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STRUCTURE AND CONDUCT OF THE WORLD RICE MARKET

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Structure and Conduct of the World Rice Market

Abstract

The purpose of this paper is to analyze the world rice market through a Structure-Conduct-Performance (SCP) framework utilizing annual data from 1970 to 2007. Since World War Two, the world rice market has been very unstable, with rice prices experiencing volatile swings in both rice price and rice availability. Therefore, a SCP framework can provide crucial insight into the world rice market for policy makers. Also, this paper describes the effects of total production, export rice price, and real exchange rate for exporting countries on total export volume from an export supply model standpoint. On the basis of these results, it is evident that market power exists in the international rice market with respect to supply elasticity and an exporting country's currency exchange rate greatly determines that country's competitiveness as a net rice exporter relative to other rice producers.

Key Words: S-C-P paradigm, world rice market, concentration ratio, HHI, export rice price, exchange rate export supply function

1. Introduction

In the past several decades, the international rice market has undergone major changes. Even with a shift in general rice policy 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[1], market organization affects market performance through various channels. Exporting countries' concentration, market structure includes product differentiation, barriers to exit, fixed costs and growth rate (Delorme, 2002). Analyzing market conduct involves the price

[1] The practical S-C-P method will be a kind of effectual industry analysis such as Figure 1.

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 paper is to examine the world rice market using S-C-P methods. In the world rice market, we analyze the main factor which can affect market power and exporting countries do have a degree of market power. Over the past fifteen years, industrial economists have seen a renewed interest in empirical analysis, which is now commonly referred to 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 paper focuses on structure and conduct methods. The structural changes will 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 rare, crude oil price, and substitute commodities' prices.

This paper is organized as follows. First, we conduct a literature review. The literature reviewed primarily, analyze the traditional S-C-P paradigm with respect to the world rice market and substitute commodities market. Second, we explain the structure for the world rice market in terms of exporting/importing countries. Third, we use 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). The empirical results show 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. 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.

Siamwlla and Haykin (1983) analyzed the Asian rice market comprehensively with respect to the S-C-P paradigm. They collected 1961-80 data within Asia countries. They estimated the price instrument of 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 affect the traded volume. 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 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 paper investigates the existence of market power within the world rice market and analyzes the main factors which influence rice export volumes.

3. Data

Data on rice[2] export quantity, production and harvest area from 1970 through 2007 are obtained from FAOSTAT and the USDA[3]. Export rice[4] price, wheat[5] and maize[6] data are based on the International Rice Research Institute, and crude oil price[7] and the real exchange rate of Baht and Rupee are obtained from annual average U.S. crude oil prices and Bank of Thailand and India, respectively. Descriptive statistics and definition of variables are summarized in Tables 1 and 2.

The export supply model consists of the total aggregated export quantity, export price, real exchange rate, and production, which also include data for the major rice exporting countries[8] (Thailand, Vietnam, India and the U.S) considered herein.

4. Structure of the 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

[2] Rice data indicate the aggregated data including rice broken, rice paddy, rice flour, rice husked, and rice milled.
[3] Data on 2006 and 2007 of rice production and quantity are drawn from the FAO Price Update (2007) and USDA World Rice Calendar.
[4] All export price are based on FOB (free on board) and 5% broken, milled, fob Bangkok
[5] Canadian No.1 Western Red Spring 13.5%
[6] U.S. No.2 yellow, fob Gulf ports
[7] http://www.inflationdata.com
[8] See Table 3.

market. The next section shows the pattern of world trade and explains the market structure for rice.

4.1. The Traded Pattern of Rice Exporting

The proportion of rice production that is traded internationally is small and increased (see Figures 2 and 3). 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 been increased but the area harvested has remained constant since about 1960. Figures 4, 5, and 6 show export quantity, production and harvested area for the top four rice exporting countries, respectively; Thailand, Vietnam, India, and the U.S. Thailand is the 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 mainland in the monsoon prone areas in Asia. Figure 7 illustrates the export price for rice, wheat, and maize, respectively. We expect that the export quantity will be related with export price for rice and also other substituted commodities. Price volatility among these commodities has trended the same since 1980, and recent export price increases by from the mid 1990s. Also, another major factor which is related with export quantity is the crude oil price (see Figure 8).

