2009

Three essays on the world rice market: a structure, conduct, and performance paradigm approach

Hyunsoo Kang
Louisiana State University and Agricultural and Mechanical College, hkang1@tigers.lsu.edu

THREE ESSAYS ON THE WORLD RICE MARKET: A STRUCTURE, CONDUCT, AND PERFORMANCE PARADIGM APPROACH

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Agricultural Economics and Agribusiness

By
Hyunsoo Kang

B.S., Korea University, 2002
M.S., Seoul National University, 2005
August 2009

ACKNOWLEDGMENTS

Almost five years have passed since I first came to study in the U.S. Although I did my best in studying, it was a very hard period in my life due to the language barrier and culture shock. However, there were, fortunately enough for me, several people who helped me along in my studies and life.

First of all, I am deeply thankful to my major professor, Dr. P. Lynn Kennedy for his dedication, effort, and guidance through completing my course works and dissertation. Also, I would like to thank my committee members, Dr. Michael E. Salassi, Dr. R. Wes Harrison, and Dr. James M. Fannin for their review, their classes, and valuable advice.

Specially, I would like to dedicate this work to my parents, Jungsik Kang and Kyoungja Baek, my elder sister, Eunjung Kang, my mother-in-law, Haesook Noh, my wife, Eunkyoung Kim, my daughter, Sun Kang, and my son, Yune Kang. Without their support, I could not have successfully completed my studies. Their love and devotion are the underlying reasons as to why I finished this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In the past several decades, the international rice market has undergone major changes experiencing a strong expansion in traded volumes and in the volatility of rice prices. International rice prices are, furthermore, expected to remain at relatively high levels because of higher fertilizer and fuel prices, especially as stocks held by those exporters still allow unrestrained sales.

With this instability in the world rice market, we need to consider the structure, conduct, and performance (S-C-P) of the world rice market. The main objective of this dissertation will be to examine the world rice market based on S-C-P methods.

This dissertation consists of three essays relating to the structure, conduct, and performance of the world rice market. The first essay is entitled "Structure and Conduct of the World Rice Market." This chapter analyzes the working of the world rice market within the confines of the structure-conduct-performance framework and uses annual data from 1970 to 2007. The second essay is entitled "The Relationships of Trade, Economic Growth, and Market Power: The Case of Rice Exporting Countries." This essay aims to analyze the relationship between rice exports and how this relationship affects economic growth in the top four rice exporting countries as well as the effects market power has on economic growth using annual data from 1994 to 2007. The third essay will be entitled "An Empirical Estimation of the Import Demand Model and Welfare Effects: The Case of Rice Importing Countries." This section estimates an import demand function and analyzes the welfare effects for the world rice market using annual data from 1994 to 2007.

Results show that market power exists in the international rice market based on static calculation and hypothesis test, the international rice trade and economic growth for major rice exporting countries (which is a bi-directional relationship), and reductions of consumer surplus all combine to have a crucial effect on major rice importing countries due to the recent trends in export rice prices.

CHAPTER 1

INTRODUCTION

1.1. Introduction

In the past several decades, the international rice market has undergone major changes, in particular a shift in general policy paradigm, and strong expansion in the volume of trade. Also, the world rice market continues to be regarded as distorted, thin and volatile. These characteristics have influenced domestic price and production policies in a number of large exporting and Asian countries.

International rice prices have been soaring since November 2007 due to an imposition of export restraints by a growing number of countries.[1] In Figure 1.1, the world rice price has gradually increased up until 2007. The April 2008 price for rice was 158% higher compared to the price for rice in April 2007. Although this phenomenon may be short lived, international rice prices are expected to remain at relatively high levels, especially as stocks held by those exporters still allowing unrestrained sales (FAO rice market monitor, 2008), diminish. With respect to the volumes of rice that are traded, the average variations of import volumes of importers from 1994 to 2007 are greater than those of exporters (see Figure 1.2). For example, Thailand's rice exports increased 10% while Indonesia's rice imports increased 265% in the period from 1994 to 2007.

Figure 1.3 shows the ratio of rice export/import value to total export/import value. Thailand and Vietnam exceed 10% for the ratio of rice exports to total export value, and Nigeria and Indonesia's rice import to total import value exceed 10%. These countries

[1] Childs and Kiawu (2008) mentioned that the main reason of rapid rice price increases was not due to supply aspects but a surge in demand. Global rice production in 2007-2008 was the largest on record, and global ending stocks increased in 2007-2008. However, exports bans, restrictions, and taxes implements by several major rice exporting countries were the most important factors behind the rice price surge.

have a relatively high share of rice export/import on total export/import value. However, exporting countries' ratios of rice exports on total export value have decreased since 1994 (with the exception of India) while importing countries have increased (with the exception of Saudi Arabia). This implies that exporting countries have decreased their rice exporting volume while rice importing countries have increased the volume of their imports.

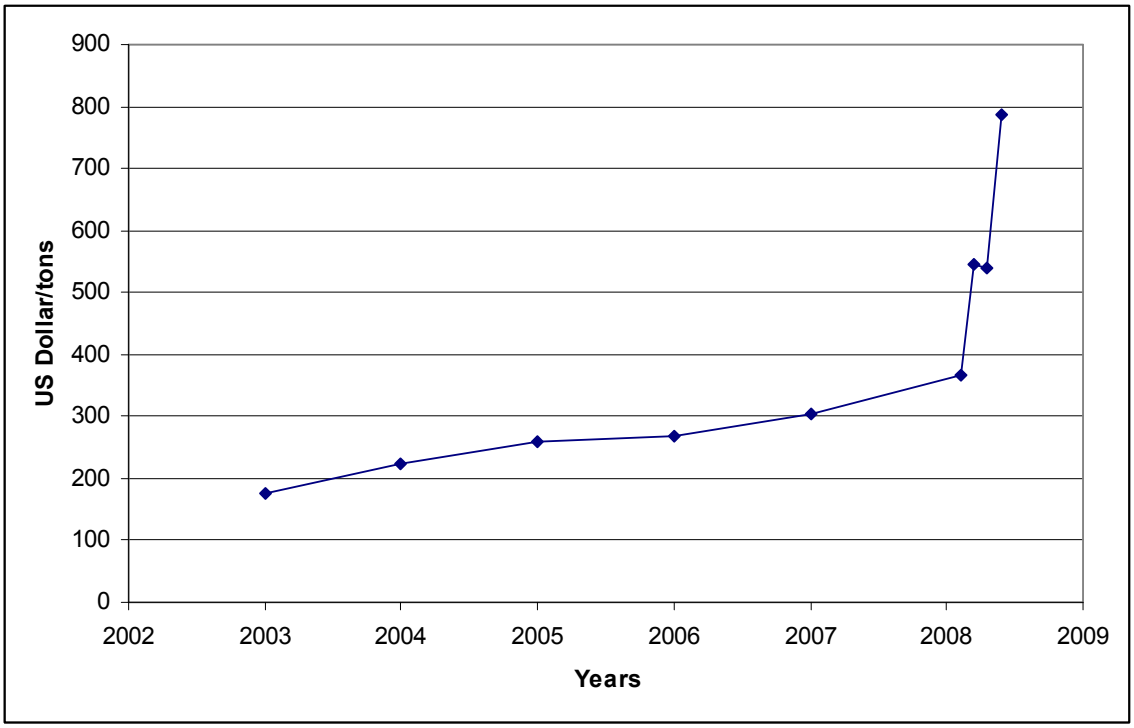


Figure 1.1. Trend of World Rice Price (From 2003 through April. 2008)
Note: World rice prices indicate the FOB Thailand 25% price. The year of 2008 includes monthly data from January to April (Source: USDA world rice calendar 2008).

In this unstable world rice market, we need to consider the structure, conduct, and performance of the world rice market due to the volatility in price and traded volumes. In the traditional structure, conduct, and performance (SCP) paradigm, as shown in Figure 1.4, market organization affects market performance through various channels. Factors to be examined include exporting countries' concentration, market structure (which includes

product differentiation), barriers to entry, fixed costs and growth rate (Delorme, 2002). Analyzing market conduct involves studying price strategy, R&D, collusion and advertising. Also, market performance is concerned with a normative evaluation of the results for market conduct (Caves, 1987).

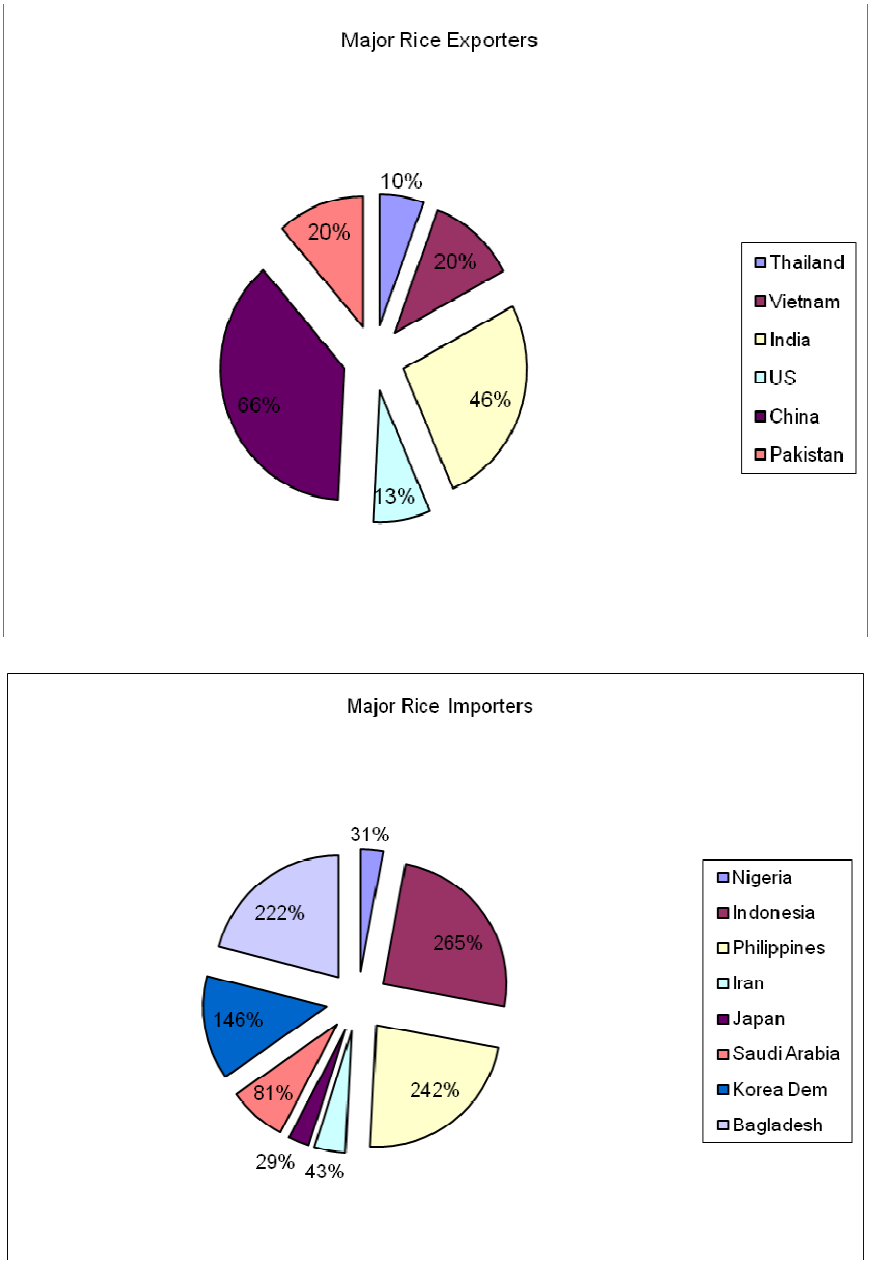
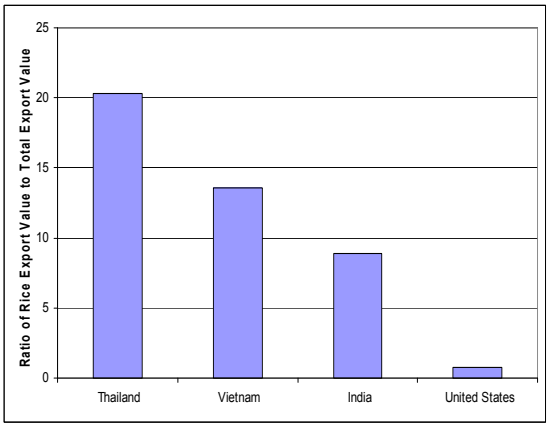
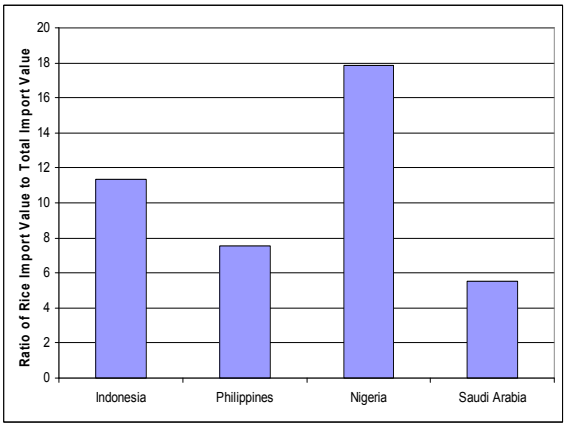
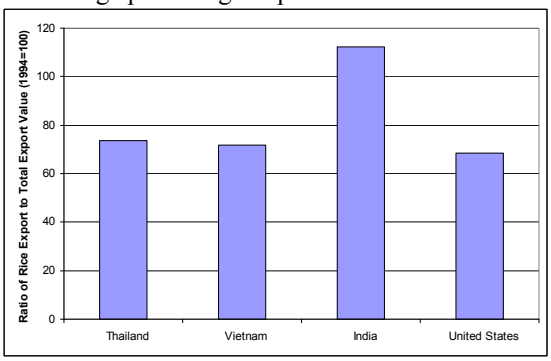


Figure 1.2. Average Variations of Rice Export and Import Trade Flows from 1994 to 2007
Source: FAO STAT (Rice Market Monitor, 2008)





Note: This figure is calculated by The World Bank Database from 1994 through 2007. The values indicate the average percentage in periods from 1994 to 2007.



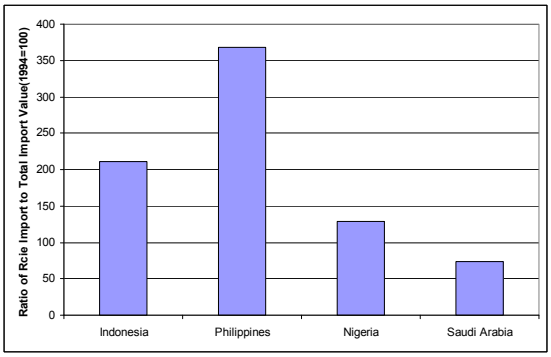


Figure 1.3 Ratio of Rice Export/Import Value to Total Rice Export/Import Value

Note: The values indicate the ratio of export/import rice to total export/import value in 2007 to 1994 (1994=100)

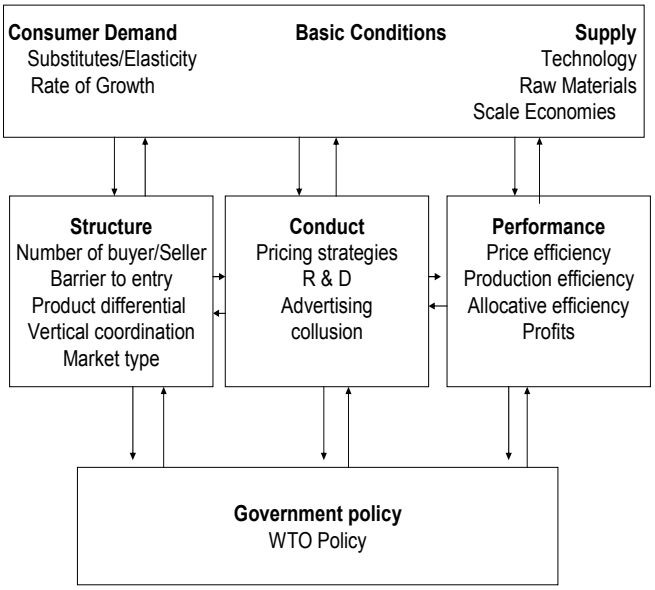


Figure 1.4. The Traditional S-C-P Paradigm

Source: Clarkson and Miller, 1982

The main objective of this dissertation will be to examine the world rice market with respect to S-C-P methods. Over the past fifteen years, industrial organization economists have seen a renewed interest in empirical analysis, which is now commonly referred to as the "new empirical industrial organization" (NEIO). This approach evaluates the presence of market power in a specific industry based on the import demand function and export supply function, and hypotheses concerning the strategic interaction of countries.

This dissertation consists of three essays relating to the structure, conduct, and performance of the world rice market. The first essay will be "Structure and Conduct of the World Rice Market." The second essay will be "The Relationships of Trade, Economic Growth, and Market Power: The Case of Rice Exporting Countries." And the third essay will be "An Empirical Estimation of the Import Demand Model and Welfare Effects: The Case of Rice Importing Countries."

The first essay, "Structure and Conduct of the World Rice Market," will analyze the workings of the world rice market, including a structure-conduct-performance framework using annual data from 1970 to 2007. The world rice market has been unstable for much of the period post-World War II, with prices volatile and the availability of supplies uncertain. Therefore, analysis of the structure and conduct of the world rice market can provide information to better formulate the direction of future policies. Also, this section will describe the effects of total production, export rice price, and real exchange rate for exporting countries on total export rice volume. On basis of the expected results, the international rice market possesses market power with respects to static calculation and hypothesis test, and it will be demonstrated that exporting

countries' currency crucially affects the exporting quantity and market power of those same exporting countries.

The second essay, "The Relationships of Trade, Economic Growth, and Market Power: The Case of Rice Exporting Countries," will aim to analyze the relationships between rice exports and economic growth in the top four rice exporting countries as well as effects of market power on economic growth. In several previous studies, trade volume was considered as an explanatory variable. However, the decreasing percentage for rice trade to economic growth ratio can be explained by the relationships between trade and economic growth. Therefore, the main objective of this section will be to analyze the effects of economic growth on rice exports as well as the effects of Foreign Direct Investment (FDI) and rice trade in terms of the export supply function. This study also will examine the existence of market power and its effect on economic growth. On basis of the expected results, the international rice market possesses market power for major rice exporting countries with respects to supply inelasticity, and moreover will have the bi-directional causality between rice trade and economic growth of major rice exporting countries.

The third essay, "An Empirical Estimation of the Import Demand Model and Welfare Effects: The Case of Rice Importing Countries," will estimate an import demand function for the world rice market using annual data from 1994 to 2007. In analysis of the import demand function, the simple regression, instrumental variables and simultaneous equation with generalized method of moments will be used. This chapter will obtain the social welfare effects for the top four rice importing countries using consumer surplus and compensated variation. Conclusions based upon empirical results will suggest that

economic growth, foreign direct investment, and population of rice importing countries positively affect the national income, and rice consumption and oil price have a strong effect on the domestic rice price in rice importing countries. Also, this section will estimate the social effects that the increasing of exporting rice price can seriously influence on the reduction of consumer surplus.

The summarized flow chart of this dissertation is shown as Figure 1.5.

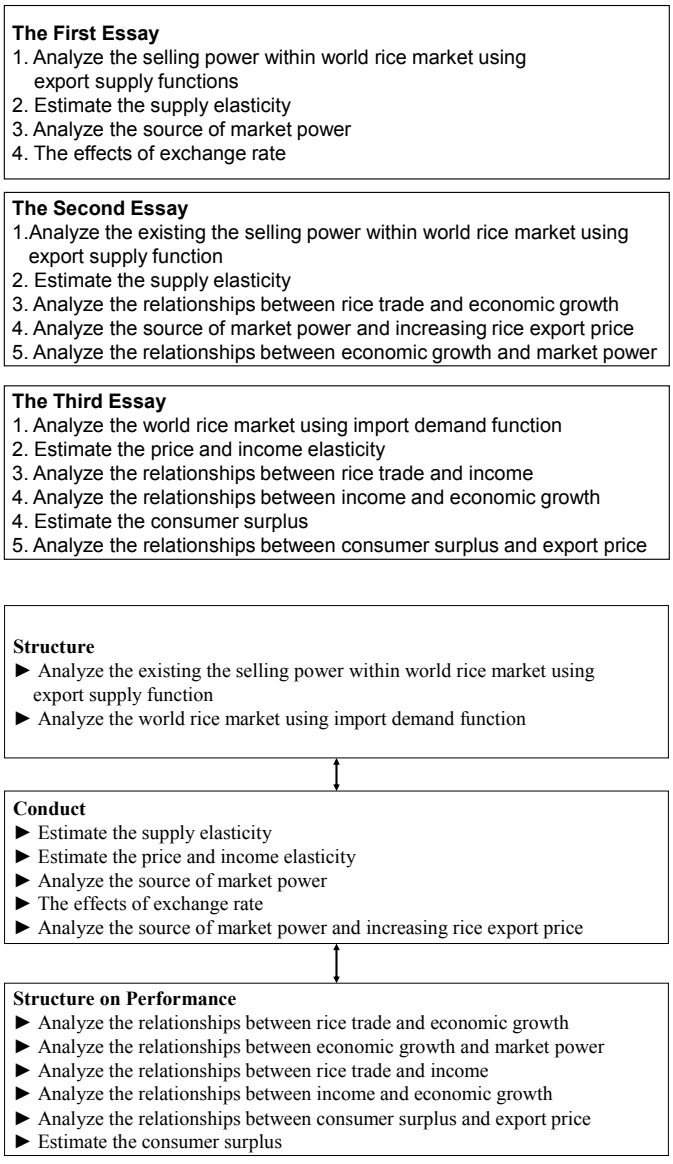


Figure 1.5. The Summary of Dissertation

1.2. Justification

1.2.1. Structure, Conduct, and Performance Paradigm

The Structure, Conduct, and Performance (SCP) Paradigm was developed by Joe Bain, although many studies have contributed to advancing and enriching Bain's basic theory. The justification of SCP was well illustrated by Bain (1968)[2] as follows:

> Market structure refers to the organizational characteristics of a market, and for practical purposes to those characteristics which determine the relations (a) of sellers in the market to each other, (b) of buyers in the market to each other, (c) of the sellers to the buyers, and (d) of selling established in the market to potential new firms which might enter it. In other words, market structure for practical purposes means those characteristics of the organization of a market that seem to exercise a strategic influence on the nature of competition and pricing within the market.
>
> Market conduct refers to the patterns of behavior that enterprises follow in adapting or adjusting to the markets in which they sell (or buy).
>
> Market performance refers to the composite of end results which firms in any market arrive at by pursuing whatever lines of conduct they espouse-end results in the dimensions of price, output, production and selling cost, product design, and so forth. For firms acting as sellers, these results measure the character of the firm's adjustments to the effective demands for their outputs; for firms buying goods, they measure the quality of adjustments made by firms to the supply conditions of the goods they purchase.

Mohsen and Ltaifa (1992), Deodha and Sheldon (1997), Dawe (2002), and Delorme and Klein (2002) analyzed the behavior of firms in terms of applying the SCP paradigm. Although their approaches are different methodologically, they all were based on Bain's SCP approach.

[2] *Industrial Organization*, J. Bain (1968)

This dissertation will also be based on Bain's work with respect to the world rice market. Rice exporting countries analyzed herein include Thailand, Vietnam, India, and the United States and rice importing countries analyzed (in terms of the aggregated rice exporting/importing volumes) include Indonesia, the Philippines, Nigeria, and Saudi Arabia; the price analysis will be based on the exporting rice price and importing rice price; the effectiveness of the rice market will be analyzed by the welfare effects with respect to consumer surplus. However, while widely applied in the SCP paradigm, this approach has major limitations in its application (McWilliams and Smart, 1993). McWilliams and Smart (1993) mentioned three weaknesses of the SCP paradigm[3]; (1) the wrong level of analysis, (2) the use of static analysis, and (3) a reliance on barriers to entry as the determinant of profitability. The problem of the level of analysis will be handled by adopting the assumption that the groups considered herein are composed of homogeneous firms. In this dissertation, the level of analysis is based on exporting/importing countries for the world rice market, and also included heterogeneity problems due to aggregated data. The static analysis of structure implies the existence of optimal conditions and maintenance including economic growth and market power, and the analysis of performance includes elasticities based on the export supply/import demand models.

Furthermore, Sohn (2006) argued that the notion of international trade can be identified as a structure, conduct, and performance paradigm. Trade openness or trade

[3] Papatheodorou (2006, page 32) mentioned "Although it appears fruitful to apply the SCP paradigm to study the market structure and conduct of industries, this approach encounters difficulties in the analysis of performance. But still, the SCP is a major theoretical pillar in Industrial Organization (IO) and can provide a useful analytical framework."

patterns deal with trade policies (it will be structure and conduct methods), and trade volume is an outcome of trading behavior (it will be performance method).

1.2.2. Export Supply Function, Import Demand Function, and Economic Growth

In the empirical analysis, the elasticities approach is based on estimating the export supply and import demand functions[4] (Aydin, Ciplak, and Yucel, 2004). In many studies applying export supply and import demand functions, export (or import) volumes are regressed on effective exchange rates, relative export (or import) price, and world (or domestic) real income. Mohsen and Ltaifa (1992) used the export supply function to investigate the effects of exchange rate on export volume. Further Carone (1996) introduced the new estimations of the aggregate demand for total and non-oil merchandise imports of the U.S. over the two decades (1970−92). Carone mentioned the utility of import demand function as follows:

> The simplest and widely used procedure for estimating aggregate import demand in the framework of the imperfect substitutes model is the use of a capitalized demand function relating the total quantity of imports demanded by a country to the level its real expenditure or real income, and to the price of imports and domestic substitutes measured in the same currency.

This dissertation will extend the work of Carone to estimate the import demand function and consumer surplus. Also, the export supply function will include the factors of economic growth in order to analyze the origins of rice export. Especially, on the basis of economic growth theory, Van den Berg and Lewer (2007) explained the relationships between trade and economic growth as follows:

[4] The simple export supply and import demand function are as follows, respectively: Export Quantity=f(Export Price, Total Production, Economic Growth) and Import Quantity=f(Domestic Price, Income)

> Trade has been referred to as an "engine of growth" in the field development economics. Recently, economists have accumulated statistical evidence showing that economic growth and international trade are positively correlated.

There have been a number of empirical studies regarding export supply functions. These studies are generally based on the notion of linkages between economic growth and international trade (Solow, 1957; Feder, 1983; Frankel and Romer, 1999; and Makki and Somwaru, 2004). They suggested that the relationship between trade and economic growth may be driven by a bi-directional causality. Not only does trade stimulate economic growth, as many other economists since Adam Smith have suggested, but improved economic growth, in turn, is also likely to create trade. Therefore, this dissertation will cover the relationships between rice trade and economic growth, and the relationships of bi-directional causality in terms of the export supply function.

1.3. Objectives

This dissertation will have the following objectives:

1) To present theoretical and empirical means of analyzing the world rice market;
2) To analyze the market structure, conduct, and performance within the world rice market;
3) To verify the selling power of the world rice market and the source of market power;
4) To develop a traditional export supply and import demand functions in terms of economic growth theory and welfare analysis;
5) To illustrate the origin of rice export with respect to economic growth and market power; and,

6) To estimate the price elasticity of demand and income elasticity for using analysis of consumer surplus.

1.4. Methodology and Data

1.4.1. Export Supply Function and Economic Growth

First, this dissertation will analyze the existence of market power in the world rice market by using *Lerner's* index, which is specified as follows:

$$(1.1)\quad Lerner\,index\,of\ monopoly\ power = \frac{P - MC}{P}$$

where P is market price and MC is the marginal cost of production of the product. However, the *Lerner* index of monopoly power requires the ability to measure marginal cost, a task not easily done. Moreover, price must refer to a constant quality unit since any difference in quality implies real changes in price (Clarkson and Miller, 1982). Therefore, if the *Lerner* index includes the export price and marginal cost of exporting countries, we can use another expressed equation instead of the marginal cost as follows:

$$(1.2)\quad \frac{P - MC}{P} = \frac{1}{\eta}$$ [5]

where η is the export price elasticity of demand, p is the export rice price, and MC is the marginal cost for exporting countries. This equation is equally useful to measure the degree of monopoly. Although the concentration ratio seems to be a useful measure of monopoly power, it has a serious shortcoming. Monopoly power is a function not only of a firm's market share, but also of potential supply from either existing firms or firms that

[5] The specific rotation and explanation of equation (1.2) is shown in the chapter 2.

it could enter the industry. Therefore, this study proposes to test the basic hypothesis which concentration ratio raises price based on the export rice price equation.

This study extends the work of Mohsen and Ltaifa which formulated the effects of real exchange rate on export volume with respect to export supply function. The export supply model includes export rice price, total production, and exchange rate to estimate the effects of export rice volume and the export price elasticity. The empirical model is as follows:

$$(1.3)\quad Log(EX_t) = \alpha_0 + \alpha_1 Log(EXRP_t) + \alpha_3 Log(TP_t) + \alpha_4 Log(ER_{it}) + \varepsilon_{1t}$$

where EX_t is the total export volume of rice in period *t*; $EXRP_t$, the export rice price in period *t*; TP_t, the total production volume of rice in period *t*; ER_{it}, the real exchange rate of *i*[6] exporting countries in period *t*; and ε_{1t} is error term. Also, this study constrains export rice price with the harvested area, crude oil price, and export price for wheat and maize because of issues related to endogeneity in export rice price. The export rice price equation[7] is as follows:

$$(1.4)\quad \begin{aligned} Log(EXRP_t) = {} & \beta_0 + \beta_1 Log(THA_t) + \beta_2 Log(OIL_t) + \beta_3 Log(EXWP_t) \\ & + \beta_4 Log(EXMP_t) + \beta_{i5} Log(ER_{it}) + \beta_6 \log(CR4_t) + \varepsilon_{2t} \end{aligned}$$

where THA_t is the total harvested area in period *t*, OIL_t is the annual average U.S. crude oil price in period *t*, $EXWP_t$ is the exporting price for wheat in period *t*, $EXMP_t$ is the

[6] "i=1" and "i=2" indicate the exchange rate of Baht/US dollar and Rupee/US dollar, respectively.

[7] This study assumes that export rice prices are influenced by supply aspects based on total harvest area, input cost based on oil price, and substitute goods prices related on export wheat/maize prices. That is, the export rice price equation includes harvest area, oil price, and substitute goods prices to estimate the effects of export rice price.

exporting price for maize in period t, $CR4_t$ is the concentration ratio for top rice exporting countries in period t, and ε_{2t} is error term.

Second, to estimate the effects of economic growth on exporting rice volumes, this study will extend the export supply function in terms of economic growth theory. The export supply function includes export rice price, total production, and economic growth to obtain the export price elasticity and effect of economic growth in major rice exporting countries. The empirical model is as follows:

$$(1.5)\quad Log(EX_t) = a_0 + a_1 Log(EXP_t) + a_2 Log(TP_t) + a_{i3} Log \sum_{i=1}^{4} (GDP_{it}) + \varepsilon_{1t}$$

where EX_t is the total export volume of rice in period t; EXP_t, the export rice price in period t; TP_t, the total production volume of rice in period t; GDP_{it}, the real gross domestic product of i exporting countries[8] in period t; and ε_{1t} is error term. Also, including all the variables in equation (1.5) yields the models specified as follows;

(1.6)

$$\begin{aligned} Log(EXP_t) = {} & b_0 + b_1 Log(CR4_t) + b_2 Log(OIL_t) + b_3 Log(EXWP_t) + b_4 Log(EXMP_t) + b_5 Log(THA_t) \\ & + b_6 Log(ER_t) + b_7 Log(CIF/FOB_t) + \varepsilon_{2t} \end{aligned}$$

(1.7)

$$\begin{aligned} Log \sum_{i=1}^{4} (GDP_{it}) = {} & c_0 + c_1 Log \sum_{i=1}^{4} (FDI_{it}) + c_2 Log \sum_{i=1}^{4} (MS_{it}) + c_3 Log \sum_{i=1}^{4} (EX_{it}) + c_4 Log \sum_{i=1}^{4} (IN_{it}) \\ & + c_5 \sum_{i=1}^{4} POP_{it} + c_6 Log \sum_{i=1}^{4} (IMGS_{it}) + c_7 Log \sum_{i=1}^{4} (HE_{it}) + c_8 Log \sum_{i=1}^{4} (GNI_{it}) + c_9 \sum_{i=1}^{4} HC_{it} \\ & + c_{10} Log \sum_{i=1}^{4} (AG_{it}) + c_{11} Log \sum_{i=1}^{4} (OP_{it}) + c_{12} Log \sum_{i=1}^{4} (FDI_{it} \times EX_{it}) + \varepsilon_{3t} \end{aligned}$$

[8] Rice exporting countries are Thailand, Vietnam, India, and the U.S. Therefore, in this study, i is equal to four.

$$(1.8)\ Log(CR4_t) = d_0 + d_1 Log\sum_{i=1}^{4}(MS_{it}) + d_2 Log\sum_{i=1}^{4}(GDP_{it}) + d_3 Log\sum_{i=1}^{4}(FDI_{it}) + \varepsilon_{4t}$$

In addition to those variables introduced in equation (1.5), $CR4_t$ is the concentration ratio for top rice exporting countries in period *t*, OIL_t is the annual average U.S. crude oil price in period *t*, $EXWP_t$ is the exporting price for wheat in period *t*, $EXMP_t$ is the exporting price for maize in period *t*, THA_t is the total harvested area in period *t*, ER_t is the real exchange rate of Baht/U.S. dollar in period *t*, CIF/FOB_t[9] is the ratio of c.i.f. to f.o.b. price in period *t*, FDI_{it} is the foreign direct investment of *i* exporting countries in period *t*, MS_{it} is the market share of *i* exporting countries in period *t*, EX_{it} is the export volume of *i* exporting countries in period *t*, IN_{it} is exporting country *i*'s inflation rate in period *t*, POP_{it} is the population growth rate of exporting country *i* in period *t*, $IMGS_{it}$ is the imports of goods and service of *i* exporting countries in period *t*, HE_{it} is the high-technology exports of *i* exporting countries in period *t*, GNI_{it} is the gross national income of *i* exporting countries in period *t*, HC_{it} is the human capital of *i* exporting countries in period *t*, AG_{it} is the agricultural values of *i* exporting countries in period *t*, and OP_{it} is the trade openness[10] measure of *i* exporting countries in period *t*. Equation (1.6) includes market power, oil price, export wheat/maize prices, total harvest area, exchange rate, and transportation cost to analyze effects of main factors influenced export rice price. Equation (1.7) includes FDI, market share, export rice quantities, some data related with rice exporting countries' economic situations (e.g. population, inflation,

[9] The Freight-on-Board (FOB) is based on 5% milled rice of Bangkok and the Cost-Insurance-Freight (CIF) is based on 5% milled rice of Indonesia and Philippines.

[10] See Alcala and Ciccone (2004).

This variable is calculated by using $Openness = \frac{total\ \exp ort\ volume + total\ import\ volume}{GDP}$

and human capital), and interaction effects between rice trade and FDI. Equation (1.8) denotes the market power equation which is based on effects of market share, economic growth, and FDI on major rice exporting countries' market power.

