the hidden layer (optional) and the output layer. Each layer is connected to each other in the form of neurones. When one neurone receives weight input, the input is converted to output and it will be sent to another neurone (Jansen, 2014).

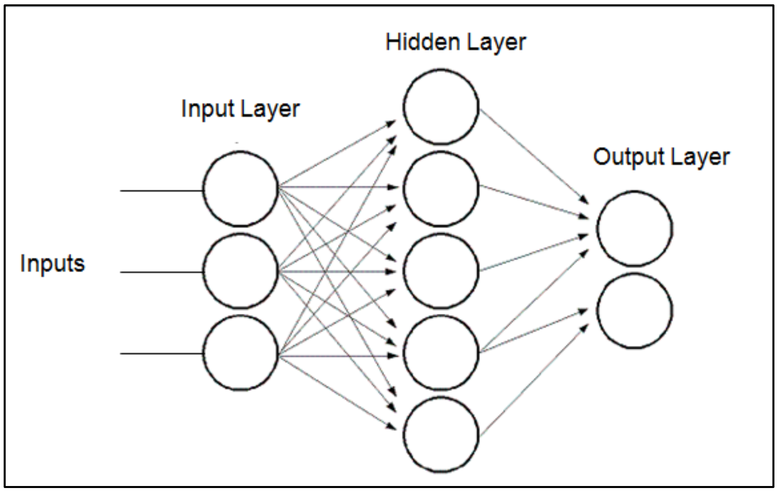


Figure 10 : Neural Network Model

Source: Adapted from "Neural network model" by wordassocation1.net cited in Jansen,2014

NN is more accurate in predicting the short-term of container volume rather than the long-term. Furthermore, even the prior research indicated that using NN to forecast cargo throughput at Hong Kong Port is more precise than regression analysis (Lam, Seabrooke, and Hui, 2004), as it requires a lot of data and is difficult to put it into practice.

2.5.2 Grey forecast

Grey forecast is proposed by Deng (1982) cited in Peng and Chu (2009). One of the characteristic of the model is that it requires fewer data to predict. The model can be used with incomplete information and small data (Peng and Chu, 2009). The grey forecasting model has been successfully applied to forecast in all kinds of fields. Nonetheless, the model seems to be unsuitable and unsatisfactory in predicting a long-term of the data sequence (Xie and Liu,2009). Generally, the grey model is written as GM(m,n), while m is referred to the order and n is a number of the model equation (Mohammadi and Zade, 2011).

2.5.3 Autoregressive Moving Average models (ARMA)

One of the popular and widely used models to forecast is the time series model. The model extrapolates the future by the use of historical data. However, this model is not suggested for long term forecasting. Van Dorsser, Wolters, and Van Wee (2011) cited in Jansen (2014) found the long-term relation between GDP and cargo growth to be unreliable, the reason being a fluctuation and changing of economic structure. ARMA is a complex time series model initiated by Box and Jenkins (1976). It is a time prediction model commonly used in time series analysis, for instance, economic and maritime statistics.

- Autoregressive Integrated Moving Average Model (ARIMA)

ARIMA is time series model in order to use with non-stationary data. It combines differencing the non-stationary time series with the ARMA. According to the study on comparison among three forecasting methods of container throughput in the port of Koper, ARIMA offers highest performance prediction method (Dragan Kramberger, and Intiher, 2014) The result of mean absolute deviation, the mean square error, the root mean square error illustrated that ARIMA is more accurate than Holt-Winters models and the decomposition models.

- Seasonal Autoregressive Integrated Moving Average Model (SARIMA)

SARIMA is a part of ARIMA, but it is widely used with the seasonal time series data which means that it is moving in a similar pattern over the period of time. For example, in monthly data, the value always tend to be high in some particular months and always tend to be low in some particular months. SARIMA was found to forecast economic and maritime statistics such as predicting the foreign trade of the Philippines by Urrutia, Alano, Aninipot, Gumapac, and Quinto (2014). Some prior researchers on container forecasting applied SARIMA in their studies, e.g. forecasting container throughputs at ports using genetic programming by Chen and Chen (2010) and forecasting container transshipment in Germany by Schulze and Prinz (2009).

2.5.4 Vector Autoregressive Model

The Vector Autoregressive Model (VAR) and Vector error correction model (VECM): VAR is one of the popular econometric models initiated by Sims in 1980. It is a hybrid model between the univariate time series model and simultaneous equation models (Brooks, 2014). This model is fruitful and flexible to cope with multivariate time series data and easy to apply. VAR is widely used in order to forecast in the maritime field, e.g. econometric modeling and forecasting of container freight rates by Rasmussen (2010). VECM is developed by adding the restrictions (co-integration equations) into the VAR model (Xiaolin, 2014). In an Indonesian port, VECM was applied to forecast the demand for container throughput of the country (Kuroda and Takebayashi, 2005). Xiaolin (2014) compares the precise performance of ARIMA, VAR and VECM. The forecast result by VECM shows the lowest error. However, it was unable to conclude that VEC is the most accurate model because it depends on other factors (e.g. range of data).

2.5.5 Dummy Variable Multiple Regression Forecasting Model

Dummy Variable Multiple Regression Forecasting Model is widely used to forecast. The example empirical studies contributed forecasting by dummy variable multiple regression e.g. to develop multiple regression forecasting model by dummy variables by Nwankwo and Oyeka (2013) and the forecasting of an export base on GDP and GDP per capita of the country by Groot, Linders, Rietveld and Subramanian (2003) cited in Jansen (2014). In their model, they mentioned that 70 per cent of bilateral trade could be explained by GDP and the trade arrangement dummy was included in the model to reduce the resistance of trade. They also stated that this is a basic model and more dummy variables can be included in the model in order to explain some characteristics shared by any two countries, e.g. religion, and border (Linders, Rietveld and Subramanian, 2003)

2.5.6 Regression

In past literature, several methods have been utilized to predict container throughput. Each method has its advantages and shortfalls. NN seems to be the most precise method, but a lot of data is required, and it is difficult to apply whereas grey forecast is more suitable for short-term forecasting with a lack of and uncertain information. Before generating a forecasting model, evaluation of the relationship between explanatory variables and explained variable is an essential need. The regression method is the simplest, easiest and the most popular in order to evaluate the relationship between the variables. There have been several research studies on the relationship between international trade volume and the macroeconomic variables (for example, GDP, GNP, and capital stock) used in the regression method. Some indicative existing literature using linear regression models are as follows: To measure the relationship between the exports volume and economic growth (Ram, 1985), to evaluate relationship between global economic growth and increasing of export in developing countries (Tyler, 1981), to analyze the relationship between trade orientation, trade distortions and growth (Edwards, 1991), forecasting cargo growth and the development of port of Hong Kong (Seabrooke, Hui, Lam, and Wong, 2003).

Over time, various studies attempted to decrease the forecast error of using a regression method. For example, studying on a modified regression model for forecasting the volumes of Taiwan's import containers by (Chou, Chu, and Liang, 2008) implied a more accurate use of a modified regression model compared to the traditional regression model. Furthermore, their study illustrated that in the traditional regression model, the non-stationary relationship between the volume of import containers and the macroeconomic variables was not considered in the forecasting leading to a forecast error. The forecast error is called "non-stationary contribution coefficient of independent variables" error. Therefore, in their study, non-stationary contribution coefficient produced by the macroeconomic variables was taken into account. The result of their study shows that the forecasting error of the volumes of Taiwan’s import containers between 2000-2001 by using modified regression model was at 201,160 TEU which is lower than the error used by traditional regression at 243,647 TEU. As regression is a method of describing and interpreting, the relationship between dependent and independent variables must be established before generating forecasting models.

2.5.7 Relationship between economic variables and container volume

Most of the previous literature studied the relationship between the macroeconomic variable growth and container volume, rather than using microeconomic factors as explanatory variables. GDP is the most popular macroeconomic variable in order to predict container volume. However, some pioneering research showed the relationship between other related variables with container volume, for instance, the population, index of price, industrial production index, and terminal infrastructure. According to the study on influencial factors on container throughput in the ports of Korea and China, Liu and Park, G. (2011) found the relationship between container throughput in Korean and China port with independent variables namely terminal storage capability, berth length, direct-call liner transshipment, hinterland’ GDP, hinterland’s import-export volume, port tariff, free trade zone area and investment of government. Their study indicated that in 2001-2007, the most influence factors on container throughput in Korean ports are direct-call liner transshipment and port tariff, rather than other factors, whereas the container throughput in China ports mostly depends on the hinterland’ GDP, hinterland’s import-export volume and government investment. The result of the study implied different influential factors on container throughput between two countries ports. The reason was that Korean ports are located in the central position of ship route from Asia, Eastern Africa to America and they act as transshipment ports. Therefore competitive prices and quick service are the most important influence factors, while China ports act as the gateway ports (transit port) making hinterland economic development and government policy as the biggest influential factors on the country's trade volume.

Jansen (2014) illustrated in forecasting container cargo throughput in ports that "each type of port should focus on different variables". This means that to forecast container throughput in transshipment ports, the variable should concentrate on the factors related to port location and main liner routes and not emphasize on the level of service, the hinterland factors. In contrast, for gateway ports, the hinterland, consumption in the country and government investment are important, and the focus should be on macroeconomic variables like income per capita, private and government investment. As a comparison between ports in developed and developing countries, the hinterland seems an important factor for both categorized countries, but in developing countries, macroeconomic variables like political stability and a country's consumption seem more important than hinterland connectivity factors. According to the study of Liu and Park, G. (2011) and the suggestion of Jansen (2014), the economic variables which are properly used for forecasting container volume in gateway port should be related with hinterland activities and the demand of the country. Table 1 indicates examples of previous empirical studies on forecasting container throughput by applying various different models.

Author	Year	Topic	Objective of the paper	Studying area	Variables	Sampled timeframe	Technics and models	Term of prediction	Time unit	Accurate measurements used	Main conclusions
I, S., Kuroda, and Takebayashi,	2005	Forecasting the demand of container throughput	To forecast the demand of container throughput	Indonesia	- Container throughput - GDP, Population - Export, and import value	1982-2002	ADF test, Impulse response function (IRF) and VECM	Long term (2003-2015)	Yearly data	Not applicable.	The result Of IRF shows that variables used in the model respond shock of itself and other variables. VECM indicates the reasonable result of forecasting container throughput in Indonesia
Chou, Chu, and Liang	2008	A modified regression model for forecasting the volumes of import containers	To determine the accurate outcome between modified regression and traditional regression	Taiwan	- Imported containers - The industrial GDP	1989-2001	Regression	Short term	Yearly data	Comparing the result from models with actual data.	After comparing the accurate prediction of modified regression and traditional regression the predictive performance of modified regression has less error than traditional regression
Schulze and Prinz	2009	Forecasting container transshipment	To forecast the container transshipment in German ports in 3 different economic regions namely Asia, Europe and North America	Germany	- German container throughput in three main economic areas ; Asia, Europe and North America	1989-2006	SARIMA and Holt–Winters ES. approach	Medium term	Quarterly data	MSE and Theil's U	The result of MSE and Theil's U from SARIMA and ES; the predictive performance of SARIMA is slightly better than ES. And forecasted result from SARIMA in 2007 and 2008, indicates a growth of transshipment container in three economic regions
Peng and Wu Chu,	2009	A comparison of univariate methods for forecasting container throughput volumes	To find out the best forecasting model of container throughput from six difference methods; classical decomposition, the trigonometric	Taiwan	- Container throughput in three ports of Taiwan; Keelung port, Taichung	2003-2006	classical decomposition, the trigonometric model, the seasonal dummy variables, the	Short term	Monthly data	MSE, MAPE, and RMSE	The result shows that the classical decomposition has the best performance to predict container throughput in Keelung port and Taichung port. While in the prediction

Author	Year	Topic	Objective of the paper	Studying area	Variables	Sampled timeframe	Technics and models	Term of prediction	Time unit	Accurate measurements used	Main conclusions
			model, the seasonal dummy variables, the grey forecast, the hybrid grey forecast and SARIMA		port and Kaohsiung Port		grey forecast, the hybrid grey forecast and SARIMA				of container throughput in Kaohsiung Port, SARIMA and the classical decomposition perform better than other methods.
Chen and Chen,	2010	Forecasting container throughputs at ports using genetic programming	To create the optimal forecasting model by comparing 3 technic; genetic programming (GP), decomposition approach and SARIMA	Taiwan	- Container throughput from three difference ports namely: Keelung Port, Taichung Port, and Kaohsiung Port	1978-2006	GP, decomposition approach and SARIMA	Short term	Monthly data	MPSE	All types technic are giving a quite accurate prediction. However, GP gives lower MAPE than other two technics.
Gosasang, Chandraprakaikul, and Kiattisin,	2011	A Comparison of traditional and NN forecasting techniques for container throughput at Bangkok Port	To compare the predictive performance of container throughput at Bangkok port by applying NN and linear regression	Thailand	- Container throughput at Bangkok port - GDP - Exchange rate - Population - Interest rate - Inflation rate - Fuel price.	1999-2010	NN and linear regression	Short term	Monthly data	MAE, RMSE	The result indicates that NN performs better than linear regression

Table 1 : The summary of example studies on forecasting container throughput

Source: Author

3. RESEARH METHODOLOGY

3.1 Characteristics of Thai Economy

Thai economy is mostly relied upon international trade. In 2014, export and import value share 69.3 per cent and 62.7 per cent respectively of GDP in the country (the World Bank, 2015). According to the World Shipping Council (2014), Thailand ranked 6th and 12th of the top world exporters and importers of containerized cargo respectively. As the transport cost of maritime transport is the lowest compared with other modes of transport, the research by Kasikonthai (2014) implied that over 88.8 per cent of Thai international trade was shared by maritime transport. However, in the domestic trade, about 80 per cent was shared by land transport and 17.4 per cent shared by maritime transport (Office of the National Economic and Social Development Board, 2015). Thai economy is a significant production base in ASEAN region particularly in automobile and electronic industries. Regard to Thailand Board of Investment (2015); the automobile industry contributed 12 per cent of GDP in the country and 2013, Thai automotive production capacity stood at 2.85 million vehicles. Meanwhile, in 2014, the electrical and electronics industry were counted almost 24 per cent of Thailand's annual export revenues.

3.2 Influential variables of container throughput at LCP

Regarding a recommendation of choosing the regressors by Liu and Park (2011) and Jansen (2014) to transit ports it was suggested that explanatory variables to create forecasting model should be involved with hinterland consumption. If the suggestion of them is correct, the influence factors of container throughput at LCP should relate to demand inside a country, for instance, private consumption and industry production, rather than factors driven by outside country e.g. bunker price and container freight rate. In this paper, the influence factors driven by activities inside the country will be named "internal independent variables" while factors driven by outside country will be called "external independent variables". In this chapter, the measurement of each explanatory variables and explained variables is stated.

3.2.1 Internal independent variables

The Internal independent variables are used in this paper namely; government expenditure, commodity sale, private consumption, private investment, industry production and employment.

- Government expenditure index

Government spending on goods and services is the tool to stimulate economies and can influence the growth of container throughput indirectly and directly. For instance, reconstructing projects can influence the import volume of construction equipment and construction machine components. The study of Liu and Park (2011) in Table 2 illustrates a relationship between the growth of container throughput in China ports and explanatory variables in the significant level at 0.05. The result shows that a relationship between government investment and container throughput at China ports is significant.

Dependent variable Container Throughput (Y) R square = 0.819,D-W value = 1.745			
Independent variable	Coefficient	t	Sig
Terminal Storage capability (X_1)	0.918	2.328	.031
Berth Length (X_2)	1.204	3.242	.069
Direct-call liner (X_3)	2.320	3.115	.041
Transshipment (X_4)	2.123	2.251	.107
Hinterland's GDP (X_5)	1.519	1.821	.001
Hinterland's import-export volume (X_6)	1.021	2.042	.002
Port tariff (X_7)	-2.012	-2.214	.081
FTZ (X_8)	1.369	3.123	.024
Investment of government (X_9)	1.218	2.012	.003

Table 2: the regression analysis result of China Ports

Source: Adapted from "Table 11: Regression analysis result of China ports" by Liu and Park, 2011

In the results of their study, it indicated that China ports largely depend on the hinterland's GDP and government investment rather than other factors because the growth of government policies could escalate the container volume in China ports through import and export volume. However, the components of government investment used in their study were not clarified.

In Thailand, the government expenditure consists of 10 components namely defence, economic affairs, environmental protection, education, public order and safety, health and general public services, housing and community, culture and religion, general administration, and social work. Therefore, the government investment is included in government expenditure (Bank of Thailand, n.d.). If the hypothesis of the Liu and Park (2011) is true, the relationship between government expenditure and container throughput at LCP should show a similar result. Figure 11 indicates a spending of the Thai government from 2010 to 2014 quarterly. During each year the government expenditure was highest in quarter 3 and lowest in quarter 1. The extreme flood in Thailand in 2011 led to the high expenditure and reconstruction cost for the government in 2012.

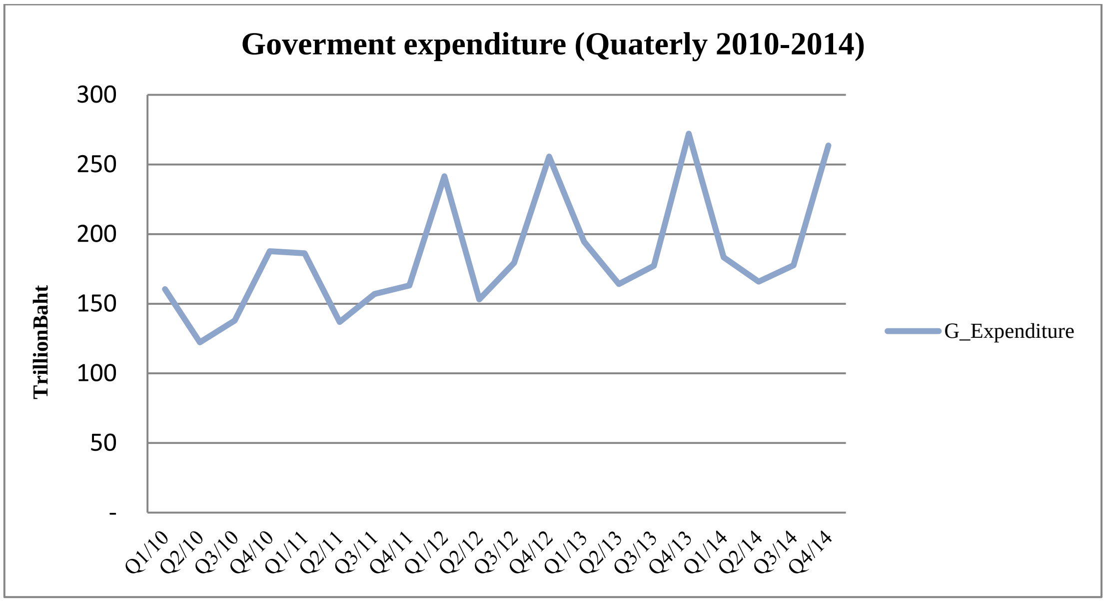


Figure 11: **Government expenditure and container throughput at LCP in quarterly (2010-2014)**

Source: Author

- Private consumption Index

About 80 per cent of container throughput in LCP is transit cargo which means these cargo transported by ship is to be used for consuming in Thailand. The private consumption index is an indicator on consuming goods by Thai citizens. Private consumption is calculatedly based on the nondurables index[4], semi-durable index[5], durable index[6], services index[7], non- resident expenditure index[8], and private consumption index (seasonal adjusted) Bank of Thailand. (n.d.) . Therefore if private consumption is high, there is more demand for goods.Then demand of goods such as apparel and automobile led to import more textile and machine components. Then the growth of container throughput escalates consecutively. In the study by Painvin and

[4] Non-durables Index consists of Nielsen"s fast moving consumer goods index, Household electricity consumption, and Sales of fuel consumption.

[5] Semi-durables Index consists of Retail sales of textile and apparel at constant price, and Import of textile and clothing at constant price.

[6] Durables Index consists of Sales of Passenger cars, Motorcycles and Commercial cars.

[7] Services Index consists of VAT of hotel and restaurant at constant price, Sales of passenger transportations at constant price. Latest data estimated by BOT

[8] Non-residents expenditure Index consists of Number of Tourism. This index is used to subtract total expenditure to obtain Thai private consumption.

Rutter (2015) they also emphasized a significant relationship between private consumption and container traffic in Europe since a large share of the goods transported are manufactured goods, notably imported from Asia. Figure 12, the trend between private consumption index and container throughput in LCP quite move simultaneously. However, in the third and fourth quarters in 2011, there was a shock affected from the flood crisis that occurred in several provinces in Thailand and also in the industry area in Ayutthaya which is mostly where automobile industries are situated. According to the crisis, the import of automobile components and machinery components decreased. However, in this period the private consumption index remained stable from the last quarter because the demand for goods in the country was unchanged.