4.2. The Market Power of the World Rice Market

Market power defines that a firm or some 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 find an alternative form of

measurement. Over time there has been a movement toward measures that focus on the size of firms in the industry. That is, the distributional size of firms in the industry has been condensed into a single measure of industry concentration.

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

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

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

Another popular measure of dispersion of firm size is the Herfindal index (HHI). It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. In other words, it is equal to

$$(2)\ HHI = \sum_{i=1}^{4} (Market\ Share)^2$$

where market share means the percent of a individual sale potion in total sales. The HHI takes into account the relative size and distribution of the firms in a market and approaches zero when a market consists primarily of a large number of firms relatively equal in size. The HHI increases both as the number of firms in the market decreases and

as the disparity in size between those firms increases. Markets in which the HHI is between 1000 and 1800 points 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[9].

As can be seen in Table 4, CR4 and HHI of exporting countries show concentrated structure for rice market and are considered as market power for selling rice. The exporting countries' CR4 varies from 0.6505 to 0.7336 and HHI ranges from 1133.45 to 1905.56. That is, we conclude that the top four of exporting countries have the market power for world rice market. However, importing countries do not show the bargaining power for world rice market. Importing countries' CR4 indicates from 0.397 to 0.5259 and HHI varies from 437.31 to 1143.

If we want to investigate the degree of market power of monopolists or oligopolists, the *Lerner* index is the useful measurement. 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

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

[9] See *Merger Guidelines and 1.5*

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 presenting greater monopoly power. If price is equal to marginal cost, the *Lerner* index is zero, and this result indicates the firm has no market power. When the *Lerner* index is closer to one this 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 over marginal cost. Rearranging the Lerner index

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

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 the perfect competition with respect to P=MC. And if the *Lerner* index is 0.20, the markup factor is 1.25 and the firm charge a price that is 1.25 times marginal cost. However, the *Lerner* index of monopoly power requires the ability to measure marginal cost but 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 can use another expressed equation instead of the 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 market demand curve, not horizontal demand curve. The monopoly profit maximization is

(5) $\Pi(q) = Pq - c(q)$

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 can obtain derivative of the equation (5) with respect to quantity and

$$
\begin{aligned}
\frac{d\Pi(q)}{dq} &= \frac{dp}{dq}q + \frac{dq}{dq}p - \frac{dc(q)}{q} \\
&= \frac{dp}{dq}q + p - \frac{dc(q)}{q} \quad where \ \frac{dq}{dq} = 1 \\
&= p(\frac{dp}{dq}\frac{q}{p}) + p - \frac{dc(q)}{q} = 0
\end{aligned} \tag{6}
$$

Rearrange equation (6) and the price elasticity is $\eta = \frac{dq}{dp}\frac{p}{q}$ and then

$$P(1+\frac{1}{\eta}) = MC \ \ or \ \ p = \frac{MC}{(1+\frac{1}{\eta})} \tag{7}$$

Equation (7) shows that the amount that price exceeds marginal cost depends upon the price elasticity. As η approaches infinity, or as demand/supply becomes elastic, price then is equal to marginal cost and we thus have a competitive market. As η approach to zero, price then is greater than marginal cost and there is a markup or market power such as extant under a monopoly. This can also be written as the *Lerner* index as follows:

$$\frac{P - MC}{P} = \frac{1}{\eta} \tag{8}$$ [10]

[10] See e.g. and introduced process in Clarkson and Miller (1982)

where η is the export price elasticity of exporting countries, 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. In this paper, we assume that market price is the exporting price for rice and the total quantity is the aggregated quantity for exporting countries.

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 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 market entrants or expansion by existing marginal firms in the industry. In the next section, we analyze the supply elasticity and the relationships between export quantity and price.

5. Conduct of the 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.

In terms of traditional S-C-P paradigm, the 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 advertising and sales promotion activities they engage in. Also, in this situation, we have questions as to which firms collude, whether collusion is open or implicit, and how responsive are firms to changes in their economic position.