1.4.2. Import Demand Function and Consumer Surplus

Empirical estimations of an import demand model include that the demand for imports is the function of domestic price and real income (Murray and Ginman, 1975; Mayes, 1981; Deyak and Sawyer, 1988; and Carnoe, 1996). This dissertation will suggest that in modeling the import demand function, the log-log model is preferable to the linear formulation. The import demand model includes income and domestic rice based on major rice importing countries to obtain the income/price elasticities. Therefore, the log-log import demand function is specified as follows;

$$(1.9) \quad Log\sum_{i=1}^{4}(IM_{it}) = a_0 + a_1 Log\sum_{i=1}^{4}(GNI_{it}) + a_2 Log(DRP_t) + \varepsilon_t$$

where IM_{it} is the import volume of rice in period *t*; GNI_{it}, the gross national income (GNI) for *i* importing countries[11] in period *t*; DRP_t, the domestic rice price[12] in period *t*; and ε_{1t} is error term. The coefficients a_1 and a_2 indicate the income and price elasticity of import demand, respectively.

The other variables including equation (1.9) are the effects of gross domestic product (GDP), foreign direct investments (FDI), inflation, and population on GNI. These factors indicate the effects which can influence on national income in terms of economic

[11] Rice importing countries are Indonesia, Philippines, Nigeria, and Saudi Arabia with respect to top four importing volumes.

[12] Domestic rice prices have related with the exchange rate (defined as domestic currency per unit of foreign) and exporting prices (see Campa and Goldberg, 2002). That is, $DRP_t = E_t * EXP_t$ where E_t is the real exchange rate (U.S. dollar/Ruphia) in period *t* and EXP_t is the exporting price in period *t*. This paper is based on the real exchange rate of Indonesia and exporting rice price of Thailand FOB 5% broken and milled. Ruphia (Rp) is the currency of Indonesia.

growth theory. Including all the variables in equation (1.9) yields specified models as follows;

(1.10)

$$Log(DRP_t) = b_0 + b_1 Log\sum_{i=1}^{4}(CON_{it}) + b_2 Log(OIL_t) + b_3 Log(DWP_t) + b_4 Log(DMP_t) + \varepsilon_{1t}$$

(1.11)

$$Log\sum_{i=1}^{4}(GNI_{it}) = c_0 + c_1 Log\sum_{i=1}^{4}(GDP_{it}) + c_2 Log\sum_{i=1}^{4}(FDI_{it}) + c_3 Log\sum_{i=1}^{4}(IN_{it}) + c_4 Log\sum_{i=1}^{4}(POP_{it}) + \varepsilon_{2t}$$

where CON_{it} is the rice consumption for *i*'s importing countries in period *t*, OIL_t is the annual average U.S. crude oil price in period *t*, and DWP_t and DMP_t [13]are the domestic prices for wheat and maize in period *t*, respectively. And FDI_{it} is the average foreign direct investment of importing countries in period *t*, IN_{it} is the average inflation rate of importing countries in period *t*, and POP_{it} is the average population rate of importing countries in period *t*. Equation (1.10) includes rice consumption, oil price, domestic wheat/maize prices all in an attempt to analyze the main effects that influence the domestic rice price. Equation (1.11) indicates that the incomes of major rice importing countries are affected by economic growth, FDI, inflation, and population based on national income account.

This dissertation will apply existing welfare estimation techniques to measure the consumer surplus and extends upon the work of Brynjolfsson and Smith (2003). They analyzed the empirical estimation that quantified the economic impact of increased product variety made available through electronic markets. Although Brynjolfsson and

[13] Domestic wheat and maize price are calculated as the same method of domestic rice price. Exporting wheat price is Canadian No.1 Western Red Spring 13.5% and exporting maize price is the US No.2 yellow, fob Gulf ports.

Smith divided the price factors in terms of existing and new products, this study used the only existing price factors. For using Roy's identity, we can obtain the compensation variation without utility level as follows:

$$(1.12)\quad CV = -y + \left[\frac{1-\delta}{1+\alpha} y^{-\delta}(p_0 x_0 - p_1 x_1) + y^{(1-\delta)}\right]^{1/(1-\delta)}$$

where CV is the compensation variation, P_0 and P_1 are the vectors of pre and post prices of existing products, y is the income (also indicates the gross national income of rice import countries), α is the price elasticity, δ is the income elasticity, and x_0 and x_1 are pre and post-production of existing products, respectively. If there is no income effects, CV will be the same value of consumer surplus (CS).

After obtaining the consumer surplus, this study will estimate the log-log model with respect to the effects of export rice price on CS because this section will focus on the percentage changes of export rice price on the percentage changes of CS as follows:

$$(1.13)\quad Log(CS_t) = \alpha_0 + \alpha_1 Log(P_t)$$

where CS_t is the consumer surplus in period *t* and P_t is the exporting rice price in period *t*. In conclusion, α_1 indicates the export price elasticity on the consumer surplus. That is, if the export rice price increases by 1 percent, we know that the importing countries' consumer surplus will decrease or increase by α_1 percent. According to estimated equation (1.13), we know the relationships between export rice price and consumer surplus in the top 4 major rice importing countries.

1.4.3. Data

The first essay will analyze the working of the world rice market, including a structure-conduct-performance framework using annual data from 1970 to 2007, while

the second and third essays will utilize annual data from 1994 through 2007. In order to analyze the export supply model, this study includes export rice volume, export rice price, exchange rate, and economic growth based on major rice exporting countries. And to investigate the import demand model, this study includes import rice volume, income, and domestic rice price based on major rice importing countries. The specific variables and sources are as follows:

Table 1.1. Definitions of Variables

Variables	Definitions
EX	**Total rice export quantity (1000 tons)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)
EXP	**Export rice price (U.S. dollar/ton)** Source: FOB Bangkok, 5% broken. International Rice Research Institute.
TP	**Total rice production volume (1000 tons)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)
ER	**Real exchange rate of Baht/U.S. dollar and Rupee/U.S. dollar** Source: The Bank of Thailand and India
THA	**Total harvested area (acre)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)
OIL	**Annual average U.S. crude oil price (U.S. dollar/bbl)** Source: Financial Trend Forecaster (www.inflationdata.com)
EXWP	**Export wheat price (U.S. dollar/ton)** Source: Canadian No.1 Western Red Spring 13.5%. International Rice Research Institute.
EXMP	**Export maize price (U.S. dollar/ton)** Source: U.S. No.2 yellow, FOB Gulf ports. International Rice Research Institute.
GDP	**Real gross domestic product (U.S. dollar)** Source: The World Bank Database
FDI	**Foreign direct investment (U.S. dollar)** Source: The World Bank Database
CR4	**Concentration ratio 4** Source: this variable is calculated by using USDA World Rice Calendar Years (2008)

Table 1.1. Continued

Variables	Definitions
CIF/FOB	**Ratio of c.i.f. to f.o.b. price** Source: The Freight-on-Board (FOB) is based on 5% milled rice of Bangkok and the Cost-Insurance-Freight (CIF) is based on 5% milled rice of Indonesia and Philippines. CIF prices obtain from Statistics of Indonesia and Philippines.
MS	**Market share of top four exporting countries** Source: this variable is calculated by using USDA World Rice Calendar Years (2008)
IN	**Inflation rate (annual %)** Source: The World Bank Database
POP	**Population growth rate (annual %)** Source: The World Bank Database
IMGS	**Imports of goods and service (% of GDP)** Source: The World Bank Database
HE	**High-technology exports (% of manufactured exports)** Source: The World Bank Database
GNI	**Gross national income (U.S. dollar)** Source: The World Bank Database
HC	**Human capital (the average years of educational attainment)** Source: The World Bank Database and UNESCO database
AG	**Agricultural values (% of GDP)** Source: The World Bank Database
OP	**Trade openness measure** Source: this variable is calculated by the working of Alcala and Ciccone (2003) $Openness\ Measure = \frac{total\ \exp ort\ volume + total\ import\ volume}{GDP}$
IM	**Total rice import quantity (1000 tons)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)
DRP	**Domestic rice price (U.S. dollar)** Source: this variable is calculated by using $DRP_t = E_t * EXP_t$ where E_t is the real exchange rate (U.S. dollar/Ruphia) in period t and EXP_t is the rice exporting price in period t. Also this is based on the real exchange rate of Indonesia and exporting rice price of Thailand FOB 5% broken and milled. Ruphia (Rp) is the currency of Indonesia.
CON	**Rice consumption (1000 tons)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)

Table 1.1. Continued

Variables	Definitions
DMP	**Domestic maize price (U.S. dollar)** Source: this variable is calculated by using $DMP_t = E_t * EXMP_t$ where E_t is the real exchange rate (U.S. dollar/Ruphia) in period *t* and $EXMP_t$ is the exporting maize price in period *t*. Also this is based on the real exchange rate of Indonesia and exporting wheat price of U.S. No.2 yellow, FOB Gulf ports. Ruphia (Rp) is the currency of Indonesia.
DWP	**Domestic wheat price (U.S. dollar)** Source: this variable is calculated by using $DWP_t = E_t * EXWP_t$ where E_t is the real exchange rate (U.S. dollar/Ruphia) in period *t* and $EXWP_t$ is the exporting wheat price in period *t*. Also this is based on the real exchange rate of Indonesia and exporting wheat price of Canadian No.1 Western Red Spring 13.5%. Ruphia (Rp) is the currency of Indonesia.

1.4.4. Correlation of Estimated Variables

Correlation coefficients indicate the relationship between two variables (Wooldridge). For example, we could let *X* denote export rice price and *Y* denote export rice volume. Then, the correlation coefficient between *X* and *Y* is as follows:

$$(1.14)\quad Corr(X,Y) = \frac{Cov(X,Y)}{sd(X) \times sd(Y)}$$

where *Corr* is the correlation coefficient between *X* and *Y*, *Cov* is the covariance between *X* and *Y*, and *sd*(*X*) and *sd*(*Y*) are standard deviation of *X* and *Y*, respectively. If *X* and *Y* are independent, then *Corr(X,Y)=0*, but zero correlation does not imply independence because the correlation coefficient is a measure of linear dependence. However, the magnitude of the correlation coefficient is easier to interpret than the size of the covariance due to the following criterion (Wooldridge).

If *Corr(X,Y)=0*, then there is no linear relationship between *X* and *Y*, and *X* and *Y* are said to be uncorrelated. Where *Corr(X,Y)=1*, this means that there is a perfectly positive relationship, which implies that we can write *Y=a+bX* for the constant *a* and

b>0. *Corr(X,Y)=−1* implies a perfectly negative relationship, so we can write *Y=a+bX* for the constant *a* and specify b<0. However, in a real situation, the extreme cases of positive or negative correlation occur rarely. Therefore, Cohen (1969) suggested a method of interpreting correlation in his psychological research and is as follows:

Table 1.2. Criterion of Correlation Coefficients

Criterions	Correlation Coefficients	
	Negative	**Positive**
Small	−0.3 to −0.1	0.1 to 0.3
Medium	−0.5 to −0.3	0.3 to 0.5
Large	−1.0 to −0.5	0.5 to 1.0

Source: *Statistical Power Analysis for the Behavioral Sciences*, Cohen (1969)

Table 1.3 indicates the correlation coefficients[14] between exporting and importing countries within rice market. These coefficients include export/import volumes,

[14] According to criterions of Cohen (1969), if x and y have a positive correlation, this implies a relationship between x and y variables such as values for x increases, values for y also increase. Otherwise, if x and y have a negative correlation, this indicates a relationship between x and y variables such as values for x increases, values for y also decreases. Based on a positive/negative correlation, this dissertation selects the estimated variables and includes empirical models. The summary of a positive/negative correlation in Table 1.3 is as follows:

	X value	**Y value**
Positive Correlations	CR4	EX
	EXRP	EX, CR4
	TP	EX
	OIL	EXRP, TP
	ER	EX
	EX FDI	EX, TP, OIL, ER
	EX GDP	EX, TP, OIL, EX FDI
	EX POP	EX GDP
	EX HC	EX, TP, OIL, ER, EX FDI, EX GDP
	c.i.f./f.o.b.	EXRP, EX POP, OIL
	IM	EX, ER, EX FDI, EX HC
	IM GNI	EX, EXRP, TP, OIL, RX FDI, EX GDP, EX HC
	DRP	EXRP, OIL, c.i.f./f.o.b.
	IM GDP	EX, EXRP, TP, OIL, EX FDI, EX GDP, EX HC, IM, IM GNI

production, export/import rice price, oil price, export/import countries' GDP and GNI, consumption, population, and consumer surplus. Figure 1.6 shows the flow chart between export and import countries in terms of correlation coefficients. According to the Cohen's criterion, the correlation coefficient between economic growth and FDI, the correlation coefficient between economic growth and population, the correlation coefficient between economic growth and export/import volume, the correlation coefficient between export/import volume and export/import price, the correlation coefficient between export price and oil price/transportation, and the correlation coefficient between economic export price and consumer surplus are all closely correlated with each other, respectively. These results will be based on the simultaneous equation model and analyze the relationships between export and import countries, and be utilized in the export supply and import demand models.

1.4.5. Stationary or Non-Stationary for Estimated Data

The notion of a stationary process has played an important role in the analysis of time series data (Wooldridge). A formal definition[15] of stationarity is as follows:

	CON	EX, TP, OIL, ER, EX FDI, EX GDP, EX HC, IM, IM GNI, IM GDP
	IM FDI	EXRP, IM GNI, DRP, IM GDP
	IM POP	EX, TP, OIL, ER, EX FDI, EX GDP, EX HC, IM, IM GNI, IM GDP, CON
Negative Correlations	OIL	EX
	EX POP	EX, TP, OIL, ER, EX FDI
	c.i.f./f.o.b.	EX, TP, ER, EX FDI, EX GDP, EX HC
	IM	EX POP, c.i.f./f.o.b.
	IM GNI	EX POP
	DRP	ER, IM
	IM GDP	EX POP, c.i.f./f.o.b.
	CON	EX POP, c.i.f./f.o.b.
	IM POP	EX POP, c.i.f./f.o.b.
	CS	EXRP, TP, EX FDI, EX GDP, IM GNI, DRP, IM GDP, IM FDI

Note: Definitions of variables are the same in Table 1.1.

[15] See Wooldridge (2002)

Table 1.3. The Correlation Results Based on the Estimated Variables

	EX	CR4	EXRP	TP	OIL	ER	EX FDI	EX GDP	EX POP	EX HC	cif/fob	IM	IM GNI	DRP	IM GDP	CON	IM FDI	IM POP	CS
EX	1																		
CR4	**0.5719**	1																	
EXRP	**0.5017**	**0.5193**	1																
TP	**0.7231**	0.0831	0.1265	1															
OIL	**-0.5787**	0.3374	**0.6791**	**0.8084**	1														
ER	**0.6124**	-0.1764	-0.4746	0.443	0.1598	1													
EX FDI	**0.76**	0.0876	0.1344	**0.9458**	**0.7437**	**0.5459**	1												
EX GDP	**0.7467**	0.3841	0.3772	**0.8754**	**0.9529**	0.3137	**0.8567**	1											
EX POP	**-0.7611**	-0.0248	0.2239	**-0.7863**	**-0.7659**	**-0.5519**	**-0.7522**	**0.7654**	1										
EX HC	**0.8615**	0.2819	0.1391	**0.8605**	**0.8839**	**0.525**	**0.8582**	**0.9547**	**-0.8647**	1									
cif/fob	**-0.8598**	0.0049	**0.5341**	**-0.7025**	**0.5796**	**-0.594**	**-0.7323**	**-0.6825**	**0.8178**	**-0.8076**	1								
IM	**0.8453**	-0.0113	-0.3763	0.4519	0.1203	**0.6334**	**0.5433**	0.341	**-0.5132**	**0.5111**	**-0.7693**	1							
IM GNI	**0.5592**	0.4478	**0.6216**	**0.749**	**0.9261**	0.1397	**0.7451**	**0.9498**	**-0.5615**	**0.8408**	-0.4791	0.116	1						
DRP	-0.2916	0.3666	**0.7963**	0.0737	**0.5117**	**-0.682**	0.0509	0.2283	0.2429	-0.0599	**0.5402**	**-0.5372**	0.4307	1					
IM GDP	**0.534**	0.4412	**0.5286**	**0.76**	**0.9747**	0.1033	**0.7202**	**0.9537**	**-0.6417**	**0.8454**	**-0.5066**	**0.5677**	**0.975**	0.4356	1				
CON	**0.899**	0.2931	-0.0302	**0.8409**	**0.8279**	**0.5716**	**0.8235**	**0.8976**	**-0.9007**	**0.9762**	**-0.8486**	**0.5904**	**0.7353**	-0.1754	**0.7654**	1			
IM FDI	-0.0225	0.4254	**0.8104**	0.0766	0.2559	-0.2809	0.1442	0.2994	0.2065	0.1021	0.2342	-0.2726	**0.5155**	**0.7004**	**0.5032**	-0.0621	1		
IM POP	**0.8668**	0.2731	0.0794	**0.8669**	**0.8776**	**0.537**	**0.8469**	**0.9426**	**-0.8854**	**0.9962**	**-0.8256**	**0.5206**	**0.811**	-0.0917	**0.8297**	**0.9868**	0.0492	1	
CS	-0.4971	-0.3916	**-0.5106**	**-0.5178**	-0.4586	0.1365	**-0.5813**	**-0.5804**	0.2295	-0.4284	0.3703	-0.377	**-0.585**	**-0.5788**	**-0.5438**	-0.3782	**-0.5055**	-0.4026	1

Note: Bold variables are over 0.5 correlations. Definitions of variables are the same in Table 1.1.

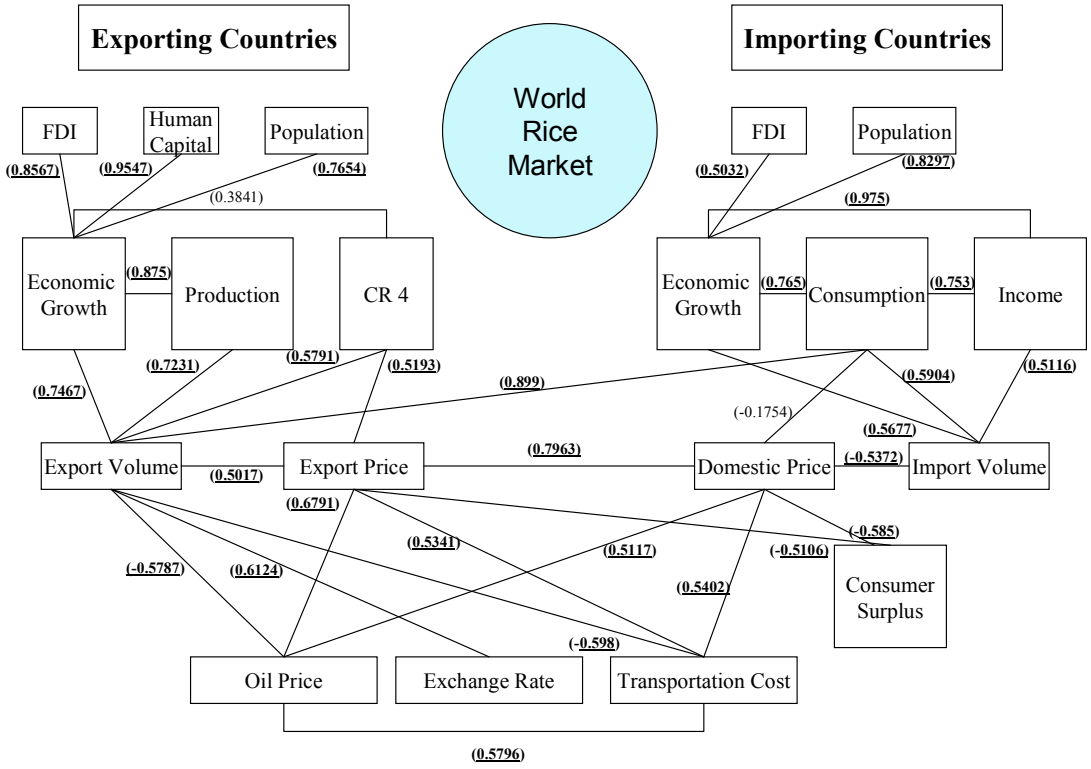


Figure 1.6. The Flow Chart for Correlations between Exporting and Importing Countries

Note: Values in parentheses are correlation coefficients. Bolden and underlined variables are over 0.5 correlations for using the correlation results.

> The stochastic process $\{x_t : t = 1,2,...\}$ is stationary if for every collection of time indices $1 \le t_1 < t_2 < ... < t_m$, the joint distribution of $(x_{t1}, x_{t2}, ..., x_{tm})$ is the same as the joint distribution of $(x_{t1+h}, x_{t2+h}, ..., x_{tm+h})$ for all integers h≥1.

That is, the sequence of time indices that are identically distributed and stationary also requires this sequence. Therefore, stationarity implies that the nature of any correlation between adjacent terms is the same across all time periods (Wooldridge, 2001).

A time-series model is weakly stationary if its variables are independent of time (Greene, 1990). Therefore, we need to look at the stationarity of the estimated data in

order to account for problems resulting from a small sample space. Figure 1.7 indicates the line graphs between time and estimated variables. Especially, export quantity, concentration ratio 4, exporting countries' FDI and GDP, importing countries' GNI/GDP and consumption have gradually increased since 1994.

It can be seen from Figure 1.7 that those line graphs indicate the existence of a trend, which means those variables may be non-stationary. Hence, a unit root test on those variables needs to be conducted. The next section will explain the unit root test and the Engle-Granger (EG) test as they are used for identifying the stationarity or non-stationarity of estimated variables.

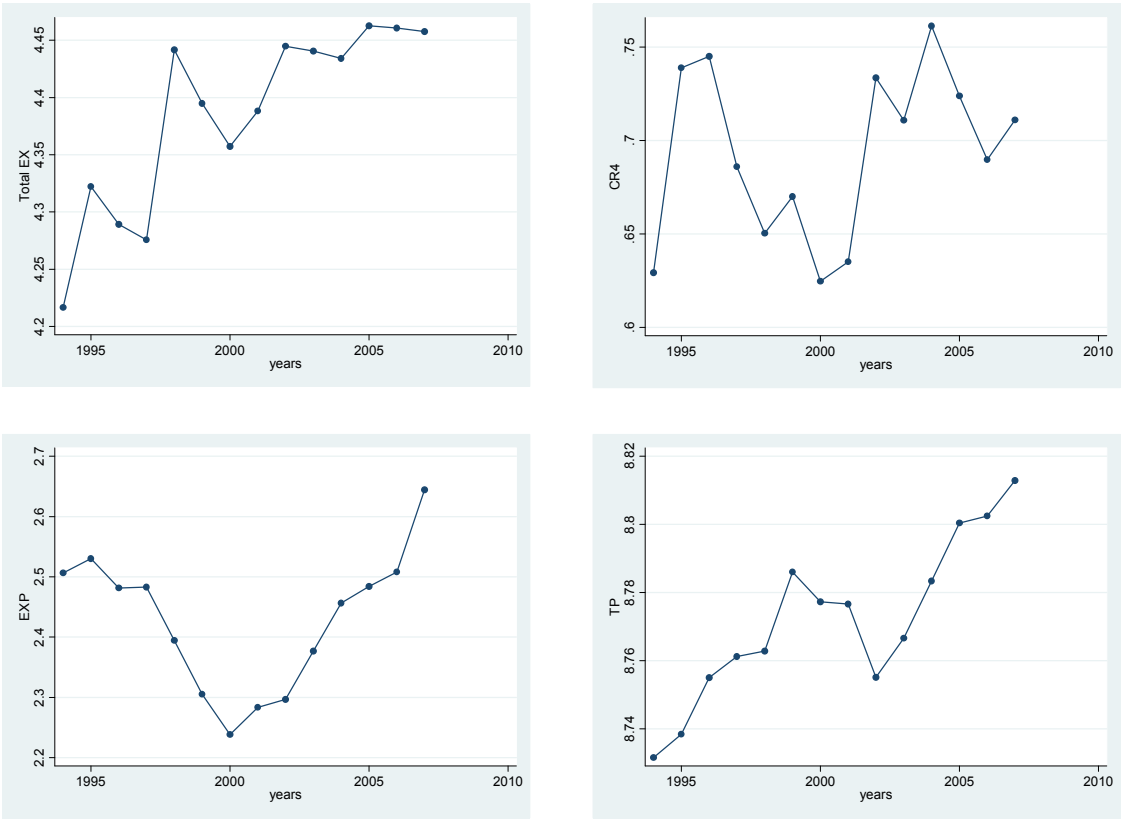


Figure 1.7. The Line Graphs between Time and Estimated Variables
Note: Definitions of variables are the same as Table 1.1. Vertical axis indicates the natural logarithmic values of estimated variables.

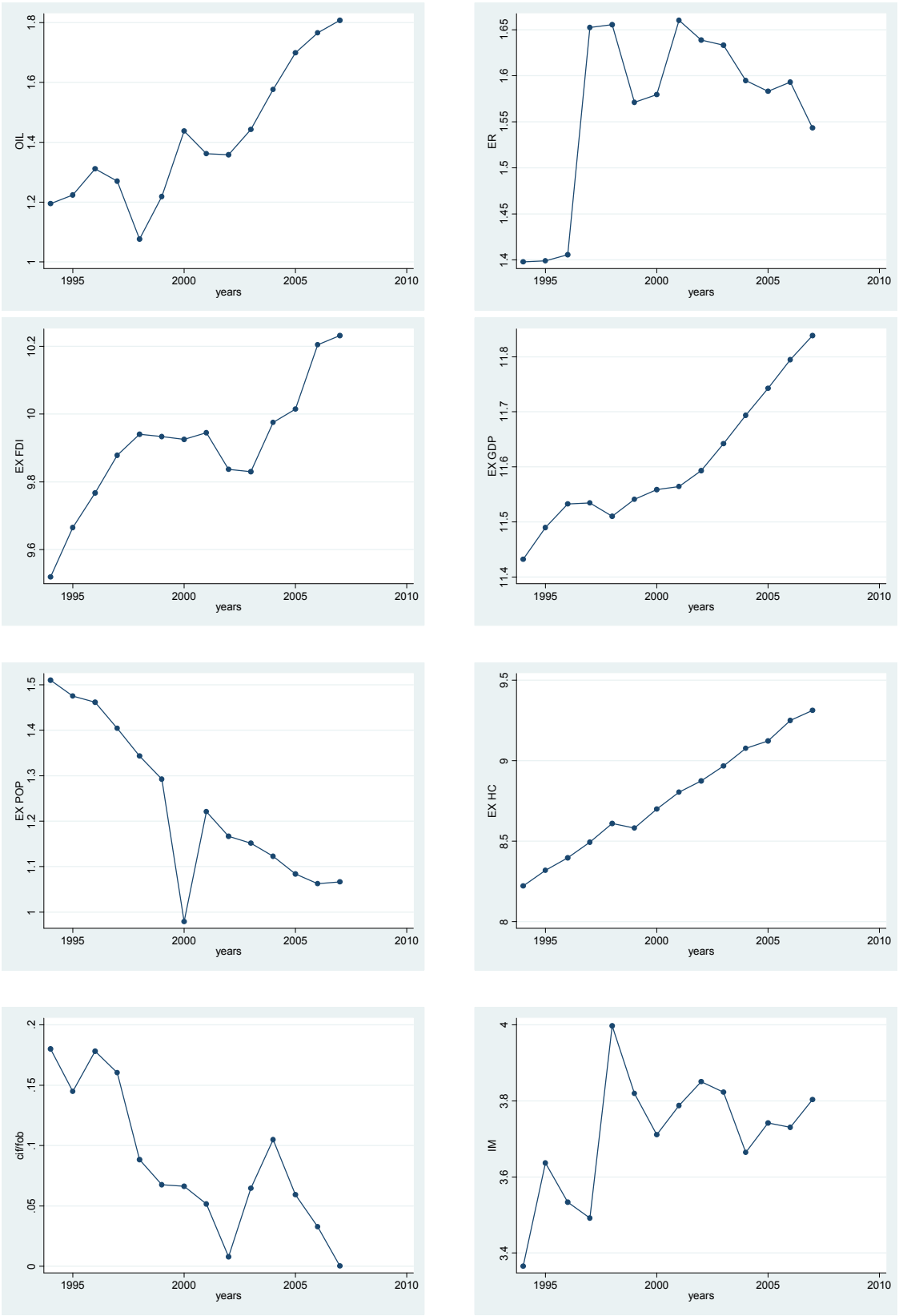


Figure 1.7. Continued

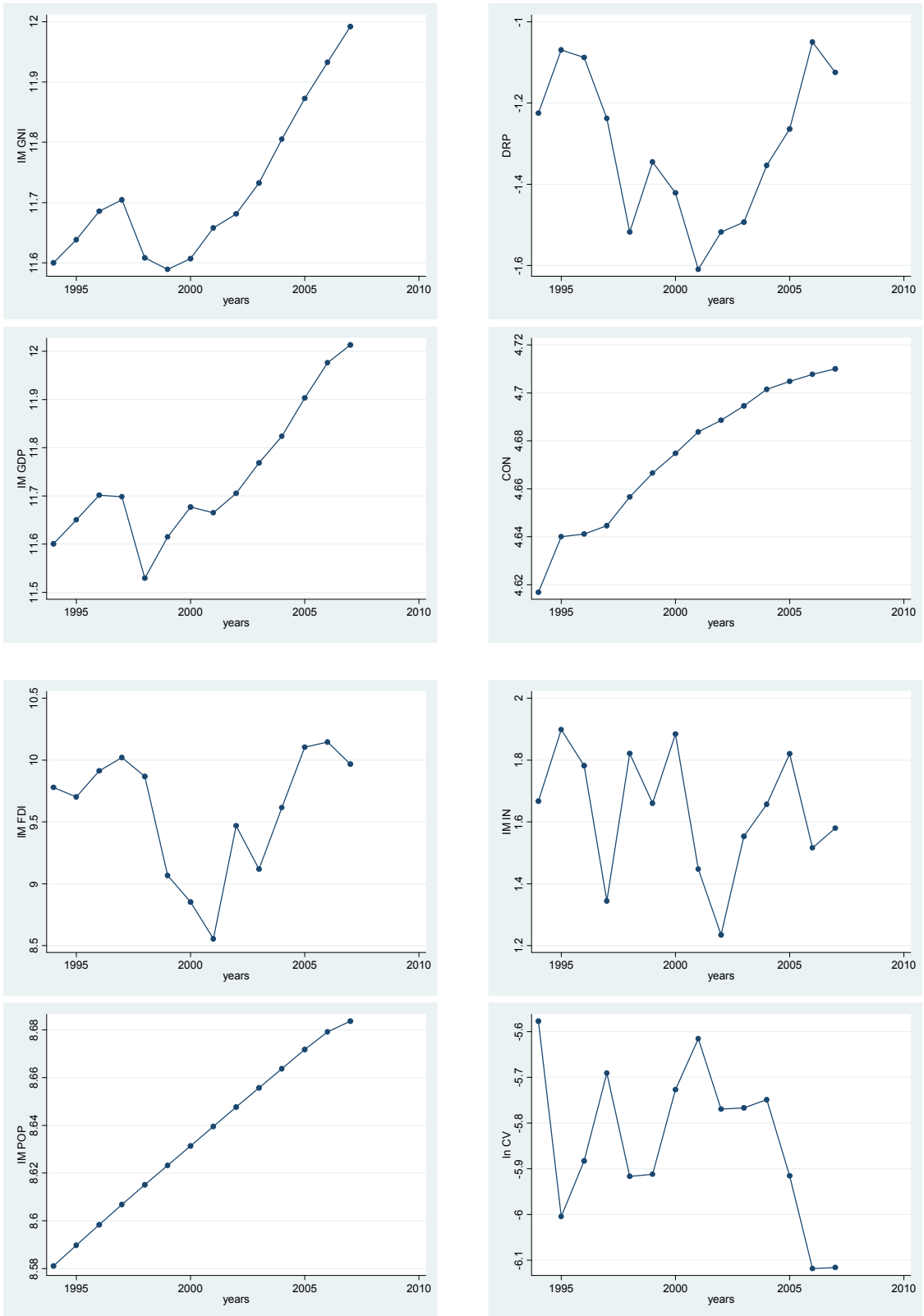


Figure 1.7. Continued

1.4.6. Unit Root Test and Engle-Granger (EG) Test

Given that this is annual data, we need to pre-test for stationarity and the existence of a cointegration vector before we move on to model specification. The unit root test is utilized to determine the order of integration of those variables that are under consideration. The unit root test tests can determine whether a time series variable is non-stationary by using an autoregressive model. This test employed for testing the order of integration is the Augmented Dickey-Fuller (ADF) test which is a version of the Dickey-Fuller (ADF) test for a larger and more complicated set of time series models (Wooldridge, 2001). This procedure statistics rejects the null hypothesis of non-stationary of all variables, when first difference variables are used.

We could let consider a simple general autoregressive (AR) of p as follows:

(1.15) $Y_t = \mu + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + ... + \phi_p Y_{t-p} + \varepsilon_t$

where p is the lag order of the autoregressive process. If this is the process generating the data but one lag order of an autoregressive (AR(1)) model is fitted,

(1.16) $Y_t = \mu + \phi_1 Y_{t-1} + \nu_t$

where $\nu_t = \phi_2 Y_{t-2} + ... + \phi Y_{t-p} + \varepsilon_t$. The same reasoning can be extended for a generic AR(p) process. Therefore, to perform an unit root test on an AR(p) model the following regression would be estimated as follows:

(1.17) $\Delta Y_t = \mu + \phi_1 Y_{t-1} - \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \varepsilon_t$

The standard Dickey-Fuller model has been 'augmented' by ΔY_{t-j}. Given the model selected above, the hypothesis can be formally formulated as:

(1.18) $\Delta Y_t = \mu + bt + \phi_1 Y_{t-1} - \alpha_1 \Delta Y_{t-1} + \varepsilon_t$

where the null hypothesis is "$(\mu, b, \beta) = (\mu, 0, 0)$." If the null hypothesis of the ADF t-test is not rejected, this implies that the data need to be differentiated to make it stationary.

To test for cointegration between two or more non-stationary time series, an OLS regression needs to be run, saving the residuals from the OLS regression and then running the ADF test on the saved residuals to determine if it is stationary. This procedure is known as the Engle-Granger (EG) test and is as follows:

(1.19) $Y_t = \beta_0 + \beta_1 X_t + \mu_t$

where Y and X are non-stationary series. To determine if they are cointegrated, a secondary regression is estimated as follows:

(1.20) $\Delta\mu_t = -\phi\mu_{t-1}$

where the null hypothesis is "$-\phi = 0$." If the null hypothesis of non-stationarity of residuals is rejected, we conclude that the residuals are stationary which means that X and Y are cointegrated.