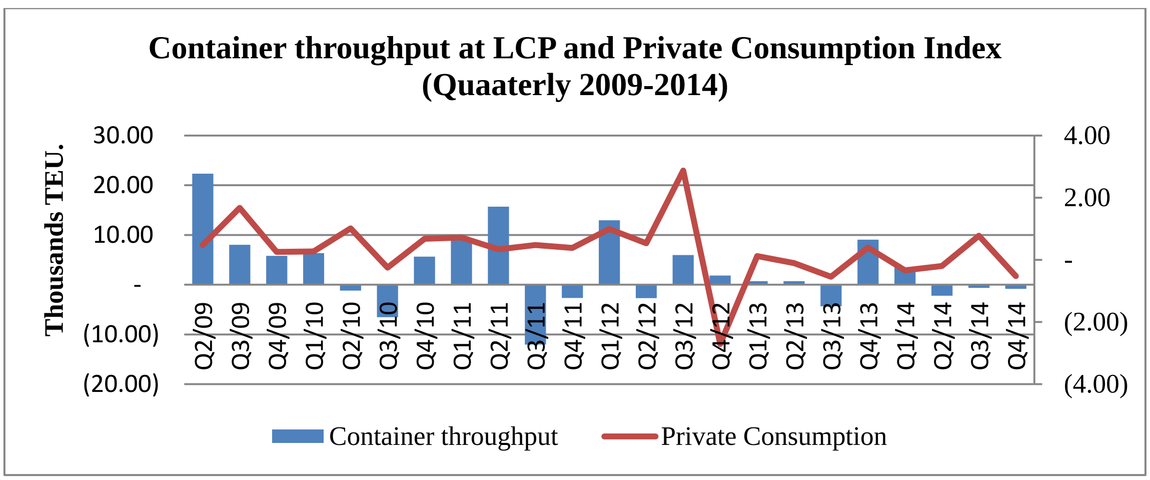


Figure 12 : Container throughput at LCP and private consumption index (Quarterly 2009-2014)

Source: Author

- Private investment index and industry production index

Some research showed that container throughput is related to the manufacturing field. The evidence is the Hong Kong Port, one of the busiest ports in the world where many direct liner transshipments call. One of the main reasons is a lot of manufacturing activities take place in the region. Thailand is one of the major base manufacturing countries, particular in automobile factories. It is an import-export oriented economy with imports accounting for 62.7 percent of the GDP in 2014 (World Bank, 2015). About 80 per cent of import and export in the country is transported through LCP. Most of the imported goods transported by vessel at LCP are semi-manufactured goods, for example electronic components, machine components, and automotive components. These components will be sent to factories in Thailand in order to produce finished goods to be consumed in the country and exported to other countries. Figure 13 illustrates that import value in Thailand is shared by top products and about 25 per cent of the imports are the products used in the producing process namely; machine components, electrical machines and automobile components and chemical products. Exports from Thailand accounting for 69.3 percent of the GDP in 2014 (World Bank, 2015).The share proportion of the country's export by difference types of cargo shown in figure 14. 66 per cent of export goods is industrial products namely automobile products and components, computer products and components and chemical products. 86 per cent of the total shipment is manufactured goods.

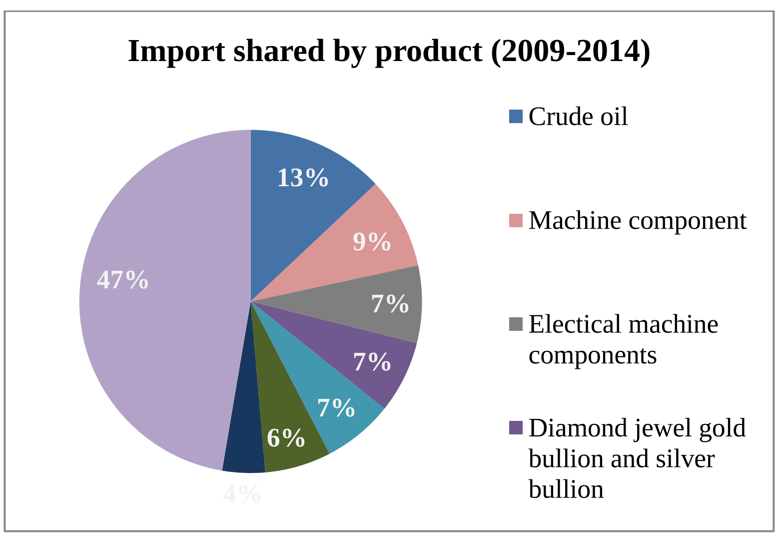


Figure 13 : Import shared by product (2009-2014)

Source: Adapted from "Data file" by Ministry of Commerce of Thailand (n.d.)

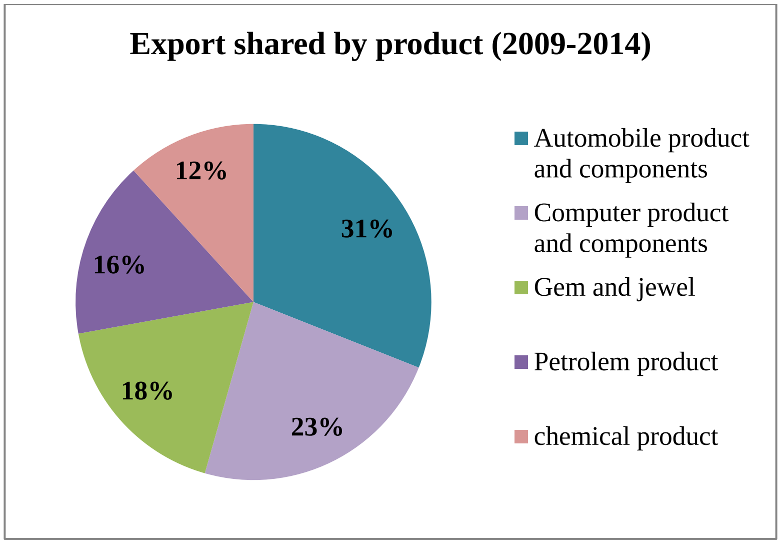


Figure 14 : Export shared by product (2009-2014)

Source: Adapted from "Data file" by Ministry of Commerce of Thailand (n.d.)

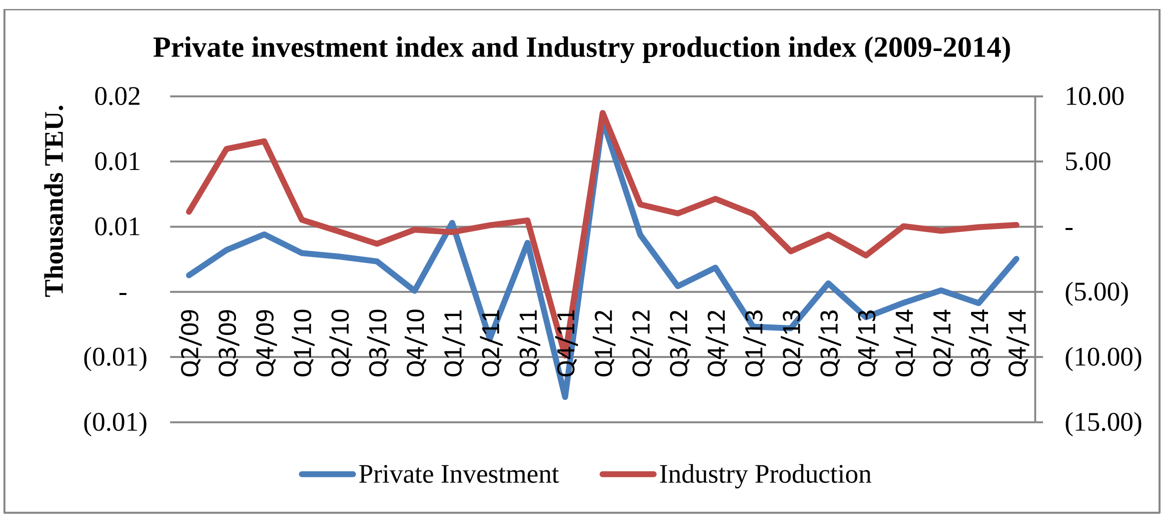


Figure 15 : Private investment index and Industry production index (2009-2014)

Source: Adapted from "Data file" by Bank of Thailand (n.d.)

Obviously, the private investment index and industry production index are indicators representing a volume of industrial activities of the country. The relationship between these two variables and container throughput is intensity. Furthermore, these two variables seem to be a close correlation as shown in figure 15. During 2009-2014, private investment index and industry production index moved simultaneously. The two variables dropped sharply in quarter 4, 2011 before gradually soaring in the first quarter in 2012. The decline of the private investment index and industry production index in fourth quarter, 2011 was because of the shock affected by the flood crisis in the automobile industries area in Ayutthaya, Thailand. According to the afore reasons, in this paper, these two variables are not presented in the same model. Both of them can be represented to each other. Industry production index covers all products produced in a manufacturing process for instance; consumable products, electronic products, chemical products and automotive products. Meanwhile the private investment index components are construction area, permitted constructions, material sales index, imports of capital goods, the value of domestic machinery sales, and the domestic car sales index for investment (Bank of Thailand). (n.d.)

- Sale of important products

Even through, the private investment index and the industry index seem to be significanty influential variables, several factors contained in these two variables might not relate to containerization. As mentioned in the previous section, manufacturing goods namely machine and automobile play an essential role in the international trade of Thailand and are mostly shifted by container ships, particularly automobiles, since Thailand is a base automobile manufacturing country. Therefore, the volume of sales of important products are chosen as independent variables namely; number of car sales, number motorbike sales and sales value of machinery. Furthermore, regarding the concept of De Langen (2012) cited in Jemsan (2014), "Forecast models that rely only on trend forecasts do not account for shocks in the economy and it is more suitable to establish models to suit with one type of cargo". Regarding this concept, this paper applies it in a reverse way by using specific cargos in order to explain container throughput in LCP.

- Employment

The well-known concept of the negative short-run relationship between unemployment and GDP was introduced by Okun's law (1962). The law declares one percent decrease in GDP corresponding to a slightly less than a two percent increase in unemployment (Cazes, 2011, cited in Ball, Leigh and Loungani,2013). On the other hand, the decrease in the unemployment rate could lead to the raise of the country's GDP. In addition, there are several empirical studies on the significant relation between income and import demand. For example, the study of Faini, Pritchett and Clavijo (1988) on import demand in developing countries and Bardakas (2013) on the asymmetric effect of income on import demand in Greece. The result showed "the demand for imports responds more to expansion than to a contraction of income in the short-run".

With regards to the above studies and Okun's law, it can presumably be hypothesized that there is a relationship between employment and import volume, as a rise in employment leads to an increase in wealth and income which could stimulate product consumption then import products tend to increase. However, different levels of the response depend on the income elasticity of demand. It means that changing of consumers' income leads to the change of demand of a product. Figure 16, indicates an income elasticity of demand i.e. graph (a) representing low elastic products which mostly are necessary products for living e.g. foods and medicine, whereas graph (b) representing high elastic products e.g. cars and computers. For the products with low elasticity, they are less sensitive to income, than products with high elasticity. As a huge amount of cargos carried by containers at LCP are manufactured products, the elasticity between employment and container throughput is supposed to be high. Nonetheless, there is a limitation of detailed data on the proportion of cargo transported by containers at LCP. A measurement of elasticity between employment and container throughput is out of the scope of this paper.

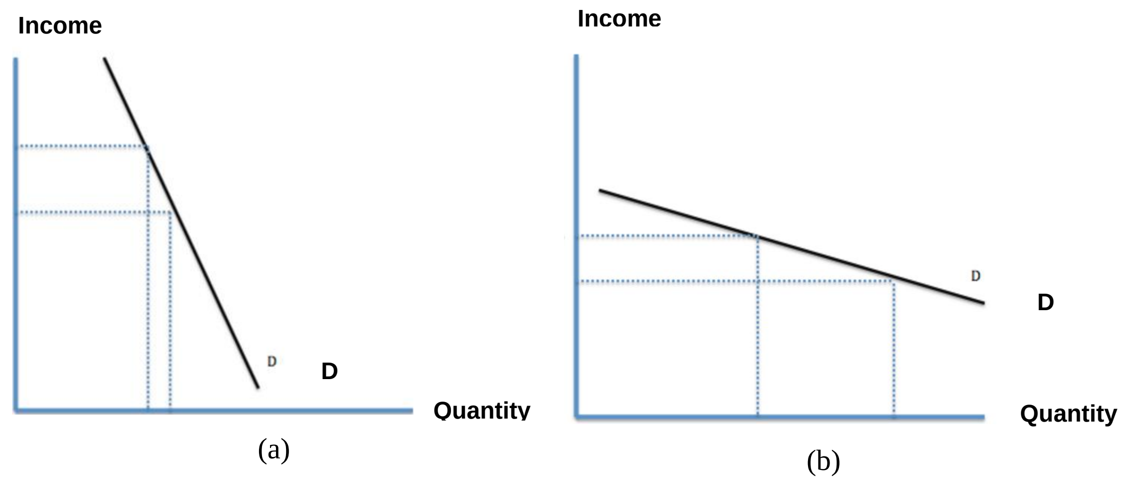


Figure 16: Low elastic products and high elastic product

Source: Author

3.2.2 Middle independent variable

The middle independent variables are derived by demand and supply between bilateral trade countries. The needs of goods for each country encourages trade's demand and consecutively influences the growth of container throughput.

- Trade between big trade partners of the country

In globalization era, a shipment of intermediate goods is obviouslyincreased. For instance, mobile phones are not produced in one country. Their parts are produced in distinct countries and transported to be assembled in other place. These activities drive a rise of the container trade. Furthermore, Container volume is a derived demand. It is originated by demand and supply among countries. Figure 17 defines the demand and supply between two countries pushing a rise of containers through trade flow between the two countries. Obviously, if there is only demand, trade cannot exist. Therefore, the trade between big trade partners influences the amount of container throughput at a port. During 2009-2014, the bilateral trade between Thailand and Japan has counted for 14 per cent of overall Thai trade, followed by trade with China and the United States shared at 13 per cent and eight per cent respectively (Figure 18). Consequently, the value of trade between Thailand and the three countries are added to be explanatory variables.

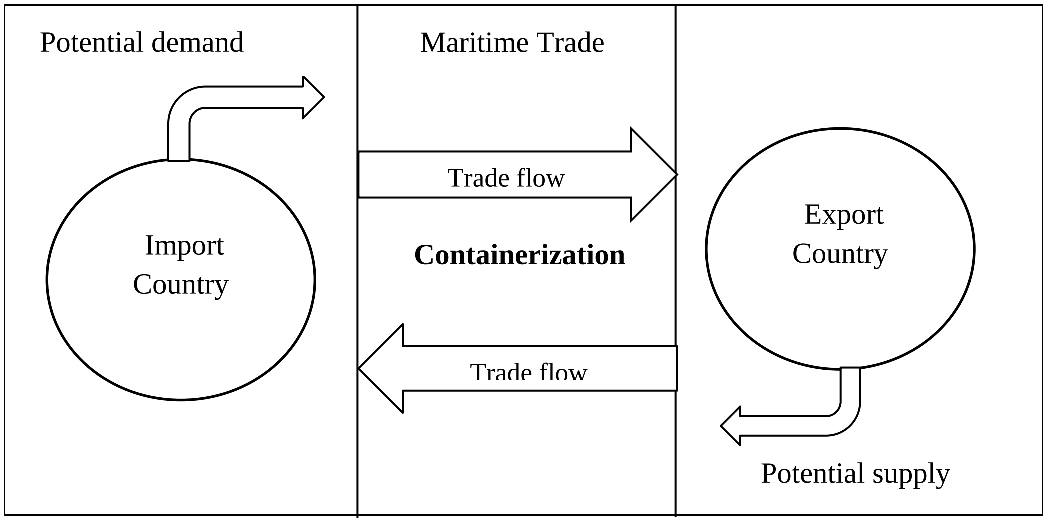


Figure 17 : Trade flow between import and export countries

Source: Author

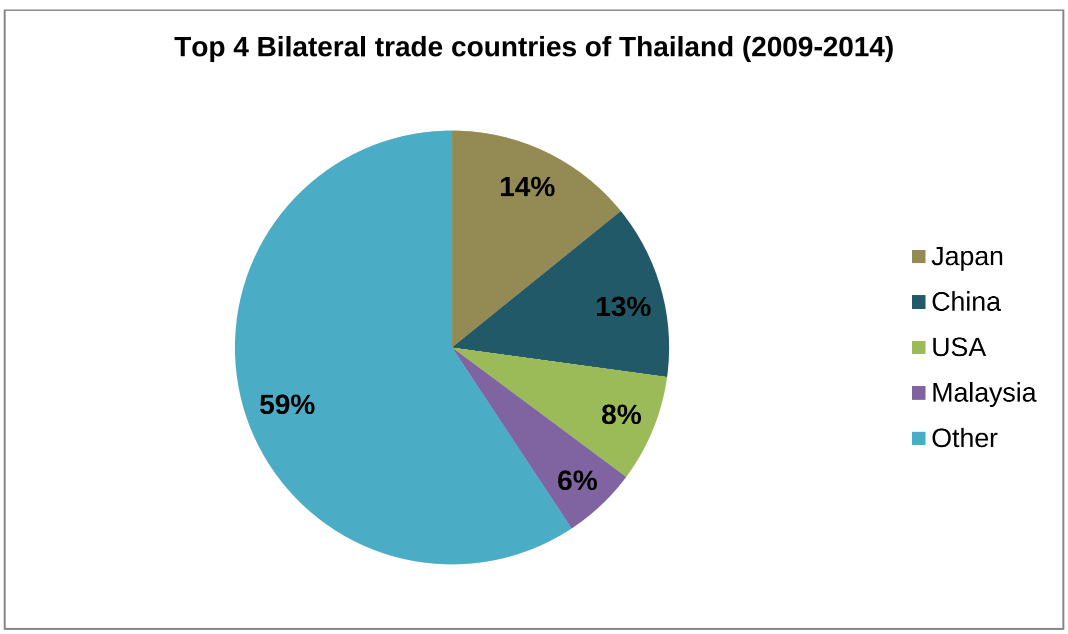


Figure 18: Top 4 bilateral trade countries of Thailand (2009-2014)

Source: Adapted from “Data file” by Ministry of Commerce of Thailand (n.d.)

3.2.3 External independent variable

These external independent variables are factors outside the country which influence the amount of container throughput of the country by indirect ways or direct ways.

- Bunker price Singapore

Bunker prices directly affect the shipping industry, particularly in shipping's operating costs because it is one of the components of transport costs. When an increase of bunker oil's price occurs, it could partially be passed on to the shippers by way of bunker surcharges (UNCTAD,2013). As the transport cost is a component of the final product cost, when it is higher until a point which producers cannot absorb, they tend to pass the partial cost onto the customer by raising the product's price. Moreover, demand for automobiles could be related to the crude oil price because the largest component of gasoline is crude oil, and gasoline is the fuel of automobiles. If the price of oil is higher it can be assumed that the demand of car may decrease. "In 2013, crude oil accounted for 68 per cent of the average retail price of gasoline, while taxes (12 per cent), refining (11 per cent), and distribution and marketing (9 per cent) account for the rest"(by American Petroleum Institute) (2014). Figure 19 shows the movement of Brent spot prices and regular gasoline prices during 2007-2013 which is clear visually a coincident moving between them. However, in the case of Thailand, the volume of car sales are rarely influenced by the gasoline prices market because of Government policy control gasoline prices in the market.

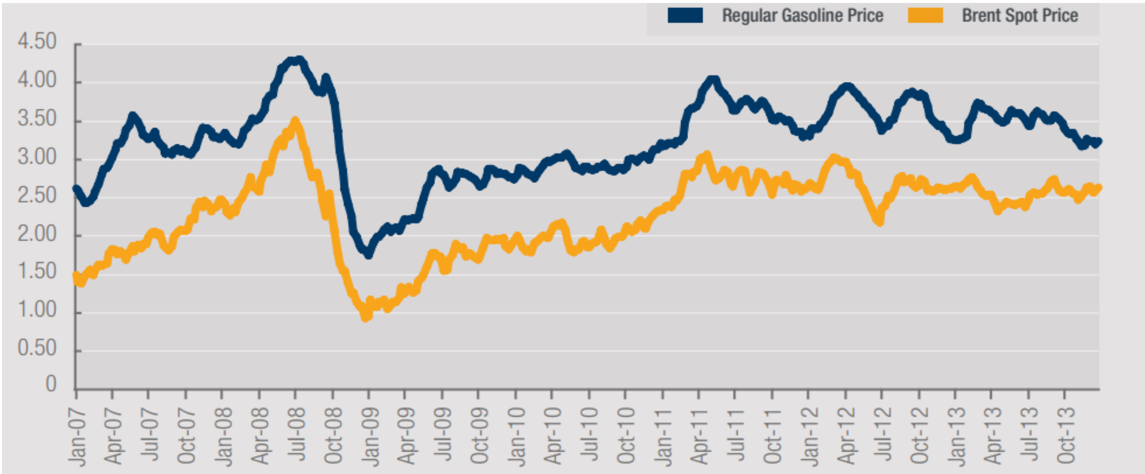
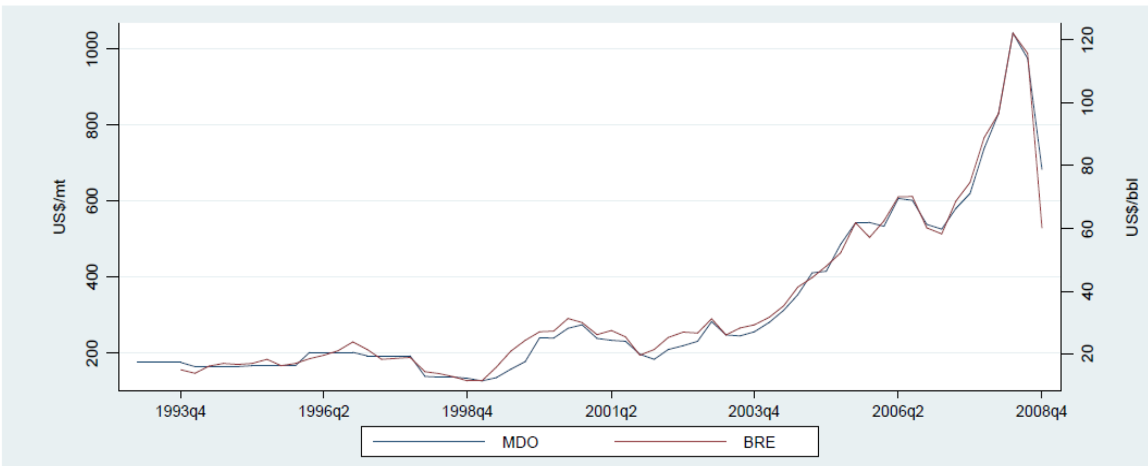


Figure 19 : Inflation-adjusted price comparison retail motor gasoline price and Brent spot price (2007-2013) (2012 dollars per gallon)

Source: EIA and Bureau of Labour Statistic (BLS), cited in American Petroleum Institute,2014

To emphasize the relationship between bunker prices and container freight rate, the research on oil prices and maritime freight rates by UNCTAD. (2010) used Brent crude oil as a proxy of bunker prices (Marine diesel oil) since the correlation between them are high at 0.98 (Figure 20). Figure 21 illustrates the bunker oil prices in major ports which closely correlated during 1993-2008. The instrumental variable with Generalized Method of Moments (IV-GMM) regressions was used to consider the relationship between Brent crude oil and the container freight rate by UNCTAD (2010). The result showed that “the higher the Brent crude oil prices, the more freight rates are affected/react” (UNCTAD, 2010) which can mean that ship-owners tend to absorb the smaller increase in oil price but for the higher increase of oil price, they tend to pass on the cost to shippers. However, there are other factors affecting freight rate, the correlation between freight rate and Brent crude oil is not high.

