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

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The Relationships of Trade, Economic Growth and Market Power: The Case of Rice Exporting Countries

This paper aims to (1) analyze the relationship between rice exports and economic growth for the world's top four exporting countries (Thailand, Vietnam, India, and the U.S) and (2) seek to determine to what extent market power affects a country's economic growth. The main objective of this paper is to determine to what extent economic growth impacts a country's rice exports as well as to what extent Foreign Direct Investment (FDI) impacts a country's ability to export rice. This analysis also examines the impact of market power on economic growth. On the basis of these results, we examine the existence of market power in the international rice market with respect to rice supply, and moreover, propose that there is a bi-directional causality between the international rice trade and economic growth for major rice exporting countries.

Key Words: *rice export, CR4, GDP, FDI, market power, trade, export supply function*

1. Introduction

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

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

Even though previous studies (Solow, 1957; Feder, 1983; Frankel and Romer, 1999; and Makki and Somwaru, 2004) showed that trade and economic growth have a positive effect, the size and sensitivity of such effects can vary across countries depending on human capital, macroeconomic situations and market power. Figure 1 indicates the percentages of world rice export volume to exporting countries' real Gross

Domestic Product (GDP) ratio. Thailand, Vietnam, India, and the U.S. are the top four rice exporting countries in the world. According to Figure 2, exporting countries' export to GDP ratio has been decreased and there are no strong positive relationships between rice export and economic growth. That is, the portion of rice exporting on GDP has gradually decreased.

In this situation, the relationships between trade and economic growth as well as the importance of Foreign Direct Investment (FDI) 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 between FDI and the rice trade. We also examine the existence of market power on exporting countries, and the effects between market power and economic growth. We estimate the effects of these roles using 1994-2007 data for four rice exporting countries.

This paper is organized as follows. First, we conduct a literature review. These papers analyzed the relationships between trade and economic growth as well as the effects of FDI and trade. Second, we explain the methodology and data, which include a discussion regarding the formulation of the export supply function and Seemingly Unrelated Regression (SUR). Third, we examine the unit root and cointegration test with respect to annual time series data. And we use the two-stage least squares (2SLS) to construct coefficient estimates for each of the endogenous variables and SUR 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.

2. Review of Literature

An extensive literature has evolved in 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 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 exports for developed countries to be less sensitive to exchange rate risk than exports for developed countries.

Van den Berg (1997) examined the econometric evidence that pointed to a relationship between trade and growth in Mexico. He showed the effects of exports, imports, and total productivity using simultaneous equations time series. He argued that Mexican development cannot reveal the present links between trade, economic growth, and productivity under Mexico's current open trade policy.

Borensztein, Gregoria, and Lee (1998) analyzed the FDI's 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 seems to have no effect on profitability. As firms sell more than one product, actual profits are overstated in the 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 analyzed that FDI and trade have a strong positive interaction, and that lowering the inflation rate, decreasing taxes, and increasing government consumption can advance the economic growth of developing countries.

3. Methodology and Data

There have been a number of empirical studies of export supply function, 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 in need of an explanation (Van and Lewer, 2007). They suggested that the relationship between trade and economic growth may be driven by 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 more trade.

As indicated previously, the main purpose of this study is to estimate the effects of economic growth on the volume of rice exports. Therefore, the hypothesis could be formulated, in simple form, as log-log-linear in format and would be specified in terms of an export supply function as follows (see Mohsen and Ltaifa, 1992; Cameron, 2005);

$$(1)\quad \sum_{i=1}^{4} Log(EX_{it}) = a_0 + a_1 Log(EXRP_t) + a_2 \sum_{i=1}^{4} Log(TP_{it}) + a_3 Log(GDP_{it}) + \varepsilon_{1t}$$

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[1] i in period t; and ε_{1t} is an error term.

Although this study can estimate equation (1) 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 to the interaction of foreign direct investment with trade and market power.

The first variable that we need to enter into equation (1) 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 we will have a better idea as to the structure of exporting rice market[2] .

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

[2] Marion and et al. (1979) analyzed the relationships between the market structures in which food chains operate their price.

The second variable is the effect of FDI and trade on economic growth. This model extends the work of Makki and Somwaru to include the period of the 1990s when FDI 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 measure, and the interaction of FDI and export volume for the top 4 rice exporters.