Therefore, the ADF test is used to determine whether one variable is stationary. Furthermore, we need to test for cointegration between two or more non-stationary time series. This procedure is obtained by the Engle-Granger (EG)[16] test which estimates a unit root test on the residual from regression model. Consider a simple regression as follows:

(1.21) $Y_t = \alpha_{t1} + \alpha_{t2} X_t + \mu_t$

where Y and X are non-stationary time series. To determine if they are cointegrated, a secondary regression is estimated as follows:

(1.22) $\Delta\mu_t = \beta_t \mu_t$

[16] See Engel and Granger (1987)

The null hypothesis of this test is that the residuals are non-stationary ($H_0 : \beta_t = 0$) and the time series can be said to be cointegrated within all variables. If the results reject the null hypothesis, we conclude that the residuals are stationary which means that dependent variables and explanatory variables of each regression models are cointegrated. Also, we can call the estimated equation the static relationship function and interpret its parameter as long run parameters (Greene, 1990).

1.4.7. Instrumental Variables (IV) and Generalized Method Moments (GMM)

Instrumental variables (IV) can be used to produce a consistent estimator of a parameter when the explanatory variables are correlated with the error terms (Greene, 1990). Also, Baum and Schaffer (2003) discussed IV estimation in the broader context of the generalized method of moments (GMM).

We could specify such an equation for estimation as follows:

(1.23) $Y = X\beta + \mu$

where $E(\mu\mu') = \Omega$. The matrix of X is $n \times K$ where n is the number of observations. The error term is distributed with mean zero and the covariance matrix Ω is $n \times n$. There are two cases for covariance matrix in terms of homoskedasticity and heteroskedasticity and are as follows:

(1.24)
$$Homoskedasticity : \Omega = \sigma^2 I$$
$$Heteroskedasticity : \Omega = \begin{pmatrix} \sigma_1^2 & & & & 0 \\ & \ddots & & & \\ & & \sigma_i^2 & & \\ & & & \ddots & \\ 0 & & & & \sigma_n^2 \end{pmatrix}$$

Some of the regressors are endogenous, so that $E(X_i \mu_i) \neq 0$, thus we partition the set of regressors with endogenous variables and exogenous variables as follows:

(1.25) $$\begin{matrix} \text{Regressors } X = [X_1, X_2] = [X_1, Z_2] = [Endogenous, Exogeneous] \\ Instruments\ Z = [Z_1, Z_2] = [Excluded, Included] \end{matrix}$$

For using the projection, the instrumental variables estimator is as follows:

(1.26) $$\hat{\beta}_{IV} = \{X'Z(Z'Z)^{-1}Z'X\}^{-1}X'Z(Z'Z)^{-1}Z'Y = (X'P_Z X)^{-1}X'P_Z Y$$

where $P_Z = Z(Z'Z)^{-1}Z'$. Also, the asymptotic variance-covariance matrix of IV estimator is as follows[17]:

(1.27) $$v(\hat{\beta}_{IV}) = \hat{\sigma}^2\{X'Z(Z'Z)^{-1}Z'X\}^{-1} = \hat{\sigma}^2(X'P_Z X)^{-1}$$

And the standard IV estimator is a special case of the GMM estimator. The assumption is that the instruments, Z, are exogenous and can be indicated as $E(Z_i\mu_i) = 0$. The *L* instrument is a set of *L* moments and is specified as follows:

(1.28) $$g_i(\hat{\beta}) = Z_i'\hat{\mu}_i = Z_i'(Y_i - X_i\hat{\beta})$$

where g_i is $L \times 1$. The exogeneity of the instrument means that there are *L* moment conditions or orthogonality conditions as follows:

(1.29) $$E\{g_i(\beta)\} = 0$$

Each of the *L* moment equations corresponds to a sample moment as follows:

(1.30) $$\bar{g}(\hat{\beta}) = \frac{1}{n}\sum_{i=1}^{n} g_i(\hat{\beta}) = \frac{1}{n}Z'\hat{\mu}$$

Therefore, the GMM is used to select an estimator for β that solves for $\bar{g}(\hat{\beta}) = 0$.

Deriving and solving the *K* first order conditions, we obtain the estimator and asymptotic variance as follows:

[17] Specific mathematical procedures are shown in Baum and Schaffer (2003).

$$\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1}X'ZWZ'Y$$
$$X(\hat{\beta}_{GMM}) = \frac{1}{n}(Q'_{XZ}\,S^{-1}Q_{XZ})^{-1} \quad (1.31)$$

where W is the weighted matrix with an $L \times L$, Q_{XZ} is $E(X_i'Z_i)$, and S is the covariance matrix with $\frac{1}{n}E(Z'\Omega Z)$.

The Breusch-Pagan, Hansen, and Anderson statistics are standard tests that test for the presence of heteroskedasticity in an OLS model in terms of processing the IV and GMM. This study will test for over-identification by using the *Hansen J-test*. Test statistics indicate that over-identification is not a problem in the equation. This study will also use the *Anderson* test to test the validity of any instruments. The *Anderson* test has a null hypothesis that the instruments are uncorrelated with the error term. In terms of the results, all cases can reject the null hypothesis and we conclude that at least one instrumental variable is not correlated with the errors. If the instrumental variables are not exogenous, then the IV procedure is not consistent and we cannot cast doubt of the validity of the instrument. *Breusch-Pagan* test illustrate that this equation has heteroskedasticity problem in terms of rejecting the null hypothesis. Therefore, this equation is estimated with IV/GMM procedure due to autocorrelation problem.

1.4.8. The Seemingly Unrelated Regression (SUR)

The Seemingly Unrelated Regression (SUR) was developed by Zellner (1962) which is a procedure for analyzing a system of multiple equations. An econometric model may contain multiple equations which are independent of each other on the surface. Especially, a set of equations that may be related not because they interact but because their error terms are related (Greene, 1990). The basic model (Srivastava and Giles:

1987) that we are concerned with comprises *m* multiple equations and is specified as follows:

$$(1.32)\quad Y_{ti} = \sum_{j=1}^{i} X_{tij}\beta_{ij} + \varepsilon_{ti}$$

where Y_{ti} is the t^{th} observation on the i^{th} dependent variable, X_{tij} is the t^{th} observation on the j^{th} explanatory variable appearing in the i^{th} equation, β_{ij} is the coefficient associated with X_{tij} at each observation, and ε_{ti} is the t^{th} value of the random disturbance term associated with the i^{th} equation. In matrix notation, the *m*-equation model can be expressed as follows:

$$(1.33)\quad \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_m \end{pmatrix} = \begin{pmatrix} X_1 & 0 & \cdots & 0 \\ 0 & X_2 & & 0 \\ \vdots & & \ddots & \vdots \\ 0 & \cdots & 0 & X_m \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_m \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_m \end{pmatrix}$$

where Y_i is a $T \times 1$ vector of sample values on dependent variables, X_i is a $T \times K_i$ vector of sample values on independent variables, and β_i is a $K_i \times 1$ vector of coefficients. The covariance matrix is assumed by the form as follows:

$$(1.34)\quad E(\varepsilon'\varepsilon) = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1m} \\ \sigma_{21} & \sigma_{22} & \cdots & \sigma_{2m} \\ \cdots & \cdots & \cdots & \vdots \\ \sigma_{m1} & \sigma_{m2} & & \sigma_{mm} \end{pmatrix} = \Phi$$

where σ_{mm} is the variance of the random disturbance in the m^{th} equation for each observation in the sample. In equation (4.34), it is assumed that the error terms of each equation have a zero mean and the generalized least square (GLS) estimator is as follows:

$$(1.35)\quad \hat{\beta} = (X'\Phi^{-1}X)^{-1}X'\Phi^{-1}Y$$

Under one of the following two conditions, OLS applied to each equation is equivalent with GLS due to the best liner unbiased estimator (BLUE) conditions.

(Condition 1) If all $\sigma_{mn} = 0$ (for $m \neq n$), implies that the matrix (4.34) is diagonal.

(Condition 2) If the exogenous variables in all equations are the same, such that $X_1 = X_2 = ... = X_m$

Under these assumptions, the SUR model is explained by equation (4.32) because each disturbance is uncorrelated both within and across equations, but that they are contemporaneously correlated across the equations of the model (Srivastava and Giles). Srivastava and Giles (1987)[18] specifically explained relationships between the SUR model and other types of econometric models as follows:

> First, if in fact the disturbances in difference equations are uncorrelated, then the model amounts to a collection of individual multiple regression equations, each of which may be estimated separately. Secondly, the SUR model is a special case of the simultaneous equations models, one involving *M* structural equations with *M* jointly dependent and *K* exogenous variables, Finally, the SUR model has a close link with the conventional multivariate regression model found in the standard statistical literature.

Therefore, this dissertation will contain several sub-equations such as equations (1.5), (1.6), (1.7), (1.8), (1.10), and (1.11) whose purpose is to analyze those simultaneous equations whose dependent variables are determined by the simultaneous interaction of several relationships.

1.5. Outline of the Dissertation

This dissertation is accomplished by three essays through a "journal-style." Also, the exporting countries and importing countries are selected by the top four aggregated

[18] *Seemingly Unrelated Regression Equations Models*, Srivastava and Giles (1987).

export/import volumes from 1994 through 2007 (see Table 1.4). Chapter two will discuss structure and conduct of world rice market. Chapter three will explain the relationships of rice trade, economic growth, and market power for exporting countries. Chapter four will analyze the empirical examination of the import demand model and discuss the welfare effects for rice importing countries. This dissertation utilized STATA 10.

Table 1.4. Top Four Export/Import Countries for the World Rice Market

Top Four Exporting Countries	Top Four Importing Countries
Thailand	Indonesia
Vietnam	Philippines
India	Nigeria
U.S.	Saudi Arabia

Note: This table is based on the total export/import volumes from 1994 through 2007

1.6. References

Asche, Frank and Nostbakken, Linda. "When will Trade Restrictions affect Producer Behavior:Oligopsony Power in International Trade." *SES Seminar Presented* (2007).

Aydin, M. Faruk, Ciplak, Ugur and Yucel, M. Eray. "Export Supply and Import Demand Models for the Turkish Economy." *Research Paper at the Central Bank of Turkey* (2004).

Bain, Joe S. *Industrial Organization*. John Wiley & Sons, 1968.

Baum, Christopher F. and Schaffer, Mark E. "Instrumental Variables and GMM: Estimation and testing." *The STATA Journal* (2003):1−31.

Childs, Nathan and Kiawu, James. "What's Behind the Surge in Global Rice Prices?" *Rice Outlook USDA*, 2008.

Clarkson, Kenneth W. and Miller, Roger LeRoy. *Industrial Organization: Theory, Evidence, and Public Policy*. The McGraw-Hill Book Company, 1982.

Greene, W. *Econometric Analysis*. New York: Macmillan Publishing Company, 1990.

McWilliams, Abagail and Smart, Dennis L. “Efficiency v. Structure-Conduct-Peformance: Implications for Strategy Research and Practice.” *Journal of Management* 19(1993): 63−78.

Mohsen, Bahmani-Oskooee and Ltaifa, Nabil. “Effects of Exchange Rate Risk on Exports: Crosscountry Analysis.” *World Development* 20(1992):1173−1181.

Papatheodorou, Andreas. *Corporate Rivalry and Market Power*. I.B. Tauris, 2006.

Sohn, Chan-Hyun. “Trade Structure, FTA and Economic Growth: Implications to East Asia.” *WTO, China, and the Asian Economics* IV(2006).

Srivastava, Virendra K. and Giles, David E.A. *Seemingly Unrelated Regression Equations Models.* Marcel Dekker, Inc, 1987.

Wooldridge, Jeffrey M. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2001.

Zellner, Arnold. “An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias.” *Journal of the American Statistical Association* 57(1962): 348−68.

CHAPTER 2

STRUCTURE AND CONDUCT OF THE WORLD RICE MARKET

2.1. Introduction

Over the past several decades, the international rice market has undergone major changes. Even with a rice policy[19] along with strong expansion in traded rice volumes, the world rice market continues to be regarded as distorted, thin and volatile. These characteristics influence domestic pricing and production policies in a number of countries around the world.

In the traditional structure, conduct, and performance (SCP) paradigm[20], market organization affects market performance through various channels. Exporting countries' concentration, market structure (which also includes product differentiation), barriers to exit, fixed costs and growth rate (Delorme, 2002) are areas of interest. Analyzing market conduct involves the price strategy, R&D, collusion and advertising. Market performance is also concerned with a normative evaluation of the results for market conduct (Caves, 1987).

The main objective of this chapter is to examine the world rice market using S-C-P methods. In the world rice market, this study analyzes the main factor which can affect market power and exporting countries' degree of market power. Over the past fifteen years, industrial organization economists have seen a renewed interest in empirical

[19] Since 2007, several rice exporters (Vietnam, India, China, and Cambodia) have banned or otherwise restricted rice exports. The objective of the bans and restrictions is to make more rice available in the domestic market and to stabilize domestic prices. The exports ban and restrictions were primarily imposed to slow the rate of increase in food prices, which largely due to rising and incomes in several major Asian developing countries, especially China and India (USDA, 2008: Prospective on the global rice situation).

[20] The practical S-C-P method will be a kind of effectual industry analysis such as Figure 1.5. The SCP approach was originally employed by Bain (1968). Bain (1968) analyzed the effect on industry of market power as market concentration and barrier to entry in U.S. manufacturing.

analysis, which is now commonly referred to as the "New Empirical Industrial Organization" (NEIO). This approach evaluates the presence of market power in a specific industry based on supply and demand, and hypotheses concerning the strategic interaction of firms.

Especially, this study focuses on structure and conduct methods. Structural changes will provide input to analyze both importing and exporting countries' situations within the world rice market, and the conduct method will focus on price strategy with respect to harvest area, exchange rate, crude oil price, concentration ratio, and substitute commodities' prices. And the expected results in this chapter will support the hypothesis that the market power possessed by rice exporters does have a significant and positive effect on export rice prices for the period of 1970-2007.

This chapter is organized as follows. First, results of a literature review are presented. The literature review analyzes the traditional S-C-P paradigm with respect to the world rice market and substitute commodities market. Second, this study explains the structure for the world rice market in terms of exporting/importing countries. Third, this study uses the two-stage least squares (2SLS) estimating procedure to construct coefficient estimates for each of exogenous variables (total production and real exchange rate), endogenous variable (export rice price), and instrumental variables (total harvest area, crude oil price, and exporting price for wheat and maize). Empirical results reflect how exporting price, total production, and exchange rate affect export quantity as a function of export supply and how market concentration and other factors influence price structure. Implications concerning the price of substitutive commodities and production

are discussed. Finally, concluding remarks are presented along with suggestions for future study.

2.2. Literature Review

An extensive literature has evolved in the past decades using economic theory to analyze the structure, conduct, and performance of agricultural commodities. This section outlines recent studies concerning the world rice market, including econometric analyses, regarding the structural, economic analysis of rice.

Siamwalla and Haykin (1983) comprehensively analyzed the Asian rice market with respect to the S-C-P paradigm. They collected 1961-80 data within Asian countries. They estimated the price instruments for Burma, Thailand, Indonesia, and the U.S. They explained the long- and short- run conduct of countries participating in the rice market and how policies affected traded volumes. An econometric model is used to estimate governments' short-run responses to fluctuations in world prices and domestic production.

Mohsen and Ltaifa (1992) examined exchange rate effects on the aggregate exports of 67 developed countries using cross-sectional data. They used an export supply function in terms of exchange rate's effects on trade. They found out that the exchange rate risk is less sensitive for developed countries as compared to that of less developed countries. Deodha and Sheldon (1997) estimated the degree of imperfect competition in the world market for soymeal exports using a structural econometric model. They analyzed the world soymeal market with respect to exporting countries and mentioned that there is no statistical confidence to measure the degree of competitiveness in the soymeal market.

Dawe (2002) explained the behavior of prices in terms of technological changes and political disturbances that have affected rice production and trade. Dawe divided time into two periods paying respect to the pre-Green Revolution from 1950 to 1964 and the post-Green Revolution from 1965 to 81. He estimated the trends in the level and stability of Asian rice production in terms of the divided periods. Calpe (2004) also analyzed the international rice market with respect to developing countries, not major export/import countries. He mentioned that the supply side of the rice market is still highly concentrated with the top four countries.

Delorme and Klein (2002) developed a model based on the previous S-C-P paradigm and made specification in terms of lag structure and simultaneous equations. They used U.S. manufacturing data from 1982 to 1992 and estimated the relationships between market concentration and profit/advertising. They mentioned that concentration does not depend on firm profitability and advertising seems to have no effect on profitability. As firms sell more than one product, actual profits are overstated in the observed industry code.

Asche and Nostbakken (2007) analyzed the oligopsony power in the swordfish market. They estimated the supply elasticity and mentioned that the trade effect depends on the importer's degree of market power. Also, they extended the political implications of imposing requirements as to the fishing practices of suppliers.

In this analysis, it is hypothesized that rice exporting countries have market power within the world rice market, and that this extant market power increases export rice prices. Therefore, this chapter investigates the existence of market power within the world rice market and analyzes the main factors which influence rice export volumes.

2.3. Data

Data on rice[21] export quantity, production and harvest area from 1970 through 2007 were obtained from FAOSTAT and the USDA[22]. Export rice[23] price, wheat[24] and maize[25] data are based on data obtained from the International Rice Research Institute, and crude oil price[26] and the real exchange rate of Baht and Rupee are obtained from annual average U.S. crude oil prices and Banks of Thailand and India, respectively. Descriptive statistics are summarized in Table 2.1.

The export supply model consists of the total aggregated export quantity, export rice price, real exchange rates for major rice exporting countries, and total rice production, which also include data for the major rice exporting countries (Thailand, Vietnam, India and the U.S) considered herein.

Table 2.1. Descriptive Data of the Estimated Variables

	Observations	Mean	Std. Dev	Min	Max
Total Export Quantity (1000 tons)	38	1244.9	1191.208	128.25	3659.54
Export Rice Price (U.S. $/ton)	38	283.57	86.137	129	542
Total Production (1000 tons)	38	4.84e+08	1.05e+08	3.07e+08	6.50e+08
Total Harvested Area (acres)	38	1.46e+08	6048928	1.32e+08	1.59e+08
Oil Price (U.S. $/bbl)	38	22.36	13.751	3.39	64.20
Export Wheat Price (U.S. $/ton)	38	165.15	48.725	62	336
Export Maize Price (U.S. $/ton)	38	106.42	22.314	56	171
Exchange Rate (Baht/US $)	38	30.97	6.317	22.406	44.96
Exchange Rate (India/US $)	38	31.57	10.448	16.556	46.926

Note: Definitions and sources of variables are the same in Table 1.1.

[21] Rice data indicate the aggregated data including rice broken, rice paddy, rice flour, rice husked, and rice milled.
[22] Data on 2006 and 2007 of rice production and quantity are drawn from the FAO Price Update (2007) and USDA World Rice Calendar.
[23] All export price are based on FOB (free on board) and 5% broken, milled, fob Bangkok
[24] Canadian No.1 Western Red Spring 13.5%
[25] U.S. No.2 yellow, fob Gulf ports
[26] http://www.inflationdata.com

2.4. Structure for World Rice Market

Rice is the staple food of a majority of the world's population, but as an item of international commerce it is only of secondary importance, ranking fourteenth among the commodities covered in the world commodity trade and price trends (Siamwalla and Haykin, 1983). The focus of this section examines the main participants in the world rice market. The next section shows the pattern of world trade and explains the market structure for rice.

2.4.1. The Traded Pattern of Rice Exports

The proportion of rice production traded internationally is small but has been increasing (see Figures 2.1 and 2.2). The volume of trade to production is small because the bulk of rice production occurs in the monsoon lands of Asia, which stretch from Pakistan to Japan. Rice production has increased due to the increase of consumption in major rice importing countries (e.g. Indonesia, Philippines, and Nigeria) but the area harvested has remained constant since about 1960. Figures 2.3, 2.4, and 2.5 show export quantity, production and harvested area for the top four rice exporting countries, respectively; Thailand, Vietnam, India, and the U.S. Of these four countries, Thailand ranks first in export quantity (about 40%) and India ranks first in the production of rice and in harvest area (about 60%). This is because the major, traditional exporters and Thailand cultivate their rice in the vast deltaic areas of their respective mainland which principally lie in monsoon prone areas in Asia. Figure 2.6 illustrates the export price for rice, wheat, and maize, respectively. It is hypothesized that the export quantity will be related with the rice export price for and prices for rice substitutes. Price volatility amongst these commodities has trended the same since 1980, and recent export price

increases since the mid 1990s. Another factor related to export quantity is the crude oil price (see Figure 2.7). The oil price is strongly related with transportation cost; this study expects that the main factor prompting the steep increase in the export rice price is the increase in crude oil prices. [27]

2.4.2. The Market Power of World Rice Market

In the typical empirical implementation of the SCP paradigm, a structural analysis is used to show the relationship between the calculated measure of market power (e.g. CR4 and HHI) and various structural factors that are hypothesized to be related to concentration (e.g. market share) and input costs (Perloff, 1991). There are two stages to a typical structural model: first, a measure of market structure is obtained through direct measurement or calculation (e.g. CR4 and HHI), and second, the obtained measure is then regressed on a number of variables that are thought to be explanatory of export rice price and dependent of market concentration ratio. This section investigates market power of the world rice market based on direct measurement, and also estimates the elasticity of market concentration ratio on export rice price including regression measurement. Market power exists when a firm or firms can change price without reducing consumption. However, the difficulties of defining the market by product or performance measures have led economists, policymakers, and others to look for an alternative form of measurement. Over time there has been a movement toward measures that focus on the size of firms in the industry in question. That is, the distributional size

[27] In Table 1.3, the estimated result of correlation value between oil price and export rice price is 0.6791, and this implies a relationship between oil price and export rice price such as values for oil price increases, values for export rice price also increase.

of firms in the industry has been condensed into a single measure of industry concentration.

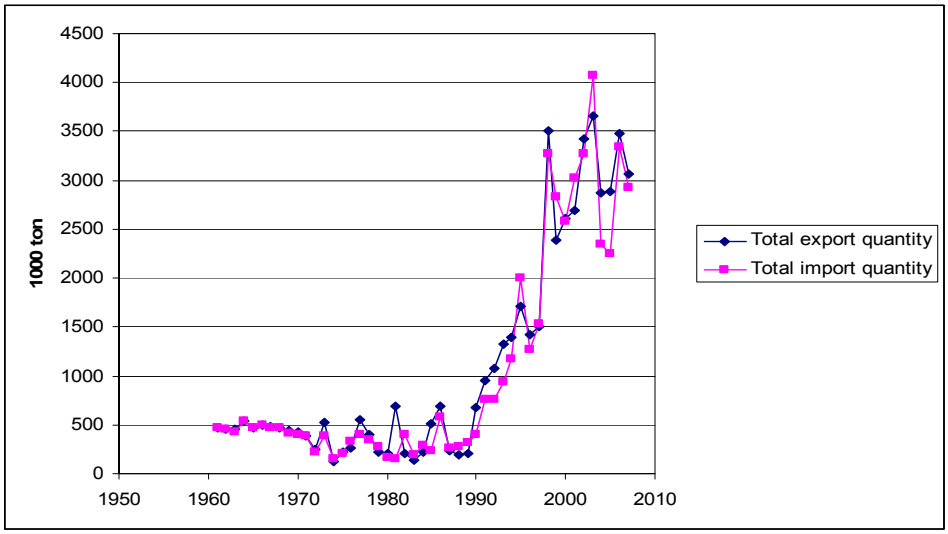


Figure 2.1. Trends of Total Rice Export/ Import Quantities
Note: Vertical axis indicates total rice export/import quantities (1000 tons)
Source: FAOSTAT and USDA World Rice Calendar Years (2008)

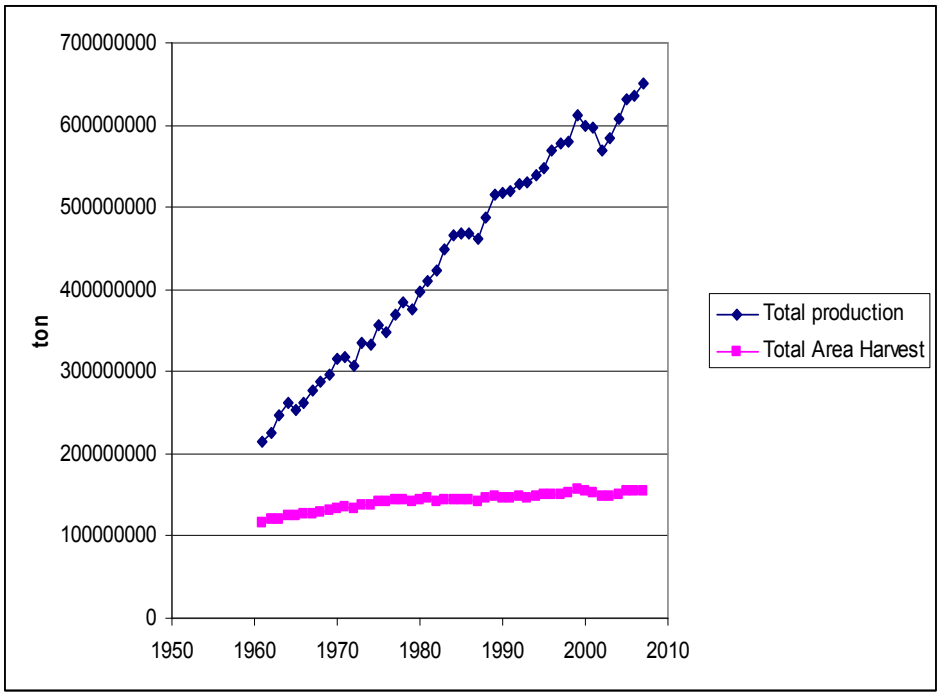


Figure 2.2. Trends of Total Rice Production and Total Rice Harvest Area
Note: Vertical axis indicates total rice production (tons) and total harvest area (acres), respectively.
Source: FAOSTAT and USDA World Rice Calendar Years (2008)

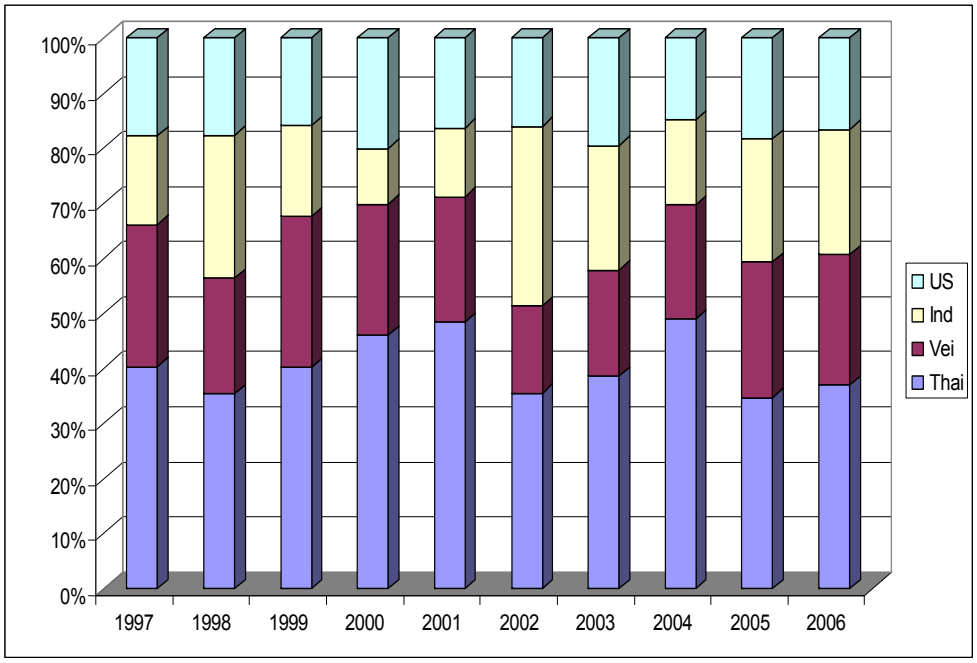


Figure 2.3. Export Rice Quantity Based on Top 4 Major Exporting Countries
Note: Vertical axis indicates the percentage of total export quantity.
Source: FAOSTAT and USDA World Rice Calendar Years (2008)

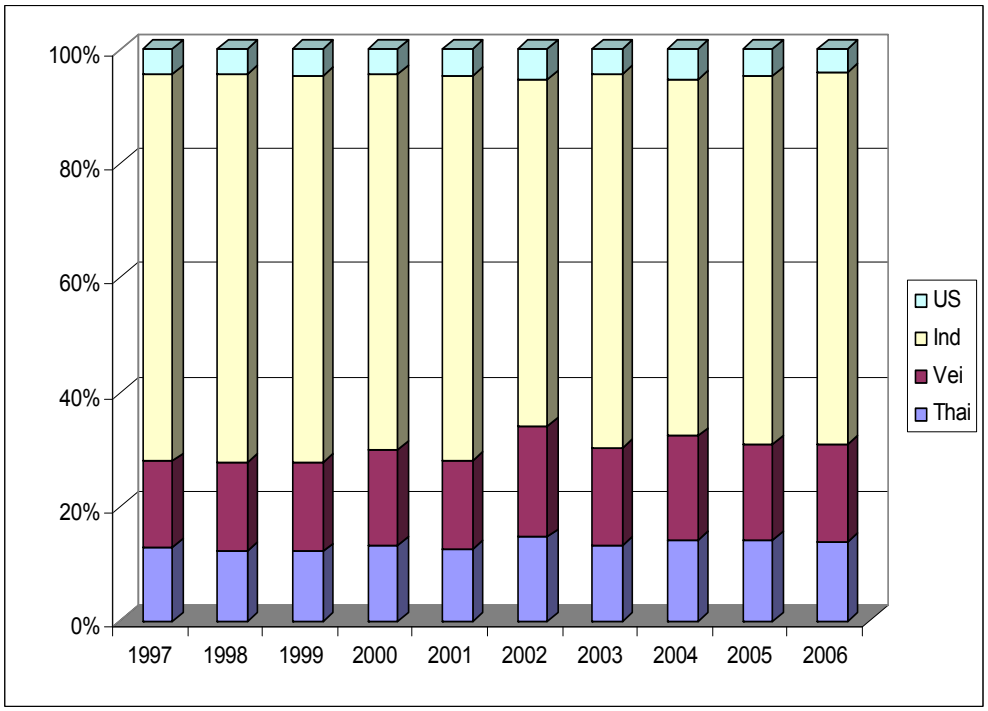


Figure 2.4. Rice Production Based on Top 4 Major Exporting countries
Note: Vertical axis indicates the percentage of total production
Source: FAOSTAT and USDA World Rice Calendar Years (2008)

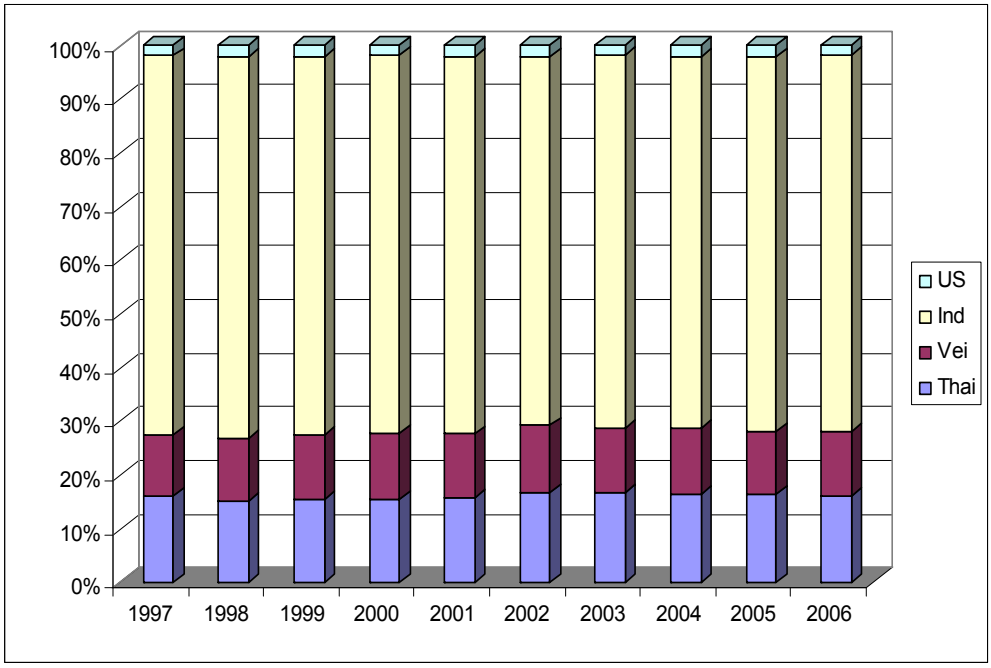


Figure 2.5. Harvest Area Based on Top 4 Major Exporting Countries
Note: Vertical axis indicates the percentage of total harvest area
Source: FAOSTAT and USDA World Rice Calendar Years (2008)

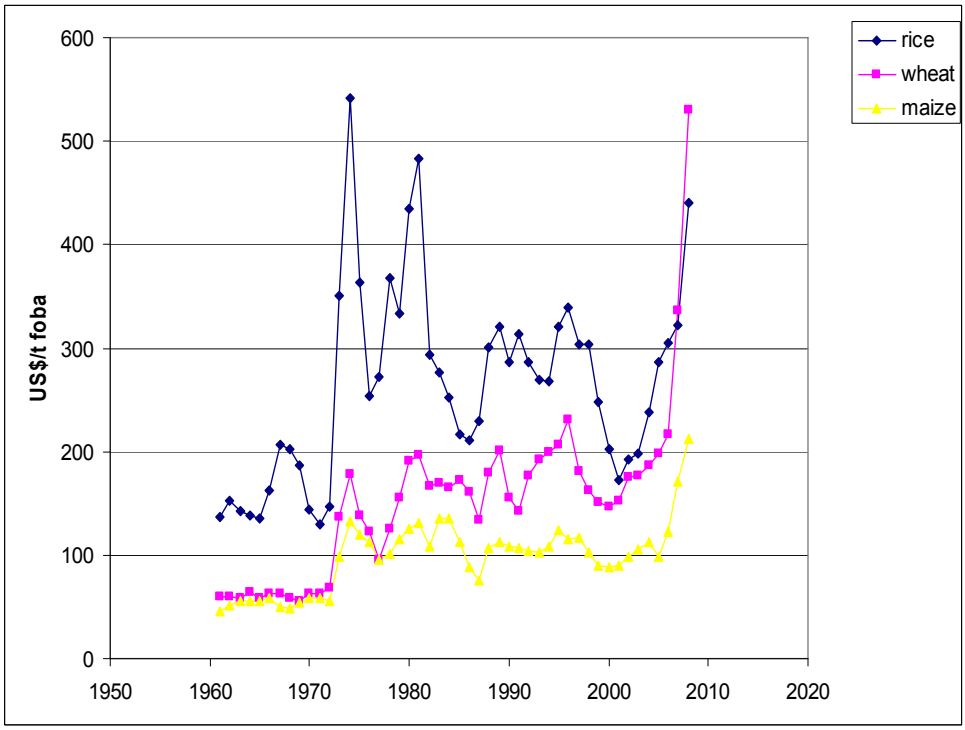


Figure 2.6. Trends of Export Prices for Rice, Wheat and Maize
Source: International Rice Research Institute

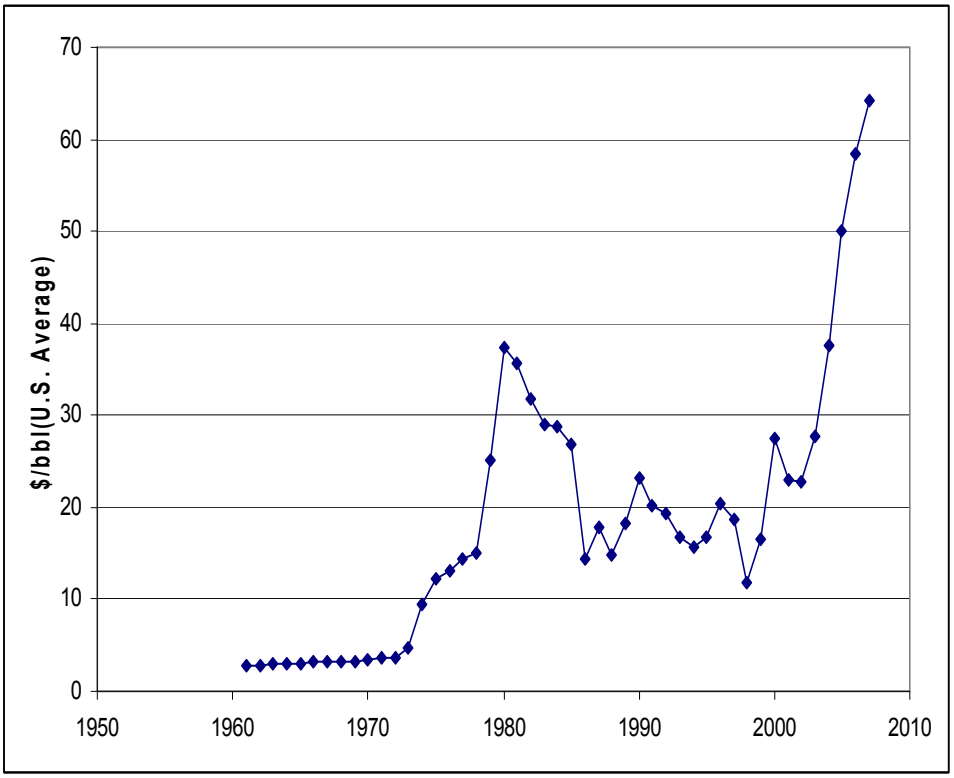


Figure 2.7. Trend of Crude Oil Price
Source: Financial Trend Forecaster

With respect to industrial organization, we often see the term "a four-firm concentration ratio" (CR4). A CR4 of 80% implies more monopoly power by this measure than a four-firm concentration ratio of 50%. In other words, it is equal to

$$(2.1)\quad CR4 = \sum_{i=1}^{4} \left(\frac{x_i}{T}\right)$$

where x_i is the absolute size of individual firm *i* and *T* is the total market size. This study uses total rice export quantity and the top four rice exporters' quantity instead of total size and individual firm size. We assume that each individual firm's behavior is similar to exporting countries' behaviors.