In this paper, we focus on market conduct with respect to export price, production and exchange rate in terms of export supply function. This section shows the empirical model for estimating supply elasticity and analyzes the effects of the exchange rate.

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. We estimate the system equation in terms of using OLS and Instrumental Variables (IV). The IV procedure overcomes endogeneity problems between export rice price and export volume.

The unit root test is to determine the order of integration of variables under consideration. This test employed for testing the order of integration is the Augmented Dikey-Fuller (ADF) test. This procedure statistics rejects the null hypothesis of non-stationarity of all the variables, when first difference variables are used. In Table 5, indicating variables that are stationary of order 1. In Table 6, we obtain the results of the Engle-Granger (EG)[11] 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 results of Table 6, we conclude that the residuals are stationary which

[11] See Engle and Granger (1987)

means that dependent variables 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).

5.2. Empirical Model for Export Supply Function

To test for elasticity and market power, we specify a total export quantity schedule which the variables are linear log-log model, and then the estimated parameters can be directly interpreted as an elasticity. We extend the work of Mohsen and Ltaifa (1992) which formulated the effects of real exchange rate on export volume with respect to export supply function. The empirical model is as follow:

$$(9)\quad Log(EX_t) = \alpha_0 + \alpha_1 Log(EXRP_t) + \alpha_3 Log(TP_t) + \alpha_4 Log(ER_{it}) + \varepsilon_{1t}$$

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[12] exporting countries in period *t*; and ε_{1t} is an error term.

Two-stage least squares regression (2SLS) is a method of extending regression to cover models which violate ordinary least squares (OLS) regression's assumption of 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.

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

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 using the newly created variables. Therefore, 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 with the Instrumental Variables (IV) procedure. We constrain export rice price with the harvest area, crude oil price, export price for wheat and maize, and four firm concentration ratio as follows:

(10)

$$Log(EXRP_t) = \beta_0 + \beta_1 Log(THA_t) + \beta_2 Log(OIL_t) + \beta_3 Log(EXWP_t) + \beta_4 Log(EXMP_t) + \beta_5 Log(CR4_t) + \varepsilon_{2t}$$

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. Therefore, the IV procedure is based on equations (9) and (10) in which the endogenous variable is the export rice price. And the main factors which influence on the export rice price are covered by equation (10).

5.3. The Impacts of the Exchange Rate for 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 dollar increases, the dollar depreciates. These relationships between supply, demand, and the value of money are critical in understanding the currency exchange market.

In this paper, we analyze the impacts of the Baht and Rupee. The Baht is the currency of Thailand and Thailand is the biggest rice exporting country. Also, the Rupee is the currency of India which is the rank third amongst rice exporters. Therefore, we doubt how the major exporting countries' exchange rate can affect export quantity. And we assume that the U.S. dollar is the representative currency tool of the rest of the world (ROW).

In Figure 11, the exporting countries's rice price will go up in terms of the depreciation on the currency of exporting countries and domestic demand decrease from *D1* to *D2* but domestic supply increase from *S1* to *S2*. Also, export quantity increases from *Q1* to *Q2* due to the shift-up of excess demand in the currency of exporting countries. ROW's price decreases in terms of the appreciation on the representative currency tool of the rest of world. And demand of ROW increase from *D1* to *D2* but supply decrease from *S1* to *S2*.

The welfare impacts of this exchange rate appreciation for the importing country indicated the domestic price increase from 100 to 110. This corresponds with a production increase from *S1* to *S2* and consumption decrease from *D1* to *D2*. The producer surplus of exporting countries increases by area *A*+*B*+*C*. The 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 case 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 12). 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 more important decision factor of export quantity than export rice price. The implication of this result is that exporting countries' governments need to consider the exchange rate rather than the regulation of export price or export subsidy.

6. Results and Discussion

We tested for over-identification using the *Hansen J-test*, and the test statistics show that over-identification is not a problem in the equation. We also tested the validity of any instruments using the *Anderson* test. This test has a null hypothesis that the instruments are uncorrelated with the error term. In terms of the results, all cases can not reject the null hypothesis and we conclude that at least one of the instrument variables is not correlated with the errors. If the instrument variables are not exogenous, then the IV procedure is not consistent and we can not cast doubt as to the validity of the instrument. The *Breusch-Pagan*[13] test illustrate that this equation has heteroskedasicity problem in

[13] The null hypothesis is the constant variance of equation (1). The result is that chi-square is 0 and p-value is 0.9417.

terms of rejecting the null hypothesis. Therefore, this equation is estimated with IV/GMM (generalized methods moments) procedure due to autocorrelation.