According to the reasons mentioned above, the hypothesis on the significantly negative relationship between bunker oil prices and container throughput is stated. The change in bunker prices could influence the final product price through transport costs and tend to affect container throughput through the demand of import cargo. In this paper, bunker prices Singapore is chosen to determine the relationship between bunker prices and container volume in LCP, as the majority of numbers of ships calling at LCP are feeders from Singapore and the fuel base in Singapore is being used for feeders.



BRE: Brent crude oil prices, Datastream. MDO: Marine Diesel Oil, expressed as an average across the five ports of Rotterdam, Singapore, Tokyo, Los Angeles and Houston,UNCTAD (2010).

Figure 20 : Brent crude oil price and bunker price (Marine Diesel Oil) (1993-2008)

Source: Adapted from "Oil prices and maritime freight rates" by UNCTAD, 2010

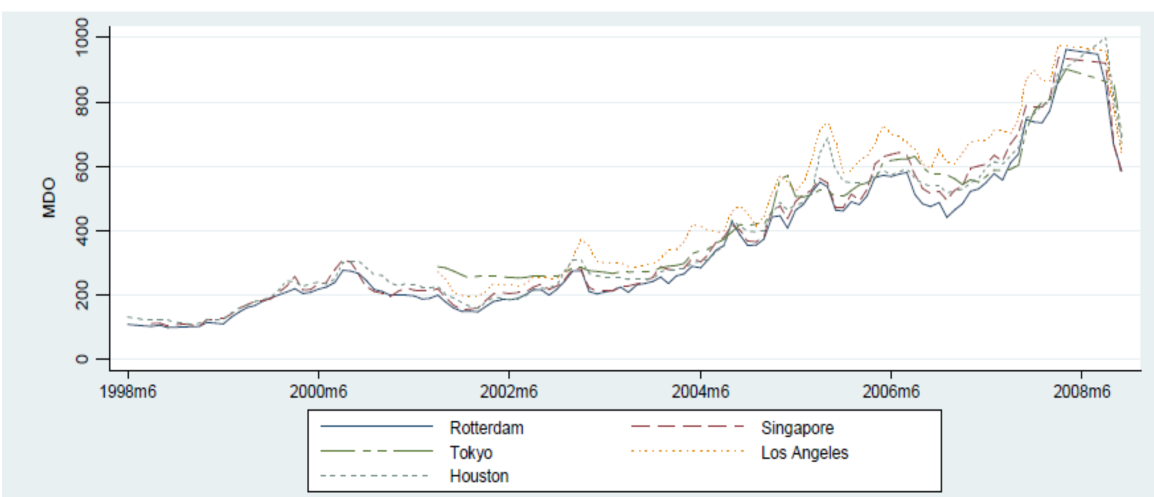


Figure 21 : Bunker fuel prices (MDO) across select bunkering ports

Source: Adapted from "Oil prices and maritime freight rates" by Bunkerworld, cited in UNCTAD, 2010

- Intra-Asia Container Freight Rate Index

The container freight rate is included in transport cost of products that some parts of their supply chain are using containerization. In the last century, when the size of container ships was bigger, sea transport costs were steadily reduced. Then the demand for sea transport and purchasing power of customers encouraged them to increase. As customers are the ones who make a decision on the transport costs and the quality of a product, it is normal to see that components of the products are produced in several places. To achieve cost-effectiveness, logistics planners have to decide where to distribute the product and the manufacturer who will assemble the product. It is more than a decade since the manufacturing base changed from Europe and America to Asian countries and the most significant factor of the causes to the shift of the manufacturing base is the gradual decrease of the sea transport cost. Obviously, the demand for sea transport depends on various factors and freight rate is one of its significant factors. The relationship between container freight rate and container trade growth is a negative correlation since the container freight rate is a cost for shifting containers. The empirical of the relationship between container freight rate and container trade in the Mainlane trade shown in figure 22 emphasizes the concept of the negative relationship between them. As geographically Thailand is located in Asia, in this paper, container freight rate Index in Intra-Asia is chosen in order to examine the relationship between container freight rate and container volume in LCP.

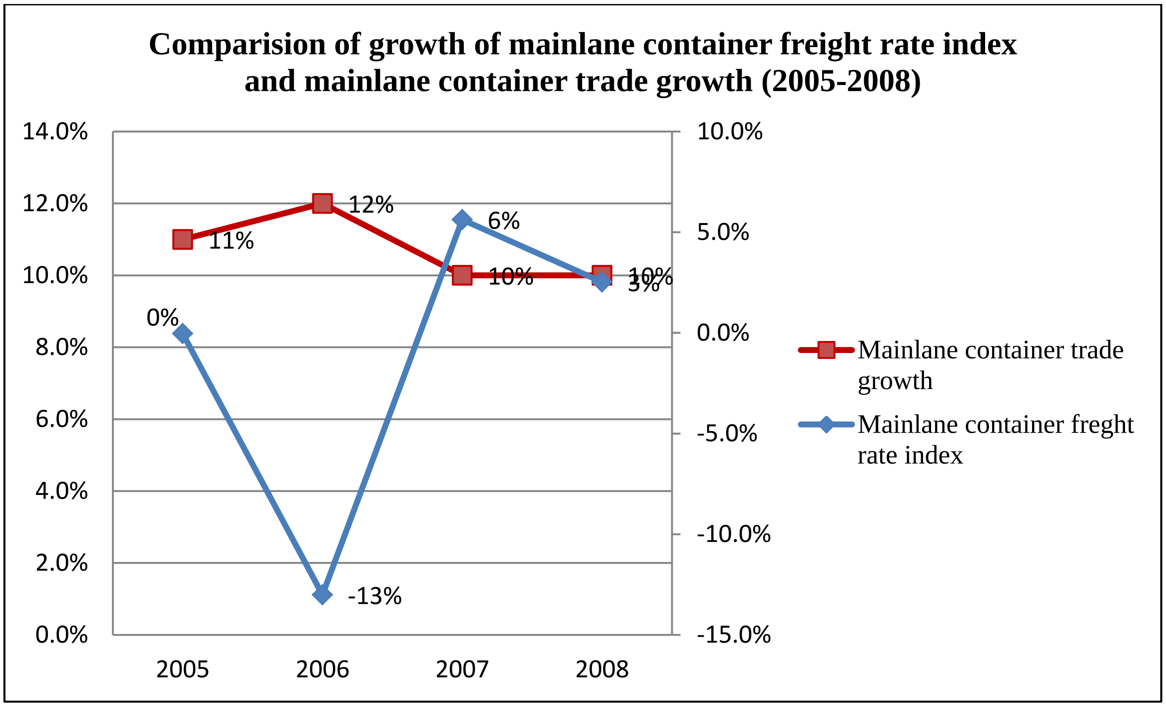


Figure 22 : Comparison growth of mainlane container freight rate index and mainlane container trade (2005-2008)

Source: adapted from Clakson (2016) and *Wilson and Benson (2009)*

- Exchange Rate :

"Since 1997, Thailand has adopted the managed-float exchange rate regime" (Bank of Thailand, n.a.) means that the changing of a domestic currency freely controlled by market conditions. The price of a currency can be explained in the same way as other product values which are affected by demand and supply of the products in the market. Variously influential factors are related to a change in the value of currency. However, influential factors of currency value are beyond the scope of this paper.

Several studies prove an existing relationship between exchange rate and import and export. According to the study of Genc and Arta (2014), they examined the effect of exchange rates of exports and imports of 22 emerging countries. The study applied the panel co-integration to measure the relationship between effective exchange rates and exports-imports of emerging countries and the result disclosed a statistically significant co-integration between the real effective exchange rate and the export-import of emerging economies in the long run. Five emerging economies (Bolivia, Cameroon, Dominica, Gabon, and Mexico) showed statistically significant co-integration between the real effective exchange rate and the export-import, the long-term relationship and the short-term relationship.

Currency depreciation boosts export volume because domestic currency value is lower than another currency's value which makes the goods price exported from a country cheaper than other countries. In contrast depreciation would cause the increase of the cost of imported cargo. The domestic firms which use imported input would suffer from currency depreciation. To evaluate the relationship between exchange rate and container throughput, as container throughput is combined both by inbound cargo (import) and outbound cargo (export) which differentially reacts to exchange rate. The outbound container volume has a negative correlation with the exchange rate. This means a rise on outbound cargo volume exists by the decrease of the exchange rate (currency depreciation), and vice versa. Meanwhile, a relationship between inbound containers has a positive relationship with the exchange rate. As 70 percent of container throughput at LCP is outbound containers (Figure 23), therefore, a correlation between container throughput at LCP and exchange rate would be negative. In this paper, Pearson's correlation coefficient test is utilized in order to evaluate the correlation between each explanatory variable and dependent variable before generate forecasting model.

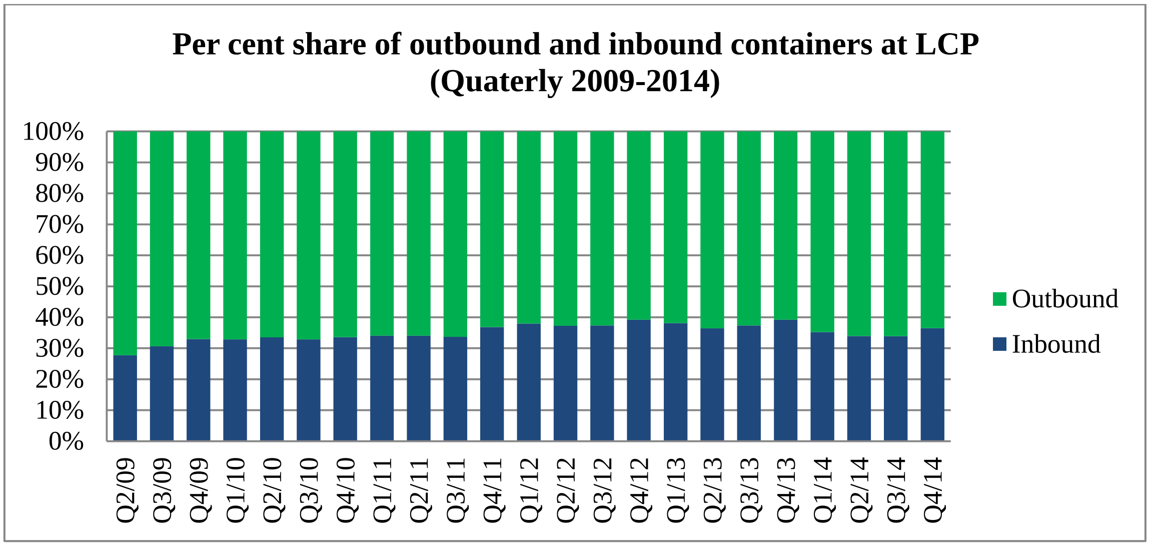


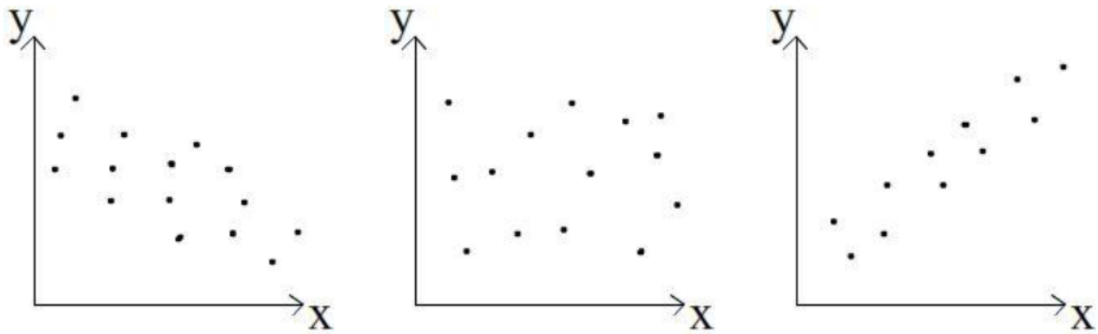
Figure 23 : Percent share of outbound and inbound at LCP (2009-2014)

Source: Adapted from "Unpublished data file" by PAT,2015

3.3 Relationship between influential variable and container throughput (explained variable)

3.3.1 The scatter plot

A scatter plot is a graphical technic to identify a potential relationship between a set of bivariate data called correlation between 2 variables. A scatter can give a draft visual of the relationship between two variables and normally used before correlation coefficient or regression model because it can help to interpret the correlation coefficient or regression model. Relationships in three different formats appear in figure 24 with figure 24 (a) indicating a negative relationship between two variables as seen in figure 24 (b) showing that there is no correlation between two variables. Figure 24 (c) illustrates the positive relationship. In Appendix B the scatter plot of each independent variable with container throughput at LCP is indicated.



(a) Negative correlation

(b) No correlation

(c) Positive correlation

Figure 24: A different relationship of bivariate data by scatter plot

Source: http://www.statstutor.ac.uk , 2016

3.3.2. Pearson's correlation coefficient

There is some misunderstanding on the correlation. The correlation is used to measure the degree of linear association between two variables. A misinterpretation on the meaning of correlation is changing Y caused by changing X; actually; it means that two variables behave symmetrically (Brooks, 2010).

Pearson's correlation coefficient, or simply called correlation coefficient, is a universally statistical tool to measure the strength correlation of linear relationship between two variables. The parameter for measuring, known as R, can be calculated by the following formula;

$$R = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{(X - \bar{X})^2}\sqrt{(Y - \bar{Y})^2}}$$

The value of R is between -1 to 1

The value R is positive value and nearly to 1 : meaning that two variables have a strong positive linear relationship.

The value R is negative value and nearly to -1 : meaning that two variables have a strong negative linear relationship.

The value R is nearly to 0 : meaning that two variables have a weak linear relationship.

The value R is equal to 0 : meaning that two variables have no linear relationship.

The value R is equal to 1 : meaning that two variables have a perfect linear relationship.

The correlation coefficient between independent variables and the container throughput (dependent variable) is presented in Appendix C. In the table of Appendix C, five independent variables are shown which have a strong positive relationship with the container throughput by the value of R between 0.7 – 1 namely private investment index, private consumption index, trade between China-Thailand and trade between the United States-Thailand and a number of the sale value of machinery, while two independent variables illustrate a weak negative correlation with the container volume, namely exchange rate and container freight rate. The other independent variables, namely employment, industry production, bunker price, trade between Japan-Thailand, the volume of the car sales, the volume of motorbike sales, and the value of government expenditure show their positive relationship with container throughput.

As important components of the private investment index is manufacturing cargo e.g. the number of machine and automobile sales and import capital products which mostly shipped by container, therefore the result of the correlation coefficient between private investment and the container throughput is strong at 0.83 In the same way the relation between value sale of machinery and the container throughput is strong at 0.80. 90 per cent of container throughput is transit containers. Most of the cargos transported by containers are to consume within the country. Therefore the relationship between private consumption index and container throughput stands at 0.86.

Surprisingly, the strength correlation of linear relationship between the trade of Japan and Thailand is weaker than the ones between Thailand and China and the United States even the trade value between Thailand and Japan is the highest, and the structure of import and export cargos between Thailand and three countries are quite similarl. Figure 25 illustrates similar export and import structures between the three countries and Thailand. The structure of trade between Thailand and the three countries shows the principle manufacturing product shared 70-80 per cent of export cargos whereas 75-80 per cent of the import structure shared by raw material and intermediate and capital goods. An important reason which can explain the weaker correlation of Trade between Thailand and Japan than the ones between Thailand and China and the United States is different types of export and import cargos. In 2009-2014, the biggest shared export manufacturing products to Japan were motorcars, parts, and accessories which were counted at 5.72 per cent of the total export cargo. These types of cargo were high-value products. Therefore, the trade value between Japan-Thailand was high. Moreover, the main traded product like motorcars shipped by Ro-Ro ships were not counted in container transport and iron steel and their products, the third large import product from Japan, shared 13.48 percent of all import cargos volume from Japan are shipped by a general carrier. Consequently, the correlation of Trade between Thailand and Japan is not high.

Meanwhile, the biggest shared of import and export between the trade of Thailand-China and between Thailand- the United States are products shipped by containers. Main products traded between Thailand-China were processing machine, electrical household appliances and machinery and parts, and the major products traded between Thailand-the United States were machinery and parts, electrical machinery and parts, chemicals and aeroplanes, gliders, instruments and parts. Therefore, the trade between the two countries and Thailand were higher than the trade of Thailand-Japan. More details on the proportion of import and export cargos of the three biggest bilateral trade partners of Thailand can be found in Appendix D.

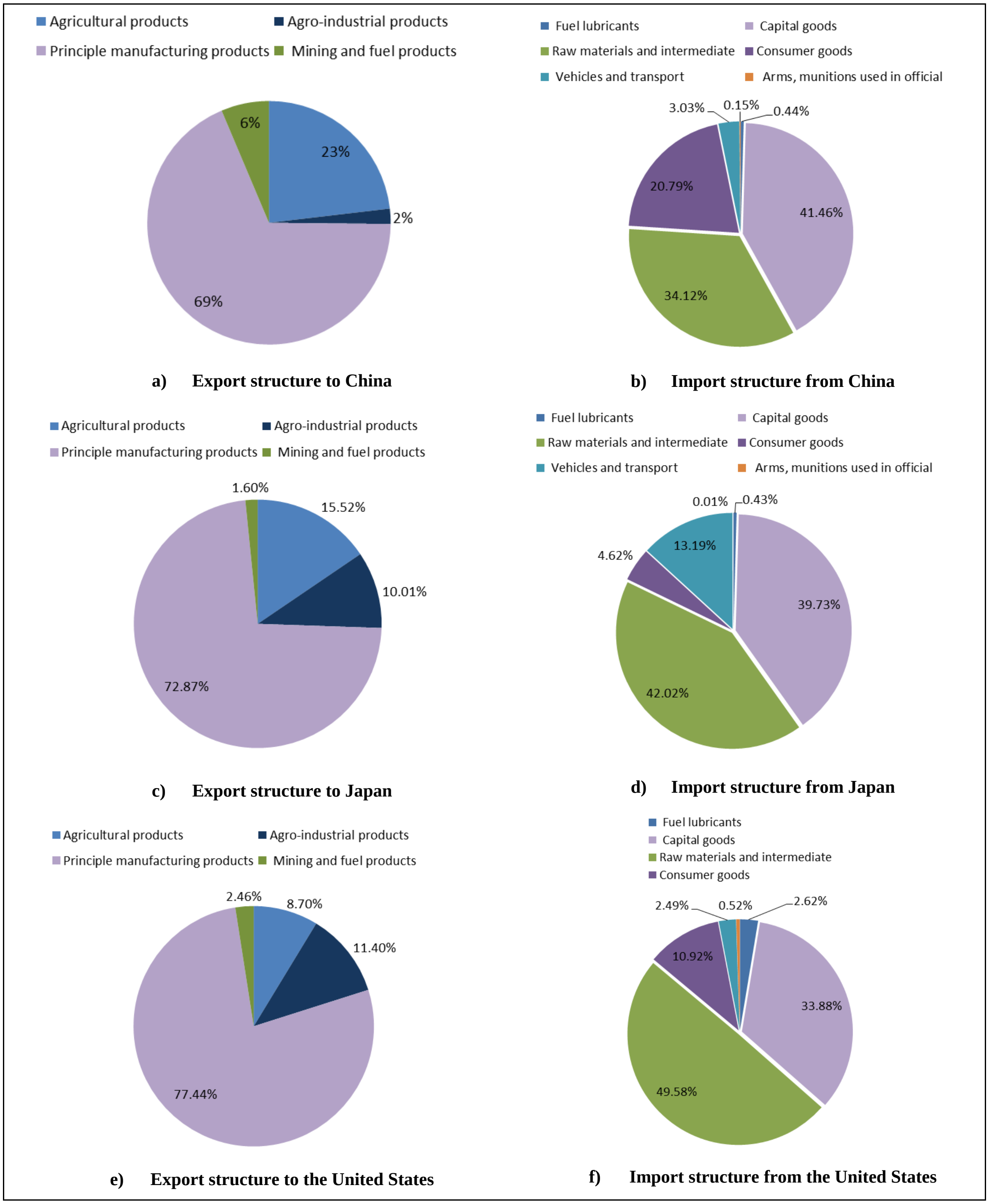


Figure 25 : Export and Import structure of top 3 bilateral trade partners of Thailand

Source: Adapted from “Data file” by Ministry of Commerce of Thailand (n.d.)