Another popular measure of dispersion for firm size is the Herfindahl index (HHI) [28]. The Herfindahl index, also known as Herfindahl-Hirschman Index or HHI, is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. In other words, it is equal to

$$(2.2)\quad HHI = \sum_{i=1}^{N} (MS_i)^2$$

where MS_i is the market share of firm i in the market and N is the number of firms. The HHI takes into account the relative size and distribution of the firms in a market and the HHI measure approaches zero when a market consists primarily of a large number of firms that are relatively equal in size. The HHI increases both as the number of firms in a market decreases and as the disparity in size between those firms increases. Markets in which the HHI is between 1000 and 1800 are considered to be moderately concentrated and those in which the HHI is in excess of 1800 points are considered to be concentrated. Transactions that increase the HHI by more than 100 points in concentrated markets presumptively raise antitrust concerns under the Horizontal Merger Guidelines issued by the U.S. Department of Justice and the Federal Trade Commission.

As can be seen in Table 2.2, CR4 and HHI[29] of exporting countries show concentrated structure for the world rice market and are considered as having market

[28] See *Merger Guidelines and 1.5*

[29] Hoskins et al (2004) mentioned that common measures of concentration are the four-firm concentration ratio (CR4) and HHI. CR4 measures the percentage of market share accounted for by the four largest firms. HHI is the sum of the squared market share, expressed as a percentage for all firms in the industry. However, a drawback of CR4 is that it does not make allowance for size disparities among the top four firms. HHI requires knowledge of the market shares of all firms, and the calculation can be tedious if there are many firms, and HHI has formed a high positive correlation between the various concentration

power for selling rice. Exporting countries' CR4 values vary anywhere from 0.6505 to 0.7336 and the HHI index ranges from 1133.45 to 1905.56. That is, this study hypothesizes that the top four rice exporting countries have market power in the world rice market. However, importing countries do not show the bargaining power for world rice market. Importing countries' CR4 estimates range from 0.397 to 0.5259 and HHI estimates vary from 437.31 to 1143. Therefore, this study proposes to test the hypothesis that market concentration ratio raises market price, and furthermore investigates the relationship between CR4 and export rice price as based upon the specified form of the export rice price equation.

If we want to investigate the degree of market power of monopolists or oligopolists, the *Lerner* index is a very useful measurement tool. The *Lerner* index has given us a measure of market structure based on monopoly power that skirts the necessity of inferring the degree of monopoly power from sales data. That is, the *Lerner* index measures the difference between price and marginal cost as a fraction of the product's price. This index is specified as:

$$(2.3)\quad Lerner\,index\,of\ monopoly\ power = \frac{P - MC}{P}$$

where P is the market price of this product and MC is the marginal cost of production of the product. The Lerner index varies between 0 and 1, with higher numbers indicating greater monopoly power. If price is equal to marginal cost, the *Lerner* index is zero, and indicates that the firm has no market power. When the *Lerner* index is closer to one this

measures, so in practice, it is likely to make little difference which measure is chosen (Hoskins et al, 2004, page 146).

is indicative of relatively weak price competition and therefore the firm has market power. From the *Lerner* index, the firm can determine the factor by which it should be over marginal cost. Rearranging the Lerner index and solving for this optimal price, *P*, yields the following equation:

$$(2.4)\quad P = (\frac{1}{1-L})MC$$

where *L* is the *Lerner* index and the markup factor is *1/(1-L)*. For example, if the *Lerner* index is zero, the markup factor is one and this shows perfect competition with respect to P=MC. If the *Lerner* index is 0.20, the markup factor is 1.25 and the firm charges a price that is 1.25 times marginal cost. However, the *Lerner* index of monopoly power requires the ability to measure marginal cost but unfortunately this is not easily done. Moreover, price must refer to a constant quality unit since a difference in quality implies a real change in price (Clarkson and Miller, 1982). Therefore, we use another expressed equation instead of marginal cost. The monopoly is the only supplier of a good for which there is no close substitute. This implies that the firm's output is equal to market output and the firm faces a downward-sloping (and not horizontal) market demand curve. Following up the work of Clarkson and Miller (1982), the monopoly profit maximization is specified as:

$$(2.5)\quad \Pi(q) = Pq - c(q)$$

where *Π* is the profit of firms, *p* is the market price, *q* is the supplied quantity, and *c(q)* is the total cost function. We obtain the derivative of equation (2.5) with respect to quantity as follows:

$$\frac{d\Pi(q)}{dq} = \frac{dp}{dq}q + \frac{dq}{dq}p - \frac{dc(q)}{q}$$

$$= \frac{dp}{dq}q + p - \frac{dc(q)}{q} \quad where \ \frac{dq}{dq} = 1 \tag{2.6}$$

$$= p(\frac{dp}{dq}\frac{q}{p}) + p - \frac{dc(q)}{q} = 0$$

Rearranging equation (2.6), the price elasticity of demand is $\eta = \frac{dq}{dp}\frac{p}{q}$ and then

$$P(1 + \frac{1}{\eta}) = MC \ \ or \ \ p = \frac{MC}{(1 + \frac{1}{\eta})} \tag{2.7}$$

Equation (2.7) shows that the amount that price exceeds marginal cost depends upon the price elasticity. As η approaches infinity, or as demand becomes elastic, price then is equal to marginal cost and we thus have a competitive market. As η approaches zero, price is then greater than marginal cost and there is a markup or market power such as extant under a monopoly. If we include the export rice price marginal cost of exporting countries into the *Lerner* index, this can also be written as the *Lerner* index as follows:

$$\frac{P - MC}{P} = \frac{1}{\eta} \tag{2.8}$$ [30]

[30] See e.g. and introduced process in Clarkson and Miller (1982)
Basic *Lerner* Index equation (Cole, 1991: page 170) is as follows:
Lerner Index= $\frac{P - MC}{P} = \frac{MS}{\varepsilon_D + (1 - MS)\varepsilon_S}$ where ε_D is the market price elasticity of demand, *MS* is the market share of dominant firm, and ε_S is the supply elasticity of the competitive fringe. Cole (1991) argued that this relates the *Lerner* Index of monopoly power to market share, but has as a critical argument the supply elasticity of the competitive firms. However, Gal (2003, page 61) mentioned that Cole's formula is not very practical, as it is unlikely that there will be precise estimates of elasticity of supply and demand.

where η is the export price elasticity[31] of demand, p is the export rice price, and MC is the marginal cost for exporting countries. This equation is equally useful to measure the degree of monopoly. Although the *Lerner* index seems to be a useful measure of monopoly power, it has a serious shortcoming. In particular, Gal (2003, page 61) mentioned that the relationship between the *Lerner* index and demand elasticity is not very practical, as it is unlikely that there will be precise estimates of elasticity of supply and demand. That is, Gal (2003) argued that inferences of market power are based on a firm's market share, on the assumption that the relevant elasticities are not unusually high or low. Therefore, this chapter investigates the existence of market power in the world rice market with respect to static calculation (based on CR4 and HHI) and also with respect to hypothesis test (based on the export rice price equation which includes explanatory of CR4 and dependent of export rice price).

Table 2.2. Comparisons of CR4 and HHI between Exporting and Importing Countries

	Exporting countries		Importing countries	
year	**CR4**	**HHI**	**CR4**	**HHI**
1997	0.6860	1348.4693	0.4091	638.4543
1998	0.6504	1133.4556	0.5259	826.5735
1999	0.6701	1297.6692	0.4540	617.5912
2000	0.6246	1244.5196	0.3970	437.3198
2001	0.6351	1325.3535	0.4562	600.5746
2002	0.7336	1521.9866	0.4704	588.7627
2003	0.7109	1389.8240	0.4890	781.4017
2004	0.7613	1905.5646	0.4463	841.5337
2005	0.7238	1385.1611	0.5126	1143.0204
2006	0.6897	1294.9176	0.4695	900.5110
2007	0.7110	1461.5192	0.4992	899.6914
2008	0.7028	1474.0022	0.4863	878.8563

[31] $\eta = \frac{dQ}{dP}\frac{P}{Q} = \frac{\ln(Q)}{\ln(P)}$ where P is export price and Q is export volume.

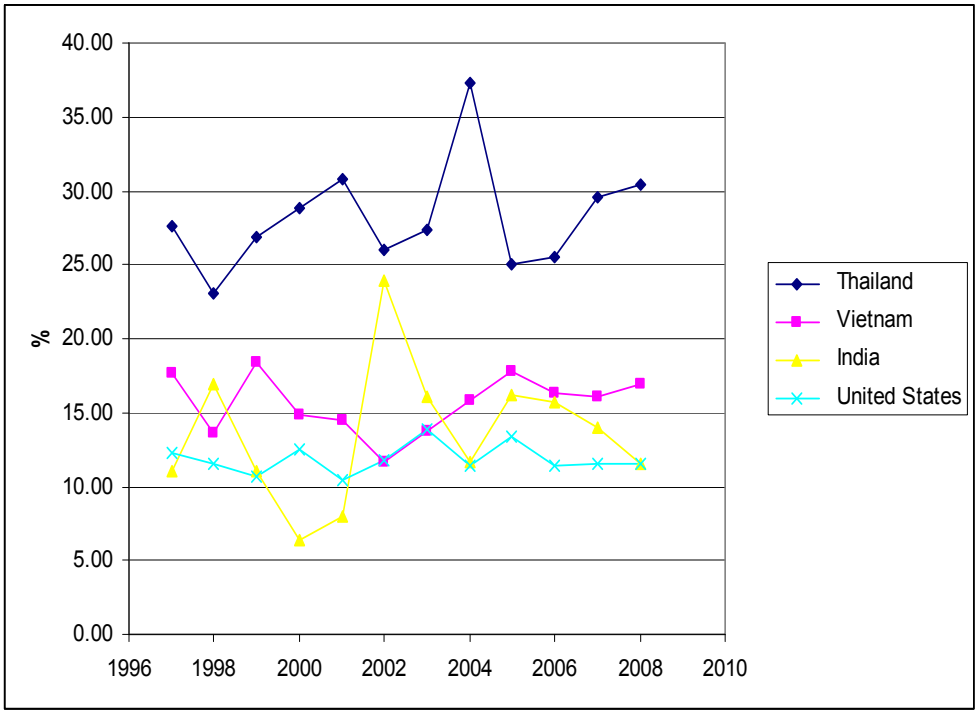


Figure 2.8. Trends of Market Share Based on Top 4 Rice Exporting Countries
Note: Vertical axis indicates market share (%) based on major rice exporting countries

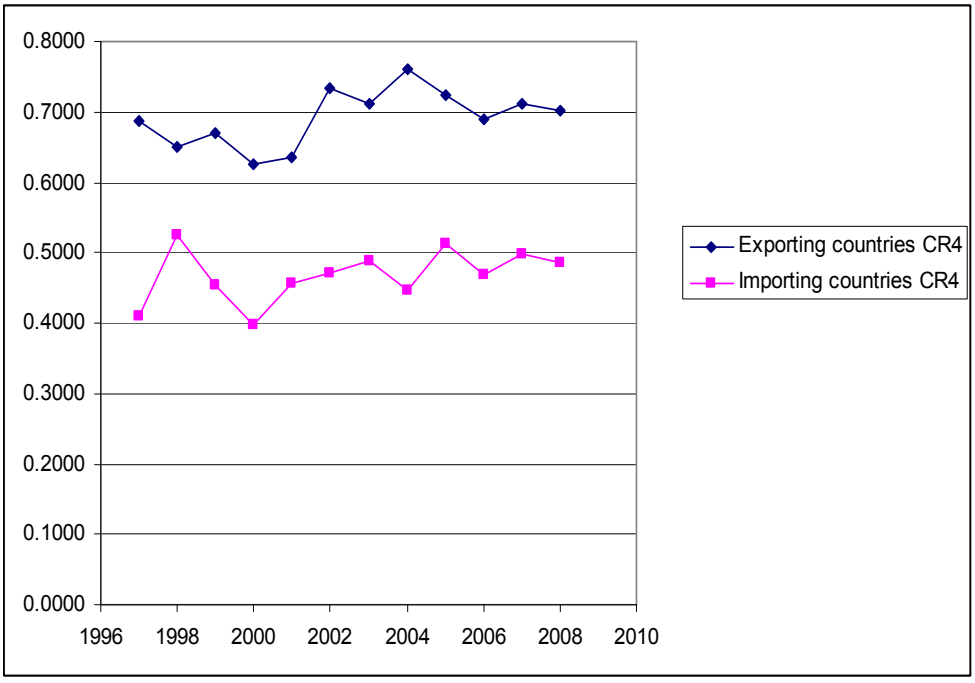


Figure 2.9. Trends of CR 4 based on Top 4 Major Exporting/Importing Countries
Note: Vertical axis indicates the concentration ratio 4 based on top 4 exporting/importing countries, respectively.

2.5. Conduct for World Rice Market

The world market influences the conduct of its participants, the national governments, in two ways (Siamwalla and Haykin, 1983). One way is through the price signal, a standard task performed by any market. Another influence is the "ambience" of the market. [32]

In terms of the traditional S-C-P paradigm, market structure affects the actual operation and conduct of individual firms. For example, market structure may influence internal organization of the firm, including some employment policies, working conditions, and other factors that directly or indirectly affect the allocation of resources within the firm. Determining the conduct of firms in a market involves studying their product designs and differentiation, the way they establish prices and determine advertising and sales promotion activities in which they engage. Also, in this situation, we have questions as to which firms collude, whether any such collusion is open, and how responsive are firms to changes in their economic position.

In this chapter, this study focuses on market conduct with respect to export price, production and the exchange rate in terms of an export supply function. This section specifies the empirical model used for estimating supply elasticity and analyzes the effects brought about by changes in the exchange rate.

2.5.1. Unit Root and Cointegration Tests

Given that this is annual time-series data, we need to pre-test for stationarity and for the existence of a cointegration vector before we move on to model specification. This study estimates the system equation in terms of using OLS and Instrumental

[32] Siamwalla and Haykin (1983) mentioned that sudden entry or exist by a government affect the market price due to the smallness of market, and the transaction cost is high because of the increase to search for markets.

Variables (IV). The IV procedure overcomes endogeneity problems between export rice price and export volume.

Table 2.3. Results of Unit Root Test

	ADF in Levels Lag(1)		ADF First Differences Lag(1)	
	Without Trend	**With Trend**	**Without Trend**	**With Trend**
Log(Total export quantity)	−0.0973	−0.5657***	−1.5436***	−1.5595***
	(−1.04)	(−3.38)	(−5.96)	(−5.89)
Log(Export Price)	−0.5498***	−0.5749***	−1.0573***	−1.0797***
	(−5.07)	(−5.36)	(−5.5)	(−5.5)
Log(Total Production)	−0.034	−0.1611	−1.285***	−1.4077***
	(−1.44)	(−1.39)	(−4.8)	(−5.34)
Log(Total Harvested Area)	−0.1237	−0.5108***	−1.2409***	−1.27***
	(−1.72)	(−3.16)	(−4.74)	(−4.82)
Log(Oil Price)	−0.1447**	−0.2004**	−0.9523***	−0.971***
	(−2.17)	(−2.39)	(−4.29)	(−4.3)
Log(Export Wheat Price)	−0.3498***	−0.5559***	−1.0697***	−1.0869***
	(−3.31)	(−4.46)	(−4.83)	(−4.72)
Log(Export Maize Price)	−0.5024***	−0.5179***	−1.069***	−1.094***
	(−4)	(−4.02)	(−4.6)	(−4.54)
Log(Exchange Rate Baht/US dollar)	−0.0865	−0.3012***	−0.9103***	−0.9278***
	(−1.4)	(−3.06)	(−4.1)	(−4.03)
Log(Exchange Rate Rupee/US dollar)	−0.0395	−0.1285	−0.8341***	−0.8498***
	(−1.14)	(−1.10)	(−3.48)	(−3.54)
Log(CR4)	−0.678*	−0.7649**	−1.4331**	−1.4461**
	(−2.09)	(−2.34)	(−3.16)	(−3.09)

Note: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

The unit root test determines the order of integration for those variables that are under consideration. The measure employed for testing the order of integration is known as the Augmented Dickey-Fuller (ADF) test. This procedure's statistic rejects the null hypothesis of non-stationarity of all the variables, when first difference variables are used. Table 2.3 indicates those variables that are stationary of order 1. Table 2.4 presents the results of the Engle-Granger (EG)[33] test, a test which estimates a unit root on the

[33] See Engle and Granger (1987)

residuals from the regression model. The null hypothesis of this test is that the residuals are non-stationary. With respect to the results of Table 2.4, this study concludes that the residuals are stationary, which means that the dependent and explanatory variables of each regression model are cointegrated. Also, we can call the estimated equation the *static relationship function* and interpret its parameter as long run parameters (Greene, 1990).

2.5.2. Empirical Models

To determine elasticities and test for market power, we specify a total export quantity schedule in which the variables are in log-log form. This is done for ease of interpreting the estimated parameters as they are interpreted as elasticities. This study extends the work of Mohsen and Ltaifa (1992) which formulated the effects of real exchange rate on export volume with respect to an export supply function. The export supply model includes export rice price, total production, and exchange rate to obtain the export rice price elasticity and effects of major exporting countries' exchange rate. The empirical model is as follows:

(2.9) $Log(EX_t) = \alpha_0 + \alpha_1 Log(EXRP_t) + \alpha_3 Log(TP_t) + \alpha_{i4} Log(ER_{it}) + \varepsilon_{1t}$

where EX_t is the total export volume of rice in period *t*; $EXRP_t$, the export rice price in period *t*; TP_t, the total production volume of rice in period *t*; ER_{it}, the real exchange rate of *i*[34] exporting countries in period *t*; and ε_{1t} is an error term. In equation (2.9), α_1 indicates the export price elasticity of supply for major exporting countries and the

[34] "*i*=1" and "*i*=2" indicate the exchange rate of Baht/US dollar and Rupee/US dollar, respectively.

expected sign is positive as indicated by supply theory. And α_{i4}[35] denoted the effects of exchange rate on export volume, and expected sign is positive because depreciates of exporting countries contribute to the increase of exporting volumes.

Two-stage least squares regression (2SLS) is a method of extending regression to cover models which violate the assumptions of the Ordinary Least Squares (OLS) model with regard to recursivity, especially models where the researcher must assume that the disturbance term of the dependent variable is correlated with the independent variables. Also, 2SLS is used for the same purpose to extend path analysis, except that in path models there may be multiple endogenous variables rather than a single dependent variable.

The procedures of 2SLS refer to (1) a stage in which new dependent or endogenous variables are created to substitute for the original ones, and (2) a stage in which the regression is computed in OLS but where the newly created variables are used. So, the purpose of the first stage is to create new dependent variables which do not violate OLS regression's recursivity assumption (Wooldridge, 2001).

If regressors (explanatory variables) are correlated with the regression error, then the least squares estimator is biased and inconsistent. Therefore, the equation is estimated

[35] Oztuk (2006) mentioned that if exporters are sufficiently risk averse, an increase in exchange rate raises the expected marginal utility of export revenue and therefore induces to increase exports. However, it is difficult to identify how trade will be affected by exchange rate because this relationship is not clear due to the degree of risk aversion. Several detail literatures on the effects of exchange rate on trade are as follows:

Main Result (the effects of exchange rate on trade)	**Studies**
Positive Effects (with significant)	Akhtar and Hilton (1984), Peree and Steinherr (1989), Savvides (1992), Chowdhury (1993), Hook and Boon (2000), Das (2003), Lee and Saucier (2005)
Negative Effects (with significant)	Branda and Mendez (1988), Asseery and Peel (1991), Mckenzie and Brooks (1997), Kasman (2005)

Source: Ozturk (2006, pages 88-92)

with the Instrumental Variables (IV) procedure. This study constrains export rice price with the harvest area, crude oil price, export price for wheat and maize, and four firm concentration ratios due to the endogeneity problem of export rice price. That is, the export rice price equation[36] is a function of total harvest area, oil price, export wheat/maize prices, CR4, and real exchange rate. To access how changes in harvest area, oil price, substitute goods price, CR4, and exchange rate affect the export rice price, the export price equation is applied as follows:

$$Log(EXRP_t) = \beta_0 + \beta_1 Log(THA_t) + \beta_2 Log(OIL_t) + \beta_3 Log(EXWP_t) + \beta_4 Log(EXMP_t) + \beta_{i5} Log(ER_{it}) + \beta_6 Log(CR4_t) + \varepsilon_{2t} \quad (2.10)$$

where THA_t is total harvested area in period t, OIL_t is the annual average U.S. crude oil price in period t, $EXWP_t$ is the exporting price for wheat in period t, $EXMP_t$ is the exporting price for maize in period t, $CR4_t$ is the concentration ratio four for major exporting countries in period t and ε_{2t} is an error term. The *OIL* coefficient, (β_2), indicates the effects of oil price on export rice price with an expected positive sign because the increase of input costs or transportations cost contributes positively to the increase of export price. The *EXWP/EXMP* coefficients, (β_3 *and* β_4), indicate the effects the price of substitutable goods have on export rice price, and their signs are expected to be positive as well, because an increase in wheat/maize prices is believed to contribute positively to an increase in the rice price (substitute goods relationship). The coefficient of *ER* (β_{i5}) indicates the effects of the exchange rate on the export rice price, and expected sign is positive because a depreciation in the exporting countries' currencies

[36] Sabushi-Sabouni and Piri (2008) utilized the export price equation to analyze the relationship between the exchange rate and the export price of saffron. Their equation is as follows:
ln(Export Price)=f(ln(Export Volume), ln(Domestic Production), ln(Real Exchange Rate)).

contribute to the increase of export price. The CR4 (β_6) coefficient indicates the effects of the market concentration on the export rice price, and the expected sign is positive based on the hypothesis that market concentration of major rice exporting countries has a positive effect on export rice price. Therefore, the IV procedure is based on equations (2.9) and (2.10) in which the endogenous variable is the export rice price. Those main factors which influence export rice price are components of equation (2.10).

2.5.3. Exchange Rate Impacts on the World Rice Market

On the basis of demand and supply theory, a variety of factors affect commodity markets. Supply quantity and demand quantity work together to determine equilibrium market price. The foreign exchange market is no different. The willingness of countries, firms, and individuals to buy and sell currency determines the price of currencies on the world market. For example, as the demand for dollars increases it causes the value of the dollar to increase. As the supply of dollars increases, the dollar depreciates. These relationships between supply, demand, and the value of money are critical in understanding the currency exchange market.

In this section, this study analyzes the impacts of the Baht and Rupee based on major rice exporting countries. The Baht is the currency of Thailand. Thailand is also the world's largest rice exporting country. Also, the Rupee is the currency of India which ranks third amongst rice exporters. Therefore, we consider how the major exporting countries' exchange rate can affect export quantity. Therefore, this study assumes that the U.S. dollar is the representative currency tool for the rest of the world (*ROW*).

In Figure 2.10, the exporting countries' rice price will go up in terms of the depreciation on the currency of exporting countries and domestic demand decreases from

D1 to *D2* but domestic supply increase from *S1* to *S2*. Also, export quantity increases from *Q1* to *Q2* due to the upward shift of excess demand in the exporting countries' currency. *ROW*'s price decreases in terms of the appreciation on the representative currency tool of the rest of world. *ROW* demand increases from *D1* to *D2* but supply decreases from *S1* to *S2*.

The welfare impacts of this exchange rate appreciation for the importing country indicate that the domestic rice price increases from 100 to 110. This corresponds with a production increase from *S1* to *S2* and consumption decrease from *D1* to *D2*. The producer surplus for exporting countries increases by area *A*+*B*+*C*. Consumer surplus decreases by area *A*+*B*. The net welfare effect for the exporting country of the currency depreciation is a gain of area *C*. And in the *ROW*, given these quantity and price changes, producer surplus decreases by area *D*. Consumer surplus increases by area *D*+*E*+*F*+*G*. This results in a net welfare gain of area *E*+*F*+*G*.

In terms of recent trends, the Baht/$ and Rupee/$ exchange rates show depreciation (see Figure 2.11). In this situation, exporting countries' producer surplus will increase but importing countries' producer surplus will decrease. Therefore, the impacts of the exchange rate effect are the important decision factor of export quantity relative to the export rice price. The implication of this result is that exporting countries' governments need to consider the exchange rate rather than just the regulation of export price or export subsidy.

2.6. Results and Discussion

This study tested for over-identification using the *Hansen J-test*, and the test statistics show that over-identification is not a problem in the equation. This study also

tested the validity of any instruments using *Anderson*'s test. This test has a null hypothesis that the instruments are uncorrelated with the error term. In terms of the results, all cases cannot reject the null hypothesis and we thus conclude that at least one of the instrumental variables is not correlated with the errors. If the instrumental variables are not exogenous, then the IV procedure is not consistent and we cannot cast doubt as to the validity of the instrument. The *Breusch-Pagan*[37] test illustrates that this equation has a heteroskedasticity problem in terms of rejecting the null hypothesis. Therefore, this equation is estimated using an IV/GMM (generalized methods moments) procedure due to autocorrelation.

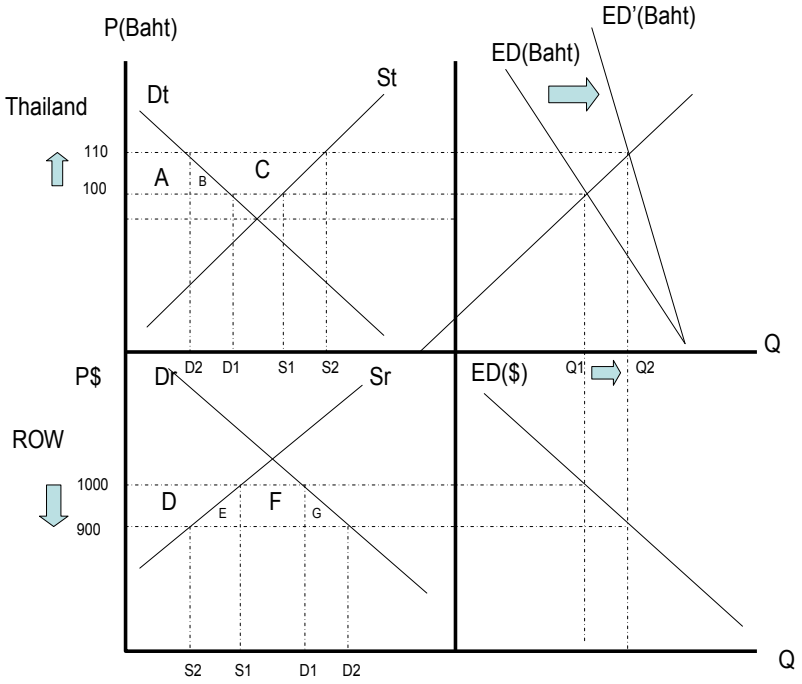


Figure 2.10. The Impacts of Exchange Rate on Export Rice Price

[37] The null hypothesis is the constant variance of equation (2.1). The result is that chi-square is 0 and p-value is 0.9417.

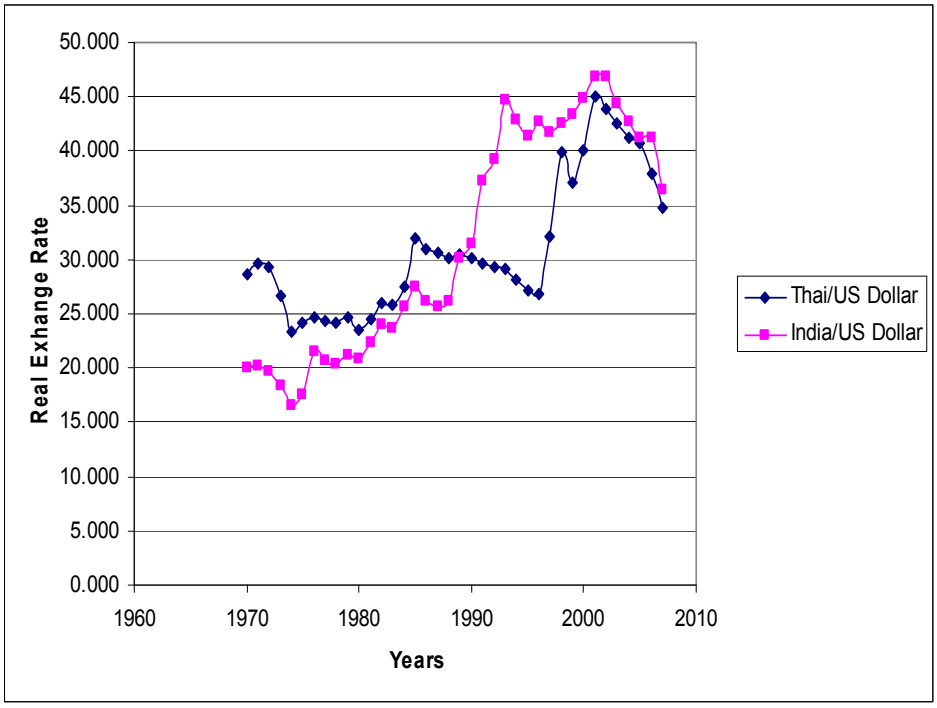


Figure 2.11. Trends of Exchange Rates for Major Rice Exporting Countries
Source: FAOSTAT

Estimated results are shown in Table 2.4. In OLS, the variables have the anticipated signs which show that increases in the export rice price, total production, and exchange rate have positively contributed to increasing total export quantity. In equation (2.9), the effects of total production, export price, and exchange rate are positive and statistically significant. A one percentage change in total production increases the export volume by 2.855%, a one percentage change in export rice price increases the export volume by 0.091%, and a one percentage change in Baht and Rupee exchange rate for increases the export volume by 3.1601% and 3.3032%, respectively. The supply elasticity for export rice price on export volume is inelastic, thus implying that changes in the export rice price do not contribute to changes in export rice volume.

In the 2SLS procedure, the estimated results are the same as those for OLS. All parameters are statistically significant and the IV procedure has very strong equation in

terms of *Hansen J-test* and the *Anderson* test. The important parameter of interest is the supply elasticity which is 0.5147 and statistically significant. And the estimated coefficients of total production and exchange rates are also positive signs and statistically significant, respectively. Therefore, total export rice volumes are significantly affected by total rice production and exchange rates for major rice exporting countries.

In Table 2.4, the Engle-Granger tests are statistically significant at the 1% level. This implies that the residuals of each model's regression model have stationarity, and that the dependent variables and explanatory variables of each regression models are cointegrated.

Table 2.4. Estimated Results: Annual Observations from 1970 through 2007 (Dependent Variable: Log (EX))

Explanatory Variables	OLS	OLS robust	IV/GMM
Intercept	15.8412* (1.74)	15.8412 (1.32)	18.4617** (1.82)
Log(TP)	2.8559** (2.20)	2.8559** (2.14)	3.5216** (2.43)
Log(EXRP)	0.0919** (2.19)	0.0919** (2.10)	0.5147** (2.78)
Log(ER Baht)	3.1601*** (3.57)	3.1601*** (4.47)	4.1663*** (5.15)
Log(ER Rupee)	3.3032*** (4.40)	3.3032*** (3.60)	3.4484*** (4.45)
R-squared	0.8152	0.8152	0.8015
Observations	38	38	38
Breusch-Pagan	0.23 p-value:0.1279	–	–
Anderson	–	–	28.997*** p-value:0.000
Hansen J	–	–	2.356 p-value: 0.5018
Engle-Granger	–	−0.7029*** (−4.03)	−0.7085*** (−4.18)

Notes: 1) t-values are in parentheses.
2) The definitions of variables are the same as Table 1.1.
3) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

The estimated result for the effects of harvested area, oil price, export prices for wheat and maize, exchange rate, and CR4 on export rice price is as follows:

(2.11)

$$Log(EXRP_t) = -32.6059 + 4.3329Log(THA_t) + 0.1361Log(OIL_t) + 0.5528Log(EXWP_t) + 0.2383Log(EXMP_t)$$
$$(-2.74)^{***} \quad (2.89)^{***} \quad (1.90)^{*} \quad (2.69)^{**} \quad (0.82)$$ [38]
$$+ 0.6969Log(ERBaht_t) + 0.5265Log(ERRupee_t) + 0.1508Log(CR4_t)$$
$$(2.98)^{***} \quad (2.58)^{**} \quad (2.50)^{**}$$
$$R^2 = 0.8038 \quad Observations = 38 \quad Engle-Granger test = -0.6094^{***}(-3.66)$$

Equation (2.11) indicates the factors which influence export rice price. Estimated coefficients of equation (2.10) are all positive and statistically significant with the exception of export maize price. The elasticity of CR4 on export rice price is 0.1508 and statistically significant. That is, the increase of CR4 in major rice exporting countries contributes to the increase of export rice price[39], and this result supports the hypothesis that market concentration has contributed to the increase of export rice price. According to results for equation (2.11), total harvested area impacts export rice price the greatest, and export wheat price, exchange rates for major rice exporting countries are also main factors that influence export rice price. [40]

2.7. Summary and Conclusions

In the past several decades, the international rice market has undergone major changes, in particular a shift in the general policy paradigm, a strong expansion in traded

[38] t-values are in parentheses. The definitions of variables are the same as Table 1.1. * indicates 90% confidence level. ** indicates 95% confidence level.*** indicates 99% confidence level.