Estimated results are shown in Table 6. In OLS, the variables have the anticipated signs which increases of export rice price, total production, and exchange rate have contributed increasing total export quantity. In equation (12), 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 for increases the export volume by 3.1601% and 3.3032%, respectively. Especially, supply elasticity for export rice price on export volume is insensitive, and this implies that changes of export rice price do not contribute the changes of export volume. Also, with respect to equation (8), if the supply elasticity is not sensitive, we conclude the existence of market power for the major rice exporting countries.

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. We conclude that the major exporting countries have the market power with respect to the previous market power equation. That is, exporting countries are not sensitive for exporting rice price due to market power and market power in the case of exporting countries.

The Engle-Granger tests are statistically significant at the 1% level and 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.

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:

$$
\begin{aligned}
Log(EXRP_t) = {} & -32.6059 + 4.3329\,Log(THA_t) + 0.1361\,Log(OIL_t) + 0.5528\,Log(EXWP_t) + 0.2383\,Log(EXMP_t) \\
& \quad (-2.74)^{***} \quad (2.89)^{***} \qquad (1.90)^{*} \qquad\quad (2.69)^{**} \qquad\quad (0.82) \\
& + 0.6969\,Log(ERBaht_t) + 0.5265\,Log(ERRupee_t) + 0.1508\,Log(CR4_t) \\
& \quad (2.98)^{***} \qquad\quad (2.58)^{**} \qquad\quad (0.50)
\end{aligned} \tag{14}
$$

$$
R^2 = 0.8038 \quad Observations = 38 \quad Engle-Granger\,test = -0.6094^{***} \; (-3.66)
$$

Equation (14) indicates the factors which influence export rice price. Estimated coefficients of equation (10) are all positive and statistically significant with the exceptions of export maize price and CR4. The elasticity of CR4 on export rice price is 0.1508 and statistically insignificant. That is, the market concentration for major exporting countries does not influence changes to export rice price. According to results for equation (14), total harvested area impacts export rice price the greatest, and export wheat price, exchange rate are also main factors that influence export rice price.

7. Concluding Remarks

In the past several decades, the international rice market has undergone major changes, in particular a shift in general policy, a strong expansion in trade volumes, and a lingering tendency for world prices to decline in real terms relative to the other two most 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 was met by traditional exporters. Thailand has maintained its leadership as the top rice exporter since 1980. Major inroads were made by Vietnam, which become the second most important source of trade supplies 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 U.S).

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 the supply elasticity even if the traditional exporting countries have large market share.

U.S. 2007/08 rice supply and use projections are no change but the season average farm price is raised 20 cents per cwt on each end of the range from $12.05 to $12.35 per cwt, compared to $9.96 per cwt for 2006/07 (USDA Outlook, 2008). Also, global production, domestic use, and 2007/08 ending stocks are raised from last month, while imports and exports are lowered. Especially, global production rises by 2.4 million tons primarily due to the increase in Indonesia (1.5 million tons), Burma (0.6 million tons), and Brazil (0.2 million tons). Global imports are lowered nearly 2 million tons due primarily to the impact of higher global prices and export bans and restrictive policies among many leading exporters.

In this situation, this paper estimates the export supply function for the world rice market using annual data from 1970 to 2007. Using the export supply function, we obtain

the supply elasticity for export rice price on export volume and analyze market power. We also explain 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. However, in terms of this study, the market power of the leading rice exporters is not main determining factor as to the changes of the exporting rice price structure. We also discovered that production and the exchange rate are also important factors in determining the magnitude of changes for export rice price if the supply elasticity is not sensitive.

The main findings of this analysis are (1) traditional rice exporting countries have market power with respect to market share and are also supply inelastic, 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. That is, the currency of 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 rice export quantity.