And 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 in equation (1) yields specified models which are as follows;

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

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

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

In addition to those variables introduced in equation (1), $CR4_t$ is concentration ratio for top rice exporters in period t, OIL_t is annual U.S. average crude oil price in period t, $EXWP_t$ is exporting price for wheat in period t, $EXMP_t$ is exporting price for maize in period t, THA_t is total harvested area in period t, ER_t is real exchange rate of

Baht/U.S. dollar in period *t*, CIF/FOB_t[3] 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*, $IMGS_{it}$ is imports of goods and service of exporting countries *i* in period *t*, HE_{it} is high-technology exports of exporting countries *i* in period *t*, GNI_{it} 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 trade openness[4] measure of exporting countries *i* in period *t*. According to past empirical studies, we expect the estimated coefficients for these variables that $a_{jt} > 0$, $b_{jt} > 0$, $c_{jt} \gtrless 0$, and $d_{jt} > 0$. Equation (1) is the basis of this empirical analysis to which we will return to in the next section.

Data[5] for this analysis were obtained from the USDA and the World Bank. The USDA database[6] includes information such as exporting volume, production, and harvested area. And The World Bank database[7] contains information such as real GDP, FDI, GNI, human capital, inflation ratio, population growth, imports of goods and service,

[3] 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.

[4] See Alcala and Ciccone (2004).

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

[5] See Table 1.

[6] Export quantity or volume indicates 1000 tons.

[7] GDP, GNI, and FDI data indicate currency 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 service are the percentage of GDP and high-technology exports is the percentage of manufactured exports. And agricultural valued added is the percentage of GDP.

high-technology exports, and agricultural values. The price databases[8] were obtained from International Rice Research Institute and Bank of Thailand. The annual data cover the top four rice exporting countries from 1994 through 2007 (see Table 1 and 2).

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 onto model specification. We estimate the system equation using Instrumental Variables (IV) and three stage least square (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 (see Greene).

4. Estimation and Results

4.1. Unit Root and Cointegration Tests

The unit root test is designed as to determine the order of integration of variables under consideration. This Augmented Dikey-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 indicates those variables that are stationary of order 1.

In Table 4, we obtain the results of the Engle-Granger (EG)[9] 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 4, we conclude that the residuals are stationary which means that the dependent and

[8] 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.
[9] See Engle and Granger (1987)

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).

4.2. Endogeneity Problems and Empirical Results

We 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 covered in the framework for the top 4 rice exporting counties from 1994 through 2007. Also, we constrained the model with three equations; One 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 the effects of FDI, market share, population growth, inflation, human capital, and trade openness have on the economic growth; and the third constraint equation examines the effects FDI, economic growth, and market share have on the concentration ratio.

Table 4 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.

We tested for over-identification using the *Hansen J-test*. 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 reject the null

hypothesis and we conclude that at least one of the instrument variables are 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 illustrates that this equation has heteroskedasicity 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 insensitive and top that three rice exporting countries have positive effects from economic growth on total export volume. According to these results, we conclude that selling market power[10] exists in the international rice market and economic growth can positively affect world rice trade.

The SUR method is utilized in order to allow for the different error variances in each equation. Table 4 indicates the econometric results of export volume using equation (1). The results of TSLS estimates 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 (1) and includes the explanatory variables of equations (2) and (3). Model 1.2 extends model 1.1 to include interaction of FDI with export volume. And Model 1.3 builds on model 1.2 by including market power effects which concentration ratio depends

[10] 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 that one firm could be zero if the potential supply elasticity were great enough. In other worlds, 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.

on the market share, economic growth, and FDI. In terms of SUR results, all variables are positive and statistically significant. Furthermore, these results indicate that the SUR estimations are more reasonable than those of IV/GMM.

Table 5 presents the econometric results of simultaneous equations using annual observation from 1994 through 2007. 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 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 Thailand is not statistically significant. The coefficients of export volume are positive while the U.S has a negative sign, implying that the rice exports of Thailand, Vietnam, and India contribute positively to economic growth but those of the U.S. do not have positive effects on the export rice volume thus not having a great impact on economic growth. 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 both positive and statistically significant. This 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 neither positive and nor 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, by itself, does not have a great effect on market power.

5. Summary and Conclusions

This paper analyzes the relationships among trade, economic growth, and market power of exporting rice countries within an export supply function. Using annual data from 1994 through 2007 for the top four rice exporting countries, we show that selling power exists in the world rice market, and has a bilateral relationship between trade and economic growth. From the empirical analysis above, we conclude that:

Export price. The supply elasticity of total rice export volume is not sensitive with statistically 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 sensitive on total rice export volume and positive in sign. That is, for a 1 percent change in exporting countries' total production increases by more than 1 percent total rice export volume.