[39] Kelton and Weiss (1989, page 41) proposed to test the basic hypothesis which concentration ratio raises price. They constructed the price equation which includes explanatory (price) and dependent (CR4) variables. They found strong evidence that rising concentration does tend to lead to price rises.
However, Marion and Geithman (1995) investigated the hypothesis that packer monopsony power had a significant negative effect on cattle prices during the 1971-86 periods. They found that cattle prices are negatively affected by increased packer concentration ratio.

[40] According to Sabushi-Sabouni and Piri (2008), the fluctuations of exchange rate have affected export price than other variables (e.g. production and export volume). Also, the effect of exchange rate of export price was positive and significant in long-run.

volumes, and a lingering tendency for world prices to decline in real terms relative to the other two most highly traded cereals, wheat and maize. Nonetheless, the world rice market continues to be regarded as distorted thin, segmented and volatile.

Most of the trade expansion witnessed in the past decades has been met by traditional exporters. Thailand has maintained its leadership as the top rice exporter since 1980. Major inroads were made by Vietnam, which became the world's second most important source of rice in the 1990s. Despite changes in the relative positions of the major exporters, we consider that the supply side of the international rice market is still highly concentrated within the top four exporting countries (Thailand, Vietnam, India and the United States).

However, price volatility and other variable factors lead to decreasing market power for the top four rice exporters. Although the industry concentration ratio and HHI are so great that we consider the market power of exporting countries, we also look into other important factors-namely, production and the exchange rate. Market power can exist in terms of static calculation and hypothesis test even if the traditional exporting countries have large market share.

This chapter estimates the export supply function for the world rice market using annual data from 1970 to 2007. Using the export supply function, this study obtains the supply elasticity for export rice price on export volume. This study also explains the main factors which influence export rice price including harvest area, oil price, substitute goods' prices, exchange rate, and CR4. The market power or market concentration for the major rice exporting countries can cause an increase in export rice price. This study also

discovered that both production and the exchange rate are important factors in determining the magnitude of changes for export rice price.

The main findings of this analysis are (1) traditional rice exporting countries have market power with respect to market share and hypothesis test (rice exporters' market power had a significant positive effect on export rice prices), and (2) that rice export quantity is strongly related to total rice quantity and the relative exchange rate between importers and exporters, rather than just rice export prices alone[41]. That is, the currency exchange rate for major rice exporting countries may influence export quantities to a great degree. In conclusion, it is shown that major rice exporting countries possess market power in the world rice market, and that the currency exchange rate for exporting countries is a significant factor which affects the quantity of rice exported.

2.8. References

Asche, Frank and Nostbakken, Linda. "When will Trade Restrictions affect Producer Behavior:Oligopsony Power in International Trade." *SES Seminar Presented* (2007).

Bain, Joe S.. *Industrial Organization*. John Wiley & Sons, 1968.

Calpe, Concepcion. "International Trade in Rice, Recent Developments and Prospects." *World Rice Research Conference*(2004).

Clarkson, Kenneth W. and Miller, Roger LeRoy. *Industrial Organization: Theory, Evidence, and Public Policy*. The McGraw-Hill Book Company, 1982.

Cole, Barry G. *After the Break up*. Columbia University Press, 1991.

Cramer, Gail L., Hansen, James M., and Wailes, Eric J. "Impact of Rice Tariffication on Japan and the World Rice Market." *AJAE* 81(1999):1149−1156.

Dawe, D. "The Changing Structure of the World Rice Market, 1950~2000." *Food Policy* 27(2002):355-70.

[41] Meckl (1996, page 72) explained the relationship between market power and exchange rated as follows: "Fluctuations in the exchange rate may have considerable effects on the price-setting behavior in imperfectly competitive markets, strengthening to market power of firms."

Delorme, Charles D. and Klein, Peter G. “Structure, Conduct and Performance: A Simultaneous Equations Approach.” *Applied Economics* 35(2002):13−20.

Deodha, Satish Y. and Sheldon, Ian M.. “Market Power in the World Market for Soymeal Exports.” *Journal of Agricultural and Resource Economics* 22(1997):78−86.

Engle, R. E. and Granger, C. W. J. "Cointegration and error-correction: Representation, estimation, and testing," *Econometrica* 55(1987):251−76.

FAO (Food and Agriculture Organization of the United Nations) web site, Available at http://faostat.fao.org/site/535/default.aspx

Gal, Michal S. *Competition Policy for Small Market Economies*. Harvard University Press, 2003.

Greene, W. *Econometric Analysis*. New York: Macmillan Publishing Company, 1990.

Hoskins, Colin, McFadyen, Stuart, and Finn, Adam. *Media Economics*. SAGE, 2004.

Kelton, C.M.L. and Weiss, Leonard W. *Change in Price, Change in Cost, Change in Demand, and Change in Concentration*. M.I.T. Press, 1989.

Kim, Donghwan and Marion, Bruce W. “Domestic Market Structure and Performance in Global Markets: Theory and Empirical Evidence from U.S. Food Manufacturing Industries.” *Review of Industrial Organization* 12(1997):355−54.

Marion, Bruce W. and Mueller, Willard F. “The Price and Profit Performance of Leading Food Chains.” *AJAE* 61(1979):420−433.

Marion, Bruce W and Geithman, Frederick E. “Concentration-Price Relations in Regional Fed Cattle Market.” *Review of Industrial Organization* 10(1995):1−19.

Meckl, Jurgen, “Market Power of Firms and Exchange-Rate Fluctuations.” *Journal of Economics* 63(1996):57−77.

Mohsen, Bahmani-Oskooee and Ltaifa, Nabil. “Effects of Exchange Rate Risk on Exports: Cross country Analysis.” *World Development* 20(1992):1173−1181.

Perloff, Jeffrey M. “Econometric Analysis of Imperfects Competition and Implications for Trade.” *CUDARE Working Papers* (1991):607−640.

Sabuhi-Sabouni, M. and Piri, M. “Consideration the Effect of Exchange Rate Volatility on Agricultural Products Export Price, the Case of Iran’s Saffron.” *American-Eurasian J. Agric. & Environ. Sci*, 2 (2008): 97−100.

Samuelson, Paul A. “Modes of Thought in Economics and Biology.” *The American Economic Review* 75(1985):166−172.

Siamwalla, Ammar and Haykin, Stephen. “The World Rice Market: Structure, Conduct, and Performance.” *Research Report* 39(1983), International Food Policy Research Institute.

Weiss, Leonard W. *Concentration and Price*. The MIT Press, 1989.

Wooldridge, Jeffrey M. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2001.

Zellner, Arnold. “An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias.” *Journal of the American Statistical Association* 57(1962): 348−68.

CHAPTER 3

THE RELATIONSHIPS OF TRADE, ECONOMIC GROWTH, AND MARKET POWER: THE CASE OF RICE EXPORTING COUNTRIES

3.1. Introduction

In the past several decades, the international rice market has undergone major changes, in particular with a shift in the general policy (e.g. restricted rice exports) paradigm and with a significant upsurge in export rice prices. Given all this, the world rice market is still regarded as distorted, thin and volatile. These characteristics influence domestic price and production policies in a number of Asian countries as well as in large exporting counties.

Van and Lewer (2007) argued that trade has been referred to as an "engine of growth" in developing economics. Economists have also recently accumulated statistical evidence showing that economic growth and international trade are positively correlated.[42]

Even though previous studies (Solow, 1957; Feder, 1983; Frankel and Romer, 1999; and Makki and Somwaru, 2004) have shown that trade and economic growth do have a positive effect, the size and sensitivity of such effects can vary across countries depending upon the level of human capital, that country's specific macroeconomic situation and market power. Figure 3.1 indicates the percentages of world rice export

[42] There are three theories related to trade and economic growth (Sohn, 2006). The first theory is 'Rybczynski' theorem which this shows an efficiency coming from continuous resource reallocations of capital into the export of capital intensive commodities. The second theory is the 'Product Differentiation' model (more trade, the bigger is the economies of scale effects. And the third theory is 'Endogenous Growth' model (trade and foreign direct investment increase knowledge spillovers across countries, and therefore these spillovers increase productivity of physical capital as well as human capital).

volume to exporting countries' real Gross Domestic Product (GDP) ratio. Thailand, Vietnam, India, and the United States are the top four rice exporting countries in the world. According to Figure 3.1, exporting countries' export to GDP ratio has decreased and there are no strong positive relationships between rice exports and economic growth. That is, the portion of rice exports as a share of total GDP for the aforementioned countries has gradually decreased.

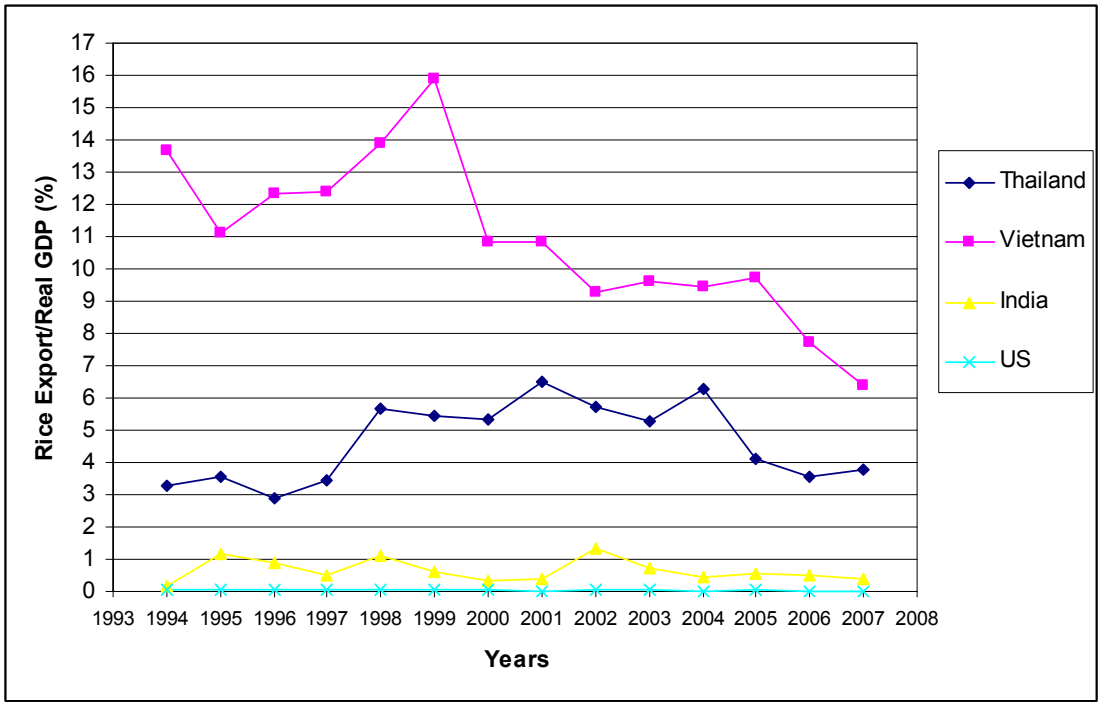


Figure 3.1. The Percentage of Rice Export on Real GDP based on Top 4 Major Exporting Countries
Source: FAOSTAT and World Bank

In this situation, the relationships between trade and economic growth, as well as the importance of Foreign Direct Investment (FDI) [43] and trade, are up for debate in the literature. Therefore, the main purpose of this study is to analyze the effects of economic growth on rice exports in terms of an export supply function, as well as, the relationships

[43] Figure 3.3 denotes the trends of FDI based on major rice exporting countries.

between FDI and the rice trade. This section also examines the existence of market power on exporting countries, and the effects between market power and economic growth. This study estimates the effects of these roles using 1994-2007 data for four rice exporting countries.

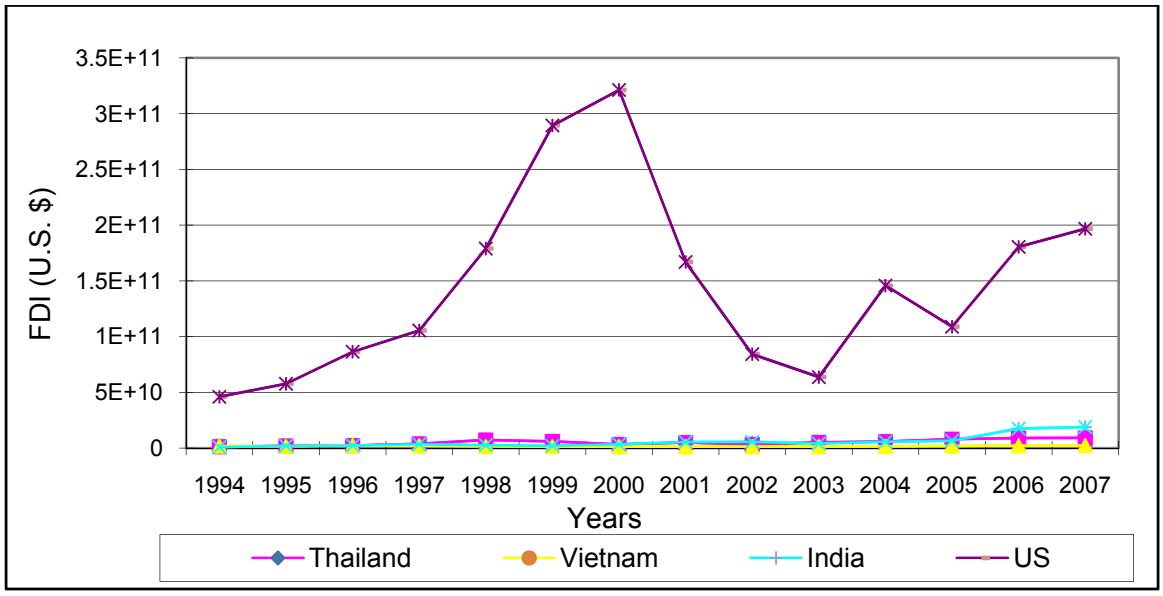


Figure 3.2. Trends of Foreign Direct Investment (FDI) based on Top 4 Rice Exporting Countries
Source: The World bank Database

This chapter is organized as follows. First, this study conducts a literature review. Previous papers in the literature have analyzed the relationships between trade and economic growth as well as the effects of FDI and trade on a nation's economy. Second, this study explains the methodology and data, in which a discussion regarding the formulation of the export supply function and Seemingly Unrelated Regression (SUR) is included. Third, this study examines the unit root and cointegration tests with respect to annual time series data and the study also uses the two-stage least squares (2SLS) estimation method in order to estimate efficient coefficient estimates for each of the endogenous variables stipulated in the SUR model that has been estimated in terms of

simultaneous equations. The econometric results illustrate just how exporting price affects both export quantity and economic growth in terms of the top four rice exporting countries and also helps throw some light on the relationship between market power and economic growth. Finally, a summary and conclusion are presented along with suggestions for future study.

3.2. Literature Review

An extensive literature has evolved in the past decades using economic theory to analyze the relationships of trade, economic growth, and market power. This section outlines recent studies concerning developing countries, including econometric analyses, structural economic analysis of trade and economic growth.

Mohsen and Ltaifa (1992) examined the effects of the exchange rate on aggregate exports for 67 developed countries using cross-sectional data. They used the export supply function in terms of the effects of the exchange rate on trade. They found that developed countries' exports are less sensitive to exchange rate risk than exports for developing countries. And they provided strong evidence that exchange rate uncertainty has reduced the volume of exports of both developed and developing countries.

Van den Berg (1997) examined econometric evidence that pointed to a relationship between trade and economic growth in Mexico. He showed the effects of exports, imports, and total productivity using simultaneous equations time series. He found that the relationship between trade and economic growth has been positive in Mexico over the period 1960-1991.

Borensztein, Gregoria, and Lee (1998) analyzed FDI in promoting economic growth using an endogenous model. They used the FDI flow from industrial countries to

developing countries during the 1980s. Their empirical analysis was based on the effects of FDI, interaction of FDI and human capital, and other variables that could potentially affect economic growth in terms of Romer's endogenous growth procedure. They mentioned that FDI is an important vehicle of technology transfer and that FDI also contributes to economic growth to a greater extent as compared to domestic investment.

Delorme and Klein (2002) developed on the traditional S-C-P paradigm in terms of lag structure and simultaneous equations. They used 1982-1992 U.S. manufacturing data to estimate the relationships of market concentration, economic growth, and profit/advertising including simultaneous equations. They mentioned that concentration does not depend on firm profitability and that advertising does not seem to have any significant effect on profitability. As firms sell more than one product, it is posited that actual profits are overstated in that particular observed industry code.

Makki and Somwaru (2004) extended the work of Borensztein, Gregoria, and Lee including in their model interactions of FDI with trade, domestic investment, and human capital in developing countries using both SUR estimation and instrumental variables (IV). They asserted that FDI and trade had a strong positive interaction and that lowering the inflation rate, decreasing taxes, and increasing government consumption could advance the economic growth of developing countries.

3.3. Methodology and Data

There have been a number of empirical studies of the export supply function. Most have been generally based on the notion of economic growth and international trade (Solow, 1957; Feder, 1983; Frankel and Romer, 1999; and Makki and Somwaru, 2004). The positive correlation between economic growth and international trade is a statistical

regularity that stands in need of explanation (Van and Lewer, 2007). Researchers have suggested that the relationship between trade and economic growth may be driven by bi-directional causality. That is to say, trade not only stimulates economic growth, as many economists (beginning with Adam Smith) have suggested, but improved economic growth, in turn, is also likely to create more trade.

The relationship between export and economic growth has been the subject of considerable interest in recent years (Feder, 1982). Especially, three possible relationships between exports and GDP are examined[44]: export-led growth, growth-driven exports, and the two-way causal relationship. According to the export-led growth (ELG)[45] hypothesis, export activity drives increases in economic growth. That is, exports directly affect the production of goods and services for nations. Another approach of export and economic growth is the growth-driven export (GDE)[46] hypothesis which postulates a reverse relationship and hypothesize that economic growth itself induces

[44]

Three possible relationships between exports and GDP	Previous researches
ELG	Michaely (1997), Feder (1982), Marin (1992), Romer (1991), Buffle (1992)
GDE	Bhagwati (1988), Findlay (1984), Kunst and Marin (1989), Vernon (1966)
Two-way causal relationship	Grossman and Helpman (1991), Globe and Mail (1993)

Source: Henriques and Sadorsky (1996, page 541)

[45] Export-led growth (ELG) is important for mainly two reasons (McCombie and Thirwall, 1994, page 421). The first is that ELG can increase profit, allowing a country to balance their finances, as well as surpass their debts as long as the facilities and materials for the export. And the second is that increased export growth can trigger greater productivity, thus creating more exports.
The export-led growth hypothesis can be specified as the following linear model:

$$Ln(Y)=f(ln(EX))$$

where *Y* represents level of real GDP and *EX* refers to the level of exports.

[46] Growth-driven export (GDE) is based on the idea that economic growth induces trade flow (Konya, 2006, page 74). That is, economic growth can create comparative advantages in certain areas leading to specialization and facilitating exports.
The growth-driven export hypothesis can be specified as the following linear model:

$$Ln(EX)=f(ln(Y))$$

where *Y* represents level of real GDP and *EX* refers to the level of exports.

trade flow (Konya, 2006). Therefore, Konya (2006, page 74) mentioned that these two approaches certainly do not exclude each other, and therefore the third notion is a feedback relationship between exports and economic growth. However, almost all of these previous papers are concerned with the relation between total exports and economic growth in developed or developing countries. Based on this literature review, it is apparent that the impact on economic growth of rice trade rarely been examined to this point.

In order to analyze the impacts of trade on GDP, the national income equation[47] (based on macroeconomic theory) is introduced and is specified as:

(3.1) $Y = C + I + G + (EX - IM)$

where Y is real GDP, C is consumption, I is investment, G is government expenditures, EX is exports, and IM is imports. Consumption (C) is driven by total income as follows:

(3.2) $C = a + cY$

where a is some fixed level of consumption and c is the marginal propensity to consume. And Imports (IM) are assumed to be a function of local income (Shaffer et al, 2003) as follows:

(3.3) $IM = b + mY$

where b is some fixed level of imports and m is the marginal propensity to import. Following up the work of Shaffer et al (2003), how changes in exports and local consumption affect the local economy can be seen by substituting equations (3.2) and (3.3) into equation (3.1), and replacing for Y and EX as follows:

[47] Shaffer et al (2003, page 65) investigated the export base multipliers which measures the spending and re-spending of an exgoneous injection of income, and results in a total change in community income exceeding the original change.

$$(3.4)\ Y = \frac{a - b + EX + I + G}{1 - (c - m)}$$

$$(3.5)\ EX = b - a - I - G + \{1 - (c - m)\}Y$$

Differentiating equation (3.4) with respect to exports (*EX*) and equation (3.4) with respect to GDP (*Y*) indicate how a change in exports influences GDP and how GDP contributes to increase in exports, respectively. Therefore,

$$(3.6)\ \frac{dY}{dEX} = \frac{1}{1 - (c - m)}$$

$$(3.7)\ \frac{dEX}{dY} = 1 - (c - m)$$

where *(c-m)* can be interpreted as the marginal propensity to consume locally. Especially, this study obtains the estimated results of equations (3.6) and (3.7) including GDP equation and export supply function, respectively.

Based on ELG and GDE hypotheses, this chapter aims to study how rice trade affects the economic growth and how the economic growth contributes to rice trade[48]. As indicated previously, the main purpose of this study is to estimate the effects of economic growth on the volume of rice exports. In order to analyze the effects of economic growth, this study includes real GDP for the major rice exporting countries in an attempt to analyze the effects of economic growth on rice trade. Therefore, the hypothesis could be

[48] Johnston and Mellor (1961, page 571) mentioned the most important ways in which increased agricultural output and export contribute to over-all economic growth can be summarized in five propositions: 1) economic growth is characterized by a substantial increase in the demand for agricultural products, and failure to expand food supplies in pace with the growth of demand can seriously impede economic growth; 2) expansions of exports of agricultural products may be one of the most promising means of increasing income and foreign exchange earnings; 3) the labor force for manufacturing and other expanding sectors of the economy can be drawn mainly from agricultural sectors; 4) agriculture, as the dominant sector of an under-developed economy, can make a net contribution to the capital required for investment and expansion of secondary industry; and 5) rising net cash incomes of the farm population may be important as a stimulus to industrial expansion.

formulated, in a simple form such as a log-log model format[49] and that it would be specified in terms of an export supply function as follows (see Mohsen and Ltaifa, 1992; Cameron, 2005);

$$(3.8)\quad Log\sum_{i=1}^{4}(EX_{it}) = a_0 + a_1 Log(EXRP_t) + a_2 Log\sum_{i=1}^{4}(TP_{it}) + a_{i3} Log(GDP_{it}) + \varepsilon_{1t}$$

where EX_{it} is rice export volume of country *i* in period *t*; $EXRP_t$, rice export price in period *t*; TP_t, total rice production volume of country *i* in period *t*; GDP_{it}, real gross domestic product of exporting countries[50] *i* in period *t*; and ε_{1t} is an error term. In equation (3.1), a_1 indicates the export price elasticity for major exporting countries.

Although this study can estimate equation (3.8) by data on total export volume and GDP for the top 4 rice exporting counties, this process needs other determinants of export price and GDP due to endogeneity problems. Therefore, we need to identify other factors of rice exporting price and GDP that are suitable for the interaction of foreign direct investment with trade and market power.

The first variable that we need to enter into equation (3.8) is the effect that the concentration ratio, input factor costs (e.g. oil price and c.i.f./f.o.b. price ratio), and substitutes have on export rice price. This variable will determine the market power with respect to the Lerner index and in so doing we will have a better idea as to the structure of that exporting rice market[51] .

The second variable is the effect FDI and trade on economic growth. This model extends the work of Makki and Somwaru to include the period of the 1990s when FDI

[49] Equation (3.8) is the extended form of equation (3.7).
[50] Major rice exporting countries are: Thailand, Vietnam, India, and the United States. Therefore, in this study, *i* is equal to four.
[51] Marion and et al. (1979) analyzed the relationships between the market structures in which food chains operate their price.

and trade grew rapidly in developing countries. This study will also cover the effects of rice export volume, population, inflation, import/export of goods and service, human capital, trade openness measures, and the interaction of FDI and export volume for the top 4 rice exporters.

The last variable included is intended to capture the effects that market share for each exporting countries, GDP, and FDI have on market power. That is, the market power or concentration ratio depends on the market share and economic growth for exporting countries. This variable indicates the relationships among trade, economic growth, and market power of international rice market.

Including all the variables specified above in equation (3.8) yields the specified models which are as follows:

(3.9)

$$Log(EXRP_t) = b_0 + b_1 Log(CR4_t) + b_2 Log(OIL_t) + b_3 Log(EXWP_t) + b_4 Log(EXMP_t) + b_5 Log(THA_t) + b_6 Log(ER_t) + b_7 Log(CIF/FOB_t) + \varepsilon_{2t}$$

(3.10)

$$Log(GDP_{it}) = c_{i0} + c_{i1} Log(FDI_{it}) + c_{i2} Log(MS_{it}) + c_{i3} Log(EX_{it}) + c_{i4} Log(IN_{it}) + c_{i5} Log(POP_{it}) + c_{i6} Log(IMGS_{it}) + c_{i7} Log(HE_{it}) + c_{i8} Log(GNI_{it}) + c_{i9} Log(HC_{it}) + c_{i10} Log(AG_{it}) + c_{i11} Log(OP_{it}) + c_{i12} Log(FDI_{it} \times EX_{it}) + \varepsilon_{3t}$$

(3.11) $$Log(CR4_t) = d_{i0} + d_{i1} Log(MS_{it}) + d_{i2} Log(GDP_{it}) + d_{i3} Log(FDI_{it}) + \varepsilon_{4t}$$

In addition to those variables introduced in equation (3.8), $CR4_t$ is the concentration ratio for top rice exporters in period t, OIL_t is the annual U.S. average crude oil price in period t, $EXWP_t$ is the export price for wheat in period t, $EXMP_t$ is the export price for maize in period t, THA_t is total harvested area in period t, ER_t is the real

Baht/U.S. dollar exchange rate in period *t*, CIF / FOB_t [52] is the ratio of c.i.f. to f.o.b. price in period *t*, FDI_{it} is foreign direct investment of exporting country *i* in period *t*, MS_{it} is market share exporting country *i* in period *t*, EX_{it} is export volume of exporting country *i* in period *t*, IN_{it} is inflation rate of exporting country *i* in period *t*, POP_{it} is population growth rate of exporting countries *i* in period *t*, $IMGS_{it}$ are the imports of goods and service of exporting countries *i* in period *t*, HE_{it} are the high-technology exports of exporting countries *i* in period *t*, GNI_{it} [53] is gross national income of exporting countries *i* in period *t*, HC_{it} is human capital of exporting countries *i* in period *t*, AG_{it} is agricultural values of exporting countries *i* in period *t*, and OP_{it} is a trade openness[54] measure of exporting countries *i* in period *t*. According to past empirical studies, we expect the following signs for the estimated coefficients for these variables to be: $a_{jt} > 0$, $b_{jt} > 0$,

[52] The Freight-on-Board (FOB) is based on 5% milled rice of Bangkok and the Cost-Insurance-Freight (CIF) is based on 5% milled rice of Indonesia and Philippines.

[53] In analyses on the state of the economy, the appropriate measure is GDP (e.g. the change in the volume of output). On the other hand, in analyses of living standards between countries over time, it is more relevant to study GNI (e.g. relation to the price of final domestic demand such as consumption and investment). That is, GNI includes the net primary income from abroad and adjusts to the development of living standards. Therefore, GDP shows output, whereas the more relevant measure of living standards is GNI. (Mankiw, 2003)

Especially, Stutely (2003, page 29) mentioned that the relationship between GNI and GDP is straightforward:

GDP+ net property income from abroad (rent, interest, profits, and dividends)
=GNI-capital consumption (depreciation)
=Net National Income

And Stutely (2003) mentioned that the difference between GDP and GNI is usually relative small, perhaps 1% of GDP. In the short term, a large change in total net property income has only a minor effect on GDP. Therefore, when reviewing longer-term trends, it is advisable to check net property income to see if it is making GNI grow faster than GDP (Stutely, 2003, page 30).

[54] See Alcala and Ciccone (2004).

This variable is calculated by using $Openness = \frac{total\ \exp ort\ volume + total\ import\ volume}{GDP}$

$c_{jt} \gtrless 0$[55], and $d_{jt} > 0$. Equation (3.9) includes market power, oil price, export wheat/maize prices, total harvest area, exchange rate, and transportation cost and in this study we will analyze the effects these main factors have had on export rice prices. Equation (3.10)[56] includes FDI, market share, export rice quantities, some macroeconomic and country specific data related to rice exporting countries' economic situations (e.g. population, inflation, and human capital), and interaction effects between the rice trade and FDI. Equation (3.11) denotes the market power equation which is based

[55]

Expected Signs	Definitions of estimated variables	Hypotheses
$c_{i1} > 0$	Foreign Direct Investment	The increase of investment from foreign countries affects the increase of economic growth in the net recipient
$c_{i2} > 0$	Market Share	The increase of market share in major rice exporting countries affects the increase of economic growth
$c_{i3} > 0$	Rice Export Volume	The increase of rice exports in major rice exporting countries contributes to developing the economic growth in these countries
$c_{i4} < 0$	Inflation	The increase of inflation in major rice exporting countries affects the decrease of economic growth
$c_{i5} > 0$	Population	The increase of population contributes to developing the economic growth in major rice exporting countries
$c_{i6} > 0$	Imports of goods and services	The increase of imports of goods and services contributes to the increase of economic growth
$c_{i7} > 0$	High-technology exports	The increase of high-technology exports contributes to the increase of economic growth
$c_{i8} > 0$	Gross National Income	The increase of incomes contributes to the increase of economic growth
$c_{i9} > 0$	Human Capital	The increase of Human capital contributes to the increase of economic growth
$c_{i10} > 0$	Agricultural Values	The increase of agricultural values contributes to the increase of economic growth
$c_{i11} > 0$	Openness Measure	The increase of openness in trading contributes to the increase of economic growth

Especially, this chapter focuses on the effects of rice export volume on GDP, and interaction effects between FDI and rice export volume. Therefore, we can expect that the estimated coefficients of EX and EX*FDI are positive signs because rice export contribute to the advancing of economic growth and FDI in the major rice exporting countries.

[56] Equation (3.10) is the extended form of equation (3.6).

on effects of market share, economic growth, and FDI on major rice exporting countries' market power.

Data[57] for this analysis were obtained from the USDA and the World Bank. The USDA database[58] includes information such as rice export volume, production, and harvested area. The World Bank database[59] contains information such as real GDP, FDI, GNI, human capital, inflation ratios, population growth, imports of goods and services, high-technology exports, and agricultural values of GDP. Price databases[60] were obtained from both the International Rice Research Institute and the Bank of Thailand. The annual data cover the top four rice exporting countries for the period of 1994 through 2007 (see Table 3.1).

Given that this is annual time-series data, we need to pre-test for stationarity and the existence of a cointegration vector before moving onto model specification. We estimate the system equation using Instrumental Variables (IV) and three stage least squares (TSLS) of the seemingly unrelated regression (SUR). The IV procedure allows us to overcome endogeneity problems between GDP and export volume. The SUR method allows for different error variances in each equation and for the correlation of these errors across equations (Greene, 1990).

[57] See Table 3.1.
[58] Export quantity or volume indicates 1000 tons.
[59] GDP, GNI, and FDI data are specified in US$. Human capital is the average years of educational attainment. Inflation ratio is the GDP deflator and annual percentage. Population growth is the annual growth percentage. Imports of goods and services are the percentage of GDP and high-technology exports is the percentage of manufactured exports. Agricultural valued added is the percentage of GDP.
[60] Exporting rice price is based on FOB and 5% broken, milled, fob Bangkok. Exporting wheat price is Canadian No.1 Western Red Spring 13.5% and exporting maize price is the US No.2 yellow, fob Gulf ports.

Table 3.1. Descriptive Data of the Estimated Variables

Variables	Obs	Mean	Std. Dev	Min	Max
Thailand rice export quantity (1000 tons)	14	6883	1410	4738	10137
Vietnam rice export quantity (1000 tons)	14	3710	882	2222	5174
India rice export quantity (1000 tons)	14	3479	1595	600	6650
U.S. rice export quantity (1000 tons)	14	3049	459	2304	3862
Total rice export quantity (1000 tons)	14	24617	4225	16456	29009
CR4	14	0.69	0.04	0.62	0.76
Thailand market share (%)	14	28	3.32	23.02	37.29
Vietnam market share (%)	14	15.02	2.2	10.99	18.35
India market share (%)	14	13.75	5.51	3.64	23.87
U.S. market share (%)	14	12.55	1.77	10.93	16.97
Export price for rice (U.S. $/ton)	14	364	55	173	339
Export price for wheat (U.S. $/ton)	14	194	47	147	336
Export price for maize (U.S. $/ton)	14	110	20	89	171
Total production (1000 tons)	14	5.93e+08	3.25e+07	5.39e+08	6.50e+08
Total harvest area (acres)	14	1.52e+08	2917795	1.47e+08	1.57e+08
Oil price (U.S. $/bbl)	14	29.36	16.74	11.91	64.2
CIF/FOB	14	0.086	0.059	0.0001	0.18
Thailand FDI (U.S. $)	14	5.16e+09	2.57e+09	1.37e+09	9.20e+09
Vietnam FDI (U.S. $)	14	1.80e+09	4.16e+08	1.30e+09	2.45e+09
India FDI (U.S. $)	14	5.84e+09	5.50e+09	9.73e+08	1.89e+10
U.S. FDI (U.S. $)	14	1.45e+11	8.39e+10	4.61e+10	3.21e+11
Thailand GDP (U.S. $)	14	1.54e+11	3.43e+10	1.12e+11	2.23e+11
Vietnam GDP (U.S. $)	14	3.67e+10	1.59e+10	1.63e+10	7.20e+10
India GDP (U.S. $)	14	5.58e+11	2.15e+11	3.24e+11	1.00e+12
U.S. GDP (U.S. $)	14	1.00e+13	2.19e+12	7.02e+12	1.40e+13
Thailand inflation growth rate (annual %)	14	0.53	0.26	0.087	0.965
Vietnam inflation growth rate (annual %)	14	0.837	0.248	0.289	1.231
India inflation growth rate (annual %)	14	0.728	0.165	0.495	1.00
U.S. inflation growth rate (annual %)	14	0.32	0.13	0.045	0.525
Exchange rate (Baht/U.S. $)	14	37.49	7.43	24.99	45.72
Thailand population growth rate (annual %)	14	0.91	0.18	0.69	1.13
Vietnam population growth rate (annual %)	14	1.36	0.41	0.15	1.87
India population growth rate (annual %)	14	1.60	0.16	1.36	1.80
U.S. population growth rate (annual %)	14	1.07	0.10	0.92	1.22
Thailand import of goods and service (% of GDP)	14	1.74	0.83	1.63	1.87
Vietnam import of goods and service (% of GDP)	14	1.76	0.08	1.62	1.89
India import of goods and service (% of GDP)	14	1.19	0.13	1.01	1.42
U.S. import of goods and service (% of GDP)	14	1.14	0.05	1.06	1.22

Note: Definitions and sources of variables are the same in Table 1.1.