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Table 1. Descriptive Data

	Observations	Mean	Std. Dev	Min	Max
Log(Total Export Quantity)	38	2.8648	0.4764	2.108	3.5634
Log(Export Rice Price)	38	2.433	0.1345	2.1105	2.7339
Log(Total Production)	38	8.6738	0.0994	8.4875	8.8129
Log(Total Harvested Area)	38	8.163	0.182	8.1212	8.1956
Log(Oil Price)	38	1.2625	0.3029	0.5301	1.8075
Log(Export Wheat Price)	38	2.1967	0.1456	1.7923	2.5263
Log(Export Maize Price)	38	2.0166	0.0998	1.7481	2.2329
Log(Exchange Rate Baht/US dollar)	38	1.4827	0.0841	1.3693	1.6528
Log(Exchange Rate India/US dollar)	38	1.4748	0.1497	1.2189	1.6714

Table 2. The Definitions of Variables

Variables	Definitions
EX	**Total rice export quantity (1000 tons)** Source: FAOSTAT and USDA World Rice Calendar Years (2008)
EXRP	**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 BAHT **ER RUPEE**	**Real exchange rate of Baht/U.S. dollar and Rupee/U.S. dollar** Source: The Bank of Thailand and India Note: Baht and Rupee are the currency of Thailand and India, respectively.
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.
CR4	**Concentration ratio 4** Note: this variable is calculated by using USDA World Rice Calendar Years (2008)

Table 3. Top Four Export/Import Countries for 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 1970 through 2007

Table 4. 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

Note: This table is based on the total export/import volumes from 1970 through 2007

Table 5. 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: t-values are in parentheses. * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level

Table 6. 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: t-values are in parentheses. The definitions of variables are the same as table 2. * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level.

Figure 1. The Traditional S-C-P Paradigm

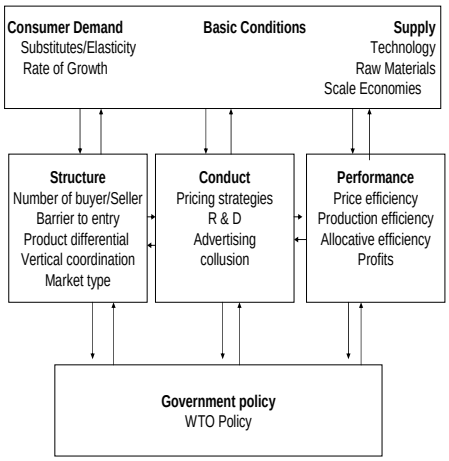

Figure 2. Total Export and Import Quantity

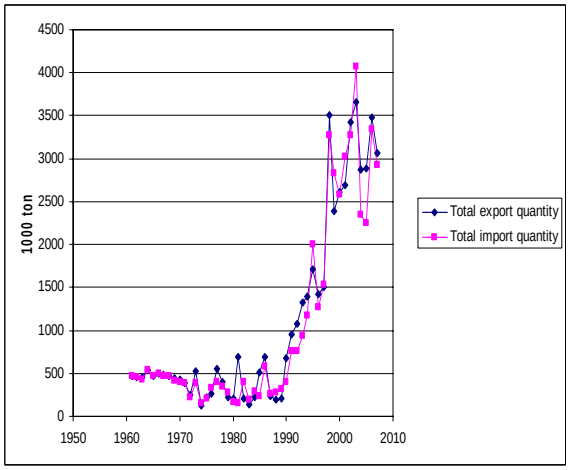

Figure 3. Total Production and Total Area Harvest

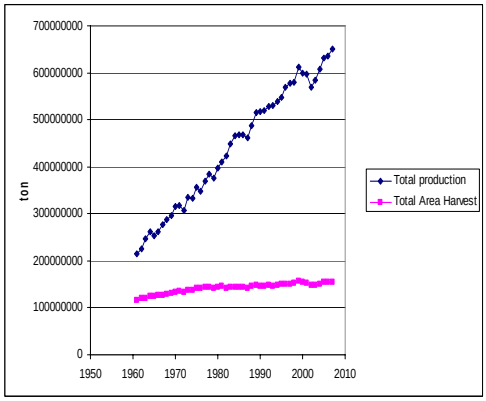

Figure 4. The Ratio of Export Quantity (Top 4 countries)