The correlation between exchange rate and container throughput is negative at -0.39 which means that the volume of container throughput will rise when an increasing currency depreciates. Comparing internal independent variables and external independent variables, container throughput is more correlated with internal independent variables. Correlations between container freight rate and container throughput are weakest at -0.21. It means that the fluctuation of container freight rate rarely influences the volume of container throughput. One important thing which should be explored is the positive correlation of the container volume and bunker oil price; the result is the difference from the hypothesis in the previous section on the negative correlation between them. An essential reason for the positive relationship between bunker price and the volume of containers throughput can be explained by the rise in the oil price affected by an increasing demand for oil which is pushed by world economic growth. On the other hand, world economic growth also pushes the demand for any product in general. After that, the producers adjust their behaviour to match the new demand. An increasing demand and production influence a high volume of containers. The study of Ghalayni (2011) concludes that the price of oil influences the behaviour of consumers and producers in G-7 countries[9].

Apart from the correlation coefficient measurement, there is an alternative statistical method to test an influential effect of one variable on another variable known as Granger Causality tests (Ghalayni , 2011). However, this test is beyond the scope of this paper.

3.3.3 Simple linear regression

A regression analysis is an important mathematical method " to evaluate the relationship between given variable and one or more variable" (Brooks, 2010). The regression is to explain a movement of dependent variables by referencing from independent variables.

[9] Canada, France, Germany, Great Britain, Italy, Japan, and the United States.

Simple linear regression is a regression attempting to explain a dependent variable by one independent variable. The general equation is declared below;

$$Y=\alpha +\beta X_t +U_t$$

This equation represents a straight line, while Y is a dependent variable and X is an independent variable. In simple regression, most important are to seek for the value of parameter or coefficient of α and β. α parameter is a value of y when x equal to zero. β is coefficient to measure a slope of the straight line. If β is equal to zero, means X is no linear relationship with Y. t is an amount of observation, and u is the error term to measure the difference between the actual value and the value indicated by the estimated line. *"*The objective is to find ordinary least square (OLS) fitting line to the data by minimizing the sum of squared error" (Brooks,2010).

3.3.4 Multiple regression

In reality, a dependent variable is mostly influenced by more than one independent variable, therefore simple regression seems improper to test. Container throughput is an example which is influenced by more than one explanatory variable. Multiple regression is a tool to measure the model which a dependent variable is explained by more than one explanatory variable (Brooks,2010). The general equation can be written by:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \ldots\ldots + \beta_k X_k + Ut, \quad t=1,2,\ldots\ldots,T$$

*"*Variables X_{2t}, X_{3t},X_{4t}……..X_{nt} are a set of k-1 independent variables which thought to influence y, while β_2, β_3, β_4……..β_k are coefficient*"* (Brooks,2010).

- R Square (R^2)

This statistical measurement of "how well does the model containing the explanatory variables that were proposed actually explain variation independent variable" (Brooks,2010) or how well the regression closely fits the data. Hence this is a measure of the proportion of variance Y explained by the independent variable (X_k) (Odland and Kaltea, 2011). The value of R square is between 0 to 1. Undoubtedly, R^2 close to one is better. The formula of R^2 can be decomposed as:

$$R^2 = \frac{\sum(\hat{Y_t} - \bar{Y})^2}{\sum(Y_t - \bar{Y})^2}$$

- Adjusted R square (R^2)

The problem of R^2 is that the degree of freedom is not taken into account. In the same combination of regression but the difference amount of variables, normally R^2 of regression with a high amount of variable is greater. In order to solve the problem, $\bar{R}^2$is performed. $\bar{R}^2$ helps analyzer to make a decision on adding extra regressors into the model. An extra regressor should be added when it makes an increase of $\bar{R}^2$ and should be deleted from the model if after adding, it leads to a falling of $\bar{R}^2$(Odland and Kaltea, 2011). The formula of $\bar{R}^2$ can be defined as:

$$\bar{R}^2 = 1 - \left[\frac{T-1}{T-K}\right](1 - R^2)$$

- Correlation between explanatory variables

The issue of high correlation between two or more explanatory variables is known as "*multicollinearity*" and should be concerned due to the damage of multicollinearity which could lead to an unstable of the regression coefficient. Unstable of regression coefficient means when adding or removing a variable from a regression equation the value of the coefficient on the other variable would be changed. The non-relationship between variables is called "*orthogonal*" (Brooks,2010). However, in reality, to find all orthogonal explanatory variables in the model is difficult. In order to save an equation from multicollinearity, the paper applies the suggestion from Nunnaly (1978) cited in Feldman and Santangelo (2008) to deleted variables which have their correlation higher than 0.70. The Pearson's correlation coefficient is utilized to measure the value of correlation. Table 3 indicates the correlation coefficient among independent variables. For the pair of independent variables of which their correlation coefficient is higher than 0.7 Both independent variables cannot be appeared in the same equation. Nevertheless, even the correlation between private investment and industry production is at 0.6736 with less than 0.70 but the two variables are quite closely related in terms of the economic viewpoint. Therefore, they would not be used in the same model. The result of testing of the Pearson's correlation coefficient for all independent variables is illustrated in Appendix C.

	PRI_CON _ID	PRI_IN _ID	INDUSTRY _P	JAP_T	CHN _T	USA_T
PRI_CON _ID	1					
PRI_IN _ID	0.9641	1				
INDUSTRY_P	0.6421	0.6736	1			
JAP_T	0.6471	0.7295	0.5512	1		
CHN _T	0.9108	0.8946	0.5757	0.6549	1	
USA_ T	0.7371	0.7102	0.4761	0.5375	0.8134	1
MACHINE	0.7780	0.8083	0.6726	0.7182	0.8210	0.7667
CAR_SALE	0.6875	0.7544	0.7400	0.6303	0.5399	0.3558
MOTOBIKE	0.4927	0.5217	0.7425	0.6323	0.4415	0.2915

Table 3 : The Pearson's correlation coefficient

Source: Author

- Unit Root Test

The "*spurious regression*" exists when analyzers include the non-stationary variable in equations. If non-stationary data is used, it may cause too high of R square and significant coefficient even two variables are unrelated. This situation may exist when two variables are trending over time (Brooks,2010). For instance; the trend of a number of short skirts sales and the rate of drowning in city swimming pools can be trending over the time because the heat is a hidden or unseen variable. Unit root test such as Augmented Dickey-Fuller (ADF), or Phillip-Perron (PP) is standard tools to test stationary. In this paper, ADF is applied to test stationary[10]. After applying the test, if any variables are non-stationary on their level but stationary on their 1st difference they have to be turned to logarithms before use in the equation.

- Co-Integration Test

The co-integration test is used to examine if a model has empirically meaningful relationships by testing stationary on the level of a residual of a pair of non-stationary variables (Sjo,2008). If the result of the test shows the residual is stationary in level, this implies a similar stochastic trend between two variables. It means that two variables could deviate from the equilibrium by economic shock in the short-run, but they obey an equilibrium relationship in the long run. The residual of a pair is called an error correction term (ECT) which should be added in the model. The models which include ECT is called error correction model (ECM) could be more appropriate than a pure 1st difference model because ECM is enabled to capture the long-run relationship.

[10] The stationarity of a series can strongly influence its behaviour and properties or it can be defined as one with a constant mean, constant variance and constant autocovariances for each given lag (Brooks,2010).

- T-test

Test- Statistics. (T-Test) is a statistical test of hypothesis testing. The objective of the test is to examine the statistical significance of an independent variable in explaining dependent variable. “To test whether β could have come from a population in which the true value was zero, the t-test is used. The coefficient is divided by its standard error” (Stopford, 2010 cited in Hoon,2013).

$$\mathrm{t-test} = \frac{\beta}{SE(\beta)}$$

If the value β is not equal zero, this means that the explanatory variables contribute significantly to explain the dependent variables, and the null hypothesis is rejected.

$H_{o\,:}$ $\beta = 0$

$H_1 : \beta = 1$

The critical values and Probability value (P-value) are used to evaluate against a set limit using null hypothesis. This paper will consider the P-value, and it is set at 5 per cent of the significant level. If the P-value is less than 0.05, this means an independent variable is statistically significant, and the null hypothesis is rejected.

- F-test

The F-test is to test multiple hypotheses. In this paper, the F-test is used to test the null hypothesis that parameters on several variables are jointly zero. If the P-value is higher than 0.05, the null hypothesis cannot be rejected which means the variables are unable to explain the variations dependent variable. Then the variables should be deleted from the model.

$H_{o:}$ $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

H_1 : $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$

- Assumption of the Classical Linear Regression Model (CLRM)

In order to fit with Best Linear Unbiased Estimators (BLUE), assumptions 1-4 need to be satisfied. "When assumption 1-4 hold, the estimators α and β determined by OLS will have a number of desirable properties, and are known as BLUE" (Brooks,2010).

1) Assumption 1

The first assumption of the CLRM is that the average value of the error terms is zero. In fact, this assumption is never infringed, if there is constancy included in the regression model (Brooks,2010).

2) Homoscedasticity

This assumption is that the variance of the errors is constant ($var(u_t) = \sigma^2 < \infty$). If variance of the error is not constant, it is known as heteroscedastic. The heteroskedastic models could hold incorrect standard errors and any inference could be misleading (Brooks,2010).

Ho: the variance of the errors is constant

H1: the variance of the errors is not constant

To test Heteroskedastic, Breusch Pagan Godfrey Test is applied. After testing, if Chi-Square probability is higher than 0.05, the null hypothesis cannot be rejected which means the error is homoscedastic.

3) Serial Correlation

The third assumption of CLRM is that the covariance between error terms over time is zero. In other words, the error terms in the regression equation are uncorrelated with one another. The error term is correlated is called serial correlation or autocorrelation. Serial correlation can cause biased standard error (Brooks,2010).

$$Ho: cov(u_i,u_j)=0$$
$$H1: cov(u_i,u_j) \neq 0$$

The Breusch-Godfrey Serial Correlation Test is applied to test autocorrelation. If the Chi-Square is higher than 0.05, the null hypothesis cannot be rejected which means there is no serial correlation in the model.

4) The x_t are non-stochastic

The fourth Assumption is to prevent the OLS estimator from bias and inconsistent by not including independent variables with correlated with the error term in the model. A model possessing stochastic repressors can cause bias and inconsistency. To meet the requirement of the fourth assumption, assumptions 1-3 have to be made. In other words, this assumption itself consists of three assumptions (Brooks,2010).

5) Normality test

The fifth assumption is that the error terms are normally distributed. “Recall that the normality assumption “(ut ∼ N(0, σ 2)) is required to conduct single or joint hypothesis tests about the model parameters”(Brooks,2010). To meet the fifth assumption, the Skewness should be zero and should have the Kurtosis coefficient of three. If the residuals are not normally distributed, the coefficient estimates could be incorrect (Brooks,2010). The Jarque-Bera test is popular to test normality.

6) Test for Lınear Functıonal Form

An appropriate function form of CLRM should be linear meaning that a proper model is assumed to be linear in parameters (Brooks, 2010). The Ramsey reset test is performed in order to detect the assumptıon of lınear functıonal form ın the regression (Hoon,2013).

Ho: linear functıonal form

H1: Non-linear functıonal form

7) Parameter Stability Test

"The assumption implied that the parameters are constant for the entire sample, both for the data period used to estimate the model and for any subsequent period used in the construction of forecasts" (Brooks, 2010). In order to test this assumption, the analyzers use the concept of split data into sub-models and compare the RSS of each model. The Chow test is performed to detect any structural break in a time series data. Before using the Chow test, CUSUM (Cumulative Sum) squared test is applied to explore any structural break in the regression equation. The structural break can lead to poor accuracy of the forecasting (Brooks, 2010).

4. PRELIMINARY STATISTICS RESULTS

4.1 ADF Test Result

Variable	ADF (Level)			Result	ADF (1st Difference)			Result
	t-stat	5% cr.value	Prob		t-stat	5% cr.value	Prob	
BUNKER_SIN	-1.4308	-2.9055	0.0562	**Non-Stationary**	-4.9473	-2.9055	0.0001	**Stationary**
CAR_SALE	-1.8555	-2.9048	0.3511	**Non-Stationary**	-7.4892	-3.5315	0.0000	**Stationary**
CONFRI	-1.9666	-2.9055	0.3006	**Non-Stationary**	-5.0666	-2.9055	0.0001	**Stationary**
CHN_T	-1.9391	-2.9055	0.3128	**Non-Stationary**	-14.0191	-2.9055	0.0000	**Stationary**
EMPLOY	-4.3390	-2.9048	0.0008	**Stationary**	-	-	-	-
EXCHAGE_RATE	-2.2783	-2.9055	0.1819	**Non-Stationary**	-59833	-2.9062	0.0000	**Stationary**
G_EXPEND	-5.0704	-2.9048	0.0001	**Stationary**	-	-	-	-
INDUSTRY_P	-3.4127	-2.9048	0.0138	**Stationary**	-	-	-	-
LCP	-1.7827	-2.9062	0.3858	**Non-Stationary**	-9.8132	-2.9062	0.0000	**Stationary**
JAP_T	-3.3555	-2.9048	0.0161	**Stationary**				**Stationary**
Machine	-2.6963	-2.9069	0.0801	**Non-Stationary**	-4.4011	-2.9069	0.0007	**Stationary**
MOTORBIKE_SALE	-3.8937	-2.9048	0.0035	**Stationary**	-	-	-	-
PRI_CON_ID	-2.3845	-2.9055	0.1499	**Non-Stationary**	14.1167	-2.9055	0.0000	**Stationary**
PRI_IN_ID	-2.3383	-2.9077	0.1634	**Non-Stationary**	-3.0506	-2.9076	0.0356	**Stationary**
USA_T	-2.4992	-2.9055	0.1202	**Non-Stationary**	-14.3734	-2.9055	0.0000	**Stationary**

Table 4 : Unit Root Test

Source: Author

The result of the ADF test in Table 4 shows four variables stationary on their level namely EMPLOY, G_Expend, INDUSTRY_P, JAP_T and MOTORBIKE_SALE. Other variables are stationary on their 1st difference which means the data have to turn to logarithms before used in the equation.

4.2 Co-Integration Test Result

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
LCP	**CHN_T**	-9.04862	-2.9048	0.0000	Stationary
	MACHINE	-4.4228	-2.9048	0.0006	Stationary
	PRI_CON_ID	-6.4845	-2.9048	0.0000	Stationary
	USA_T	-7.3018	-2.9048	0.0000	Stationary
CHN_T	**PRI_CON_ID**	-3.4441	-2.9055	0.0217	Stationary
	USA_T	-5.1647	-2.9048	0.0001	Stationary
MACHINE	**PRI_CON_ID**	-3.1299	-2.9069	0.0292	Stationary
	USA_T	-5.6285	-2.9048	0.0000	Stationary
PRI_CON_ID	**PRI_IN_ID**	-5.6737	-2.9048	0.0000	Stationary

Table 5 : Co-integration between non-stationary

Source: Author

The result of co-Integration test implies nine ECT (Table 5). For all of the results of the pairs of all non-stationary variables see Appendix E. Apparently in any pair of independent variables which their correlation coefficient is high or called multicollinearity, ECT between them exist. Therefore, in this paper, the ECT of any pairs which their correlation coefficient appear multicollinearity. The ECT will not be added in the model. Hence, there will be only four ECTs used in the model namely the ECT between LCP and CHN_T (ECTLCPCHN), the ECT between LCP and MACHINE (ECTLCPMAC), the ECT between LCP and PRI_CON_ID (ECTLCPPRICON) and ECT between LCP and USA_T (ECTLAPUSA).

As there are several multicollinearities between the pair of regressors (Appendix C), some regressors which have multicollinearities could not fit into the same model. Under this condition, only two proper equations are formed (Figure 26).

4.3 T-Test Result

Dependent Variable: LOGLCP Method:Least Squares Date: 08/26/16 Time:10:37 Sample: 2009M04 2013M12 Included observations: 57				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.730551	0.611658	4.464179	0.0000
EMPLOY	2.03E-05	4.89E-06	4.152410	0.0001
LOGPRI_IN_ID	0.368516	0.121037	3.044665	0.0037
LOGEXCAHGE_RATE	0.123450	0.284721	0.433582	0.6665
LOG_BUNKER_SIN	0.216804	0.064442	3.364338	0.0015
MOTOBIKE_SALE	1.82E-07	1.31E-07	1.386245	0.1719
G_EXPEND	1.65E-08	7.95E-08	0.208007	0.8361
LOGCONFRI	0.186494	0.132128	1.411461	0.1644
R-squared	0.854823	Mean dependent var		5.549785
Adjusted R-squared	0.834084	S.D. dependent var		0.059449
S.E. of regression	0.024215	Akaike info criterion		-4.474200
Sum squared resid	0.028732	Schwarz criterion		-4.187456
Log likelihood	135.5147	Hannan-Quinn criter.		-4.362761
F-statistic	41.21709	Durbin-Watson stat		2.138405
Prob(F-statistic)	0.000000			

(a) Model I

Dependent Variable: LOGLCP Method:Least Squares Date: 08/26/16 Time:10:51 Sample: 2009M04 2013M12 Included observations: 57				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.102268	0.621258	4.993530	0.0000
EMPLOY	2.55E-05	4.99E-06	5.099877	0.0000
LOGEXCAHGE_RATE	-0.119854	0.291333	-0.411399	0.6825
LOG_BUNKER_SIN	0.340698	0.064467	5.284873	0.0000
INDUSTRY_P_ID	0.000632	0.000246	2.574325	0.0131
LOGCONFRI	0.287878	0.138468	2.079017	0.0428
G_EXPEND	6.30E-08	8.34E-08	0.754560	0.4541
R-squared	0.826595	Mean dependent var		5.549785
Adjusted R-squared	0.805786	S.D. dependent var		0.059449
S.E. of regression	0.026199	Akaike info criterion		-4.331608
Sum squared resid	0.034319	Schwarz criterion		-4.080707
Log likelihood	130.4508	Hannan-Quinn criter.		-4.234100
F-statistic	39.72366	Durbin-Watson stat		2.220374
Prob(F-statistic)	0.00000			

(b) Model II

Figure 26: T test

Source: Author

The model I: The result from the T- test illustrates four insignificant variables appearing in the model, EXHANGE_RATE, MOTOBIKE_SALE, G_EXPEND, and LOGCONFRI. Before removing insignificant regressors from the model, the F-Test needs to be tested.

Model II: The result from the T- test illustrates three insignificant variables appearing in the model, LOGEXHANGE_RATE, G_EXPEND, and LOGCONFRI. Before removing insignificant regressors from the model, the F-Test needs to be tested.

4.4 F-Test Result

(a) Model I

Wald Test: Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	1.230629	(4, 49)	0.3101
Chi-square	4.922516	4	0.2953
Null Hypothesis: C(4)=C(6)=C(7)=C(8)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		0.123450	0.284721
C(6)		1.82E-07	1.31E-07
C(7)		1.65E-08	7.95E-08
C(8)		0.186494	0.132128
Restrictions are linear in coefficients.			

(b) Model II

Wald Test: Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	0.336271	(2, 50)	0.7160
Chi-square	0.672541	2	0.7144
Null Hypothesis: C(3)=C(7)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(3)		-0.119854	0.291333
C(7)		6.30E-08	8.34E-08
Restrictions are linear in coefficients.			

(a) Model I (b) Model II

Figure 27 : Wald Test

Source: Author

After testing F-Test for insignificant regressors of model I and model II (Figure 27), the result of the test shows that the P-value of two models are higher than 0.05. The P-value of Model I and Model II are 0.2953 and 0.7714 respectively meaning the regressors are not significant, and should be removed from the model.