Economic growth. OLS and IV/GMM result indicate that the GDP for Thailand, Vietnam, and India positively effect of rice export volume while U.S. GDP has a negative effect. However, SUR results show that top four rice export countries have the positive GDP effect on rice export volume, and India's GDP has a sensitive effect on rice export volume. According to OLS and IV/GMM results, U.S. has the negative effects for GDP on rice export volume which indicates that for positive U.S. economic growth, total rice export volumes would decrease.

Concentration Ratio. This variable has positive effects of CR4 on rice export price even if it is not sensitive. That is, increasing of market power or market concentration on rice export can increase rice export price.

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 sensitive to rice export price. This implies that increasing of input cost on rice export can affect the increasing of rice export price.

Export wheat and maize price. Export wheat price has positive and statistically significant effects on rice export price while export maize price is also positive with statistically insignificant. That is, wheat and rice are substitutable goods but insensitively so in terms of substitute effects.

Total harvested area. This variable has a negative effect on rice export price. This implies that increasing harvested area within exporting countries decrease rice export price with respect to supply and demand.

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

FDI, market share, export volume, inflation, population, GNI, human capital, agricultural value, and openness measure. Figure 2 illustrates that the GDP of both Thailand and India have significantly increased with respect to rice export volume. Although top four exporting countries GDPs increase in response to increase in rice export volumes, Vietnam and the U.S. are under the 45 degree line (AB). That is, Thailand and India have relatively strong effects which increasing economic growth can increase the rice export volume. And, the increasing of FDI, market share, rice export volume within top four exporting countries have positive (though insensitive) GDP effects. Inflation rates have negative effects on GDP with exception of 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 growth economic theory. Also, the interaction between FDI and rice trade has a positive effect on GDP and implies that FDI and rice trade complement each other in developing economic growth within the top four rice exporting countries.

Concentration ratio on market share and GDP. The effects of market share on CR4 are positive and insensitive. This means that increasing market share will increase the market power or concentration within rice export market. The effects of GDP on CR4 are positive and insensitive. 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 have relatively high impacts on market concentration.

On the basis of this paper, the main findings are as follows. First, the international rice market has the market power for exporting countries in terms of supply inelasticity.

Second, this study shows that trade and economic growth have a bi-directionally causal relationship. Several previous studies (Solow, Feder, Frankel and Romer, and Makki and Somwaru) 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 estimated results, there are also positive effects of economic growth on trade within the world rice market, implying that we need to consider the bilateral directions between trade and economic growth. For example, in Thailand, the effect of economic growth on trade is 0.983 with statistically significance but the effects of trade on economic growth is 10.262 and also is statistically significant. Even if the effects of trade on economic growth are greater than those of economic growth on trade, there exist positive relationships between trade and economic growth.

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, we conclude that the effects of FDI and rice export on economic growth in Thailand, Vietnam, and India (relative low developed countries) are relatively strong.

Finally, in model 1.3, we 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 have especially strong positive relationships between market power and economic growth. We conclude that these countries have more market power on world rice market in terms of more economic growth.

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Table 1. Descriptive Data

Variables	Obs	Mean	Std. Dev	Min	Max
Log(Thai export quantity)	14	3.2829	0.088	3.6755	4.0059
Log(Vietnam export quantity)	14	3.557	0.1101	3.3467	3.7138
Log(India export quantity)	14	3.4805	0.27	2.7781	3.8228
Log(U.S. export quantity)	14	3.4796	0.0653	3.3624	3.5868
Log(Total export quantity)	14	4.3846	0.0803	4.2163	4.4625
Log(CR4)	14	0.6935	0.0457	0.6246	0.7612
Log(Thai market share)	14	1.4448	0.0486	1.3622	1.5715
Log(Vietnam market share)	14	1.1723	0.066	1.041	1.2637
Log(India market share)	14	1.0958	0.2181	0.5618	1.3779
Log(U.S. market share)	14	1.0949	0.0582	1.0167	1.2299
Log(Export price for rice)	14	2.4277	0.1152	2.238	2.6444
Log(Export price for wheat)	14	2.302	0.1317	2.1673	2.6263
Log(Export price for maize)	14	2.0539	0.0989	1.9493	2.281
Log(Total production)	14	8.7721	0.0237	8.7315	8.8129
Log(Total harvest area)	14	8.1804	0.0083	8.1681	8.1956
Log(Oil price)	14	1.4102	0.2254	1.0759	1.8075
CIF/FOB	14	0.0861	0.0595	0.0001	0.18
Log(Thai FDI)	14	9.6518	0.2531	9.1355	9.9638
Log(Vietnam FDI)	14	9.2445	0.0999	9.1232	9.3895
Log(India FDI)	14	9.6284	0.3483	8.9882	10.2775
Log(U.S. FDI)	14	11.0938	0.257	10.6639	11.5068
Log(Thai GDP)	14	11.1775	0.0939	11.0486	11.349
Log(Vietnam GDP)	14	10.5296	0.1804	10.2118	10.8571
Log(India GDP)	14	11.7195	0.1543	11.5098	12
Log(U.S. GDP)	14	12.9926	0.0943	12.8461	13.1469
Log(Thai inflation growth rate)	14	0.5361	0.2698	0.0878	0.9655
Log(Vietnam inflation growth rate)	14	0.8372	0.2484	0.2896	1.2314
Log(India inflation growth rate)	14	0.7287	0.1659	0.4952	1
Log(U.S. inflation growth rate)	14	0.3282	0.136	0.0457	0.5259
Log(Exchange rate)	14	1.5648	0.0955	1.3979	1.6601