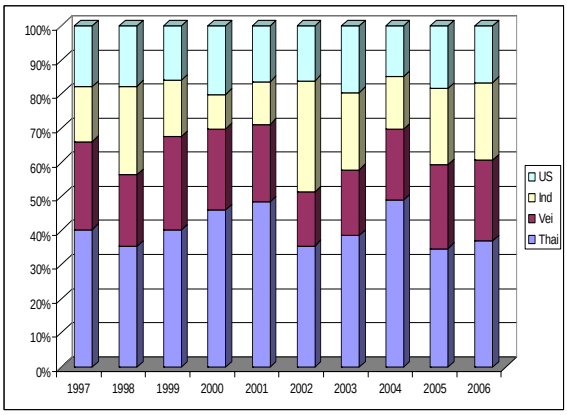

Figure 5. The Ratio of Production (Top 4 exporting countries)

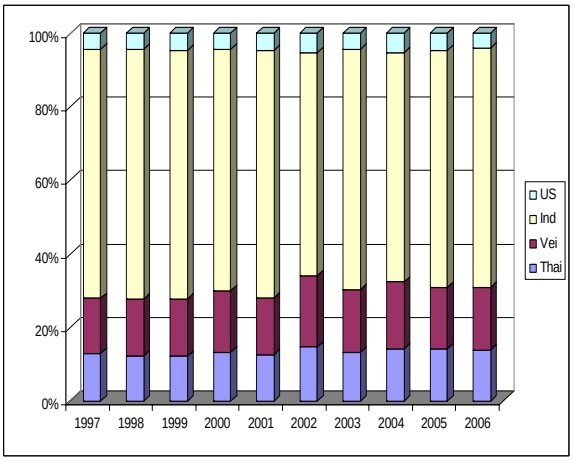

Figure 6. The Ratio of Harvest Area (Top 4 exporting countries)

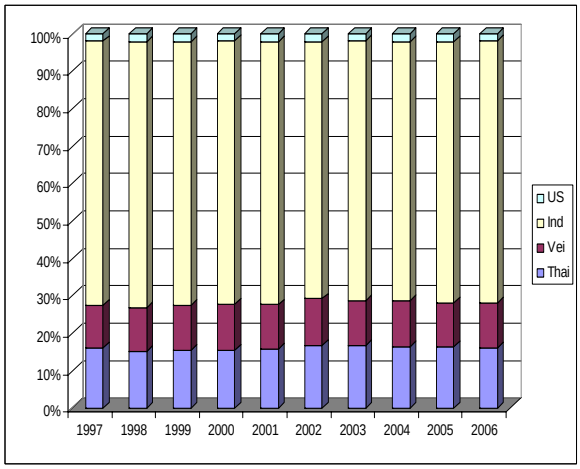

Figure 7. Export Price for Rice, Wheat and Maize

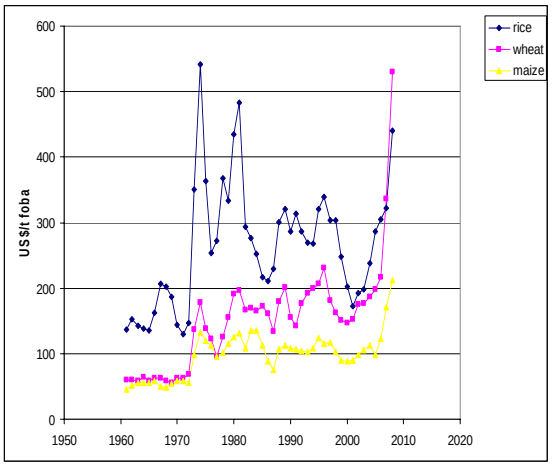

Figure 8. Crude Oil Price

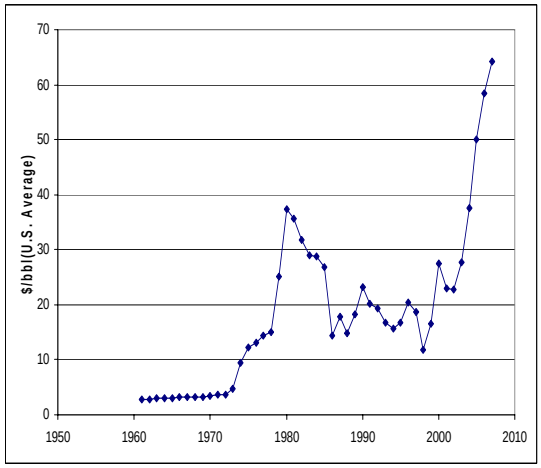

Figure 9. Market Share (Top 4 exporting countries)