4.5 Breusch-Godfrey Test for Heteroskedasticity

(a) Model I

Heteroskedasticity Test: Breusch-Godfrey				
F-statistic	1.212986	Prob. F(3,53)		0.3141
Obs*R-squared	3.662155	Prob. Chi-Square(3)		0.3003
Scaled explained SS	3.788051	Prob. Chi-Square(3)		0.2853
Test Equation: Dependent Variable: RESID^2 Method:Least Squares Date: 08/26/16 Time:10:39 Sample: 2009M04 2013M12 Included observations: 57				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.010463	0.005752	1.819077	0.0746
EMPLOY	-2.70E-07	1.71E-07	-1.575570	0.1211
LOGPRI_IN_ID	0.002072	0.003170	0.653597	0.5162
LOG_BUNKER_SIN	-0.001575	0.002116	-0.744346	0.4600
R-squared	0.064248	Mean dependent var		0.000555
Adjusted R-squared	0.011281	S.D. dependent var		0.000866
S.E. of regression	0.000861	Akaike info criterion		-11.20981
Sum squared resid	3.93E-05	Schwarz criterion		-11.06644
Log likelihood	323.4797	Hannan-Quinn criter.		-11.15409
F-statistic	1.212986	Durbin-Watson stat		2.292429
Prob(F-statistic)	0.314051			

(b) Model II

Heteroskedasticity Test: Breusch-Godfrey				
F-statistic		Prob. F(3,53)		0.2172
Obs*R-squared		Prob. Chi-Square(3)		0.2083
Scaled explained SS		Prob. Chi-Square(3)		0.1837
Test Equation: Dependent Variable: RESID^2 Method:Least Squares Date: 08/25/16 Time:18:47 Sample: 2009M04 2013M12 Included observations: 57				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.115336	0.075898	1.519616	0.1346
EMPLOY	-0.023019	0.017180	-1.339848	0.1860
LOG_BUNKER_SIN	0.000673	0.001728	0.389469	0.6985
LOGINDUSTRY_P_ID	-0.004743	0.003708	-1.278990	0.2065
R-squared	0.079739	Mean dependent var		0.000661
Adjusted R-squared	0.027648	S.D. dependent var		0.001047
S.E. of regression	0.001032	Akaike info criterion		-10.84706
Sum squared resid	5.64E-05	Schwarz criterion		-10.70369
Log likelihood	313.1411	Hannan-Quinn criter.		-10.79134
F-statistic	1.530776	Durbin-Watson stat		2.189301
Prob(F-statistic)	0.217240			

(a) Model I (b) Model II

Figure 28 : Breusch Pagan Godfrey test

Source: Author

Since The Chi-Square Probability appeared in the Breusch-Godfrey Test (Figure 28) of two models are higher than 0.05 hence (Model I: 0.3003 and Model II: 0.2083), the null hypothesis cannot be rejected; the two equations are homoscedastic.

4.6 Breusch-Godfrey Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	2.284380	Prob. F(12,41)	0.0247
Obs*R-squared	22.83961	Prob.Chi-Square(12)	0.0291
Test Equation: Dependent Variable: RESID Method:Least Squares Date: 08/26/16 Time:10:40 Sample: 2009M04 2013M12 Included observations: 57 Presample missing value lagged residuals set to zero			

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	1.586807	Prob. F(12,41)	0.1338
Obs*R-squared	18.07704	Prob.Chi-Square(12)	0.1134
Test Equation: Dependent Variable: RESID Method:Least Squares Date: 08/25/16 Time:18:48 Sample: 2009M04 2013M12 Included observations: 57 Presample missing value lagged residuals set to zero			

(a) Model I **(b) Model II**

Figure 29 : Breusch Godfrey serial correlation

Source: Author

Date: 08/26/16 Time:10:41
Sample: 2009M04 2013M12
Included observations: 57
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.074	-0.074	0.3297	
		2	0.094	0.089	0.8650	0.352
		3	0.086	0.100	1.3242	0.516
		4	-0.214	-0.214	4.2377	0.237
		5	-0.016	-0.066	4.2553	0.373
		6	-0.249	-0.233	8.3288	0.139
		7	0.123	0.153	9.3437	0.155
		8	-0.123	-0.115	10.380	0.168
		9	0.055	0.062	10.593	0.226
		10	-0.044	-0.185	10.733	0.294
		11	-0.166	-0.137	12.755	0.238
		12	0.327	0.272	20.741	0.036

*Probabilities may not be valid for this equation specification.

Model I

Figure 30: Q-Statistic Test

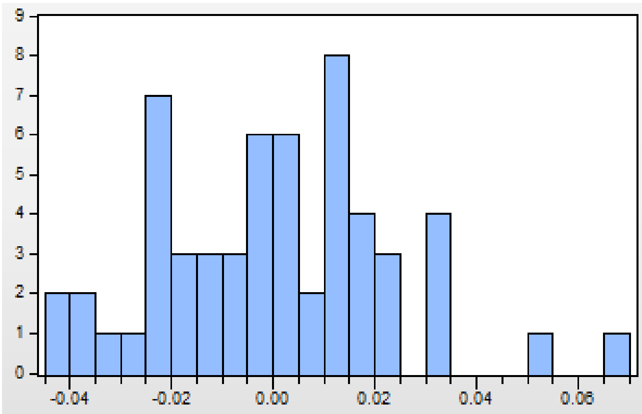
Source: Author

Testing serial correlation by using Breusch-Godfrey Test (Figure 29), the result of Chi-Square of model II is over 0.05 meaning the null hypothesis cannot be rejected while the result of Chi-Square of the model I is less than 0.05 meaning the null hypothesis is rejected. There is a serial correlation in the model I. In order to solve the problem of serial correlation, the autoregressive AR of order p, denoted as AR(p) which is the previous value of Y should be added in the model. After adding AR(q), the autocorrelation will decay exponentially (Brooks,2010).

$$AR(p)=\sum_{i=1}^{p} C_i \, Y_{t-p}$$

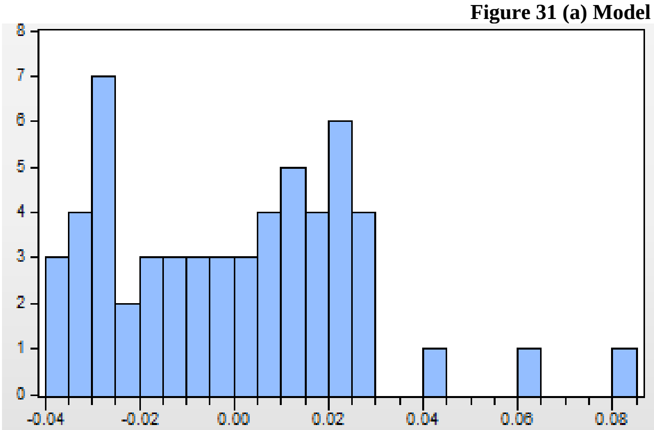
In this paper, the result displays that AR(2) is statistically significant and the Q-test is applied to test the autocorrelation problem. Figure 30 shows the Autocorrelation Coefficient (AC) nearly to zero which means the autocorrelation problem is solved. The result of Q-Test implies that a Partial autocorrelations coefficient (PAC) for all other lags are not statistically significant.

4.7 Normality Test



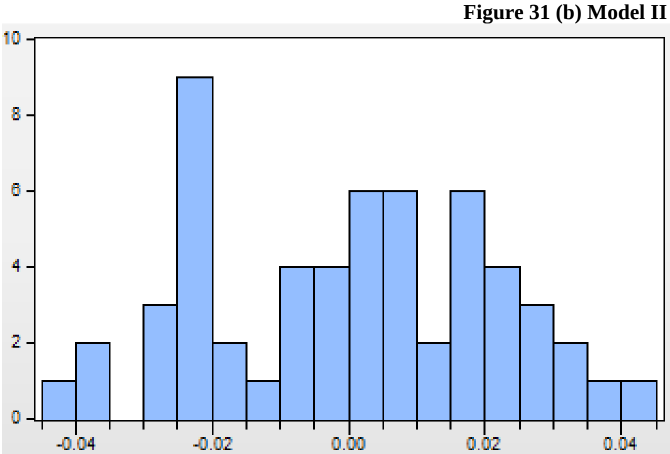
Series: Residuals Sample: 2009M04 2013M12 Observations: 57	
Mean	0.000117
Median	0.000527
Maximum	0.065034
Minimum	-0.043800
Std. Dev.	0.022447
Skewness	0.343309
Kurtosis	3.161556
Jarque-Bera	1.181665
Probability	0.553866

Figure 31 (a) Model I



Series: Residuals Sample: 2009M04 2013M12 Observations: 57	
Mean	-8.11e-16
Median	0.000232
Maximum	0.081454
Minimum	-0.037583
Std. Dev.	0.025820
Skewness	0.59916
Kurtosis	3.400136
Jarque-Bera	3.790190
Probability	0.150304

Figure 31 (b) Model II



Series: Residuals Sample: 2009M04 2013M12 Observations: 57	
Mean	1.46e-15
Median	0.001403
Maximum	0.040399
Minimum	-0.041820
Std. Dev.	0.021078
Skewness	-0.110890
Kurtosis	2.097768
Jarque-Bera	2.050123
Probability	0.358774

Figure 31 (c) Adjusted normality by adding dummy variable in Model II

Figure 31 : Normality Test

Source: Author

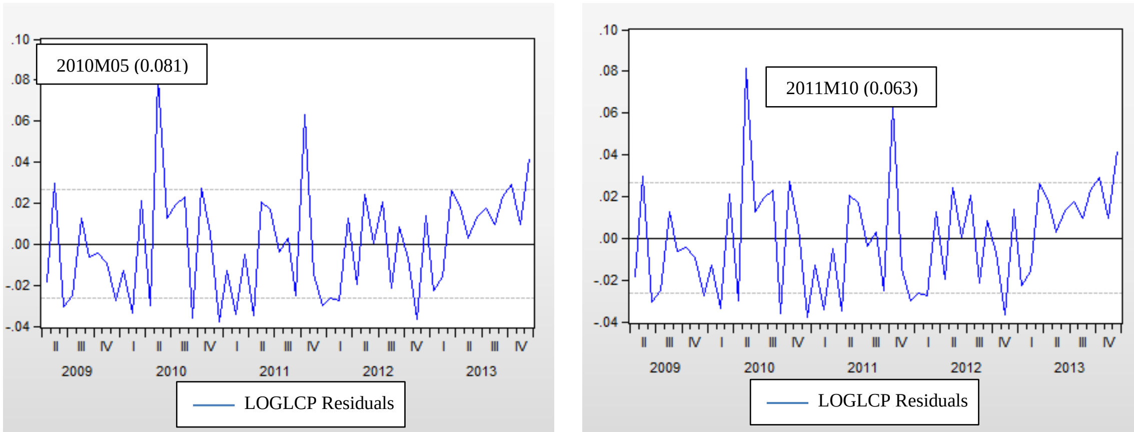


Figure 32 : Residual graph of Model II

Source: Author

Normality test by using Jarque-Bera (Figure 31), the Jarque-Bera probability of two models are greater than 0.05 (Model I: 0.1503 and Model II: 0.3587). Hence, the residuals both models are normally distributed. Furthermore, to be safe with this assumption, the value of Skewness and Kurtosis should be considered. The assumption suggests that the Skewness should be zero and Kurtosis should be three. The result shows that the model I satisfies the second conditions as Kurtosis is closer to 3 at 3.1615 and Skewness is near zero at -0.1108 (Figure 31 (a)), whereas model II, Skewness is high at 0.5991(Figure 31 (b)).

According to Brooks (2010), "dummy can decay the non-normality by taking value one for only a single observation has an effect exactly equivalent to knocking out that observation from the sample altogether, by forcing the residual for that observation to zero". In this monthly model, two dummies are added in Model II; value one was taken in May 2010 and October 2011. The name of dummy (D) are Dummy10m05 and Dummy11m10 (Figure 32), and the regression is changed to this:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 D_i + \beta_5 D_j + Ut,$$

After adding two dummies into the model, Skewness is improved from 0.5991 to -0.11 while Kurtosis is farther from 3 (Figure 31(c)). However, there is some argument on adding the dummy to decay non-normality. Several econometricians dispute that to remove outlying residuals by adding dummy term is fudging the result because the residual sum of square, standard error will reduce whereas R^2 increases. Overall the apparent fit of the model is improved. Nonetheless, changing outliers can have a serious effect on coefficient estimates. In Chapter 5, the evaluation of adding a dummy to remove outlying will be discussed.

4.8 Ramsey Reset Test for Lınear Functıonal Form

Ramsey RESET Test
Equation: UNTITLED
Specification: LOGLCP C EMPLOY LOGPRI_IN_ID LOG_BUNKER_SIN
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.839231	52	0.4052
F-statistic	0.704309	(1, 52)	0.4052
Likelihood ratio	0.766850	1	0.3812
F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	0.000423	1	0.000423
Restricted SSR	0.031619	53	0.000597
Unrestricted SSR	0.031196	52	0.000600
LR test summary:			
	Value	df	
Restricted LogL	132.7864	53	
Unrestricted LogL	133.1699	52	

Unrestricted Test Equation:
Dependent Variable: LOGLCP
Method:Least Squares
Date: 08/26/16 Time:10:43
Sample: 2009M04 2013M12
Included observations: 57

(a) Model I

Ramsey RESET Test
Equation: UNTITLED
Specification: LOGLCP C EMPLOY LOG_BUNKER_SIN INDUSTRY_P_ID DUMMY1005 DUMMY1110
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.255400	50	0.7995
F-statistic	0.065229	(1, 50)	0.7995
Likelihood ratio	0.074313	1	0.7852
F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	3.26E-05	1	3.26E-05
Restricted SSR	0.025003	51	0.000490
Unrestricted SSR	0.024971	50	0.000499
LR test summary:			
	Value	df	
Restricted LogL	139.4769	51	
Unrestricted LogL	139.5141	50	

Unrestricted Test Equation:
Dependent Variable: LOGLCP
Method:Least Squares
Date: 08/26/16 Time:10:58
Sample: 2009M04 2013M12
Included observations: 57

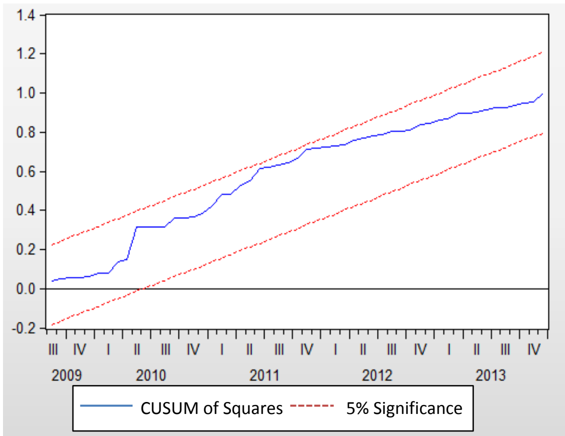
(b) Model II

Figure 33 : Ramsey Reset Test

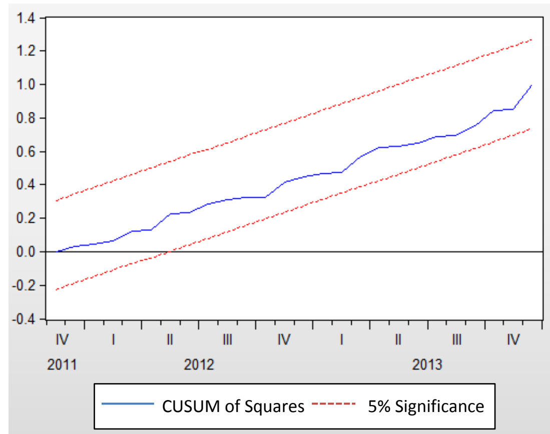
Source: Author

Ramsey Reset Test is applied to detect non-lınear functıonal form. Figure 33 implies that the probability of F-statistic of both models is greater than the significant level at 0.05. Hence, the null hypothesis is not rejected. There is no apparent non-linearity in both of the regression equations.

4.9 CUSUM Squared Test



(a) Model I



(b) Model II

Figure 34 : CUSUM (Cumulative Sum) squared Test

Source: Author

According to the CUSUM Squared Test, the result appears in Figure 34. The blue lines of both models remain inside the red line through the sample period meaning that there is not any structure break in both models.

4.10 The Final Model

Dependent Variable: LOGLCP
Method: ARMA Maximum Likelihood (OPG – BHHH)
Date: 08/26/16 Time:12:39
Sample: 2009M04 2013M12
Included observations: 57
Convergence achieved after 8 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.180331	0.177835	17.88359	0.0000
EMPLOY	1.94E-05	4.27E-06	4.553725	0.0000
LOGPRI_IN_ID	0.464968	0.114354	4.066040	0.0002
LOG_BUNKER_SIN	0.197519	0.070065	2.819101	0.0068
AR(2)	0.337792	0.129177	2.614946	0.0117
SIGMASQ	0.000495	0.000104	4.776422	0.0000
R-squared	0.857429	Mean dependent var		5.549785
Adjusted R-squared	0.843451	S.D. dependent var		0.059449
S.E. of regression	0.023522	Akaike info criterion		-4.558235
Sum squared resid	0.028217	Schwarz criterion		-4.343177
Log likelihood	135.9097	Hannan-Quinn criter.		-4.474656
F-statistic	61.34323	Durbin-Watson stat		2.064903
Prob(F-statistic)	0.000000			

(a) Model I

Dependent Variable: LOGLCP
Method:Least Squares
Date: 08/26/16 Time:14:27
Sample: 2009M04 2013M12
Included observations: 57

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.223838	0.154323	20.89019	0.0000
EMPLOY	2.95E-05	4.29E-06	6.862395	0.0000
LOG_BUNKER_SIN	0.354292	0.038660	9.164347	0.0000
INDUSTRY_P_ID	0.001047	0.000205	5.098738	0.0000
DUMMY1005	0.087596	0.023187	3.777806	0.0004
DUMMY1110	0.081858	0.025487	3.211758	0.0023
R-squared	0.873666	Mean dependent var		5.549785
Adjusted R-squared	0.861281	S.D. dependent var		0.059449
S.E. of regression	0.022142	Akaike info criterion		-4.683400
Sum squared resid	0.025003	Schwarz criterion		-4.468342
Log likelihood	139.4769	Hannan-Quinn criter.		-4.599821
F-statistic	70.53853	Durbin-Watson stat		2.135280
Prob(F-statistic)	0.000000			

(b) Model II

Figure 35 : The final model

Source: Author

After satisfying all assumptions, there are 2 models namely the autoregressive model (Model I) with R^2 at 0.8574 (Figure 35 (a)) and Dummy variable regression model (Model II) with R^2 at 0.8736 (Figure 35 (b)).

5. FORECASTING MODEL

A forecast is essential for planning. Even though the forecast cannot predict the future 100 per cent, all analyzers attempt to increase the predictive precision. The data from the past is commonly used to predict the future. The main objective of this paper is to find the best accurate forecast model based on the scope of the data. The data used is from 2009-2013 in order to forecast the container throughput in 2014. The models found in the preceding chapter are used for forecasting. In this chapter, the accuracy of two forecast models is evaluated based on popular criteria measurements namely the mean absolute error (MAE), root mean squared error (RMSE), and mean absolute percentage error (MPAE).

5.1 Appraisement performance of model

5.1.1 Autoregressive model

After model, I found in the preceding chapter, model I is the autoregressive (AR) model. The equation included three regressors and AR2 (two lagged (pass value)) of regressand in order to explain the current value of the regressand (Rasmussen, 2010). The formula of model I is displayed on below:

Model I: $Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 Y_{t-2} + Ut$,

$Y = 3.18033 + 1.94E\text{-}0.5X_1 + 0.46496X_2 + 0.19751X_3 + 0.33779\ Y_{t-2} + Ut$

Where,

Y = Container throughput

X_1 = Employment

X_2 = Private investment index

X_3 = Bunker price at Singapore

$\beta_4 Y_{t-2}$= AR(2)

Ut = Sum of residuals (error terms)

Model I indicates that employment, private investment index and bunker price in Singapore are positive relation with container throughput.

5.1.2 Estimating adding a dummy for removing non normality

Model II as found in the preceding chapter, is a multiple regression with dummy variables. The model consists of three explanatory variables and two dummy variables namely Dummy10m05 and Dummy11m10. The formula of model II is shown below:

Model II : $Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 D_i + \beta_5 D_j + Ut$,

$Y = 3.22383 + 2.95E\text{-}0.5X_1 + 0.35429X_2 + 0.00104X_3 + 0.08759\ D_i + 0.81858\ D_j + Ut$

Where,

Y = Container throughput

X_1 = Employment

X_2 = Bunker price at Singapore

X_3 = Industry Production Index

D_i = Dummy10m05

D_j = Dummy11m10

Ut = Sum of residuals (error terms)

Model II illustrates the positive relationship between three explanatory variables (employment, industry production index and bunker price at Singapore) with container throughput.

The objective of adding a dummy is to remove the outlying residual. However, adding a dummy to decay normality is still argued among econometricians, because “coefficient estimates is seriously effected by removing outlying, since, by definition, OLS will receive a big penalty, in the form of an increased RSS, for points that are a long way from the fitted line" (Brooks, 2010). Table 6 compares the performance of three models.

Model	$\mathbf{R^2}$	$\mathbf{\bar{R}^2}$	**RSS**[11]	**Standard error(S.E.)**[12]
Model I (AR model)	0.85742	0.84345	0.02821	0.02352
MD*	0.87366	0.86128	0.02500	0.02214
PM**	0.81136	0.80069	0.03733	0.02654

Remarks :* Model II (Multiple regression with dummy variables)
** Model II (Pure multiple regression)

Table 6: the comparison table of the statistical measurements
Source: Author

The AR model with R^2 at 0.85742 means 85.742 per cent of data fits a regression while $\bar{R}^2$ is high at 0.84345. The RSS of the model is at 0.02821 and 0.02352 meaning there is 0.02821 error remaining in the regression and S.E. at 0.2352 implies that there is 0.2352 of the deviation between the sample mean and the actual mean of a population.

The figure shown in Table 6 proves the dispute of econometricians, as adding a dummy leads to decreasing S.E. and RSS and increasing $\bar{R}^2$ and R^2. Since the $\bar{R}^2$ and R^2 of Multiple regression with dummy variable model (MD) are higher than $\bar{R}^2$ and R^2 of pure multiple regression model (PM), and S.E. and RSS of MD are lower than PM, the result can lead to the conclusion of adding dummy making an improvement of model apparent.

11 A residual sum of squares (RSS) is a statistical technique used to measure the amount of variance in a data that is not explained by the regression equation. RSS is a measure of the amount of error remaining between the regression function and the data set. A smaller RSS mean that a regression function can explains a greater amount of the data (Brooks, 2010).