Table 3.1. (Continued)

Variables	Obs	Mean	Std. Dev	Min	Max
Thailand high technology export (% of total export)	14	1.46	0.04	1.37	1.53
Vietnam high technology export (% of total export)	14	0.54	0.31	0.13	1.04
India high technology export (% of total export)	14	0.66	0.06	0.47	0.73
U.S. high technology export (% of total export)	14	1.49	0.01	1.47	1.53
Thailand GNI (U.S. $)	14	1.51e+11	3.04e+10	1.20e+11	2.17e+11
Vietnam GNI (U.S. $)	14	3.31e+10	1.76e+10	3.27e+09	6.72e+10
India GNI (U.S. $)	14	5.55e+11	2.28e+11	3.04e+11	1.07e+12
U.S. GNI (U.S. $)	14	9.62e+12	3.24e+12	1.01e+12	1.39e+13
Thailand human capital (average years of education attainment)	14	7.35	0.73	6.3	8.5
Vietnam human capital (average years of education attainment)	14	8.15	0.18	7.9	8.48
India human capital (average years of education attainment)	14	6.63	0.28	6.09	7.05
U.S. human capital (average years of education attainment)	14	12.92	0.2	12.59	13.22
Thailand agricultural value (% of GDP)	14	0.99	0.02	0.95	1.03
Vietnam agricultural value (% of GDP)	14	1.37	0.04	1.3	1.44
India agricultural value (% of GDP)	14	1.35	0.07	1.23	1.45
U.S. agricultural value (% of GDP)	14	0.11	0.08	0.002	0.26
Thailand openness measure	14	0.03	0.12	0.111	0.25
Vietnam openness measure	14	0.08	0.14	0.12	0.33
India openness measure	14	0.78	0.14	0.53	0.95
U.S. openness measure	14	0.91	0.28	0.86	0.96
Thailand FDI*export quantity	14	2.45e+38	4.91e+38	3.79e+33	1.41e+39
Vietnam FDI*export quantity	14	6.46e+33	1.13e+34	1.22e+31	3.20e+34
India FDI*export quantity	14	4.21e+36	8.85e+36	9.35e+24	2.83e+37
U.S. FDI*export quantity	14	1.80e+39	2.12e+39	5.63e+36	5.61e+39

Note: Definitions of variables are the same in Table 1.1.

3.4. Estimation and Results

3.4.1. Unit Root and Cointegration Tests

The unit root test is designed to determine the order of integration of variables under consideration. This Augmented Dickey-Fuller (ADF) test is employed for testing the order of integration. This procedure statistic rejects the null hypothesis that all variables are non-stationary, when first difference variables are used. Table 3.2 indicates those variables that are stationary of order 1.

In Table 3.3, this study obtains the results of the Engle-Granger (EG)[61] test which estimates a unit root test on the residuals from the regression model. The null hypothesis of this test is that the residuals are non-stationary. With respect to the Table 3.3's results, we conclude that the residuals are stationary which indicates that the dependent and explanatory variables of each regression model are cointegrated. Given these conditions, we can call the estimated equation the *static relationship function* and interpret its' parameters as long run parameters (Greene, 1990).

Table 3.2. Results of the Unit Root Test

	ADF in Levels Lag(1)		**ADF First Differences Lag(1)**	
	Without Trend	**With Trend**	**Without Trend**	**With Trend**
Log(Total export quantity)	−0.335	−1.547**	−2.189***	−2.28***
	(−1.34)	(−3.13)	(−5.62)	(−6.23)
Log(Export Price)	−0.192	−0.082	−0.269*	−0.91*
	(−0.94)	(−0.48)	(−2.01)	(−1.96)
Log(Total Production)	−0.217	−0.715*	−1.019*	−1.01*
	(−1.01)	(−2.04)	(−2.07)	(−1.94)
Log(Thailand GDP)	−0.291	−0.301	−0.89*	−1.529***
	(−1.19)	(−1.42)	(−2.27)	(−5.22)
Log(Vietnam GDP)	−0.07**	−0.23	−0.501*	−0.693***
	(−2.35)	(−1.67)	(−2.12)	(−3.93)
Log(India GDP)	−0.047	−0.265	−0.442*	−0.862*
	(−0.8)	(−1.56)	(−1.98)	(−2.1)
Log(U.S. GDP)	−0.004	−0.63**	−0.769*	−0.781*
	(−0.23)	(−2.69)	(−2.24)	(−2.2)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

3.4.2. Endogeneity Problems and Empirical Results

This study tested the effect of export price, total production, and economic growth on total export quantity with respect to the export supply function. This analysis is

[61] See Engle and Granger (1987)

covered in the framework for the top 4 rice exporting counties from 1994 through 2007. Furthermore, this study constrains the model with three equations: the first equation includes the effects of the concentration ratio, input prices, substitutive prices, exchange rate on export rice price; the second constraint equation takes into account how FDI, market share, population growth, inflation, human capital, and trade openness affect economic growth; and the third constraint equation examines the effects of FDI, economic growth, and market share on the concentration ratio.

Table 3.3 shows the econometric results of the OLS and IV/GMM estimation procedures. In terms of OLS results, all variables are positive in sign (with the exception of U.S. GDP) but are statistically insignificant. However, IV/GMM results indicate that all variables are positive in sign (with exception of U.S. GDP) and are statistically significant.

This study tested for over-identification using *Hansen's J-test*. Test statistics show that over-identification is not a problem in the equation. We also tested the validity of instruments using the *Anderson* test. This test has a null hypothesis that states that the instruments are uncorrelated with the error term. In terms of the results, all cases can reject the null hypothesis and conclude that at least one of the instrumental variables are not correlated with the errors. If the instrumental variables are not exogenous, then the IV procedure is not consistent and we cannot cast doubt as to the validity of the instrument. The *Breusch-Pagan* test illustrates that this equation has heteroskedasticity in terms of rejecting the null hypothesis. Therefore, as a result, this equation is estimated with the IV/GMM procedure due to autocorrelation.

According to endogeneity test results, IV/GMM results are more efficient than OLS. Therefore, we conclude that world rice market supply elasticity (0.0904) is inelastic and that, in the top three rice exporting countries, economic growth has a positive effect on total rice export volume. According to these results, we conclude that selling market power[62] exists in the international rice market and that economic growth can have a positive effect on world rice trade.

The SUR method is utilized in order to allow for the different error variances in each equation. Table 3.3 indicates the econometric results of export volume using equation (3.8). The estimated results in Table 3.3 show that the IV/GMM estimation yields similar results as those obtained by using the SUR procedure. We extend the model in terms of the SUR method, as referenced by models 1.1, 1.2, and 1.3. Model 1.1 is based on equation (3.1) and includes the explanatory variables of equations (3.9) and (3.10). Model 1.2 extends model 1.1 to account for the effects of interaction of FDI with export volume. Model 1.3 builds on model 1.2 by including market power effects which concentration ratio depends upon market share, economic growth, and FDI. In terms of SUR results, all variables are positive and statistically significant. Furthermore, these results indicate that those estimates obtained from SUR are more reasonable than those from IV/GMM.

[62] Although the concentration ratio seems to be a useful measure of monopoly power, it has a serious shortcoming. Monopoly power is a function not only of a firm's market share, but also of potential supply from either existing firms or firms that it could enter the industry. Samuelson (1965) mentioned that the monopoly power of one firm could be zero if the potential supply elasticity were great enough. In other words, a price that yields monopoly profits in this situation will cause the existing monopoly to be deluged by new entrants or expansion by existing marginal firms in the industry.

Table 3.3. Model Results of Export Supply Model Using Equation (3.8): Annual Observations from 1994 through 2007 (Dependent Variable: Log (Total Export Quantity))

Independent Variables	OLS	IV/GMM	SUR Estimates		
			1.1	1.2	1.3
Intercept	36.7157*	43.5223***	37.9601***	39.4215***	41.5875***
	(1.97)	(4.35)	(2.89)	(3.0)	(3.17)
Log (Export Price)	0.1678	0.0904**	0.1397*	0.1757*	0.22*
	(0.61)	(3.29)	(1.99)	(1.98)	(1.98)
Log (Total Production)	1.768	1.8183**	1.766**	1.7652**	1.8849**
	(1.54)	(2.67)	(2.17)	(2.17)	(2.32)
Log (Thailand GDP)	0.8505**	1.0167***	0.9229***	0.9383***	0.938***
	(2.43)	(6.9)	(3.77)	(3.81)	(3.81)
Log (Vietnam GDP)	0.9145	1.3961**	0.9771**	0.9732**	0.9958**
	(1.73)	(3.24)	(2.62)	(2.6)	(2.66)
Log (India GDP)	1.5074	1.3976***	1.5058*	1.6646**	1.7904**
	(1.38)	(4.66)	(1.97)	(2.16)	(2.33)
Log (U.S. GDP)	−2.6324	−3.2853***	0.7218**	0.905**	0.1646**
	(−1.43)	(−3.71)	(2.11)	(2.28)	(2.45)
R-square	0.8839	0.8647	0.8826	0.8825	0.8819
Observations	56	56	56	56	56
Breusch-Pagan	3.25*	—	10.169	11.343	18.001
	p-value: 0.071		p-value: 0.809	p-value: 0.7279	p-value: 0.6489
Anderson	—	13.456**	—	—	—
		p-value: 0.0363			
Hansen J	—	5.809	—	—	—
		p-value: 0.3252			
Engle-Granger	−2.114***	−1.719***	−2.035***	−2.026***	−2.019***
	(−8.75)	(−5.98)	(−8.48)	(−8.14)	(−7.75)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

Table 3.4 presents the econometric results of simultaneous equations using annual observations from 1994 through 2007[63]. Charles et al. (2002) used a simultaneous equation framework for estimating the relationships between structure, conduct, and performance in U.S. manufacturing in the 1990s. They mentioned that structure is influenced by conduct and performance, and therefore creates a simultaneity bias in the OLS estimates when measuring the effects of market structure on performance. A simultaneous equations procedure, however, can produce consistent and unbiased estimates when these feedback effects exist.

Model 1.1 reveals that export rice price is positively related to the concentration ratio, oil price, exporting wheat price, exchange rate, and transportation cost of the c.i.f./f.o.b. ratio. The estimated coefficients for FDI and market share are positive and statistically significant while those for Thailand are not statistically significant. The coefficients for export volume are positive while the United States has a negative sign, implying that the rice exports of Thailand, Vietnam, and India contribute positively to those nations' economic growth but U.S. rice exports do not. Also, the coefficients for human capital are positive, which signifies positive effects between human capital and economic growth within rice exporting countries. The coefficients for the trade openness measure, with the exception of the U.S. are positive and statistically significant, indicating that Thailand, Vietnam, and India experience more economic growth as their economies become more open.

Model 1.2 indicates the interactions between FDI and trade with respect to model 1.1. The coefficients of FDI and trade yield are positive and statistically significant. This

[63] See APPENDIX III with related to comparisons between expected signs and estimated results' signs.

implies that FDI and rice trade complement in advancing the economic growth of rice exporting countries.

Model 1.3 includes additional variables that account for the relationships between market power and economic growth. The coefficients of market share and GDP for exporting countries are positive and statistically significant while the variable coefficient that account for the effects of FDI are positive and not statistically significant. This means that market share and economic growth can positively affect market power for the world rice market but the effects of FDI are ambiguous. According to models 1.2 and 1.3, FDI and rice trade have complementary relationships while FDI, when considered by itself, does not have a great effect on market power.

3.5. Summary and Conclusions

This chapter analyzes the relationships amongst trade, economic growth, and market power for the four major rice exporting countries within an export supply function framework. Using annual data from 1994 through 2007 for the top four rice exporting countries, this study show that selling power exists in the world rice market and there is a bi-causal relationship between trade and economic growth. From the empirical analysis above, this study concludes that:

●**Export Price.** The supply elasticity of total rice export volume is not elastic with any statistical significance (the OLS result is not significant). This implies that for a 1 percent change in rice export price, total rice export volume increases less than 1 percent.

●**Total Production.** This variable is elastic on total rice export volume and positive in sign. That is, for a 1 percent change in exporting countries' total production, total rice export volume increases by more than 1 percent.

Table 3.4. Model Results of Simultaneous Equations Using annual Observations from 1994 through 2007 (Model 1.1.)

Estimated Variables (Definitions)	Estimated Results of Equation (3.2)	Estimation Results of Equation (3.3)			
		Thailand	Vietnam	India	U.S.
b_0(Intercept)	-20.1274* (-2.02)				
b_1(CR4)	0.7345*** (3.4)				
b_2(OIL)	0.1753** (2.34)				
b_3(EXWP)	0.9625*** (3.95)				
b_4(EXMP)	0.1749 (0.57)				
b_5(THA)	-2.3116* (-1.91)				
b_6(ER)	0.4362*** (3.26)				
b_7(CIF/FOB)	1.4254*** (6.49)				
c_0(Intercept)		4.2562*** (3.79)	8.2959*** (23.27)	9.6005*** (18.34)	7.3259*** (26.37)
c_1(FDI)		0.0229 (0.54)	0.0236* (1.87)	0.0322 (0.84)	0.018** (2.10)
c_2(MS)		0.0154 (0.15)	0.0773*** (4.15)	0.4518*** (3.44)	0.1295*** (4.79)
c_3(EX)		0.167** (2.64)	0.1973*** (6.97)	0.3721*** (3.28)	-0.1318*** (-7.54)
c_4(IN)		-0.0957*** (-2.90)	0.1088*** (13.38)	0.1188** (2.43)	-0.0619 (-7.50)
c_5(POP)		0.8027*** (3.52)	0.0396*** (7.40)	0.2586 (1.33)	-0.0078 (-0.30)
c_6(IMGS)		1.2343** (2.66)	-1.2081*** (-10.06)	-0.8715 (-1.37)	-0.2773*** (-4.10)
c_7(HE)		0.3832** (2.26)	0.0551*** (6.72)	0.063** (2.05)	-0.0948 (-0.99)
c_8(GNI)		0.4094* (1.78)	1.1845*** (36.55)	1.9643*** (4.72)	1.1638*** (22.58)
c_9(HC)		0.2677*** (4.28)	0.0812*** (3.15)	0.1437*** (3.16)	0.0792** (2.77)
c_{10}(AG)		0.4118 (1.32)	0.9741*** (3.15)	-2.496*** (-4.55)	-0.158*** (-9.66)
c_{11}(OP)		1.1472*** (3.10)	0.9493*** (9.00)	0.7195* (1.78)	0.02 (0.92)
c_{12}(FDI*EX)					
R^2	0.8826				
Breusch-Pagan Test	10.169 (p-value=0.809)				
Engle-Granger Test	-2.035*** (-8.48)				

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level.
3) Definitions of variables are the same in Table 1.1.

Table 3.4. Continued (Model 1.2.)

Estimated Variables (Definitions)	Estimated Results of Equation (3.2)	Estimation Results of Equation (3.3)			
		Thailand	Vietnam	India	U.S.
b_0(Intercept)	-23.266** (-2.32)				
b_1(CR4)	0.7757*** (3.57)				
b_2(OIL)	0.1461* (1.95)				
b_3(EXWP)	0.7462*** (2.92)				
b_4(EXMP)	0.3474 (1.08)				
b_5(THA)	-2.7269** (-2.26)				
b_6(ER)	0.3241** (2.36)				
b_7(CIF/FOB)	1.3362*** (5.81)				
c_0(Intercept)		4.6233*** (3.09)	8.0851*** (20.27)	15.9457*** (9.05)	9.2899*** (3.38)
c_1(FDI)		4.1846** (2.74)	0.8966*** (26.71)	0.7909*** (3.57)	0.1511 (0.74)
c_2(MS)		0.5157** (2.76)	0.0585*** (3.29)	0.6631*** (5.78)	0.1169*** (3.80)
c_3(EX)		10.2621** (2.71)	2.1587*** (27.38)	1.5467*** (2.92)	0.6549 (1.04)
c_4(IN)		-0.1819*** (-4.41)	0.1098*** (13.62)	0.1872*** (4.65)	-0.0616*** (-7.57)
c_5(POP)		0.5978*** (2.93)	0.0395*** (7.56)	0.3176** (2.17)	-0.0265 (-0.71)
c_6(IMGS)		0.4921 (1.13)	-1.2874*** (-10.70)	0.0082 (0.02)	-0.2329** (-2.39)
c_7(HE)		0.5481*** (3.56)	0.0571*** (6.92)	0.5054*** (3.13)	-0.042 (-0.39)
c_8(GNI)		0.9165*** (3.77)	1.1887*** (37.50)	1.8171*** (5.83)	1.1584*** (21.74)
c_9(HC)		0.1144 (1.64)	0.0751*** (3.00)	0.1526*** (4.43)	0.0653* (1.95)
c_{10}(AG)		-0.0149 (-0.05)	0.9606*** (11.92)	-2.9601*** (-6.81)	-0.1518*** (-8.25)
c_{11}(OP)		0.4143 (1.13)	1.0039*** (9.58)	1.5633*** (4.19)	0.0016 (0.75)
c_{12}(FDI*EX)		1.1232*** (2.75)	0.2545*** (24.25)	0.2201*** (3.64)	0.0476*** (3.83)
R^2	0.8825				
Breusch-Pagan Test	11.343 (p-value=0.7279)				
Engle-Granger Test	-2.026*** (-8.14)				

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level
3) Definitions of variables are the same in Table 1.1.

Table 3.4. Continued (Model 1.3.)

Estimated Variables (Definitions)	Estimated Results of Equation (3.2)	Estimation Results of Equation (3.3)			
		Thailand	Vietnam	India	U.S.
b_0(Intercept)	-20.9604**				
	(-2.10)				
b_1(CR4)	0.7593***				
	(3.50)				
b_2(OIL)	0.141*				
	(1.91)				
b_3(EXWP)	0.6537***				
	(2.58)				
b_4(EXMP)	0.4766				
	(1.50)				
b_5(THA)	-2.4350*				
	(-2.03)				
b_6(ER)	0.3449***				
	(2.53)				
b_7(CIF/FOB)	1.3535***				
	(5.89)				
c_0(Intercept)		5.0457***	5.0256***	16.0663***	9.2744***
		(3.44)	(19.50)	(9.12)	(3.83)
c_1(FDI)		4.641***	0.09011***	0.8044***	0.1518
		(3.06)	(26.89)	(3.64)	(0.74)
c_2(MS)		0.6109***	0.0603***	0.6489***	0.1155***
		(3.34)	(3.39)	(5.66)	(3.76)
c_3(EX)		11.3473***	2.1714***	1.6181***	0.6554
		(3.02)	(27.59)	(3.05)	(1.04)
c_4(IN)		-0.1848***	0.1109***	0.1892***	-0.0608***
		(-4.52)	(13.79)	(4.70)	(-7.48)
c_5(POP)		0.5011**	0.0401***	0.2756*	-0.0251
		(2.50)	(7.69)	(1.89)	(-0.67)
c_6(IMGS)		0.2421	-1.3033***	0.0082	-0.2361**
		(0.58)	(-10.84)	(0.33)	(-2.42)
c_7(HE)		0.5846***	0.0576***	0.5197***	-0.0377
		(3.94)	(7.05)	(3.22)	(-0.31)
c_8(GNI)		1.0669***	1.1931***	1.7193***	1.1577***
		(4.56)	(37.68)	(5.56)	(21.78)
c_9(HC)		0.0717	0.0716***	0.1501***	0.0068*
		(1.06)	(2.89)	(4.37)	(1.99)
c_{10}(AG)		-0.2199	0.9683***	-2.8891***	-0.1513***
		(-0.75)	(12.02)	(-6.67)	(-8.23)
c_{11}(OP)		-0.1782	1.0176***	1.6476***	0.0168
		(-0.51)	(9.72)	(4.41)	(0.78)
c_{12}(FDI*EX)		1.2431***	0.2562***	0.2258***	0.0477
		(3.07)	(24.46)	(3.74)	(0.83)
R^2	0.8819				
Breusch-Pagan Test	18.001 (p-value=0.6489)				
Engle-Granger Test	-2.019*** (-7.75)				

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level
3) Definitions of variables are the same in Table 1.1.

Table 3.4. Continued (Model 1.3.)

Estimated Variables (Definitions)	Estimation Results of Equation (3.4)			
	Thailand	**Vietnam**	**India**	**U.S.**
d_0(Intercept)	0.2354	0.3561*	0.3564**	0.0264
	(0.25)	(2.01)	(2.33)	(0.95)
d_1(MS)	0.5736***	0.2435***	0.2817***	0.1226**
	(18.72)	(10.64)	(26.89)	(7.58)
d_2(GDP)	0.3195***	0.3161***	0.7321***	0.1773***
	(7.58)	(4.68)	(12.01)	(10.14)
d_3(FDI)	-0.1151***	0.1389***	-0.0211	0.0133*
	(17.11)	(6.91)	(-1.52)	(1.93)
R^2	0.8911			
Breusch-Pagan Test	18.001 (p-value=0.6489)			
Engle-Granger Test	-2.019*** (-7.75)			

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level
3) Definitions of variables are the same in Table 1.1.

●**Economic Growth.** OLS and IV/GMM results indicate that the GDPs for Thailand, Vietnam, and India positively affect rice export volume while U.S. GDP has a negative effect. However, SUR results show that top four rice exporting countries have a positive GDP effect on rice export volumes, and India's rice export volume is elastic relative to India's GDP. According to OLS and IV/GMM results, U.S. GDP negatively affects rice export volumes, which indicates that for positive U.S. economic growth, total rice export volumes would decrease. [64]

[64] In Figure 3.3, in the United State, ratio of GDP is less than ratio of rice export volume. And the ratio of US rice exports to US GDP is less than 1% (compared to Thailand (4%), Vietnam (6.5%)). Therefore, US (relatively developed country) rice exports have a negative effect on GDP with respect to OLS and IV models. However, if we consider the other major rice exporting countries' situation (Thailand, Vietnam, and India) based on SUR estimation, the effects of US rice exports on US GDP are ambiguous (model 1.1 has a negative with statistically significant, model 1.2 and 1.3 have a positive with statistically insignificant). Thus, the evidences of the U.S. support to the neutrality proposition regarding of rice exports in the U.S. economy. The U.S. economy may have grown with the aid of domestic capital formation and independently of the growth of rice exports.

●**Concentration Ratio.** CR4 positively affects rice export price even if it is not elastic. That is, increasing market power or intensified market concentration regarding rice exports can increase rice export prices.

●**Oil Price and Transportation Cost.** Oil price and transportation cost (c.i.f./f.o.b. ratio) have positive effects on rice export price, and transportation cost is elastic to rice export price. This implies that increasing transportation costs (for rice exports) can affect an increase in the rice export price.

●**Export Wheat and Maize Prices.** Export wheat price has a positive and statistically significant effect on rice export price while the export maize price is also positive but is statistically insignificant. That is, wheat and rice are substitutable goods but inelastic in terms of their substitute effects.

●**Total Harvested Area.** This variable has a negative effect on rice export price. This implies that increasing harvested area within exporting countries puts downward pressure on rice export price with respect to supply and demand.

●**Exchange Rate.** The exchange rate has a positive effect on rice export price. In terms of the relationships between the exchange rate and export price, if an exporting country's currency depreciates, excess demand for that exporting country will shift up resulting in an increased export rice price and export volume. Therefore, increasing exporting countries' exchange rate will increase both export rice price and volume.

●**FDI, Market Share, Export Volume, Inflation, Population, GNI, Human Capital, Agricultural Value, and Openness Measure.** Figure 3.3 illustrates that the GDP of both Thailand and India have significantly increased with respect to rice export volume. In Figure 3.3, although top four exporting countries GDPs increase in response to increase

in rice export volumes, Vietnam and the United States are under the 45 degree line (AB). That is, Thailand and India have relatively strong effects where increases in economic growth can increase the volume of rice exported. And, the increasing of FDI, market share, rice export volume within the top four exporting countries have positive (though insensitive) effects on GDP. Inflation rates have negative effects on GDP (but not for India and Vietnam). GNI, human capital, population, and openness measure have positive effects on GDP. This implies that income and human capital are two sources that increase GDP with respect to economic growth theory. Also, the interaction between FDI and the rice trade has a positive GDP effect and implies that FDI and rice trade complement each other in developing economic growth for the top four rice exporting countries.

●**Concentration Ratio on Market Share and GDP.** The effects of market share on CR4 are positive and inelastic. This means that increasing market share will increase the market power or concentration within the rice export market. GDP's effects of on CR4 are positive and inelastic. This implies that the economic growth of exporting countries affect the increase of market power. Especially, the economic growth rates of Thailand, India, and Vietnam all have relatively high impacts on market concentration.

On the basis of this chapter, the main findings are as follows: First, the major rice exporting countries have market power in the international rice market because major rice exporter's market power has a significant positive effect on export rice price. That is, rising concentration ratio in major rice exporting countries does tend to lead to export rice price rises. Second, this analysis shows that trade and economic growth have a bi-directional causal relationship. Several previous studies (Solow, 1957; Feder, 1983; Frankel and Romer, 1999; and Makki and Somwaru, 2004) have shown the effects of

trade on economic growth. However, in this paper, we analyze the bi-directional effects of trade and economic growth. With respect to the estimated results, there are also positive effects economic growth has on trade within the world rice market, implying that we need to consider the bilateral direction that exists between both trade and economic growth. For example, in Thailand, the effect of economic growth on trade is 0.983 and is statistically significant and the effect of trade on economic growth is 10.262 and is statistically significant as well. Even if the effects of trade on economic growth are greater than those effects of economic growth on trade, there exist positive relationships between trade and economic growth. However, the validity of relationship between trade and economic has been widely debated because the results are mixed and there is a lack of substantive evidence (Jin and Yu, 1996)

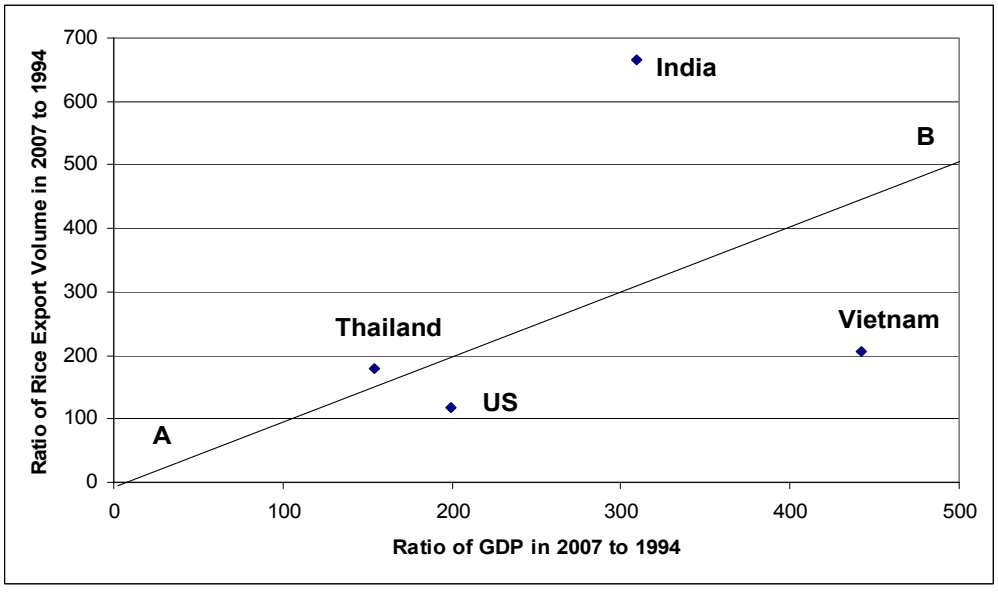


Figure 3.3. The Changes in GDP and Rice Export based on Top 4 Major Rice Exporting Countries (1994=100)
Note: The line AB indicates the 45 degree line.

Third, FDI and rice exports contribute towards advancing economic growth in Thailand, Vietnam, and India because there is positive interaction between FDI and rice export in model 1.2. Makki and Somwaru (2004) mentioned that FDI is often the main channel through which advanced technology is transferred to developing countries. In this paper, the empirical result of interaction effect between FDI and rice export is greatest in magnitude for Thailand. Therefore, this study concludes that the effects of FDI and rice export on economic growth in Thailand, Vietnam, and India are relatively strong.

Finally, in model 1.3, this chapter showed the relationship between market power and economic growth. According to this result, economic growth can affect trade volume, and furthermore can affect market power. Thailand, Vietnam, and India exhibit especially strong positive relationships between market power and economic growth. This study concludes that these countries have more market power on the world rice market in terms of increased economic growth stemming directly from increased rice exports.

The findings in this chapter suggest that rice exports in major rice exporting countries positively affect the economic growth in these countries, while the economic growth in major rice exporting countries contribute to the increase of rice exports. This highlight is the importance of agricultural exports as an engine of economic growth, and integral role rice exports imply in these economies. This result supports Johnston and Mellor's (1961) argument that increasing agricultural exports is an important factor for stimulating economic growth. Therefore, agricultural exports should not be ignored as an important factor of economic growth. Furthermore, rice export-promotion policies in major rice exporting countries continue to be considered as tools to not only enhance exports, but to spur economic growth as well.

3.6. References

Alcala, Francisco and Ciccone, Antonio. "Trade and Productivity." *The Quarterly Journal of Economics* (2003)

Borensztein, E., Gregorio, J. De, and Lee, J-W. "How does Foreign Direct Investment affect Economic Growth?" *Journal of International Economics* 45(1998):115−35.

Cameron, Sam. "Export Supply Function Estimates for the Pakistan Carpet Industry." *BCI Research Paper* 9(2005).

Charles, D. DeLorme, Klein, Peter G., Kamerschen, David R., Voeks, Lisa Ford. "Structure, Conduct, and Performance: A Simultaneous Equations Approach." *Applied Economics* 35(2002):13−20.

Engle, R. E. and Granger, C. W. J., "Cointegration and error-correction: Representation, estimation, and testing," *Econometrica* 55(1987):251−76.

Feder, G. "On Exports and Economic Growth." *Journal of Development Economics* 12(1983):59−73.

Frankel, J.A, and Romer, D. "Does Trade Cause Growth?" *American Economic Review* 89(1999):379−399.

Greene, W. *Econometric Analysis*. New York: Macmillan Publishing Company, 1990.

Henriques, Irene and Sadorsky, Perry, "Export-led Growth or Growth-Driven Exports? The Canadian Case." *The Canadian Journal of Economics*, 29(1996):540−555.

Jin, Jang C. and Yu, Eden S. H. 1996. "Export-led Growth and the US Economy: Another Look." *Applied Economics,* 3, pp.341−44.

Johnston, Bruce F. and Mellor, John W. "The Role of Agriculture in Economic Development." *The American Economic Review*, 51(1961): 566−593.

Konya, Laszlo. "Exports and Growth: Granger Causality Analysis on OECD Countries with a Panel Data Approach." *Economic Modeling,* 23(2006):978−992.

McCombie, J.S.L and Thirwall, A.P. *Economic Growth and the Balance-of-Payments Constraint*. New York: St. Martin's, 1994.

Makki, Shiva S. and Somwaru, Agapi. "Impact of Foreign Direct Investment and Trade on Economic Growth: Evidence from Developing Countries." *AJAE* 86(2004): 795−801.

Mankiw, N. Gregory, *Macroeconomics.* Worth Publishers, 2003.

Marion, Bruce W., Muller, Willard F., Cotterill, Ronald W., Geithman, Fredrick E., Schmelzer, John R. "The Price and Profit Performance of Leading Food Chains." *AJAE* 61(1979): 420−33.

Martinesz, Inmaculada and Celestino, Suarez-Burguet. "Transport Costs and Trade: Empirical Evidence for Latin American Imports from the European Union*." J. Int Trade and Economic Development* 14(2005):353−71.

Mohen, Bahmani-Oskooee and Ltaifa, Nabil. "Effects of Exchange Rate Risk on Exports: Cross-country Analysis." *World Development* 20(1992): 1173−81.

Samuelson, Paul A. "Modes of Thought in Economics and Biology." *The American Economic Review* 75(1985):166−172.

Shaffer, Ron, Deller, Steve, and Marcouiller, Dave. *Community Economics*. Blackwell Publishing, 2003.

Sohn, Chan-Hyun. "Trade Structure, FTA and Economic Growth: Implications to East Asia." *WTO, China, and the Asian Economics* IV(2006).

Solow, R.M. "Technical Change and the Aggregate Production." *Review of Economics and Statistics* 39(1957):312−20.

Stutely, Richard. *Guide to Economic Indicator.* Bloomberg Press, 2003.

Van, den Berg and Lewer. *International Trade and Economic Growth*: M.E. Sharpe. 2007.

Van, den Berg. "The Relationship between International Trade and Economic Growth in Mexico." *North American Journal of Economic and Finance* 8(1997):1−21.

Wooldridge, Jeffrey M. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2001.

Zellner, Arnold. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." *Journal of the American Statistical Association* 57(1962): 348−68.

CHAPTER 4

AN EMPIRICAL EXAMINATION OF THE IMPORT DEMAND MODEL AND WELFARE EFFECTS: THE CASE OF RICE IMPORTING COUNTRIES

4.1. Introduction

Since November 2007, international rice prices have been soaring exacerbated by the imposition of export restraints imposed by a growing number of countries. Figure 4.1 illustrates that the trend in world rice price has gradually increased up until 2007. The rice price for April 2008 was up 158% as compared to the same period in 2007. Although this phenomenon may signal a short term trend, international rice prices are expected to remain at relatively high levels due to increased fertilizer and fuel costs, this holds true especially as rice stocks held by those exporters are still marketed and sold in an unrestrained fashion (FAO rice market monitor, 2008). Average year to year variations for rice importers are greater than for rice exporters (see Figure 4.2). That is, the world rice market is under the unbalanced situation which limits exporting countries while expanding rice consumption. For example, in Figure 4.2, major rice exporting countries' exported volumes have annually increased less than 50% while major rice importing countries' imported volumes have annually increased over 200%.[65]

In this situation, we need to consider the rice import demand market structure in order to analyze resulting price effects. Therefore, this chapter presents econometric

[65] In Figure 4.2, annual average variations of rice exported volumes for Thailand, Vietnam, India, and the United States are 10%, 20%, 46%, and 13%, respectively. However, annual average variations of rice imported volumes for Nigeria, Indonesia, and Philippines are 222%, 265%, and 242%, respectively. In addition to the unbalanced exported/imported volume situation, continued restrictive export policies are expected to constrain world supplied and potentially sustain high prices (FAO rice monitor, 2008).

estimates of the world rice market for an import demand function using annual data from 1994 through 2007. This study estimates price and income elasticities for the world rice market and calculates the welfare effects in terms of consumer surplus for the top four rice importing countries (Indonesia, Philippines, Nigeria, and Saudi Arabia).