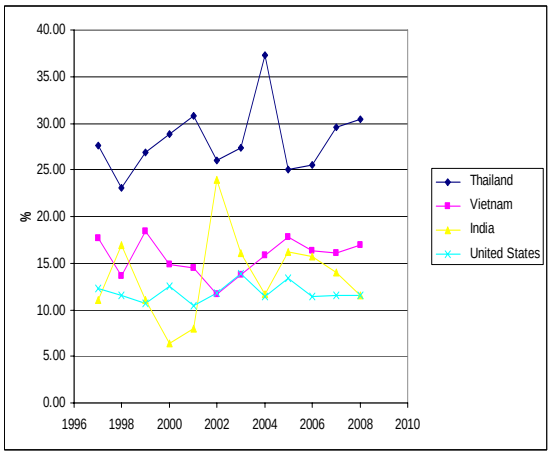

Figure 10. Comparison CR4 between exporting and importing countries

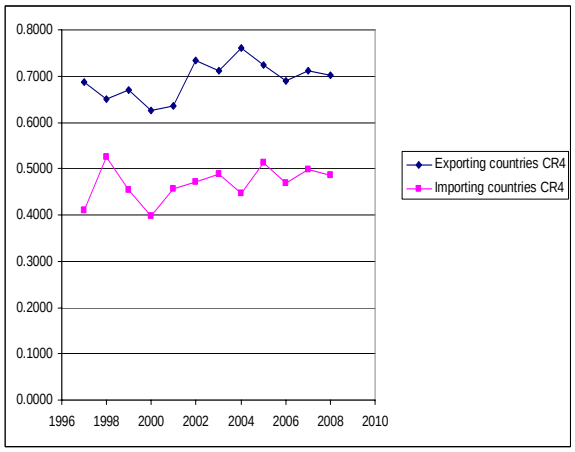

Figure 11. The Impacts of Exchange Rate

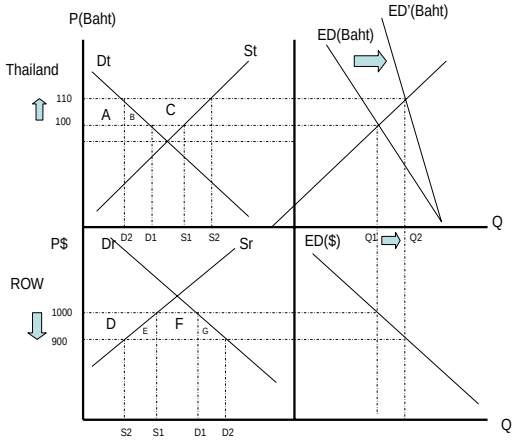
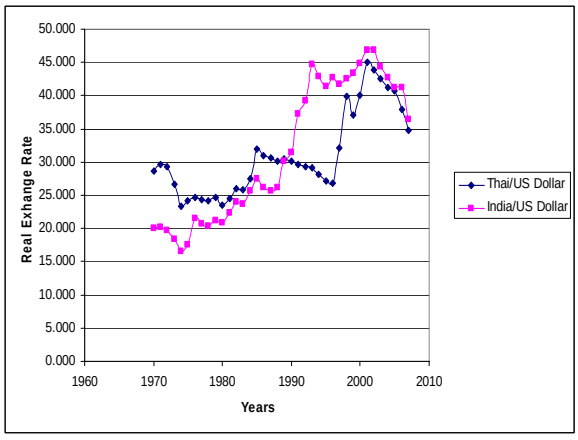
Figure 12. Trends of the Exchange Rate