12 A standard error is known as the standard deviation. It is a statistical technique used to measure the accuracy with which a sample represents a population. the small standard error means the sample is good in term of represent a population (Brooks, 2010).

Nonetheless, a conclusion should not be stated as long as the other statistical technics have not yet applied to ensure that OLS is not significantly affected by removing outlying.

5.2 Evaluation forecasting model

The objective of this paper is to figure out the most accurate model to forecast the container throughput at LCP in 2014. Three models are compared by the statistical technic namely MAE, RMSE, and MPAE, and the model which is performing the less deviation from actual data means it is the most accurate forecast model. Table 7 illustrates the deviation between the value predicted by three models and actual data by using absolute percentage error (APE) defined as (Error / Actual Observed Value) × 100. The result of deviation in each month from three forecasting models is less than 3 per cent.

YYYY-MM	Actual	AR(2)	AR(APE)	MD*	MD(APE)	PM**	PM(APE)
2014-01	5.5565	5.5661	0.17%	5.5463	0.18%	5.5516	0.09%
2014-02	5.5707	5.5620	0.16%	5.5454	0.45%	5.5512	0.35%
2014-03	5.6466	5.5648	1.45%	5.5469	1.77%	5.5519	1.68%
2014-04	5.5900	5.5508	0.70%	5.5270	1.13%	5.5335	1.01%
2014-05	5.6282	5.5611	1.19%	5.5381	1.60%	5.5438	1.50%
2014-06	5.6400	5.5737	1.17%	5.5588	1.44%	5.5622	1.38%
2014-07	5.6356	5.5742	1.09%	5.5560	1.41%	5.5599	1.34%
2014-08	5.6418	5.5692	1.29%	5.5538	1.56%	5.5577	1.49%
2014-09	5.6381	5.5690	1.23%	5.5538	1.50%	5.5565	1.45%
2014-10	5.6371	5.5481	1.58%	5.5150	2.17%	5.5181	2.11%
2014-11	5.6437	5.5517	1.63%	5.5084	2.40%	5.5107	2.36%
2014-12	5.6357	5.5410	1.68%	5.4911	2.57%	5.4878	2.62%

Remarks :* Model II (Multiple regression with dummy variables)
** Model II (Pure multiple regression)

Table 7: the comparison table of APE
Source: Author

5.2.1 Mean Absolute Error (MAE)

MAE is a a basic statistical technic to measure the accuracy of models while avoiding the problem of positive and negative. MAE is calculated by average the absolute between the difference of the forecasted value and the actual value (Chai and Draxler,2014). The MAE can be decomposed as:

$$MAE = \frac{\sum_{t=1}^{n} \left| \widehat{Y_t} - Y_t \right|}{n}$$

$\widehat{Y_t}$ and Y_t are the forecasted and actual values respectively and n is an amount of observation. If the value of MAE is small, it indicates the accuracy of the model. According to Willmott and Matsuura, (2005) cited in Chai and Draxler, (2014), they compared between MAE and RMSE and they suggested that MAE is a better measurement to estimate model performance. However, Chai and Draxler, (2014) have also studied the two technics and have concluded that the RMSE is likely suitable for the type of model with normally distributed error whereas MAE is appropriate to represent model performance to model with a uniformly distributed error.

5.2.2 Root Mean Squared Error (RMSE)

RMSE is calculated by taking the square root of the mean absolute square error. The RMSE suites to describe the performance of the model with Gaussian error distribution (Chai and Draxler,2014). If the smallest value of RMSE means the most accuracy of model, the RMSE is defined as:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n} \left| \widehat{Y_t} - Y_t \right|}{n}}$$

5.2.3 Mean Absolute Percentage Error (MAPE)

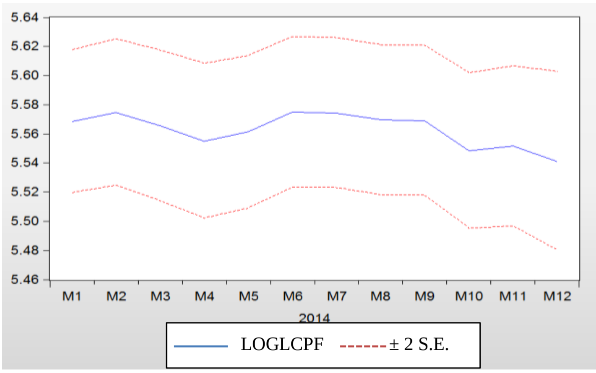
MAPE is a commonly statistical technic to measure cross-sectional forecast. The MAPE is allowed to be used to compare a forecast of different series in different scales (Wood, 2012). The accuracy of a model is measured by the small amount of the MAPE. The closer value to zero indicates the model is more accurate. The formula of MAPE is shown as:

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{\widehat{Y_t} - Y_t}{Y_t}\right| \times 100$$

5.2.4 Theil's Inequality Coefficient

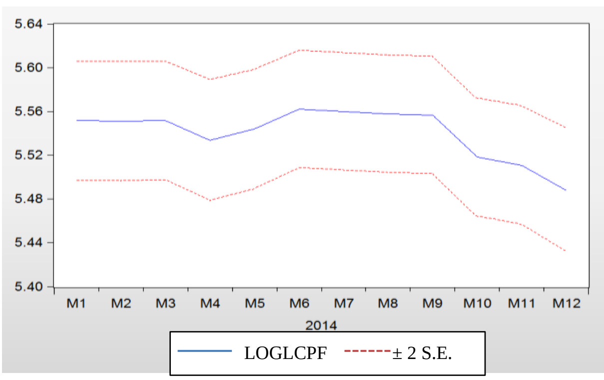
Theil's coefficient of inequality is a statistical forecasting evaluator and the symbol to represent Theil's Inequality Coefficient is "U". The value of U is between zero to one. If U is equal to zero, it is denoted that the forecast value is a perfect fit with actual value, in contrast, if U is equal to one, it is signified that the predictive performance is totally unmatched with actual value (Bliemel, 2016). U can be decomposed as:

$$U = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(\hat{Y}_t - Y_t\right)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n} Y_t^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{n} \hat{Y}_t^2}}$$



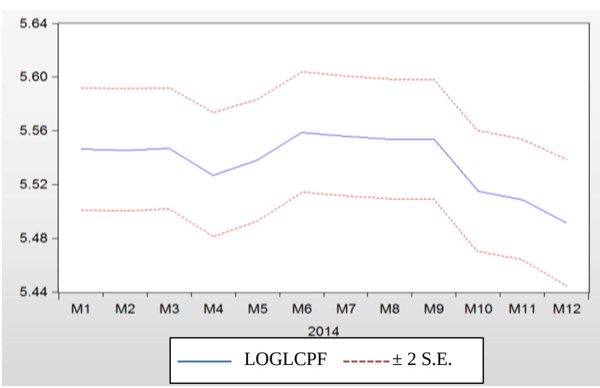
Forecast: LOGLCPF Actual: LOGLCP Forecast sample: 2014M01 2014M12 Included observation: 12	
Root Mean Squared Error	0.068088
Mean Absolute Error	0.061787
Mean Abs. Percent Error	1.096538
Theil Inequality Coefficient	0.006087
Bias Proportion	0.753750
Variance Proportion	0.077011
Covariance Proportion	0.169239

Figure 36 (a) The forecasting graph of AR model



Forecast: LOGLCPF Actual: LOGLCP Forecast sample: 2014M01 2014M12 Included observation: 12	
Root Mean Squared Error	0.090775
Mean Absolute Error	0.081571
Mean Abs. Percent Error	1.447818
Theil Inequality Coefficient	0.008132
Bias Proportion	0.807481
Variance Proportion	0.006679
Covariance Proportion	0.185840

Figure 36 (b) The forecasting gasph of PM model



Forecast: LOGLCPF Actual: LOGLCP Forecast sample: 2014M01 2014M12 Included observation: 12	
Root Mean Squared Error	0.093400
Mean Absolute Error	0.085285
Mean Abs. Percent Error	1.513988
Theil Inequality Coefficient	0.008370
Bias Proportion	0.833769
Variance Proportion	0.009334
Covariance Proportion	0.156897

Figure 36 (c) The forecasting graph of MD model

Figure 36: The forecasting graph in 2014 (monthly)

Source: Author

Figure 36 illustrates the forecasting graph of container throughput at LCP in 2014 in terms of a logarithm. Table 7 shows a comparison of the forecasting performance of three different models. The result of the AR model indicates the lowest value MAPE MAE and RMSE meaning the AR model is the most accurate forecasting model. An essentially hidden reason of the high performance of the AR model is because the private investment index is included as an independent variable in the model different from MD and PM which industry production is one of their explanatory variables. In comparison, the correlation of the container throughput and private investment index at 0.8298 is higher than correlation coefficient of the container throughput and industry production at 0.4763 which means the strength of the relationship between container throughput and private investment index is higher than the strength of the relationship between container throughput and industry production. Regarding the result, it could lead to the conclusion in any equation which contains the independent variable with high correlation with the dependent variable; the equation inclines to have a highly accurate performance.

Considering the components of the industry production and the private investment index, the industry production index consists of several types of products for instance consumable products, electronic products, chemical products and automotive products while the private investment index components are construction area permitted construction, material sales index, imports of capital goods, the value of domestic machinery sales, and the domestic car sales index for investment. Undoubtedly, as most container volume of Thailand is from transport capital and manufacturing product, the private investment index is better than the industry production in order to forecast container throughput at LCP.

The result of RASE, MAE and MAPE between MD and PM can emphasize the concept of the serious effect of coefficient estimates after removing outlier by a dummy. Since

Skewness decays after including two dummy variables into the regression equation implied that the normality is fixed. The S.E.,RSS, $\overline{R}^2$ and R^2 of MD show a better appearance than PM but the RASE,MAE and MAPE of the MD is higher than PM which indicates the predictive performance of MD is worse than PM. From the result of the forecasting performance between PM and MD, the state of "Removing outlying from model lead to low predictive performance" is true. Nevertheless, the difference of predictive results of MD and PM is not seriously significant as the difference of RASE, MAE and MAPE of both models are 0.00262, 0.00372 and 0.06617 respectively.

However, the result might be changed depending on the type and range of data. In some data, the regression with dummy variable could lead to a higher predictive performance than the pure regression equation. Therefore, after adding a dummy in the model, S.E., RSS, $\overline{R}^2$ and R^2 test is not sufficient to measure how well is the performance of equations. Other statistical measurements should be tested in order to ensure that coefficient estimates will not make a massive impact on the predictive performance.

By the result of Theil's Inequality Coefficient displayed in Table 8, the predictive performance of three models in 2014 closely fit with the actual data. Figure 37 illustrates a comparison of predictive value from three forecasting models, and the predictive value of AR model (LOGLCPAR) denotes the least deviation from actual value while the predictive value of MD (LOGLCPMD) and the predictive value of PM (LOGLCPPM) perform nearly the same. Overall the most accurate forecasting model from all three models is the AR model.

YYYY-MM	AR	MD	PM
RASE	0.06809	0.09340	0.09078
MAE	0.06179	0.08529	0.08157
MAPE	1.09654	1.51399	1.44782
Theil Inequality Coefficient	0.00608	0.00837	0.00813

Remarks :* Model II (Multiple regression with dummy variables)
** Model II (Pure multiple regression)

Table 8: the table of predictive performance of three models
Source: Author

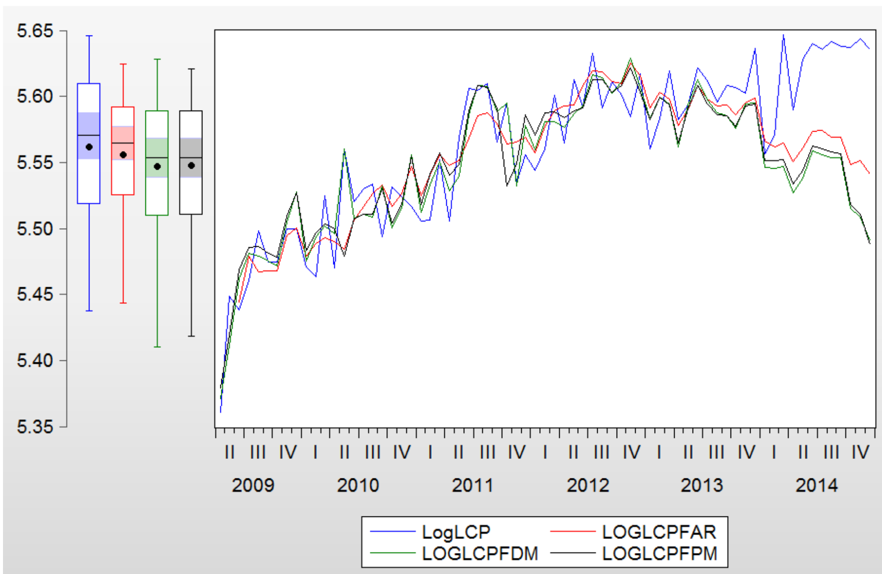


Figure 37: The graphs of comparison between predictive value and actual value
Source: Author

6 CONCLUSION

6.1 Overview and Conclusion

Forecasting is a widely common statistical task to assist the decision making of investment and planning. Regarding the expanding project at LCP, it stimulates port analyzers to figure out the forecasting model in order to predict the container throughput in the future and help port planners to make a decision on the port's expanding project. Prior empirical studies implied that different types of ports are influenced by dissimilar factors. In order to generate the forecasting model of container throughput at a particular port, the performance of a model depends on how proper independent variables are used in the model.

As LCP is a transit port, proper explanatory variables for generating model should be related to the demand and business activities in the hinterland. Before generating a forecasting model, the test of correlation between independent variables and dependent variable should be made. Pearson's correlation coefficient is applied in this paper in order to measure the correlation between each independent variable and dependent variable. The result supports the concept that container volume at a transit port is more correlated with factors related to demand inside the country rather than external factors outside the country. The correlation coefficient between container throughput with the private consumption index, the private investment index, the value of machinery sales and the bilateral trade of Thailand-China and Thailand-USA are dramatically higher than coefficient with bunker oil prices, exchange rates, and container freight rates. The result of correlation coefficient test shows that only two independent variables have a negative relationship with container throughput namely; container freight rates and exchange rates. The study also indicates that bunker oil prices have a positive relationship with container throughput which is different from the prior hypothesis of this paper. The prior hypothesis of this paper expects that the bunker oil prices will be moving contrastingly with the growth of container throughput, since bunker price is one of the transport cost Changing of bunker prices could influence the final product prices through transport costs and tends to lead to the decrease of container throughput through the demand of import cargo. However, the increase of bunker prices can refer to the growth of economy which simultaneously stimulates the growth of container throughput at LCP. Moreover, the result of the forecast is also consistent with the economic viewpoint. As the growth of an amount of employment encourages demand of any product in the country, leads to a rise in container volume simultaneously with the increase of container throughput affected by the growth of private investment through an increase of import cargos.

This paper found the proper forecasting model by utilizing regression method; the result indicates two appropriate models. First is autoregressive model consisted of AR(2) and three regressors namely private investment index, employment volume, and bunker oil prices, and the second model is multiple regression with two dummy variables and three regressors namely industry production index, employment volume, and bunker oil price. Surprisingly, private consumption index is not included in any model even it has strong correlation with container throughput. The outcome of two models' evaluation implies that the AR model can give a more accurate on predictive value than multiple regression with dummy variables. Nonetheless, the result of this paper cannot conclude that AR model is more accurate than multiple regression with dummy variables in general term because of the difference between the independent variable of two models. Besides, the model with its independent variables with strong correlation with dependent variable would give a higher predictive value than the model that its independent variables have a weak correlation with dependent variable. Private investment index has higher correlation with container throughput than industry production index. Therefore, the AR model produces greater precise forecast than multiple regression with dummy variables. Another conclusion found from this paper is the method to improve normality by adding dummy variable which can ruin coefficient estimates and lead to low predictive efficiency of the model. Therefore, if the model has its Jarque-Bera probability higher than the significant level but Skewness and Kurtosis do not reach normality assumption, the suggestion from this paper is to continue to use suchmodel.

The autoregressive forecasting model found in this paper could meet the paper's objective because the RASE, MAE, MAPE and Theil Inequality Coefficient of the forecasting model are low at 0.06809, 0.06179, 1.09654 and 0.00608 respectively. It denoted that the forecasting value in 2014 slightly deviated from actual volume. Furthermore, the result of the small error of model's predictive performance from this paper can prove that container throughput can be forecasted and modelled well by using economic factors as the explanatory variables.

Last but not least, as this paper tries to figure out the forecasting container throughput through the quantitative methodology by using macroeconomic variables as the independent variable of the model However, the macroeconomic variable is vulnerable affected by other factors, some economic shock which is difficult to predict by the model. For instance the influence of the global financial in 2009 made the GDP of Thailand hit the bottom at 2.3 percent (Bank of Thailand, 2010) This year the gradual decrease of export in Thailand leads to the shrinkage of container throughput of LCP at 13 per cent.

6.2 Limitation

The forecasting model could be more accurate if a larger amount of data can be provided. The larger sample size leads to the smaller of the coefficient standard errors (Brooks, 2010). However, the difficulty is to find all monthly data over ten years. In addition to the limitation of the range of data period, the evaluation of forecast performance can be generated up to one year (2014). If there is more data available, the appraisement on predictive performance can be done further than one year. Furthermore, the model lacks the explanatory variables controlled by the port authority for instance; free trade area, terminal storage capability, and hinterland network. All of the independent variables used in the forecasting model in this paper are macroeconomic factors. There are some previous empirical studies that indicate the controllable factors by the port are seemingly significant related to the growth of container throughput. For instance; the increase of efficient and effective services e.g. the large area of free trade zone and the increase of the number of the rail tracks to connect port and hinterland could influence the growth of container throughpu, However, these controllable factors are rarely available.

Moreover, other knowledge and other statistical technics e.g. the Granger Causality tests can be applied in this paper in order to potentiate the predictive performance of forecasting model, but this has been obstructed by the time limit.

6.3 Recommendation for future study

In this paper, the methodological methods applied are the multiple regression and autoregressive. However, there are several methodological methods which could be applied to generate a forecasting model for instance VAR, VECM, NN, and Grey forecast. The suggestion for the next step of future study is to compare the predictive performance of forecasting models generated from diversified methodological methods. Furthermore, this paper is focusing on short-term forecasting (1 year). In fact, the port development planning is normally done in three terms namely short-term (less than one year), medium-term (1-5 years) and long-term (more than five years). Therefore, the range of forecasting should suit to the port planning.

7 REFERRENCES

Alderton, P. (2008). *Port management and operations third edition*. London: Informa. Retrieved from http://www.harbour-maritime.com/uploads/1/2/9/8/12987200/port_management_and_operations.pdf

American Petroleum Institute. (2014). *Understanding crude oil and product markets*. Retrieved from http://www.api.org/oil-and-natural-gas/energy-primers/crude-oil-and-product-markets

Ball, L., Leigh, D., & Loungani, P. (2013). Okun's law:fit at fifty *NBER Working Paper Series*, 1-27. Retrieved from http://www.nber.org/papers/w18668.pdf

Bank of Thailand. (n.d.). Statistics [Data File].. Retrieved 2016, from https://www.bot.or.th/Thai/Statistics/Pages/default.aspx.

Bardakas, I. C. (2013). The asymmetric effect of income on import demand in Greece. Retrieved from http://www.bankofgreece.gr/Pages/en/Publications/PapersDetail.aspx?List_ID={7e6b3766-bd04-4a45-af1b-c033a426bd8b}&Item_ID=2569

Bliemel, F. (2016). Theil's Forecast Accuracy Coefficient: A Clarification.*Journal of Marketing Research, 10*(4). doi:10.2307/3149394

Brooks, C. (2010). *Introductory econometrics for finance*. Cambridge: Cambridge Univ. Press.

Brooks, C. (2014). *Introductory econometrics for finance 3rd edition*. Cambridge: Cambridge Univ. Press.

Cenek, P., Kean, R., Kvatch, I., & Jamieson, N. (2012). *Freight transport efficiency: A comparative study of coastal shipping, rail and road modes* (Rep. No. 497). Retrieved http://www.nzta.govt.nz/assets/resources/research/reports/497/docs/497.pdf

Chai, T., & Draxler, R. R. (2014). Root mean square error (RMSE) or mean absolute error (MAE)? – Arguments against avoiding RMSE in the literature. Retrieved from http://www.geosci-model-dev-discuss.net/7/C591/2014/gmdd-7-C591-2014-supplement.pdf

Chen, S., & Chen, J. (2010). Forecasting container throughputs at ports using genetic programming. *Expert Systems with Applications,37*(3), 2054-2058. doi:10.1016/j.eswa.2009.06.054

Chou, C., Chu, C., & Liang, G. (2008). A modified regression model for forecasting the volumes of Taiwan’s import containers. *Mathematical and Computer Modelling, 47*(9-10), 797-807. doi:10.1016/j.mcm.2007.05.005

Diaz, R., Talley, W., & Tulpule, M. (2011). Forecasting Empty Container Volumes. *The Asian Journal of Shipping and Logistics, 27*(2), 217-236. doi:10.1016/s2092-5212(11)80010-6

Dragan, D., Kramberger, T., & Intiher, M. (2014). A comparison of methods for forecasting the container throughput in north Adriatic ports.