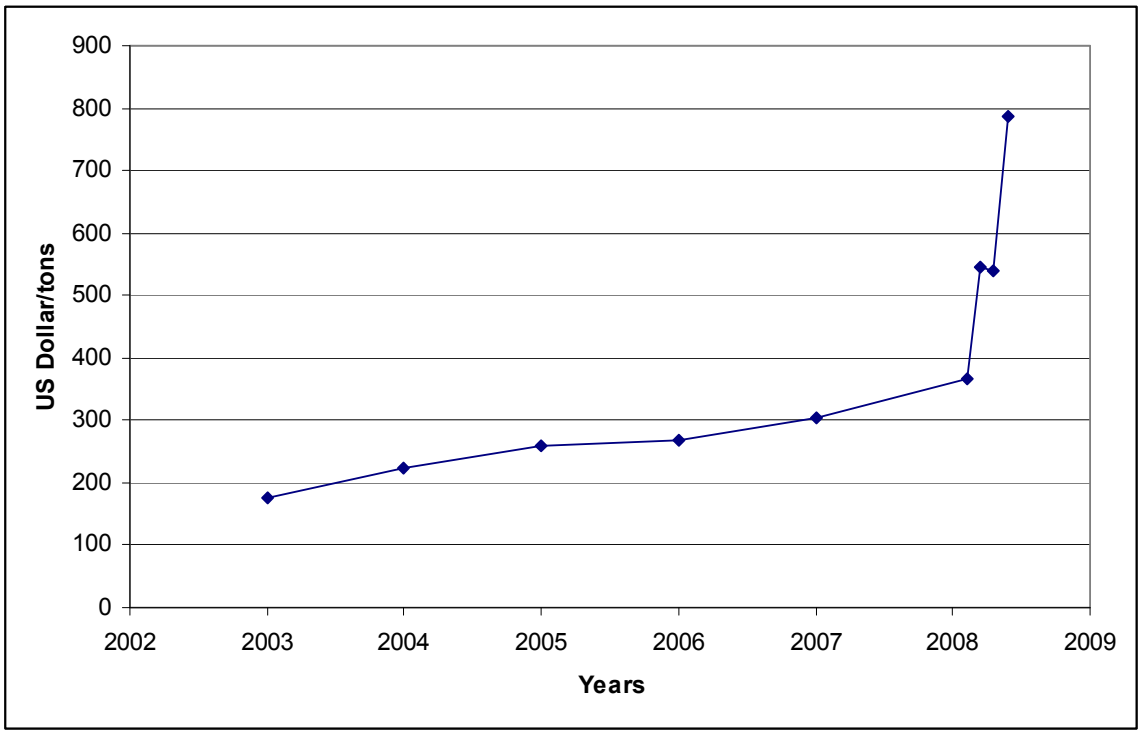
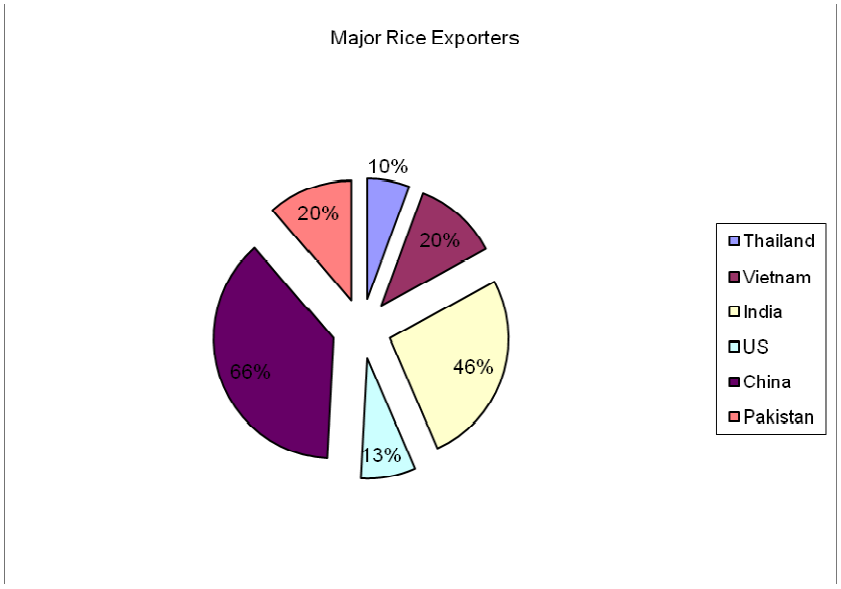


Figure 4.1. World Rice Price Trends (From 2003 through April. 2008)
Note: World rice price is FOB Thailand 25% price. The year of 2008 includes monthly data from January to April (Source: USDA world rice calendar 2008).

This chapter is organized as follows: First, a comprehensive literature review is conducted. The considered papers estimated the import demand function with respect to price and income. Second, methodology and data are discussed. The methodological approach adopted herein includes an import demand function, Instrumental Variable (IV) and Seemingly Unrelated Regression (SUR) models. Third, this study examines the unit root and cointegration tests with respect to annual time series data and then uses two-

stage least squares (2SLS) and the SUR method (in terms of simultaneous equations) to construct efficient coefficient estimators for each of the endogenous variables. Empirical results show how importing price and income affect rice import quantity in the top four rice importing countries. Finally, a summary and conclusion are presented along with suggestions for future study.



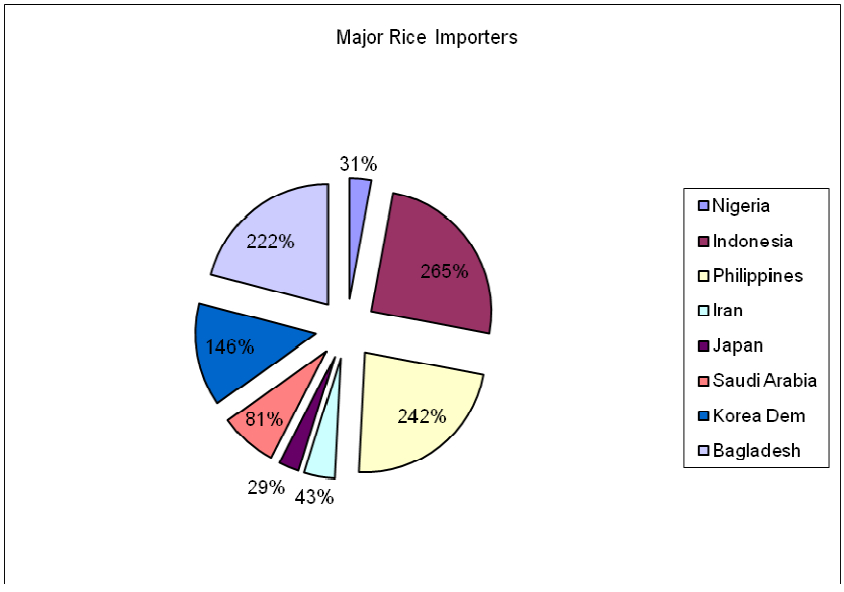


Figure 4.2. Average Variations of Rice Export and Import Trade Flows from 1994 to 2007
Source: FAO STAT (Rice Market Monitor, 2008)

4.2. Literature Review

An extensive literature has evolved in the past decades using economic theory to estimate the import demand function. This part outlines recent studies concerning developing countries, including econometric analyses, and structural economic analysis of import volumes and domestic price.

Houthakker and Magee (1969) analyzed demand elasticities for imports and exports in terms of income and price within the United Kingdom, Japan, and the United States using 1951-1966 annual data. They used the import and export equations which included variables for income, Gross Domestic Product (GDP), and a price index. They mentioned that the U.S. income elasticity of demand for total imports is about the same as that of other developed countries, but the income elasticity of other countries' demand for U.S. exports is relatively low and therefore, trends for the U.S. trade balance have worsened over time.

Murray and Ginman (1975) argued that imports depend upon the price of imports specified in domestic currency as well as the price of domestically produced substitutes. They estimated the relationships which constrain the influence of the two prices. They used a linearized, logarithmically transformed model with respect to the import demand function. Their model included the import price, domestic price, and domestic price indices with non-traded items. They mentioned that the traditional import demand model is inappropriate for estimating aggregate import demand parameters due to the aggregation of heterogeneous factors and the existence of differentiated commodity groupings.

Deyak et al. (1988 and 1993) analyzed the sensitivity of Canadian import demand in terms of changes in prices, incomes, and exchange rate from the 1970s to the 1980s. They include the exchange rate which they defined as foreign currency per unit of domestic currency in the import demand function. Also, they distinguished the models with respect to foreign prices, domestic prices, and exchange rates. They concluded that import demand is relatively elastic in income and relatively inelastic in prices because Canadian import demand is not homogeneous and three types of prices (foreign wholesale price, Canadian wholesale price, and the exchange rate) tend to affect the quantity imported.

Carone (1996) introduced new estimations of aggregate demand for total and non-oil related merchandise imports for the U.S. over two decades (1970−92). He extended the import demand function in terms of the quantity of non-petroleum merchandise imports. Carone discovered strong relationships between the level of imports to real income and relative prices. Also, he mentioned that income effects play a role in determining import demand with a very high degree of elasticity while estimated price elasticities are very low, or inelastic. That is, strong domestic economic activity can provide the expansion impulse to the rest of industrialized countries and advance growth in developing countries.

4.3. Modeling and Data

Empirical estimations of an import demand model include that the demand for imports is the function of domestic price and real income (Murray and Ginman, 1975; Mayes, 1981; Deyak and Sawyer, 1988; and Carone, 1996). The import demand model includes domestic rice price and income based on major rice importing countries to

estimate price/income elasticities. This chapter suggests that in modeling the import demand function, the log-log model is preferable to a linear model. In order to assess how changes in income and domestic rice price affect the export rice price, the log-log import demand function is specified as follows:

$$(4.1) \quad Log\sum_{i=1}^{4}(IM_{it}) = a_0 + a_1 Log\sum_{i=1}^{4}(GNI_{it}) + a_2 Log(DRP_t) + \varepsilon_t$$

where IM_{it} is the import volume of rice for country i in period t; GNI_{it} is the Gross National Income (GNI) for importing country[66] i in period t; DRP_t is domestic rice price in period t; and ε_{1t} is the random error term. Equation (4.1) indicates the rice export price is a function of income of major rice importing countries, and domestic rice price. Coefficients a_1 and a_2 indicate the income and price elasticities of import demand, respectively. On the basis of demand theory, we can expect that $a_1 > 0$ and $a_2 < 0$.

Although this study can be estimated in terms of equation (4.1) by utilizing data on GNI and domestic rice prices for the top four rice importing counties, this process needs other determinants of the two explanatory variables (*GNI* and *DRP*) due to problems resulting from endogeneity issues. We therefore need to identify other factors associated with domestic price and GNI that are suitable for interaction with domestic consumption, oil price and substitute goods' prices.

Other variables that need to enter into equation (4.1) are the effects of GDP, FDI, inflation, and population on GNI. These factors indicate the effects which can influence national income in terms of economic growth theory. The domestic rice price equation (4.2) includes rice consumption, oil price, and substitute goods prices (wheat and maize)

[66] Rice importing countries are Indonesia, Philippines, Nigeria, and Saudi Arabia with respect to top four importing volumes.

based on rice importing countries, and GNI equation (4.3) includes real GDP, FDI, inflation, population. Including all the variables in equation (4.1) yields the specified models as follows;

(4.2)

$$Log(DRP_t) = b_0 + b_1 Log\sum_{i=1}^{4}(CON_{it}) + b_2 Log(OIL_t) + b_3 Log(DWP_t) + b_4 Log(DMP_t) + \varepsilon_{1t}$$

(4.3)

$$Log\sum_{i=1}^{4}(GNI_{it}) = c_0 + c_1 Log\sum_{i=1}^{4}(GDP_{it}) + c_2 Log\sum_{i=1}^{4}(FDI_{it}) + c_3 Log\sum_{i=1}^{4}(IN_{it}) + c_4 Log\sum_{i=1}^{4}(POP_{it}) + \varepsilon_{2t}$$

where CON_{it} is the rice consumption for importing country *i* in period *t*, OIL_t is the annual average U.S. crude oil price in period *t*, and DWP_t and DMP_t [67] are the domestic price for wheat and maize in period *t*, respectively. And FDI_{it} is the average foreign direct investment of importing country *i* in period *t*, IN_{it} is the average inflation rate of importing country *i* in period *t*, and POP_{it} is the average population rate of importing country *i* in period *t*. In order to estimate how changes in rice consumption, oil price, the assumption that domestic wheat/maize prices affect the domestic rice price, equation (4.2) is utilized, and how ease of access affects changes in GDP, FDI, inflation, population effects on GNI are included also in equation (4.3), respectively. Based on demand theory, we can expect the estimated coefficients' signs to be as follows; $b_1 < 0$, $b_2 > 0$, $b_3 > 0$, $b_4 > 0$, $c_1 > 0$, $c_2 > 0$, $c_3 < 0$, and $c_4 > 0$.

[67] Domestic wheat and maize price are calculated as the same method of domestic rice price. Exporting wheat price is Canadian No.1 Western Red Spring 13.5% and exporting maize price is the US No.2 yellow, fob Gulf ports.

Data for this analysis were obtained from the United States Department of Agriculture (USDA) and the World Bank. The USDA database includes information such as importing volume and consumption. And the World Bank database contains information such as real GDP, FDI, GNI, inflation ratio, and population growth. Price databases were obtained from the International Rice Research Institute and the Bank of Indonesia. The annual data cover the top four rice importing countries from 1994 through 2007 (see Table 4.1).

Given that this is annual time-series data, we need to pre-test for stationarity and the existence of a cointegration vector before we move on to model specification. We estimate the system equation in terms of using IV and three stage least squares (TSLS) for the SUR model. The IV procedure allows us to overcome endogeneity problems that exist between the interaction between GNI and domestic price. The SUR method allows for different error variances in each equation and for the correlation of these errors across equations (Greene, 1990).

Table 4.1. Descriptive Data of the Estimated Variables

Variables	Observations	Mean	Std	Min	Max
Import Quantity (1000 tons)	14	5471.78	1929.00	2318	9941
Importing countries' GDP (U.S. $)	14	5.77e+11	2.10e+11	3.39e+11	1.03e+12
Importing countries' GNI (U.S. $)	14	5.51e+11	1.87e+11	3.88e+11	9.83e+11
Domestic Rice Price (U.S. $/ton)	14	0.054	0.022	0.024	0.089
Domestic Wheat Price (U.S. $/ton)	14	0.034	0.017	0.012	0.075
Domestic Maize Price (U.S. $/ton)	14	0.017	0.008	0.007	0.034
Oil Price (U.S. $/bbl)	14	29.36	16.74	11.94	64.2
Importing countries' FDI (U.S. $)	14	5.98e+09	4.52e+09	3.60e+08	1.40e+10
Importing countries' Inflation Rate (annual %)	14	47.13	19.80	17.17	79.06
Importing countries' Consumption (1000 tons)	14	47274	3209.05	41380	51300
Importing countries' Population	14	4.32	3.34	3.81	4.83

Note: Definitions of variables are the same in Table 1.1.

4.4. Estimation and Results

4.4.1. Unit Root and Cointergration Tests

Given that this is annual time-series data, we need to pre-test for stationarity and the existence of a cointegration vector before we move on to the model specification. This study estimates the system equation by OLS and Instrumental Variables (IV). The IV estimation procedure allows us to overcome endogeneity problems stemming from the interaction between national income and domestic rice price.

The unit root test is utilized in order to determine the order of integration for the variables under consideration. Another test employed for testing the order of integration is known as the Augmented Dickey-Fuller (ADF) test. This procedure statistics rejects the null hypothesis of non-stationarity of all variables, when first difference variables are used. Table 4.2 identifies those variables that are stationary of order 1. In Tables 4.3 and 4.4, are listed the results of the Engle-Granger (EG)[68] test which is conducted as to estimate unit roots on the residuals from the regression model. The null hypothesis of this test is that the residuals are non-stationary. With respect to the results tabulated in Tables 4.3 and 4.4, this study concludes that the residuals are stationary which means that the dependent variables and explanatory variables for each of the regression models are cointegrated. Also, we call the estimated equation the *static relationship function* and interpret its parameters as long run parameters (Greene, 1990).

4.4.2. Endogeneity Problems and Empirical Results

This study tested for the effect of domestic price and income on total import quantity with respect to the import demand function. This analysis is covered in the framework of the top 4 rice importing counties from 1994 through 2007. Also, this study

[68] See Engle and Granger (1987)

constrained the model to two equations. The first model examines the effects of consumption, oil price, and domestic wheat and maize prices on domestic rice price; and the second model examines the effects of GDP, FDI, inflation, and population on national income.

Table 4.2. Results of Unit Root Test

	ADF in Levels Lag(1)		ADF First Differences Lag(1)	
	Without Trend	**With Trend**	**Without Trend**	**With Trend**
Log(Import quantity)	−0.8188*	−0.9847*	−2.004***	−2.2044***
	(−2.21)	(−2.2)	(−4.32)	(−4.77)
Log(GNI)	−0.232	−0.244	−0.6041	−1.0974**
	(−0.14)	(−1.26)	(−1.67)	(−3.23)
Log(Domestic Rice Price)	−0.4866	−0.3364	−1.1109*	−1.8638***
	(−1.81)	(−1.10)	(−2.23)	(−3.92)
Log(Consumption)	−0.0587	−0.0289	−0.743*	−1.21***
	(−1.32)	(−0.08)	(−1.96)	(−5.57)
Log(Oil Price)	−0.0536	−0.7707*	−1.5415***	−1.917***
	(−0.25)	(−2.27)	(−3.96)	(−6.07)
Log(Domestic Wheat Price)	−0.3391	−0.2161	−0.6915*	−1.7614**
	(−1.13)	(−0.9)	(−1.98)	(−3.26)
Log(Domestic Maize Price)	−0.4125	−0.2887	−1.0537*	−1.949***
	(−1.33)	(−0.99)	(−1.99)	(−4.09)
Log(GDP)	−0.0543	−0.4088	−1.2632**	−1.8371***
	(−0.24)	(−1.29)	(−2.6)	(−4.27)
Log(FDI)	−0.4308	−0.4069	−0.9442*	−1.1732*
	(−1.43)	(−1.28)	(−1.97)	(−1.99)
Log(Inflation)	−1.2478**	−1.3354**	−1.7715**	−1.8242**
	(−2.95)	(−2.85)	(−3.11)	(−3.0)
Log(Population)	−0.0171	−1.395***	−1.3473*	−0.0264*
	(−1.21)	(−4.48)	(−2.08)	(−2.12)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

This study tested for over-identification using the *Hansen J-test.* Test statistics show that over-identification is not a problem in the equation. Instrument validity was tested using the *Anderson* test. The *Anderson* test has a null hypothesis that the instruments are uncorrelated with the error term. In terms of the results, all cases can reject the null hypothesis and thus it can be concluded that at least one of the instrumental variables is not correlated with the errors. If the instrument variables are not exogenous, then the IV procedure is not consistent and we cannot cast doubt as to the validity of the instrument. The *Breusch-Pagan* test indicates that this equation has heteroskedasticity (because the null hypothesis was rejected). Therefore, this equation is estimated with the IV/GMM procedure due to autocorrelation.

Table 4.3 shows the econometric results of OLS, IV/GMM, and SUR. In terms of the OLS results, the GNI coefficient is positive but is not statistically significant. The domestic rice price coefficient is negative and statistically significant. However, both IV/GMM and SUR results indicate that the coefficient signs are correct and are statistically significant.

According to OLS results, we conclude that price elasticity and income elasticity of the world rice market are −0.6346 and 0.5357, respectively, and inelastic, but income elasticity is not statistically significant. Also, the results of IV/GMM and SUR indicate that price elasticity is −0.9385 and −0.787, and income elasticity is 0.8799 and 0.5308 with statistically significance, respectively.[69] In the next section, we estimate the welfare effects for using these price and income elasticities.

[69] According to Islam (1978) and Barker et al. (1985), estimated price/income elasticities for rice were as follows:

Table 4.3. Empirical Results of Import Volume: Annual Observations from 1994 through 2007 (Dependent Variable: Log (Import Quantity))

Independence Variables	OLS	IV/GMM	SUR Estimates
Intercept	−3.399	−7.8537	−3.5415
	(−0.89)	(−1.76)	(−1.09)
Log (GNI)	0.5357	0.8799**	0.5308*
	(1.70)	(2.49)	(1.98)
Log (Domestic Rice Price)	−0.6346**	−0.9385**	−0.787***
	(−2.87)	(−2.98)	(−4.34)
R-square	0.4366	0.3043	0.406
Observations	14	14	14
Breusch-Pagan	0.69	–	–
	p-value: 0.4058		
Anderson	–	20.264**	–
		p-value: 0.00	
Hansen J	–	3.983	–
		p-value: 0.2634	
Engle-Granger	−1.4702***	−1.164***	−1.4246***
	(−3.57)	(−3.3)	(−3.55)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

Rice Importing Countries	Islam (1978)		Barker et.al (1985)	
	Price Elasticity	Income Elasticity	Price Elasticity	Income Elasticity
India	-6.09	10.32	-0.45	0.5
Korea	-3.35	2.72	N/A	N/A
Malaysia	-0.32	0.34	N/A	N/A
Pakistan	-8.17	5.05	N/A	N/A
Philippines	-5.31	1.18	-0.4	0.25
Sri Lanka	-0.82	0.97	-0.6	0.4
China	N/A	N/A	-0.5	0.45
Indonesia	N/A	N/A	-0.6	0.5

Table 4.4 shows the results of the simultaneous equations in terms of equations (4.2) and (4.3). The oil price and consumption coefficients are positive and statistically significant. But the effects of substitute goods are not statistically significant. That is, increasing consumption and oil price affect the increasing domestic rice price. And, the coefficients of GDP, FDI, and population are positive and statistically significant. These results imply that increasing economic growth, FDI, and population can advance income in rice importing countries.

Table 4.4. Empirical Results of Simultaneous Equations Using Annual Observations from 1994 through 2007

Simultaneous Equation Estimates

$$Log(DRP_t) = 25.7149 + 1.86475Log(Consumption_t) + 0.6652Log(OIL_t) + 0.5339Log(DWP_t) - 0.1462Log(DMP_t)$$
$$(3.09)^{**} \quad (3.07)^{***} \qquad (2.48)^{**} \qquad (1.04) \qquad (-0.25)$$

$$Log(GNI_t) = -3.173 + 0.6507Log(GDP_t) + 0.0611Log(FDI_t) - 0.0119Log(Inflation_t) + 0.7748Log(POP_t)$$
$$(-1.51) \quad (7.84)^{***} \qquad (4.82)^{**} \qquad (-0.47) \qquad (2.36)^{**}$$

$R^2 = 0.9775$ Engle-Granger test= -1.4246^{***} (-3.55)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

4.4.3. Welfare Effects of Import Demand Function

In Figure 4.1, the world rice price gradually increased up until 2007 when in April 2008 rice prices spiked 158% compared to the same period in 2007. Because of this variation, we need to consider the changes in social welfare, especially, consumer surplus because the increase of commodity price can positively or negatively affect the producer

(due to a dependency on the supply elasticity) while the consumer can be negatively affected (no matter what the price elasticity is) in terms of social welfare theory.

This chapter applies existing welfare estimation techniques to measure the consumer surplus and extends the work of Brynjolfsson and Smith (2003). They analyzed the empirical estimation that quantified the economic impact of increased product variety made available through electronic markets. Although Brynjolfsson and Smith (2003) divided price factors into terms of existing and new products, this study used only existing price factors.

In order to determine consumer surplus, we need to utilize compensating variation because consumer surplus cannot be directly obtained, and the utility functional forms for import rice countries are not known. The Compensating Variation (CV), as defined from increased quantity, represents the amount of money which must be taken away from the consumer following the increase in quantity that leaves the consumer just as well off as before the change (see Just, Hueth, and Schmitz, 2004). That is, the maximum amount of money the consumer would be willing to pay rather than giving a higher quantity. The theoretical formation of CV is as follows:

(4.4) $CV = e(P_0, u_1) - e(P_1, u_1)$

where CV is the compensation variation, P_0 and P_1 are the vectors of pre and post prices of existing products, and u_1 is the post utility level. In terms of CV definition, equation (4.4) explains how much a pre-consumer would need to be compensated to be just as well off as he would be after the price change.

Equation (4.4) contains the expenditure function with respect to utility level. Again, it is hard to estimate the utility level in equation (4.4). Therefore, we need another

expression of CV in terms of using the indirect utility function. To apply the indirect utility function, we specify the standard log-log linear demand function. This paper is based especially on the import demand function for estimating CV. The Hicksian demand function is specified as follows:

(4.5) $x(p, y) = Ap^{\alpha} y^{\delta}$

where P is the domestic rice price, y is income (also indicates the gross national income of rice importing countries), α is price elasticity, δ is income elasticity and A is the constant. Using Roy's identity, we obtain another expression of equation (4.5) and specify it as follows:

(4.6) $x(p, y) = -\dfrac{\partial v(p, y) / \partial p}{\partial v(p, y) / \partial y}$

where $v(p, y)$ is the indirect utility function. Using the partial difference of equation (4.5),

(4.7) $v(p, y) = -A\dfrac{p^{1+\alpha}}{1+\alpha} + \dfrac{y^{1-\delta}}{1-\delta}$

And the expenditure function

(4.8) $e(p,u) = \left[(1-\delta)(u + \dfrac{Ap^{1+\alpha}}{1+\alpha}) \right]^{1/(1-\delta)}$

Fortunately, we obtain the CV equation without utility level if we substitute equation (4.8) into equation (4.4)[70].

(4.9) $CV = -y + \left[\dfrac{1-\delta}{1+\alpha} y^{-\delta} (p_0 x_0 - p_1 x_1) + y^{(1-\delta)} \right]^{1/(1-\delta)}$

where x_0 and x_1 are pre and post-production of existing products, respectively.

[70] See the specific procedures of Hausman (1981)

To compare between CV and Consumer Surplus (CS), we need to look at the income elasticity due to the difference between Marshallian demand and Hicksian compensated demand. Figure 4.3 shows the effects of decreasing price with respect to utility level. If the price decrease from p_1 to p_2, the utility curve move upward from u_1 and u_2. Marshallian demand is $D(y_1)$ at initial income and Hicksian demand is $H(u_1)$ at the initial utility level. In this situation, CV and CS are the area of $A+B$ and $A+B+C$, respectively. If there are no income effects, $D(y_1)$ and $H(u_1)$ are identical line, and therefore the area of C will disappear. Applying this situation to equation (4/9), we obtain the simple equation as follows:

(4.10) $$CV = -\frac{p_1 x_1}{1+\alpha}$$

In Table 4.4, the results of OLS indicate that price elasticity estimated to have a value of −0.6346 and is statistically significant while income elasticity estimated is 0.5357 but is statistically insignificant. In terms of these results, this paper calculates consumer surplus[71] using the value of $\alpha = -0.6346$ and $\delta = 0$ obtained from the OLS results. Also, we use the coefficients of the IV/GMM and SUR procedures, with $\alpha = -0.9385$ and $\delta = 0.8799$, and $\alpha = -0.787$ and $\delta = 0.5308$, respectively.

In order to analyze the welfare effects of major rice importing countries influenced rising export rice price, this chapter focuses on the percentage changes of export rice price on the percentage changes of CS. This procedure provides export rice price's effect on consumer surplus for the four major rice importing countries, and includes consumer surplus for major rice importing countries and export rice price to obtain the elasticity of export rice price on CS. To access how changes in the export rice

[71] The calculated CS is shown by Table 5.

price affect the consumer surplus of major rice importing countries, this study uses the simple log-log model specified as follows:

(4.8) $Log(CS_t) = \alpha_0 + \alpha_1 Log(P_t)$

where CS_t is consumer surplus in period *t* and P_t is exporting rice price in period *t*. In conclusion, α_1 indicates the export price elasticity on consumer surplus. The OLS result[72] is as follows:

$$Log(CS_t) = -6.5297 - 0.527 Log(P_t)$$
$$(-25.80)^{***} \quad (-2.91)^{**} \qquad [73]$$
(4.9)
$$R^2 = 0.335 \quad Observations = 14 \quad \text{Engle-Granger test} = -1.0476^{*} (-2.15)$$

Equation (4.9) indicates that the price elasticity on CS is −0.527 and is statistically significant. That is, if export rice price increases by one percentage, importing countries' consumer surplus will decrease by 0.527%. Table 8 shows the changes of consumer surplus with respect to the variable changes of export rice price. Applying this to the recent situation where export rice price has increased approximately 150% since 2007 (see Figure 4.1). In this case, importing countries' CS decreases by about 79% (see Table 4.7). Although the elasticity of export price on CS is less than 1, the reduction of consumer surplus seriously influences importing countries due to recent rice market trends. In coincidence with estimated results in this section, Wailes (2006) investigated the impact of rice price on importers and exporters, and mentioned that in

[72] Again, this study tests the unit root (see Table 4.6). With respect to results of Table 4.6, we conclude that the residuals are stationary which means that dependent variables and explanatory variables of each regression models are cointegrated. P_t indicates the FOB Thailand 25% price from 1994 through 2007 (Source: USDA world rice calendar 2008). t-values are in parentheses.
* indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level.

[73] The results of using the coefficients on IV/GMM and SUR are −0.8969 and −0.8697, respectively. The coefficient signs are correct but statistically insignificant.

2006, rice exporting countries gain producer surplus ($70.3 billion) from higher rice prices while rice importing countries loss consumer surplus ($68.8 billion).

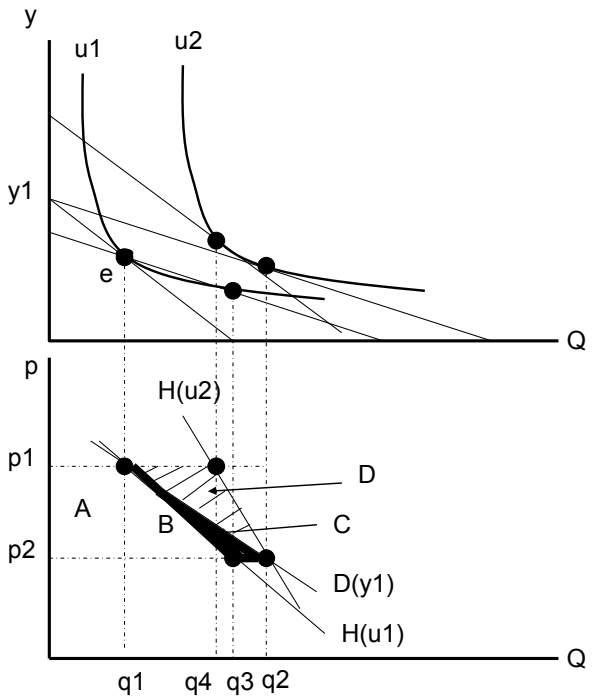


Figure 4.3. The Relationships between CV and CS
Note: The initial point is "e". CV=A+B and CS=A+B+C if price decreases from p1 to p2. D(y1) indicates the Marshallian demand at income y1. H(u1) and H(u2) are the Hicksian demands at u1 and u2, respectively.

4.5. Summary and Conclusions

This chapter analyzes the effects of the domestic rice price and income on the import rice volumes for the top four rice importers using an import demand function. Using annual data from 1994 through 2007, this study shows the price elasticity and income elasticity in rice importing countries. This study explains that consumption and oil price influence on the domestic rice price, and economic growth, FDI, and population contribute to the income of importing countries. Furthermore, this chapter estimates the welfare effects on the increasing export rice price.

Table 4.5. Consumer Surplus Estimates for the Top Four Rice Importing Countries (thousand U.S. dollar)

Years	CS (a)	CS (b)	CS (c)
1994	377870.1	1162292.01	3355917.14
1995	1011197	3762635.21	1086398.09
1996	763977.5	1468752.9	1424076.07
1997	490862.5	1622602.78	16468497.44
1998	825387.2	1987436.77	19573838.4
1999	816750.1	513137.7	514815.92
2000	533672	1681795.51	1485588.11
2001	412455.4	720159.35	720793.32
2002	588362.8	1045080.72	1031748.9
2003	584169.6	2491230.85	2577192.98
2004	560849.9	1385443.27	1400022.29
2005	823526.4	1560582.92	14505911.8
2006	1313315	2909873.77	2840175.86
2007	1306285	4176528.68	1205898.87

Note: (a) is based on $\alpha = -0.6346$ and $\delta = 0$ of OLS using equation (7). (b) is based on $\alpha = -0.9385$ and $\delta = 0.8799$ of IV/GMM using equation (6). (c) is based on $\alpha = -0.787$ and $\delta = 0.5308$ of SUR using equation (6). The calculated values are absolute number. The consumer surplus is the aggregated value of importing countries. CS indicates the thousand U.S. dollar.

Table 4.6. Results of Unit Root Test using variables of CS and export price

	ADF in Levels Lag(1)		ADF First Differences Lag(1)	
	Without Trend	**With Trend**	**Without Trend**	**With Trend**
Log(OLS CS)	−0.665	−0.4866	−1.5655***	−1.8638***
	(−1.52)	(−1.81)	(−4.49)	(−3.92)
Log(IV/GMM CS)	−1.2924***	−1.6909***	−2.0189***	−2.0754***
	(−2.73)	(−3.4)	(−3.19)	(−2.91)
Log(SUR CS)	−1.2929***	−1.6906***	−2.0193***	−2.0762**
	(−2.73)	(−3.4)	(−3.2)	(−2.91)
Log(Export Rice Price)	−0.4866	−0.3364	−1.1109*	−1.8638**
	(−1.81)	(−1.10)	(−2.23)	(−3.92)

Notes: 1) t-values are in parentheses.
2) * indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

Table 4.7. The Changes of Consumer Surplus on Export Rice Price

% Changes of Rice Price	% Changes of Consumer Surplus
1	−0.527
5	−2.635
10	−5.270
15	−7.905
20	−10.541
25	−13.176
30	−15.811
35	−18.447
50	−26.35
100	−52.70
150	−79.05

Note: Rice price indicates FOB Thai 25% price. Consumer surplus is calculated by using the price elasticity of −0.6346 and the income elasticity of zero based on OLS results.

On the basis of results, the main findings are as follows. First, domestic rice price positively influences though not elastic rice import volume. Also, importing countries' incomes have a negative effect (though not elastic) on rice import volumes. That is, the price elasticity of demand and income elasticity are inelastic as regards import rice quantity.

Second, increasing both importing countries' rice consumption and oil price positively affect domestic rice price. In terms of demand theory, increasing consumption can affect price which coincides with the current situation. Oil price also influences transport costs for rice which is adjusted by cost theory.

Third, increasing economic growth, FDI, and population can affect an increase in importing countries' income. This implies that economic growth and population are

sources of national income in terms of economic growth theory, and FDI is the main channel through which advanced technology is transferred to rice importing countries.

Finally, although the elasticity of export price on consumer surplus is less than 1, reductions of consumer surplus have a crucial effect on importing countries due to the recent trends of the world rice market.

4.6. References

Barker, Randolph, Hedt, Robert W., and Rose, Beth. *The Rice Economy of Asia*, Int. Rice Res, Inst, 1985.

Brynjolfsson, Erik and Smith, Michael D. "Consumer Surplus in the Digital Economy: Estimating the Value of Increased Product Variety at Online Booksellers." *Manage Science* 49(2003): 1580−1596.

Campa, Jose Manuel and Goldberg, Linda S. "Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon*?" FRB of New York Staff Report 149*(2002).

Carone, Giuseppe. "Modeling the U.S. Demand for Imports through Cointegration and Error Correction." *Journal of Policy Modeling* 18(1996):1−48.

Deyak, Timothy A., Sawyer, W. Charles., and Sprinkle, Richard L. "An Empirical Examination of the Structural Stability of Disaggregated U.S. Import Demand." *The Review of Economics and Statistics* (1988):337−41.
― "The Adjustment of Canadian Import Demand to Changes in Income, Prices, and Exchange Rates." *Canadian Journal of Economics* (1993):890−900.

Engle, R. E. and Granger, C. W. J. "Cointegration and error-correction: Representation, estimation, and testing," *Econometrica* 55(1987):251−76.

Greene, W. *Econometric Analysis*. New York: Macmillan Publishing Company, 1990.

Hausman, J.A. "Exact Consumer's Surplus and Deadweight Loss." *American Economic Review* 71(1981): 662−76.

Houthakker, H.S. and Magee, Stephen P. "Income and Price Elasticities in World Trade." *The Review of Economics and Statistics* (1969):111−25.

Islam, Badrul, "Price, Income, and Foreign Exchange Reserve Elasticity for Asian Rice Imports." *AJAE* 60(1978): 532−535.

Just, Richard E., Hueth, Darrel L., and Schmitz, Andrew. *The Welfare Economics of Public Policy*. Edward Elgar, 2004.

Mayes, G.M. *Applications of Econometrics*. Principle Hall, 1981.

Murray, Tracy and Ginman, Peter J. "An Empirical Examination of the Traditional Aggregate Import Demand Model." *The Review of Economics and Statistics* (1975):75−80.

Wailes, Eric J. "Rice: Global Trade, Protectionist Policies, and the Impact of Trade Liberalization." *The World Bank* (2006): 177−193.

Wooldridge, Jeffrey M. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2001.

Zellner, Arnold. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." *Journal of the American Statistical Association* 57(1962): 348−68.

CHAPTER 5

CONCLUSIONS

5.1. Conclusions and Policy Implications

This dissertation attempts to analyze the world rice market based on the S-C-P paradigm. In the world rice situation characteristics, we consider the world rice market as distorted, thin and volatile. That is, analyzing structure, conduct, and performance of the world rice market can provide valuable insights for policymakers involved in the world rice market.

In chapter two, this study determined that market power exists in the international rice market with respect to static calculation and hypothesis test, and an exporting country's currency exchange rate greatly determines that country's competitiveness as a net rice exporter relative to other rice producers.

In chapter three, this study examines the existence of market power in the international rice market under the tenets of economic growth theory. The main results propose that there is a bi-directional causality between the international rice trade and economic growth for major rice exporting countries.

In chapter four, empirical results suggest that economic growth, FDI, and importing countries' population positively affect national income, thus, positively affecting rice consumption. Oil price has a strong effect on the domestic rice prices in importing countries. This chapter also estimates the social effects arising from increased rice export prices and examines how consumer surplus is affected in major rice importing countries.

In summary, this study analyzes 1) the structure of the world rice market based on the export supply model; 2) the world rice market was analyzed for what, if any, effect the exchange rate and economic growth have on rice export volumes; and 3) performance of world rice market was examined in terms of how consumer surplus influences rice export prices (See Figure 5.1). Therefore, this dissertation will provide valuable information concerning how export/import rice markets are organized, the sources of market power, the engine of economic growth, and whether welfare effects are changed by price volatility in the world rice market.

In light of these conclusions, it is important for those governments and individuals involved in the formulation and implementation of rice policy that they not consider the impact of domestic rice policies in isolation, but also consider that the broader implications of rice exports extend to the economy as a whole.

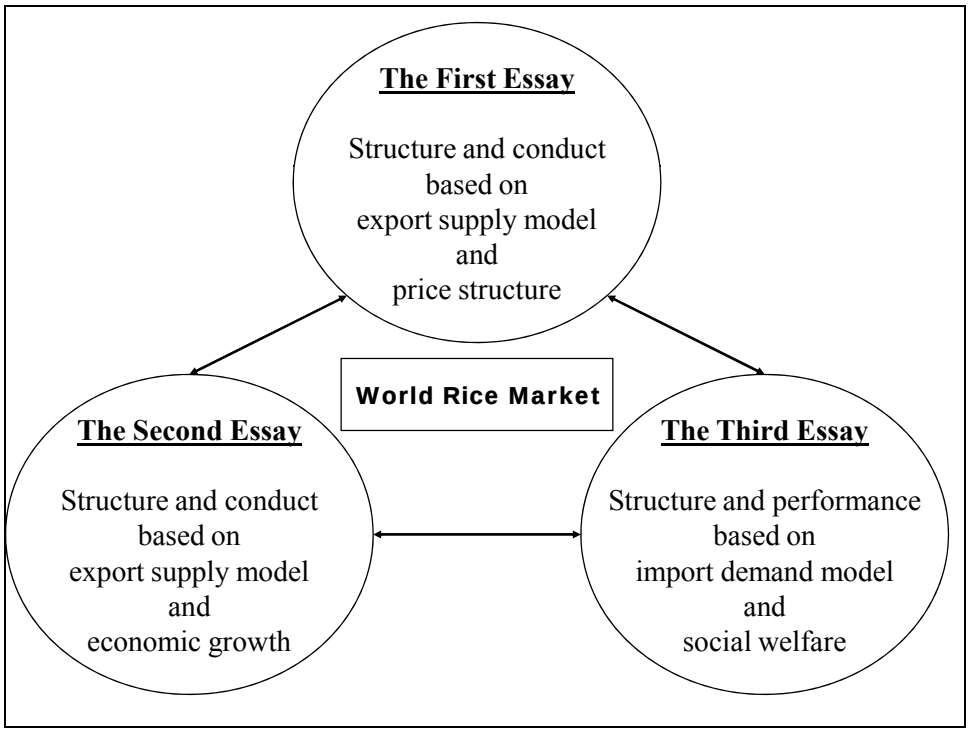


Figure 5.1. Summary of Dissertation

5.2. Limitations and Further Research Opportunities

This study investigates the characteristics of the world rice market and estimates the effects of rice exports/imports on both economic growth and national welfare. However, this dissertation has some limitations that must be addressed in light of conducting future research.

The first limitation of this study is that it cannot follow up the traditional S-C-P paradigm due to the characteristics of rice itself. Rice is not an industrial product, and therefore it depends on regional differences. This study uses aggregated rice data, and the analysis would likely yield different results if rice types were differentiated. Therefore, there remains considerable room to improve the specification of rice types.

The second limitation of this study is that it did not consider impacts stemming from the Asian financial crisis that occurred in the late 1990s. The main rice exporters are located in Asia and were consequently affected by this financial crisis.

Finally, there has been no previous research that has attempted to incorporate empirical estimation into the S-C-P paradigm. Therefore, it was hard to justify the framework empirically. But, the ideas of the export supply model and import demand model were worth of performing the model in the world rice market. In addition, economic growth theory and social welfare analysis are useful of analyzing the conduct and performance of the world rice market.

This study attempted to analyze the relationship between rice exports and economic growth. According to the export-led growth (ELG) hypothesis, export activity leads to economic growth. That is, exports directly affect the production of goods and service for a nation. However, the current study represents the only effort to examine the

effect of rice exports on economic growth based on the log-log function. That is, it is merely saying that both rice exports and economic growth contribute positively to each other. This provides information as to the relationships and impacts between rice exports and economic growth under the static model. Therefore, further study is needed to look into the correlation between rice exports and economic growth based on the impulse response function (IRF) and Granger causality methods. However, examining additional methods which examine the relationships between rice exports and economic growth are beyond the scope of the study.

APPENDIX I. STATA PROGRAM USED FOR THE ECONOMETRIC ESTIMATION

```
reg  ex tp exrp ert  eri
hettest
reg  ex tp exrp ert  eri, robust
predict e, residual
dfuller e, reg lag(0)
reg  exrp op tha exwp exmp ert eri cr4
hettest
predict e1, residual
dfuller e1, reg lag(0)
ivreg2  ex tp (exrp= op exwp exmp tha) ert  eri
predict e2, residual
dfuller e2, reg lag(0)

tsset  year

* Simple Reg

reg  lnworldtotalexportquantity lnexportingprice  lntotalproduction lntaigdp lnveigdp
lnindgdp lnusgdp

*Hetero test
hettest
predict e, residual
scatter e year, connect(1)

dfuller e, reg lag(1)

*IV/GMM
ivreg2 lnworldtotalexportquantity (lnexportingprice= cr4 lnoilprice lnexportwheatprice
lnexportmaizeprice lntotalareaharvest lnexhangeratebahtusdollar ciffob )
lntotalproduction lntaigdp lnveigdp lnindgdp lnusgdp, gmm


predict e1, residual
scatter e1 year, connect(1)
dfuller e1, reg lag(1)

*model 1
reg3 (lnworldtotalexportquantity lnexportingprice lntotalproduction lntaigdp lnveigdp
lnindgdp lnusgdp) ( lnexportingprice cr4 lnoilprice lnexportwheatprice lnexportmaizeprice
lntotalareaharvest lnexhangeratebahtusdollar ciffob)( lntaigdp lntaifdi lnthaimakets
lnthaiexportquantity lntaiinf taipop lntaiims lntaihe lntaigni taihc lntaiag lntaiopen)
(lnveigdp lnveifdi  lnviemarkets  lnvieexportquantity lnveiinf veipop lnveiims lnveihe
lnveigni  viehc lnveiag  lnvieopen) (lnindgdp lnindfdi lnindmarkets lnindexportquantity
lnindinf indpop lnindims lnindhe lnindgni indhc lnindag lnindopen) (lnusgdp lnusfdi
lnusmarkets lnusexportquantity lnusinf uspop lnusims lnushe lnusgni ushc lnusag
lnusopen), sure

predict e2, residual
scatter e2 year, connect(1)
dfuller e2, reg lag(1)

*model 2
reg3 (lnworldtotalexportquantity lnexportingprice lntotalproduction lntaigdp lnveigdp
lnindgdp lnusgdp) ( lnexportingprice cr4 lnoilprice lnexportwheatprice lnexportmaizeprice
lntotalareaharvest lnexhangeratebahtusdollar ciffob) ( lntaigdp lntaifdi lnthaimakets
lnthaiexportquantity lntaiinf taipop lntaiims lntaihe lntaigni taihc lntaiag lntaiopen
taia) (lnveigdp lnveifdi  lnviemarkets  lnvieexportquantity lnveiinf veipop lnveiims
lnveihe lnveigni  viehc lnveiag  lnvieopen  viea) (lnindgdp lnindfdi lnindmarkets
lnindexportquantity lnindinf indpop lnindims lnindhe lnindgni indhc lnindag lnindopen
inda) (lnusgdp lnusfdi lnusmarkets lnusexportquantity lnusinf uspop lnusims lnushe
lnusgni ushc lnusag lnusopen  usa), sure

predict e3, residual
scatter e3 year, connect(1)
dfuller e3, reg lag(1)
```

```
*model 3
reg3 (lnworldtotalexportquantity lnexportingprice lntotalproduction lntaigdp lnveigdp
lnindgdp lnusgdp) ( lnexportingprice cr4 lnoilprice lnexportwheatprice lnexportmaizeprice
lntotalareaharvest lnexhangeratebahtusdollar ciffob)( lntaigdp lntaifdi lnthaimakets
lnthaiexportquantity lntaiinf taipop lntaiims lntaihe lntaigni taihc lntaiag lntaiopen
taia) (lnveigdp lnveifdi  lnviemarkets  lnvieexportquantity lnveiinf veipop lnveiims
lnveihe lnveigni  viehc lnveiag  lnvieopen  viea) (lnindgdp lnindfdi lnindmarkets
lnindexportquantity lnindinf indpop lnindims lnindhe lnindgni indhc lnindag lnindopen
inda) (lnusgdp lnusfdi lnusmarkets lnusexportquantity lnusinf uspop lnusims lnushe
lnusgni ushc lnusag lnusopen  usa) ( cr4 lnthaimakets lnviemarkets lnindmarkets
lnusmarkets lntaigdp lnveigdp lnindgdp lnusgdp lntaifdi lnveifdi lnindfdi lnusfdi), sure


predict e4, residual
scatter e4 year, connect(1)
dfuller e4, reg lag(1)



ivreg2  lnimportquantity lngni ( lndomesticprice= lnconsumption lnoilprice
lndomesticwheatprice lndomesticmaizeprice
> ), gmm small


reg3 ( lnimportquantity lngni lndomesticprice) ( lngni lnsumgdp lnfdi lninflation lnpop)
( lndomesticprice lnconsu
> mption lnoilprice lndomesticwheatprice lndomesticmaizeprice), sure small

sum

tsset  year

dfuller  lnimportquantity, regress lag(1)
dfuller  lnimportquantity, regress lag(1) trend
dfuller  d.lnimportquantity, regress lag(1)
dfuller  d.lnimportquantity, regress lag(1) trend

dfuller  lngni, regress lag(1)
dfuller  lngni, regress lag(1) trend
dfuller  d.lngni, regress lag(1)
dfuller  d.lngni, regress lag(1) trend

dfuller  lndomesticprice, regress lag(1)
dfuller  lndomesticprice, regress lag(1) trend
dfuller  d.lndomesticprice, regress lag(1)
dfuller  d.lndomesticprice, regress lag(1) trend

dfuller  lnconsumption, regress lag(1)
dfuller  lnconsumption, regress lag(1) trend
dfuller  d.lnconsumption, regress lag(1)
dfuller  d.lnconsumption, regress lag(1) trend

dfuller  lnoilprice, regress lag(1)
dfuller  lnoilprice, regress lag(1) trend
dfuller  d.lnoilprice, regress lag(1)
dfuller  d.lnoilprice, regress lag(1) trend

dfuller  lndomesticwheatprice, regress lag(1)
dfuller  lndomesticwheatprice, regress lag(1) trend
dfuller  d.lndomesticwheatprice, regress lag(1)
dfuller  d.lndomesticwheatprice, regress lag(1) trend


dfuller  lndomesticmaizeprice, regress lag(1)
dfuller  lndomesticmaizeprice, regress lag(1) trend
dfuller  d.lndomesticmaizeprice, regress lag(1)
dfuller  d.lndomesticmaizeprice, regress lag(1) trend

dfuller  lnsumgdp, regress lag(1)
dfuller  lnsumgdp, regress lag(1) trend
dfuller  d.lnsumgdp, regress lag(1)
```

```
dfuller  d.lnsumgdp, regress lag(1) trend

dfuller  lnfdi, regress lag(1)
dfuller  lnfdi, regress lag(1) trend
dfuller  d.lnfdi, regress lag(1)
dfuller  d.lnfdi, regress lag(1) trend

dfuller  lninflation, regress lag(1)
dfuller  lninflation, regress lag(1) trend
dfuller  d.lninflation, regress lag(1)
dfuller  d.lninflation, regress lag(1) trend


dfuller  lnpop, regress lag(1)
dfuller  lnpop, regress lag(1) trend
dfuller  d.lnpop, regress lag(1)
dfuller  d.lnpop, regress lag(1) trend

reg  lnimportquantity lngni lndomesticprice
hettest
predict e1, residual
dfuller e1, reg lag(1)

reg  lnimportquantity lngni lndomesticprice, robust
predict e2, residual
dfuller e2, reg lag(1)

ivreg2      lnimportquantity   lngni   (   lndomesticprice=   lnconsumption   lnoilprice
lndomesticwheatprice lndomesticmaizeprice)
predict e3, residual
dfuller e3, reg lag(1)

ivreg2      lnimportquantity   lngni   (   lndomesticprice=   lnconsumption   lnoilprice
lndomesticwheatprice lndomesticmaizeprice), gmm
predict e4, residual
dfuller e4, reg lag(1)

reg3 ( lnimportquantity lngni lndomesticprice) ( lngni lnsumgdp lnfdi lninflation lnpop)
(  lndomesticprice  lnconsumption  lnoilprice  lndomesticwheatprice  lndomesticmaizeprice),
sure
predict e5, residual
dfuller e5, reg lag(1)
```

APPENDIX II. DATA USED IN THE STUDY

Year	Thailand EX	Vietnam EX	India EX	US EX	EX	TP	HA
1994	3.6756	3.3467	2.7782	3.4462	4.2163	8.7316	8.1682
1995	3.7731	3.3632	3.6234	3.4876	4.3222	8.7384	8.1749
1996	3.7226	3.4829	3.5510	3.4190	4.2891	8.7550	8.1769
1997	3.7173	3.5221	3.3195	3.3625	4.2754	8.7613	8.1793
1998	3.8039	3.5770	3.6689	3.5016	4.4417	8.7629	8.1813
1999	3.8247	3.6585	3.4396	3.4223	4.3947	8.7860	8.1956
2000	3.8162	3.5276	3.1611	3.4544	4.3571	8.7773	8.1880
2001	3.8763	3.5475	3.2869	3.4050	4.3882	8.7766	8.1814
2002	3.8600	3.5112	3.8228	3.5179	4.4449	8.7551	8.1691
2003	3.8781	3.5792	3.6455	3.5837	4.4405	8.7665	8.1707
2004	4.0059	3.6330	3.5013	3.4900	4.4343	8.7834	8.1766
2005	3.8618	3.7138	3.6709	3.5868	4.4625	8.8004	8.1889
2006	3.8678	3.6726	3.6568	3.5194	4.4607	8.8025	8.1884
2007	3.9294	3.6628	3.6021	3.5185	4.4577	8.8129	8.1875

Note: All values are based on natural log values.

APPENDIX II. Continued

Year	CR4	Thailand MS	Vietnam MS	India MS	US MS	HHI
1994	0.6292	1.4593	1.1304	0.5618	1.2299	3.1182
1995	0.7388	1.4510	1.0411	1.3012	1.1654	3.1856
1996	0.7451	1.4335	1.1937	1.2618	1.1298	3.1749
1997	0.6860	1.4419	1.2466	1.0441	1.0871	3.1298
1998	0.6504	1.3623	1.1354	1.2273	1.0599	3.0544
1999	0.6701	1.4300	1.2637	1.0449	1.0275	3.1132
2000	0.6246	1.4591	1.1705	0.8040	1.0973	3.0950
2001	0.6351	1.4880	1.1593	0.8987	1.0168	3.1223
2002	0.7336	1.4151	1.0663	1.3779	1.0729	3.1824
2003	0.7109	1.4375	1.1387	1.2050	1.1431	3.1430
2004	0.7613	1.5716	1.1986	1.0670	1.0556	3.2800
2005	0.7238	1.3992	1.2513	1.2084	1.1243	3.1415
2006	0.6897	1.4071	1.2118	1.1961	1.0587	3.1122
2007	0.7110	1.4717	1.2050	1.1443	1.0608	3.1648

Year	EXP	EXWP	EXMP	OIL	ER
1994	2.5065	2.3160	2.0934	1.1948	1.3979
1995	2.5302	2.3636	2.0645	1.2240	1.3990
1996	2.4814	2.2577	2.0682	1.3109	1.4058
1997	2.4829	2.2122	2.0086	1.2704	1.6524
1998	2.3945	2.1790	1.9542	1.0759	1.6555
1999	2.3054	2.1673	1.9494	1.2191	1.5713
2000	2.2380	2.1818	1.9542	1.4376	1.5794
2001	2.2833	2.2455	1.9956	1.3617	1.6602
2002	2.2967	2.2480	2.0212	1.3581	1.6389
2003	2.3766	2.2718	2.0492	1.4423	1.6334
2004	2.4564	2.2967	1.9956	1.5759	1.5948
2005	2.4843	2.3365	2.0864	1.6993	1.5832
2006	2.5079	2.5263	2.2330	1.7657	1.5932
2007	2.6444	2.6263	2.2810	1.8075	1.5432

APPENDIX II. Continued

Year	Thailand GDP	Vietnam GDP	India GDP	US GDP	Thailand FDI	Vietnam FDI	India FDI	US FDI
1994	11.1599	10.2118	11.5099	12.8462	9.1356	9.2888	8.9882	10.6640
1995	11.2250	10.3167	11.5518	12.8658	9.3155	9.2505	9.3311	10.7619
1996	11.2593	10.3919	11.5892	12.8900	9.3684	9.3793	9.3849	10.9371
1997	11.1787	10.4288	11.6138	12.9165	9.5905	9.3464	9.5536	11.0236
1998	11.0487	10.4347	11.6194	12.9392	9.8642	9.2230	9.4207	11.2529
1999	11.0876	10.4576	11.6537	12.9646	9.7855	9.1498	9.3362	11.4616
2000	11.0889	10.4938	11.6629	12.9897	9.5271	9.1133	9.5544	11.5069
2001	11.0627	10.5120	11.6797	13.0033	9.7042	9.1139	9.7381	11.2228
2002	11.1034	10.5450	11.7058	13.0178	9.5231	9.1461	9.7502	10.9262
2003	11.1542	10.5971	11.7795	13.0377	9.7189	9.1614	9.6358	10.8045
2004	11.2078	10.6574	11.8425	13.0666	9.7680	9.2068	9.7613	11.1638
2005	11.2461	10.7251	11.9062	13.0933	9.9057	9.2909	9.8246	11.0374
2006	11.3146	10.7853	11.9599	13.1194	9.9547	9.3646	10.2419	11.2567
2007	11.3491	10.8571	12.0000	13.1470	9.9638	9.3895	10.2775	11.2940

Year	Thailand GNI	Vietnam GNI	India GNI	US GNI	Thailand HC	Vietnam HC	India HC	US HC
1994	3.3927	2.3010	2.5185	4.4254	6.3	7.9	6.09	12.59
1995	3.4502	2.3979	2.5798	4.4458	6.4	7.92	6.28	12.67
1996	3.4843	2.4771	2.6128	4.4619	6.5	7.99	6.39	12.70
1997	3.4472	2.5315	2.6232	4.4758	6.7	8.01	6.53	12.73
1998	3.3263	2.5441	2.6232	4.4860	7	8	6.65	12.79
1999	3.3032	2.5563	2.6435	4.5087	7.1	8.05	6.37	12.80
2000	3.3032	2.5911	2.6532	4.5366	7.2	8.1	6.6	12.89
2001	3.2967	2.6128	2.6628	4.5417	7.4	8.2	6.68	12.94
2002	3.3010	2.6335	2.6721	4.5467	7.6	8.18	6.73	12.99
2003	3.3404	2.6721	2.7243	4.5737	7.8	8.28	6.7	13.09
2004	3.4031	2.7324	2.7993	4.6120	8	8.29	6.89	13.13
2005	3.4425	2.7924	2.8633	4.6356	8.1	8.33	6.91	13.15
2006	3.4843	2.8451	2.9138	4.6504	8.4	8.41	7.01	13.18
2007	3.5211	2.8921	2.9085	4.6704	8.5	8.48	7.05	13.22

APPENDIX II. Continued

Year	Thailand IN	Vietnam IN	India INF	US IN	Thailand POP	Vietnam POP	India POP	US POP
1994	0.7167	1.2292	1.0000	0.3241	1.1347	1.8743	1.8037	1.2263
1995	0.7474	1.2315	0.9579	0.3095	1.1275	1.7984	1.7840	1.1908
1996	0.6032	0.9394	0.8777	0.2796	1.1270	1.7926	1.7629	1.1634
1997	0.6089	0.8194	0.8101	0.2228	1.1203	1.5492	1.7417	1.2040
1998	0.9656	0.9463	0.9021	0.0457	1.0907	1.3949	1.7205	1.1657
1999	0.6062	0.7585	0.5798	0.1598	1.0307	1.2919	1.6994	1.1483
2000	0.1291	0.5326	0.5467	0.3384	0.9509	0.1552	1.6782	1.1321
2001	0.3159	0.2897	0.4953	0.3818	0.8633	1.3439	1.6160	1.0606
2002	0.0879	0.5954	0.5899	0.2430	0.7862	1.3151	1.5537	1.0116
2003	0.1232	0.8252	0.5793	0.3286	0.7301	1.4630	1.4915	0.9224
2004	0.5044	0.9127	0.6404	0.4529	0.7034	1.3862	1.4293	0.9726
2005	0.6554	0.9132	0.6482	0.4807	0.6974	1.2998	1.3671	0.9723
2006	0.7000	0.8618	0.7722	0.5032	0.6976	1.1999	1.3816	0.9703
2007	0.7421	0.8666	0.8029	0.5259	0.6974	1.20568	1.39125	0.97125

Year	Thailand IMGS	Vietnam IMGS	India IMGS	US IMGS	Thailand HE	Vietnam HE	India HE	US HE
1994	1.6406	1.6381	1.0132	1.0647	1.3721	0.1354	0.4731	1.4982
1995	1.6865	1.6223	1.0850	1.0901	1.3877	0.1956	0.6334	1.4884
1996	1.6583	1.7146	1.0674	1.0944	1.4624	0.2983	0.7093	1.4947
1997	1.6683	1.7096	1.0817	1.1075	1.4865	0.3479	0.6769	1.5029
1998	1.6334	1.7173	1.1084	1.1084	1.5352	0.2312	0.6119	1.5215
1999	1.6602	1.7228	1.1339	1.1329	1.5090	0.1384	0.6292	1.5342
2000	1.7645	1.7596	1.1508	1.1794	1.5219	1.0426	0.7002	1.5254
2001	1.7735	1.7555	1.1347	1.1428	1.4971	0.9263	0.7319	1.5114
2002	1.7597	1.7819	1.1892	1.1377	1.4867	0.7675	0.6776	1.5008
2003	1.7701	1.8263	1.2050	1.1498	1.4802	0.7449	0.6770	1.4867
2004	1.8185	1.8650	1.3015	1.1866	1.4485	0.6497	0.6888	1.4800
2005	1.8757	1.8665	1.3671	1.2120	1.4246	0.7274	0.6838	1.4760
2006	1.8438	1.8853	1.4117	1.2173	1.4360	0.7324	0.6847	1.4782
2007	1.8367	1.8909	1.4204	1.2278	1.4404	0.7558	0.6979	1.4949

APPENDIX II. Continued

Year	IM	GNI	DRP	IM GDP	CON
1994	3.3651	11.600	−1.225	11.6009	4.6168
1995	3.6369	11.638	−1.069	11.6501	4.6400
1996	3.5339	11.686	−1.088	11.7018	4.6411
1997	3.4918	11.705	−1.238	11.6984	4.6446
1998	3.9974	11.608	−1.518	11.5296	4.6566
1999	3.8195	11.589	−1.345	11.6148	4.6666
2000	3.7111	11.607	−1.421	11.6770	4.6748
2001	3.7877	11.658	−1.610	11.6653	4.6838
2002	3.8503	11.681	−1.518	11.7056	4.6886
2003	3.8227	11.733	−1.493	11.7688	4.6946
2004	3.6645	11.805	−1.353	11.8236	4.7016
2005	3.7423	11.873	−1.264	11.9030	4.7048
2006	3.7306	11.933	−1.050	11.9763	4.7077
2007	3.8035	11.992	−1.125	12.0131	4.7101

Year	DWP	DMP	IM FDI	IM IN	IM POP
1994	−1.3489	−1.571	9.779	1.668	8.581
1995	−1.2914	−1.591	9.701	1.898	8.590
1996	−1.3943	−1.584	9.913	1.782	8.598
1997	−1.5158	−1.719	10.020	1.345	8.607
1998	−1.9051	−2.130	9.868	1.821	8.615
1999	−1.7288	−1.947	9.066	1.660	8.623
2000	−1.7432	−1.971	8.852	1.884	8.631
2001	−1.7311	−1.981	8.556	1.447	8.639
2002	−1.6443	−1.871	9.469	1.235	8.648
2003	−1.5596	−1.782	9.118	1.554	8.656
2004	−1.5224	−1.823	9.615	1.657	8.664
2005	−1.4903	−1.740	10.103	1.820	8.672
2006	−1.2350	−1.528	10.147	1.516	8.679
2007	−1.1195	−1.465	9.968	1.580	8.684

APPENDIX III. COMPARISONS BETWEEN EXPECTED AND ESTIMATED RESULTS SIGNS

Expected Signs	Estimated Results Signs (Thailand)			
	Model 1.1.	Model 1.2.	Model 1.3.	Criterions
$c_{i1} > 0$ (FDI)	**+**	**+**	**+**	
$c_{i2} > 0$ (Market share)	**+**	**+**	**+**	**Consistency**
$c_{i3} > 0$ (Rice exports)	**+**	**+**	**+**	
$c_{i4} < 0$ (Inflation)	**−**	**−**	**−**	**Consistency**
$c_{i5} > 0$ (Population)	**+**	**+**	**+**	**Consistency**
$c_{i6} > 0$ (Imports of goods and services)	**+**	+	+	
$c_{i7} > 0$ (High-technology exports)	**+**	**+**	**+**	**Consistency**
$c_{i8} > 0$ (GNI)	**+**	**+**	**+**	**Consistency**
$c_{i9} > 0$ (Human capital)	**+**	+	+	
$c_{i10} > 0$ (Agricultural Values)	+	**−**	**−**	
$c_{i11} > 0$ (Openness measure)	**+**	+	**−**	
$c_{i12} > 0$ (FDI*Rice exports)	N/A	**+**	**+**	**Consistency**

Note: Boldness indicates statistically significant with 90% confidence level. 'Consistency' implies that estimated results of models 1.1, 1.2, and 1.3 have the same signs of both expected and estimated coefficients, and statistically significant, respectively.

APPENDIX III. Continued

Expected Signs	Estimated Results Signs (Vietnam)			
	Model 1.1.	Model 1.2.	Model 1.3.	Criterions
$c_{i1} > 0$ (FDI)	**+**	**+**	**+**	**Consistency**
$c_{i2} > 0$ (Market share)	**+**	**+**	**+**	**Consistency**
$c_{i3} > 0$ (Rice exports)	**+**	**+**	**+**	**Consistency**
$c_{i4} < 0$ (Inflation)	**+**	**+**	**+**	
$c_{i5} > 0$ (Population)	**+**	**+**	**+**	**Consistency**
$c_{i6} > 0$ (Imports of goods and services)	**−**	**−**	**−**	
$c_{i7} > 0$ (High-technology exports)	**+**	**+**	**+**	**Consistency**
$c_{i8} > 0$ (GNI)	**+**	**+**	**+**	**Consistency**
$c_{i9} > 0$ (Human capital)	**+**	**+**	**+**	**Consistency**
$c_{i10} > 0$ (Agricultural Values)	**+**	**+**	**+**	**Consistency**
$c_{i11} > 0$ (Openness measure)	**+**	**+**	**+**	**Consistency**
$c_{i12} > 0$ (FDI*Rice exports)	**N/A**	**+**	**+**	**Consistency**

Note: Boldness indicates statistically significant with 90% confidence level. 'Consistency' implies that estimated results of models 1.1, 1.2, and 1.3 have the same signs of both expected and estimated coefficients, and statistically significant, respectively.

APPENDIX III. Continued

Expected Signs	Estimated Results Signs (India)			
	Model 1.1.	**Model 1.2.**	**Model 1.3.**	**Criterions**
$c_{i1} > 0$ (FDI)	**+**	**+**	**+**	
$c_{i2} > 0$ (Market share)	**+**	**+**	**+**	**Consistency**
$c_{i3} > 0$ (Rice exports)	**+**	**+**	**+**	**Consistency**
$c_{i4} < 0$ (Inflation)	**+**	**+**	**+**	
$c_{i5} > 0$ (Population)	**+**	**+**	**+**	**Consistency**
$c_{i6} > 0$ (Imports of goods and services)	**−**	+	+	
$c_{i7} > 0$ (High-technology exports)	**+**	**+**	**+**	**Consistency**
$c_{i8} > 0$ (GNI)	**+**	**+**	**+**	**Consistency**
$c_{i9} > 0$ (Human capital)	**+**	**+**	**+**	**Consistency**
$c_{i10} > 0$ (Agricultural Values)	**−**	**−**	**−**	
$c_{i11} > 0$ (Openness measure)	**+**	**+**	**+**	**Consistency**
$c_{i12} > 0$ (FDI*Rice exports)	N/A	**+**	**+**	**Consistency**

Note: Boldness indicates statistically significant with 90% confidence level. 'Consistency' implies that estimated results of models 1.1, 1.2, and 1.3 have the same signs of both expected and estimated coefficients, and statistically significant, respectively.

APPENDIX III. Continued

Expected Signs	Estimated Results Signs (United States)			
	Model 1.1.	**Model 1.2.**	**Model 1.3.**	**Criterions**
$c_{i1} > 0$ (FDI)	**+**	+	+	
$c_{i2} > 0$ (Market share)	**+**	**+**	**+**	**Consistency**
$c_{i3} > 0$ (Rice exports)	**−**	+	+	
$c_{i4} < 0$ (Inflation)	**−**	**−**	**−**	
$c_{i5} > 0$ (Population)	**−**	**−**	**−**	
$c_{i6} > 0$ (Imports of goods and services)	**−**	**−**	**−**	
$c_{i7} > 0$ (High-technology exports)	**−**	**−**	**−**	
$c_{i8} > 0$ (GNI)	**+**	**+**	**+**	**Consistency**
$c_{i9} > 0$ (Human capital)	**+**	**+**	**+**	**Consistency**
$c_{i10} > 0$ (Agricultural Values)	**−**	**−**	**−**	
$c_{i11} > 0$ (Openness measure)	+	+	+	
$c_{i12} > 0$ (FDI*Rice exports)	N/A	**+**	+	

Note: Boldness indicates statistically significant with 90% confidence level. 'Consistency' implies that estimated results of models 1.1, 1.2, and 1.3 have the same signs of both expected and estimated coefficients, and statistically significant, respectively.

VITA

Hyunsoo Kang was born in December, 1975, in Seoul, South Korea. In 1996, he served in the Korean Army for two years. After finishing his military service in 2002, Hyunsoo received his Bachelor of Economics degree from Korea University located in Seoul, South Korea. In 2002, Hyunsoo entered the master's program in the Seoul National University and worked with Dr. Taeho Lee. Hyunsoo completed his master's program by authoring his master's thesis entitled "A Policy Evaluation Matrix (PEM) Analysis on the Effects of Rice Policies," along his major professor, Dr. Taeho Lee.

Hyunsoo married Eunkyoung Kim, in December 2005. In addition, the Kangs had a baby, Sun Kang, born to them in January 2007 and another baby named Yune Kang born in June 2009.

Hyunsoo came to the United States of America in 2005 to pursue his doctorate in agricultural economics at Louisiana State University in Baton Rouge, Louisiana. He worked with Dr. P. Lynn Kennedy and will complete his doctoral degree in the summer of 2009.