Edwards, S. (1991). Trade Orientation, Distortions and Growth in Developing Countries. doi:10.3386/w371

Fabbri, D. (2015, April 21). How Singapore's port helped change the country's economy. *Channel NewsAsia*. Retrieved from http://www.channelnewsasia.com/news/business/singapore/how-singapore-s-port/1796336.html

Faini, R., Pritchett, L., & Clavijo, F. (1988). *Import Demand in Developing Countries* (Working paper No. 122). Retrieved http://documents.worldbank.org/curated/en/709691468740961987/pdf/multi0page.pdf

Feldman, M. P., & Santangelo, G. D. (2008). *New perspectives in international business research*. Bingley: JAI Press.

Genc, E. G., & Artar, O. K. (2014). The effect of exchange rates on exports and imports of emerging countries. Retrieved from http://eujournal.org/index.php/esj/article/download/3346/3110

Ghalayini, L. (2011). The interaction between oil price and economic growth. Retrieved fromhttps://www.researchgate.net/publication/235939209_The_Interaction_between_Oil_Price_and_Economic_Growth

Gosasang, V., Chandraprakaikul, W., & Kiattisin, S. (2011). A Comparison of Traditional and Neural Networks Forecasting Techniques for Container Throughput at Bangkok Port. *The Asian Journal of Shipping and Logistics,27*(3), 463-482. doi:10.1016/s2092-5212(11)80022-2

Hoon, K. K. (2013). *Forecasting the capesize freight market* (Master's thesis, Sweden/World Maritime University, 2013) (pp. 1-80). Malmo: World Maritime University.

I, S., Kuroda, K., & Takebayashi, M. (2005). Forecasting the demand of container throughput in Indonesia. *Memoirs of Construction Engineering Research Institute, 47*, 1-10. Retrieved from http://syafii.staff.uns.ac.id/files/2010/02/forecasting-of-container-throughput-in-indonesia.pdf

Information of Laem Chabang Port. (2013). Retrieved from http://www.laemchabangportnew.com/

Jansen, M. (2014). *Forecasting container cargo throughput in ports* (Master's thesis, Erasmus University Rotterdam, 2014). Erasmus University Rotterdam. Retrieved from https://thesis.eur.nl/pub/16985/MA-thesis-M.-Jansen-386267.pdf.

Kasikonthai. (2014, April 9). Maritime transport 2014 the growth of import and border trade. *K-Econ Annalysis, 2488*. Retrieved from https://www.kasikornresearch.com/th/k-econanalysis/pages/ViewSummary.aspx?docid=32578

Kostiner, K. (2012). FloraHolland save costs by expanding sea freight operations. Retrieved from http://www.copybook.com/freight/news/floraholland-save-costs-by-expanding-sea-freight-operations

Lam, W. H., Ng, P. L., Seabrooke, W., & Hui, E. C. (2004). Forecasts and reliability analysis of port cargo throughput in Hong Kong.Journal Of Urban Planning And Development, (3), 133

Liu, L., & Park, G. (2011). Empirical Analysis of Influence Factors to Container Throughput in Korea and China Ports. *The Asian Journal of Shipping and Logistics*, *27*(2), 279-303. doi:10.1016/s2092-5212(11)80013-1

Mackey, M. (2016, January 25). Seagate switches more air cargo to land and sea, and begins to see the benefits. Retrieved from http://theloadstar.co.uk/seagate-asia-manufacturing-air-freight-rail/

Mayer, H. M. (1988), “The Physical Harbour: New Demands on a Scarce Resource”, in Urban Ports and HarborManagement, edited by Marc J. Hershman, Taylor & Francis

Merk, O. (2013). The Competitiveness of Global Port-Cities: Synthesis Report. *OECD Regional Development Working Papers*. doi:10.1787/5k40hdhp6t8s-en

Ministry of Commerce of Thailand. (n.d.). Trade of Thailand [Data File]. Retrieved 2016, from http://www2.ops3.moc.go.th/

Mohammadi, A., & Zade, S. Z. (2011). Appling grey forecasting method to forecast the portfolio’s rate of return in stock market of iran. *Australian Journal of Business and Management Research*. Retrieved from http://www.ajbmr.com/articlepdf/ajbmr_16_19i1n7a1.pdf

Nwankwo, C. H., & Oyeka, I. C. (2013). Dummy variable multiple regression forecasting model. *International Journal of Engineering Science Invention*. Retrieved from www.ijesi.org/papers/Vol(2)3%20(Version-1)/G234251.pdf

Ocean freight cost. (n.d.). Retrieved from http://www.container-transportation.com/ocean-freight-cost.html

Odland, J., & Kaltea, F. (2011). *Forecasting model for dry bulk sea freight*(Master's thesis, Sweden/Lund University). Lund: Lund University. doi:lup.lub.lu.se/student-papers/record/1979787/file/1979790.pdf

OECD. (2015). Impact of ports in their cities. In *The competitiveness of global port-cities* (pp. 35-36). Paris: OECD Publishing. doi:https://books.google.se/books?isbn=9264205276

Office of the National Economic and Social Development Board. (2015, June). Thailand’s logistics report 2014. *Annual Report of Logistics of Thailand 2014*, *1906-4373*, 1-17. Retrieved from http://www.nesdb.go.th/ewt_dl_link.php?nid=3390

Painvin, N., & Rutter, S. (2015). *Global trade and industry changes suggest lower growth assumptions* (pp. 1-10, Rep.). Fitchratings. Retrieved from https://shippingitalia.files.wordpress.com/2015/03/eu-container-ports-05-01-2015.pdf.

Peng, W. Y., & Chu, C. W. (2009). A comparison of univariate methods for forecasting container throughput volumes. *Mathematical and Computer Modelling*, 1045-1057. http://dx.doi.org/10.1016/j.mcm.2009.05.027

Ram, R. (1985). Exports and Economic Growth: Some Additional Evidence.Economic Development and Cultural Change, 33(2), 415-425. doi:10.1086/451468

Rasmussen, H. W. (2010). *Econometric modeling and forecasting of container freight rates* (Master's thesis, Aarhus School of Business, University of Aarhus). Handelshøjskolen Aarhus Universitet. Retrieved from http://pure.au.dk/portal-asb-student/files/13123/Thesis_upload.pdf

Roa, I., Peña, Y., Amante, B., & Goretti, M. (2013). Ports: Definition and study of types, sizes and business models. *Journal of Industrial Engineering and Management JIEM*, *6*(4). doi:10.3926/jiem.770

Sanchez, J. M., & Liborio, C. (2012). The Relationships Among Changes in GDP, Employment, and Unemployment: This Time, Itâ□™s Different.*Economic Synopses Short Essays and Reports on the Economic Issues of the Day*. Retrieved from https://research.stlouisfed.org/publications/es/12/ES_2012-05-18.pdf.

Schulze, P. M., & Prinz, A. (2009). Forecasting container transshipment in Germany. *Applied Economics*, *41*(22), 2809-2815. doi:10.1080/00036840802260932

Seabrooke, W., Hui, E. C., Lam, W. H., & Wong, G. K. (2003). Forecasting cargo growth and regional role of the port of Hong Kong.*Cities*, *20*(1), 51-64. doi:10.1016/s0264-2751(02)00097-5

Sjo, B. (2008). The test for unit root and cointegration. doi:10.1017/s026646660808002x

Song, D.W. (2016).Maritime Logistics and Marketing. Unpublished lecture, World Maritime University, Malmö, Sweden.

Sorgenfrei, J. (2013). *Port business*. Norderstedt, Germany: BoD-Books on Demand GmBII.

Thailand Board of Investment. (2015). Thailand: The world’s electrical and electronics industry investment destination. Retrieved from http://www.boi.go.th/upload/content/BOI-brochure%202015-E&E_67848.pdf

Thailand Board of Investment. (2015). *Thailand: Global Green Automotive Production Base*. Retrieved from http://www.boi.go.th/upload/content/BOI-brochure%202015-automotive-20150325_70298.pdf

The annual report of the Port Authority of Thailand 2015. (2015). Retrieved from http://www1.port.co.th/port2014/download/annual_report/PAT_annual_report_year58.pdf

Tyler, W. G. (1981). Growth and export expansion in developing countries.Journal of Development Economics, 9(1), 121-130. doi:10.1016/0304-3878(81)90007-9

UNCTAD. (2010). Oil prices and maritime freight rates: An empirical investigation. In *United Nations Conference on Trade and Development*. Retrieved from http://unctad.org/en/Docs/dtltlb20092_en.pdf

UNCTAD. (2013). Review maritime transport 2013. Retrieved from http://unctad.org/en/PublicationsLibrary/rmt2013_en.pdf

UNCTAD. (2015). Review of Maritime Transport 2015. Review of Maritime Transport. doi:10.18356/e9299843-en

Urrutia, J., Alano, E., Aninipot, P., Gumapac, K., & Quinto, J. (2014). Modeling and forecasting foreign trade of the philippines using time series SARIMA model. *Polytechnic University of the Philippines*

Wilson, W. W., & Benson, D. (2009). Container Flows in World Trade, U.S. Waterborne Commerce and Rail Shipments in North American Markets. Retrieved from http://www.ugpti.org/pubs/pdf/DP203.pdf

Wood, T. (2012). Using mean absolute error to forecast accuracy. Retrieved from http://canworksmart.com/using-mean-absolute-error-forecast-accuracy/

World Bank. (2007). Port reform toolkit second edition. Retrieved from http://www.ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/pdf/modules/03_TOOLKIT_Module3.pdf.

World Bank. (2015). Exports of goods and services (% of GDP). *In World Bank National Accounts Data, and OECD National Accounts Data Files*. Retrieved from http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS

World Bank. (2015). Imports of goods and services (% of GDP). *In World Bank national accounts data, and OECD National Accounts data files*. Retrieved from http://data.worldbank.org/indicator/NE.IMP.GNFS.ZS

World Shipping Council. (2014). Top 20 exporters and importers of containerized cargo-2010, 2013 & 2014. In Trade Statistics. Retrieved 2016, from http://www.worldshipping.org/about-the-industry/global-trade/trade-statistics#2

Xiaolin, W. (2014). *The impact of economic crisis on ports in post-crisis period*(Master's thesis, Rotterdam/Erasmus University). Rotterdam: Erasmus University. Retrieved from https://thesis.eur.nl/pub/16633/MA-thesis-Y.Wang.pdf

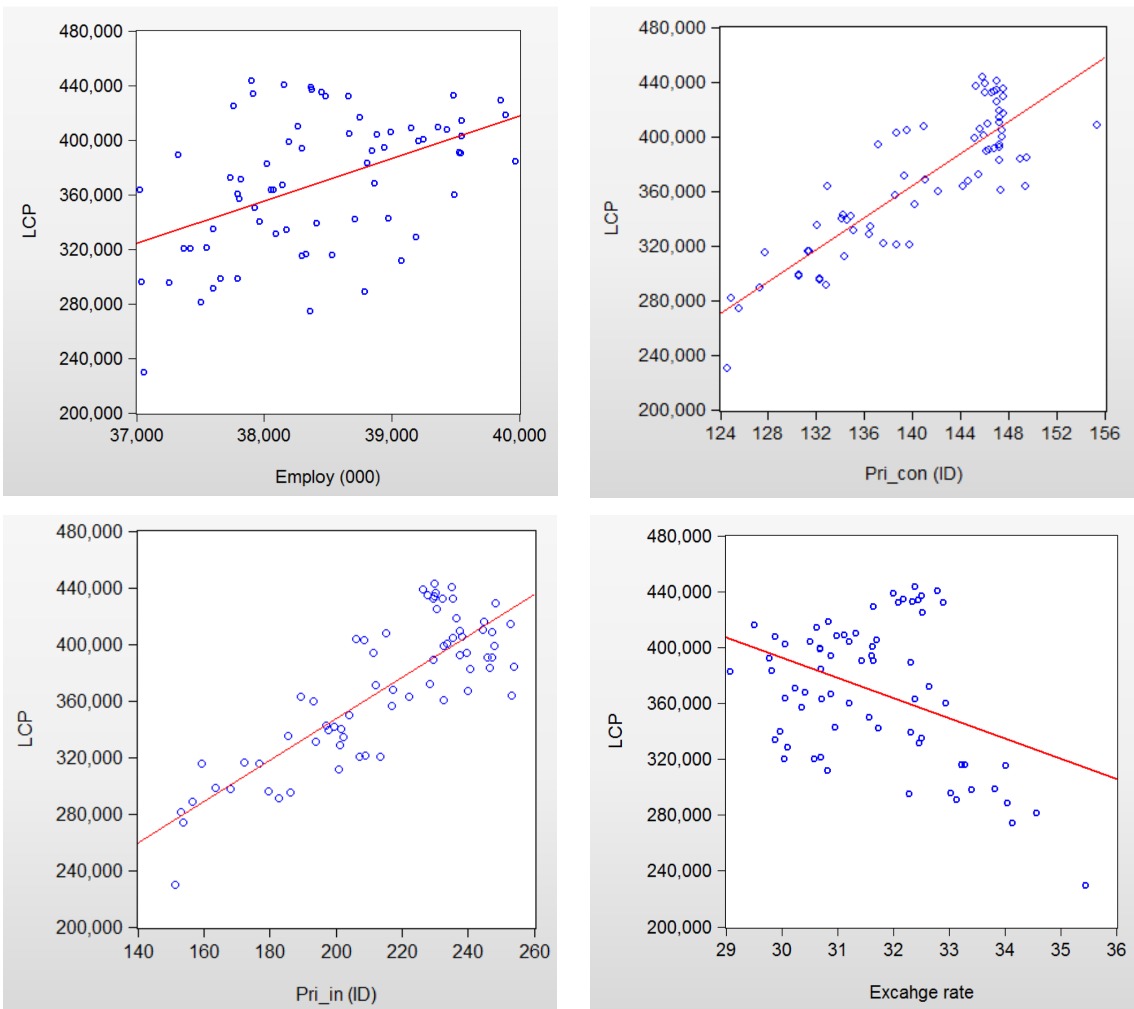
Xie, N., & Liu, S. (2009). Discrete grey forecasting model and its optimization. *Applied Mathematical Modelling*, *33*(2), 1173-1186. doi:10.1016/j.apm.2008.01.011

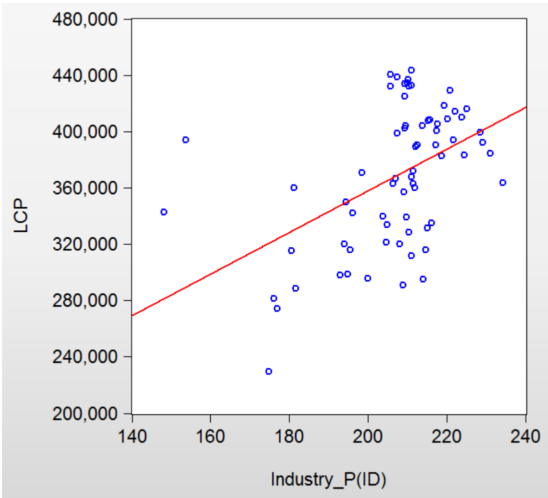
Xinghua, C., Meng, G., Wang, Y., & Hou, X. (2012). Seasonal Autoregressive Integrated Moving Average Model For Precipitation Time Series. *Journal of Mathematics and Statistics*, *8*(4), 500-505. doi:10.3844/jmssp.2012.500.505

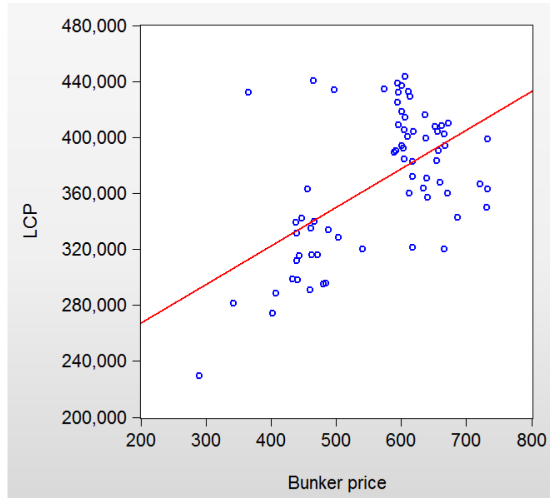
Appendices

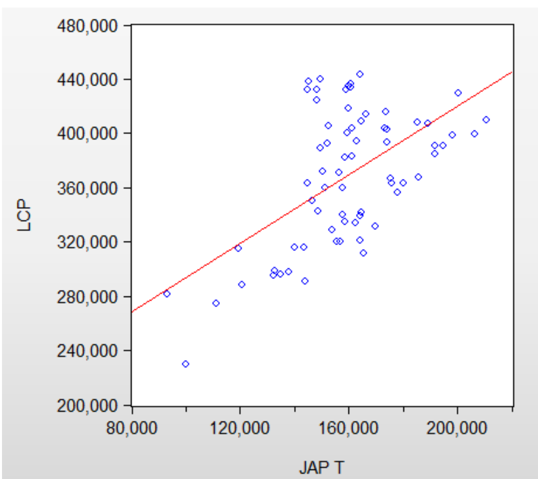
Appendix A

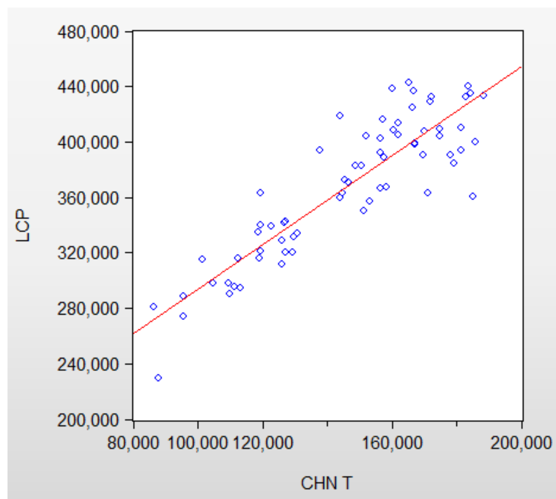
The potential relationship between independent variables and container throughput

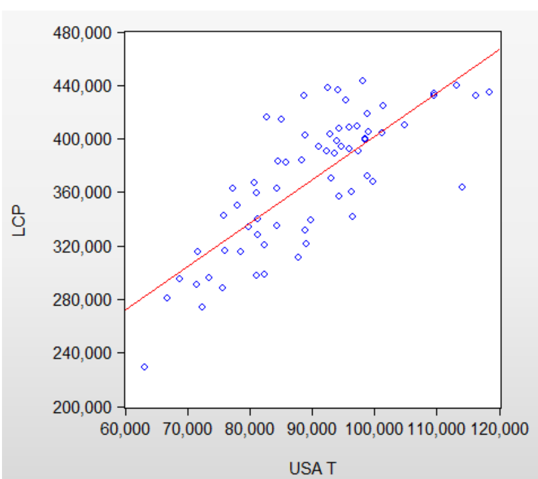


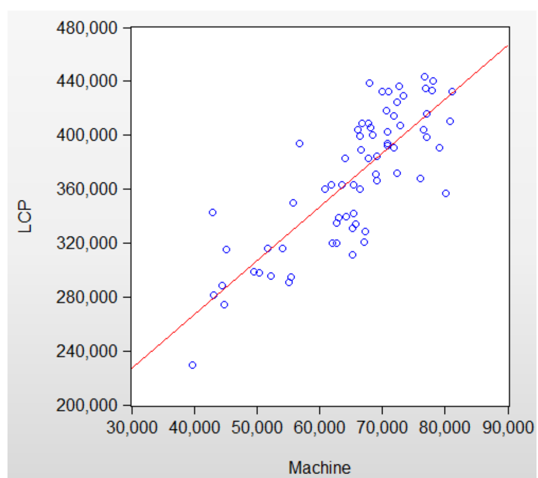

LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
140
160
180
200
220
240
Industry_P(ID)

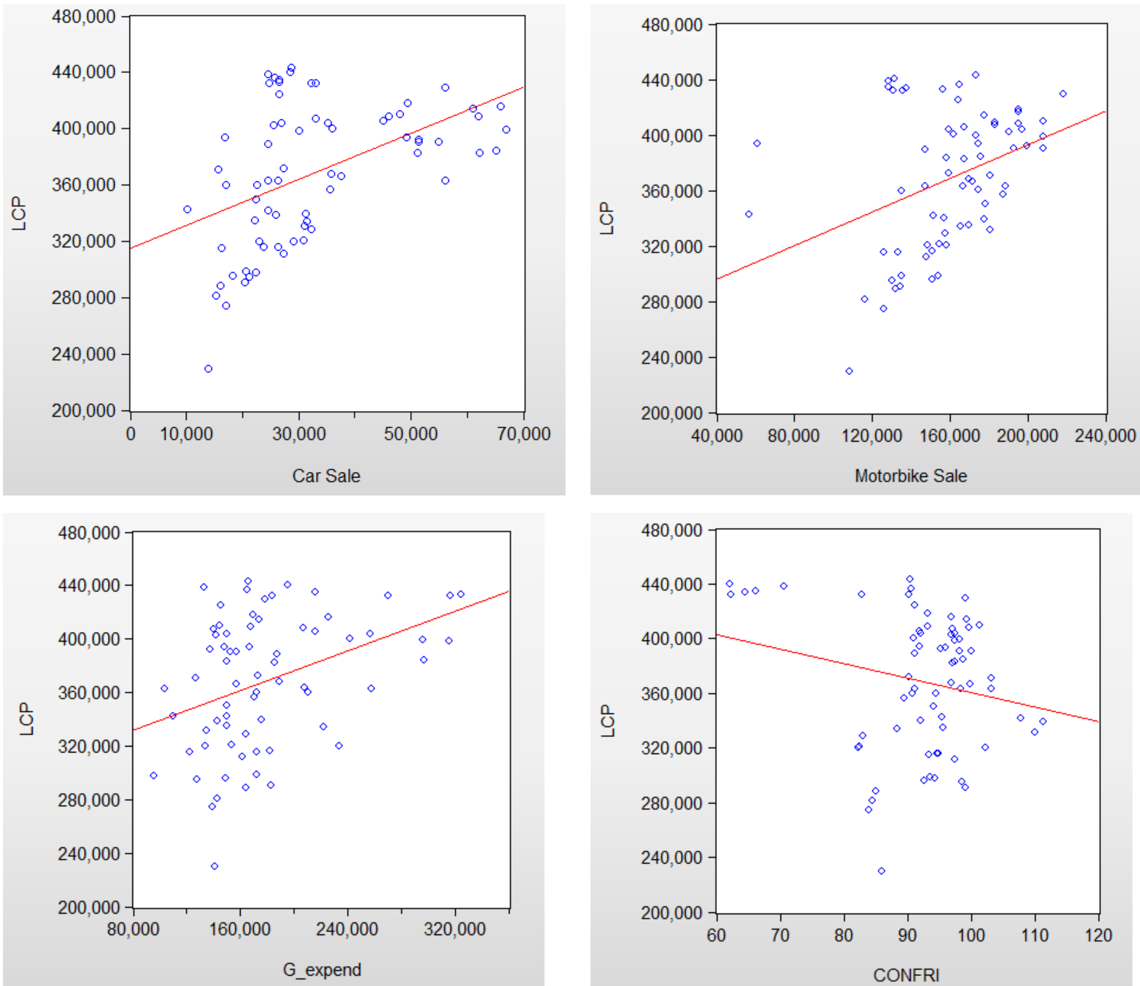

LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
200
300
400
500
600
700
800
Bunker price


LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
80,000
120,000
160,000
200,000
JAP T


LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
80,000
100,000
120,000
160,000
200,000
CHN T


LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
USA T


LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
Machine


LCP
480,000
440,000
400,000
360,000
320,000
280,000
240,000
200,000
0
10,000
30,000
50,000
70,000
Car Sale
40,000
80,000
120,000
160,000
200,000
240,000
Motorbike Sale
80,000
160,000
240,000
320,000
G_expend
60
70
80
90
100
110
120
CONFRI

Appendix B

Table of correlation between explanatory variables

	LCP	*Employ (000)*	*Pri_con (ID)*	*Pri_in (ID)*	*Excahge rate*	*Industry_P(ID)*	*Bunker_Sin*	*JAP T*	*CHN T*	*USA T*	*Machice*	*Car Sa*
LCP	1											
Employ (000)	0.4716	1										
Pri_con (ID)	0.8572	0.4325	1									
Pri_in (ID)	0.8298	0.4496	0.9641	1								
Excahge rate	-0.3922	-0.3611	-0.5123	-0.6000	1							
Industry_P(ID)	0.4763	0.2774	0.6421	0.6736	-0.4108	1						
Bunker_Sin	0.5675	0.3324	0.6823	0.6789	-0.6834	0.2670	1					
JAP T	0.5701	0.4652	0.6471	0.7295	-0.6718	0.5512	0.6674	1				
CHN T	0.8867	0.4539	0.9108	0.8946	-0.4094	0.5757	0.6129	0.6549	1			
USA T	0.7765	0.2897	0.7371	0.7102	-0.2641	0.4761	0.3561	0.5375	0.8134	1		
Machice	0.8084	0.3385	0.7780	0.8083	-0.5233	0.6726	0.4933	0.7182	0.8210	0.7667	1	
Car Sale	0.4775	0.5530	0.6875	0.7544	-0.5346	0.7400	0.3954	0.6303	0.5399	0.3558	0.5219	
Motobike Sale	0.3670	0.3253	0.4927	0.5217	-0.4380	0.7425	0.4144	0.6323	0.4415	0.2915	0.6124	0.61
G_expend	0.3806	0.2303	0.4731	0.4399	-0.1581	0.3069	0.2120	0.3117	0.4877	0.3558	0.3450	0.30
Confri	-0.2076	0.1268	-0.0907	-0.0006	-0.2813	0.1226	0.2444	0.3296	-0.1839	-0.2926	-0.1193	0.22

	LCP	*EMPLOY*	*PRI_CON _ID*	*PRI_IN _ID*	*EXCAHGE _RATE*	*INDUSTRY _P*	*BUNKER _SIN*	*JAP_T*	*CHN _T*	*USA_T*	*MACHINE*	*CAR _SALE*	*MOTOBIKE*	*G_EXPEND*	*CONFRI*
LCP	1														
EMPLOY	0.4716	1													
PRI_CON _ID	0.8572	0.4325	1												
PRI_IN _ID	0.8298	0.4496	0.9641	1											
EXCAHGE_RATE	-0.3922	-0.3611	-0.5123	-0.6000	1										
INDUSTRY_P	0.4763	0.2774	0.6421	0.6736	-0.4108	1									
BUNKER_SIN	0.5675	0.3324	0.6823	0.6789	-0.6834	0.2670	1								
JAP_T	0.5701	0.4652	0.6471	0.7295	-0.6718	0.5512	0.6674	1							
CHN _T	0.8867	0.4539	0.9108	0.8946	-0.4094	0.5757	0.6129	0.6549	1						
USA_ T	0.7765	0.2897	0.7371	0.7102	-0.2641	0.4761	0.3561	0.5375	0.8134	1					
MACHINE	0.8084	0.3385	0.7780	0.8083	-0.5233	0.6726	0.4933	0.7182	0.8210	0.7667	1				
CAR_SALE	0.4775	0.5530	0.6875	0.7544	-0.5346	0.7400	0.3954	0.6303	0.5399	0.3558	0.5219	1			
MOTOBIKE	0.3670	0.3253	0.4927	0.5217	-0.4380	0.7425	0.4144	0.6323	0.4415	0.2915	0.6124	0.6128	1		
G_EXPEND	0.3806	0.2303	0.4731	0.4399	-0.1581	0.3069	0.2120	0.3117	0.4877	0.3558	0.3450	0.3082	0.1206	1	
CONFRI	-0.2076	0.1268	-0.0907	-0.0006	-0.2813	0.1226	0.2444	0.3296	-0.1839	-0.2926	-0.1193	0.2250	0.3722	-0.3304	1

Appendix C

Major import and export cargos of the three biggest bilateral trade partner of Thailand (2009-2014)

Japan Import	Value (million baht)							Share (%)						
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**
Machinery and parts	162,392	227,702	253,044	367,882	274,684	246,869	1,532,573	18.9%	18.8%	19.6%	24.1%	21.9%	21.4%	21.0%
Iron, steel and products	102,049	168,799	174,217	195,125	173,541	169,234	982,964	11.9%	13.9%	13.5%	12.8%	13.8%	14.7%	13.5%
Parts and accessories of vehicles	68,255	119,775	123,065	210,850	184,455	124,500	830,899	7.9%	9.9%	9.6%	13.8%	14.7%	10.8%	11.4%
Electrical machinery and parts	82,340	111,452	114,396	152,252	120,433	117,055	697,927	9.6%	9.2%	8.9%	10.0%	9.6%	10.1%	9.6%
Chemicals	64,725	88,635	92,706	85,025	79,155	76,845	487,090	7.5%	7.3%	7.2%	5.6%	6.3%	6.7%	6.7%
Scientific, medical, testing appliances and instruments	30,727	43,689	47,785	55,900	43,907	40,467	262,476	3.6%	3.6%	3.7%	3.7%	3.5%	3.5%	3.6%
Electronic integrated circuites	82,557	92,698	75,831	54,748	47,385	56,791	410,010	9.6%	7.7%	5.9%	3.6%	3.8%	4.9%	5.6%
Import Total	**860,125**	**1,211,476**	**1,288,155**	**1,523,458**	**1,256,045**	**1,154,513**	**7,293,772**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Japan Export	**Value(million baht)**							**Share (%)**						
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**
Motor cars, parts and accessories	18,867	37,886	37,832	51,232	40,520	42,224	228,561	3.5%	5.9%	5.3%	7.1%	6.0%	6.0%	5.7%
Automatic data processing	34,515	38,864	28,804	31,968	24,806	30,887	189,843	6.4%	6.1%	4.0%	4.4%	3.7%	4.4%	4.8%
Prepared poultry	22,694	23,422	27,901	32,837	30,372	27,640	164,866	4.2%	3.6%	3.9%	4.5%	4.5%	4.0%	4.1%
Polymers of ethylene, propylene, etc in primary forms	9,358	13,752	24,487	25,494	22,757	29,956	125,804	1.7%	2.1%	3.4%	3.5%	3.4%	4.3%	3.2%
Prepared or preserved fish, crustaceans, molluscs in airtight	18,662	18,585	23,576	26,526	23,435	21,151	131,935	3.5%	2.9%	3.3%	3.7%	3.5%	3.0%	3.3%
machines and parts thereof	11,501	16,722	22,190	22,766	22,746	22,768	118,692	2.1%	2.6%	3.1%	3.1%	3.4%	3.3%	3.0%
Plastic products	15,368	17,948	21,375	20,959	19,701	21,273	116,624	2.9%	2.8%	3.0%	2.9%	2.9%	3.0%	2.9%
Export Total	**535,880**	**641,910**	**719,383**	**725,044**	**671,805**	**698,952**	**3,992,973**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total	**1,396,005**	**1,853,387**	**2,007,537**	**2,248,502**	**1,927,850**	**1,853,465**	**11,286,745**	-	-	-	-	-	-	-

Source: Adapted from “Data file” by Ministry of Commerce of Thailand (n.d.)

China Import	Value(million baht)							Share (%)						
	2009	2010	2011	2012	2013	2014	2009-2014	2009	2010	2011	2012	2013	2014	2009-2014
Electrical machinery and parts thereof	84,164	102,997	121,694	149,826	152,487	166,982	778,148	14.4%	13.3%	13.1%	12.9%	13.2%	13.3%	13.3%
Computers, parts and accessories	94,447	108,058	116,659	134,139	109,102	101,034	663,438	16.1%	13.9%	12.5%	11.6%	9.4%	8.1%	11.3%
Electrical household appliances	56,683	68,443	88,150	126,290	123,533	134,595	597,693	9.7%	8.8%	9.5%	10.9%	10.7%	10.8%	10.2%
Machinery and parts	47,804	68,394	87,069	124,260	121,975	131,823	581,325	8.2%	8.8%	9.4%	10.7%	10.6%	10.5%	9.9%
Chemicals	39,380	53,850	65,628	72,602	74,536	88,719	394,714	6.7%	6.9%	7.1%	6.3%	6.5%	7.1%	6.7%
Iron, steel and products	15,621	33,546	50,815	69,057	62,920	74,964	306,922	2.7%	4.3%	5.5%	6.0%	5.4%	6.0%	5.2%
Parts and accessories of vehicles	5,032	8,339	11,191	38,332	43,470	42,669	149,032	0.9%	1.1%	1.2%	3.3%	3.8%	3.4%	2.5%
Metal manufactures	16,337	20,479	26,245	33,814	35,518	43,506	175,899	2.8%	2.6%	2.8%	2.9%	3.1%	3.5%	3.0%
Import Total	**586,143**	**775,391**	**930,826**	**1,160,449**	**1,155,295**	**1,251,528**	**5,859,634**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
China Export	**Value(million baht)**							**Share (%)**						
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**
Automatic data processing machines and parts thereof	147,429	159,944	129,284	139,043	79,249	67,457	722,405	26.9%	23.6%	16.3%	16.8%	9.6%	8.4%	16.1%
Rubber	52,729	77,039	139,096	111,544	114,275	88,636	583,320	9.6%	11.4%	17.6%	13.4%	13.9%	11.0%	13.0%
Chemical products	46,270	56,450	80,945	90,068	96,543	84,386	454,662	8.4%	8.3%	10.2%	10.9%	11.7%	10.5%	10.1%
Polymers of ethylene, propylene, etc in primary forms	36,940	51,362	73,639	79,935	87,013	97,751	426,640	6.7%	7.6%	9.3%	9.6%	10.6%	12.1%	9.5%
Rubber products	26,656	44,615	54,135	65,424	69,981	57,247	318,057	4.9%	6.6%	6.8%	7.9%	8.5%	7.1%	7.1%
Tapioca products	26,775	36,706	41,045	46,224	60,989	75,004	286,743	4.9%	5.4%	5.2%	5.6%	7.4%	9.3%	6.4%
Refine fuels	25,744	25,180	9,027	36,838	33,377	35,339	165,504	4.7%	3.7%	1.1%	4.4%	4.0%	4.4%	3.7%
Electronic integrated circuits	25,124	25,590	20,628	12,031	13,871	17,064	114,307	4.6%	3.8%	2.6%	1.4%	1.7%	2.1%	2.6%
Woods and wood products	13,672	20,310	27,560	29,403	33,377	35,339	159,661	2.5%	3.0%	3.5%	3.5%	4.0%	4.4%	3.6%
Export Total	**548,760**	**678,631**	**791,212**	**829,848**	**824,672**	**806,437**	**4,479,562**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total	**1,134,904**	**1,454,023**	**1,722,039**	**1,990,297**	**1,979,968**	**2,057,966**	**10,339,196**	-	-	-	-	-	-	-

Source: Adapted from “Data file” by Ministry of Commerce of Thailand (n.d.)

USA Import	Value(million baht)							Share (%)						
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**
Machinery and parts	33,946	38,957	35,940	43,610	46,890	45,676	245,018	11.8%	11.4%	8.8%	11.1%	10.5%	9.6%	10.4%
Chemicals	27,374	35,222	37,364	39,340	38,156	40,225	217,680	9.5%	10.3%	9.1%	10.1%	8.5%	8.5%	9.3%
Electronic integrated circuites	34,238	44,335	39,079	36,093	32,947	42,819	229,511	11.9%	13.0%	9.6%	9.2%	7.4%	9.0%	9.8%
Vegetables and vegetable product	19,874	20,837	24,633	29,324	24,351	34,561	153,580	6.9%	6.1%	6.0%	7.5%	5.4%	7.3%	6.5%
Electrical machinery and parts	20,277	20,745	20,305	24,105	22,776	22,803	131,010	7.0%	6.1%	5.0%	6.2%	5.1%	4.8%	5.6%
Aeroplanes, gliders, instruments and parts	2,968	6,925	9,728	18,769	56,854	74,436	169,680	1.0%	2.0%	2.4%	4.8%	12.7%	15.7%	7.2%
Jewellery including silver bars and gold	4,803	10,553	57,318	22,591	46,588	32,822	174,675	1.7%	3.1%	14.0%	5.8%	10.4%	6.9%	7.4%
Computers, parts and accessories	19,884	21,537	16,497	13,361	17,665	18,467	107,411	6.9%	6.3%	4.0%	3.4%	3.9%	3.9%	4.6%
Scientific, medical, testing appliances and ins truments	15,747	17,762	16,821	18,503	17,738	15,912	102,483	5.5%	5.2%	4.1%	4.7%	4.0%	3.4%	4.4%
Import Total	**288,566**	**342,120**	**408,651**	**391,398**	**447,476**	**474,102**	**2,352,312**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
USA Export	**Value(million baht)**							**Share (%)**						
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2009-2014**
Automatic data processing machines and parts thereof	100,314	104,725	86,112	122,099	127,877	144,714	685,841	17.7%	16.4%	13.1%	17.3%	18.2%	20.8%	24.9%
Rubber products	29,503	39,744	53,586	49,534	47,088	49,537	268,993	5.2%	6.2%	8.2%	7.0%	6.7%	7.1%	9.8%
Prepared or preserved fish, crustaceans	42,564	44,116	49,733	42,385	35,797	35,929	250,524	7.5%	6.9%	7.6%	6.0%	5.1%	5.2%	9.1%
Precious stones and jewellery	28,607	34,590	40,408	39,429	39,884	43,691	226,608	5.0%	5.4%	6.2%	5.6%	5.7%	6.3%	8.2%
Radio-broadcast receivers, and parts	22,907	25,323	27,984	35,669	31,182	45,373	188,439	4.0%	4.0%	4.3%	5.1%	4.4%	6.5%	6.8%
Articles of apparel and clothing accessories	40,162	39,974	34,438	31,438	30,777	32,146	208,936	7.1%	6.3%	5.2%	4.5%	4.4%	4.6%	7.6%
Other electrical equipment and parts thereof	25,840	33,139	32,538	30,453	20,818	19,886	162,675	4.6%	5.2%	5.0%	4.3%	3.0%	2.9%	5.9%
Electronic integrated circuits	16,489	17,583	15,726	16,279	20,135	20,418	106,630	2.9%	2.8%	2.4%	2.3%	2.9%	2.9%	3.9%
Export Total	**567,699**	**638,820**	**656,592**	**703,918**	**703,918**	**694,326**	**2,758,755**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total	**856,265**	**980,940**	**1,065,243**	**1,095,316**	**1,151,394**	**1,168,429**	**6,317,586**	-	-	-	-	-	-	-

Source: Adapted from “Data file” by Ministry of Commerce of Thailand (n.d.)

Appendix D

Co-Integration between non-stationary variables

Co-Integration between LCP and independent variables

Pairing		**ADF**			**Stationary**
		t-stat	**5% cr.value**	**Prob**	
LCP	**BUNKER_SIN**	-0.9108	-2.9055	0.7790	Non-stationary
	CAR_SALE	-1.6425	-2.9055	0.4555	Non-stationary
	CON_FREIGHT	-2.5907	-2.9055	0.0999	Non-stationary
	CHN_T	-9.0486	-2.9048	0.0000	Stationary
	EXCHANGE_RATE	-0.6940	-2.9062	0.8407	Non-stationary
	MACHINE	-4.4228	-2.9048	0.0006	Stationary
	PRI_CON	-6.4845	-2.9048	0.0000	Stationary
	PRI_IN	-2.8109	-2.9055	0.0621	Non-stationary
	USA_T	-7.3018	-2.9048	0.0000	Stationary

Co-Integration between Bunker_Singapore and independent variables

Pairing		**ADF**			**Stationary**
		t-stat	**5% cr.value**	**Prob**	
BUNKER_SIN	**CAR_SALE**	-1.7015	-2.9055	0.4259	Non-stationary
	CHN_T	-1.3779	-2.9048	0.5881	Non-stationary
	CONFRI	-1.9361	-2.9055	0.3141	Non-stationary
	EXCHANGE_R	-1.9263	-2.9055	0.3185	Non-stationary
	MACHINE	-1.5645	-2.9048	0.4951	Non-stationary
	PRI_CON_ID	-0.9931	-2.9048	0.7513	Non-stationary
	PRI_IN_ID	-0.9969	-2.9055	0.7499	Non-stationary
	USA_T	-1.5432	-2.9048	0.5058	Non-stationary

Co-Integration between Car_Sale and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
CAR_SALE	**CHN_T**	-1.9441	-2.9048	0.3106	Non-stationary
	CONFRI	-2.1188	-2.9084	0.2381	Non-stationary
	EXCHANGE_R	-1.9818	-2.9048	0.2941	Non-stationary
	MACHINE	-1.3294	-2.9048	0.6113	Non-stationary
	PRI_CON_ID	-2.2005	-2.9048	0.2080	Non-stationary
	PRI_IN_ID	-2.2245	-2.9048	0.1997	Non-stationary
	USA_T	-2.0116	-2.9048	0.2813	Non-stationary

Co-Integration between Con_Freight and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
CONFRI	**CHN_T**	-2.1398	-2.9055	0.2301	Non-stationary
	EXCHANGE_RATE	-2.2597	-2.9055	0.1879	Non-stationary
	MACHINE	-2.2715	2.9055	0.1841	Non-stationary
	PRI_CON_ID	-2.0604	2.9055	0.2611	Non-stationary
	PRI_IN_ID	-1.9676	2.9055	0.3002	Non-stationary
	USA_T	-2.2288	2.9055	0.1983	Non-stationary

Co-Integration between Chn_T and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
CHN_T	EXCHANGE_RATE	-1.1587	-2.9055	0.6874	Non-stationary
	MACHINE	-2.2752	-2.9069	0.1829	Non-stationary
	PRI_CON_ID	-3.4441	-2.9055	0.0217	Stationary
	PRI_IN_ID	-2.6688	-2.9055	0.0848	Non-stationary
	USA_T	-5.1647	-2.9048	0.0001	Stationary

Co-Integration between Exchange_R and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
EXCHANGE_RATE	MACHINE	-2.2433	-2.9048	0.1933	Non-stationary
	PRI_CON_ID	-1.8243	-2.9055	0.3658	Non-stationary
	PRI_IN_ID	-2.0539	-2.9055	0.2638	Non-stationary
	USA_T	-2.1872	-2.9048	0.2127	Non-stationary

Co-Integration between Machine and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
MACHINE	PRI_CON_ID	-3.1299	-2.9069	0.0292	Stationary
	PRI_IN_ID	-2.8122	-2.9069	0.0621	Non-stationary
	USA_T	-5.6285	-2.9048	0.0000	Stationary

Co-Integration between Pri_Con and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
PRI_CON_ID	**PRI_IN_ID**	-5.6737	-2.9048	0.0000	Stationary
	USA_T	-2.3817	-2.9055	0.1507	Non-stationary

Co-Integration between Pri_In and independent variables

Pairing		ADF			Stationary
		t-stat	5% cr.value	Prob	
PRI_IN_ID	**USA_T**	-2.1959	-2.9055	0.2097	Non-stationary