Table 1. (Continued)

Variables	Obs	Mean	Std. Dev	Min	Max
Thai population growth rate	14	0.9112	0.1893	0.6973	1.1346
Vietnam population growth rate	14	1.3621	0.4117	0.1552	1.8742
India population growth rate	14	1.6014	0.162	1.367	1.0836
U.S. population growth rate	14	1.0794	0.1065	0.9224	1.2262
Log(Thai import of goods and service)	14	1.7421	0.0831	1.6333	1.8757
Log(Vietnam import of goods and service)	14	1.7682	0.088	1.6223	1.8909
Log(India import of goods and service)	14	1.1907	0.1329	1.0131	1.4203
Log(U.S. import of goods and service)	14	1.1465	0.0514	1.0647	1.2277
Log(Thai high technology export)	14	1.4634	0.4823	1.372	1.5352
Log(Vietnam high technology export)	14	0.5495	0.3112	0.1353	1.0426
Log(India high technology export)	14	0.6625	0.0634	0.4731	0.7318
Log(U.S. high technology export)	14	1.4995	0.1803	1.4759	1.5342
Log(Thai GNI)	14	3.3925	0.0798	3.2966	3.5211
Log(Vietnam GNI)	14	2.6128	0.1662	2.301	2.892
Log(India GNI)	14	2.6998	0.1242	2.5185	2.9138
Log(U.S. GNI)	14	4.5407	0.0788	4.4253	4.6704
Thai human capital	14	7.3571	0.7355	6.3	8.5
Vietnam human capital	14	8.1528	0.1748	7.9	8.48
India human capital	14	6.634	0.282	6.09	7.05
U.S. human capital	14	12.9228	0.2074	12.6	13.22
Log(Thai agricultural value)	14	0.9922	0.0293	0.9553	1.0372
Log(Vietnam agricultural value)	14	1.3783	0.0472	1.3087	1.4434
Log(India agricultural value)	14	1.3522	0.0765	1.2313	1.4551
Log(U.S. agricultural value)	14	0.1197	0.0866	0.0002	0.2619
Log(Thai openness measure)	14	−0.0397	0.1286	−0.2528	0.1113
Log(Vietnam openness measure)	14	−0.0801	0.1481	−0.3319	0.1273
Log(India openness measure)	14	−0.788	0.1472	−0.9572	−0.5359
Log(U.S. openness measure)	14	−0.9139	0.0285	−0.963	−0.8672
Log(Thai FDI*export quantity)	14	36.976	1.6696	33.5787	39.1521
Log(Vietnam FDI*export quantity)	14	32.8836	1.0995	31.0872	34.5048
Log(India FDI*export quantity)	14	33.5587	3.3294	24.9706	37.4521
Log(U.S. FDI*export quantity)	14	38.5997	1.0506	36.7505	39.7492

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	**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** Note: this variable is calculated by using USDA World Rice Calendar Years (2008)
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) $Openness\ Measure = \frac{total\ \exp ort\ volume + total\ import\ volume}{GDP}$

Table 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)	−0.335	−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: t-values are in parentheses.
* indicates 90% confidence level
** indicates 95% confidence level
*** indicates 99% confidence level

Table 4. Model Results of Export Volume Using Equation (1): Annual Observations from 1994 through 2007 (Dependent Variable: Log (Total Export Quantity))

Independence 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	14	14	14	14	14
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: t-values are in parentheses.

All variables are the first difference with exception of Vietnam GDP.

* indicates 90% confidence level

** indicates 95% confidence level

*** indicates 99% confidence level

Table 5. Model Results of Simultaneous Equations using the Annual Observations from 1994 through 2007

Model	Simultaneous Equation Estimates
1.1	$Log(EXP_t) = -20.1274 + 0.7345Log(CR4_t) + 0.1753Log(OIL_t) + 0.9628Log(EXWP_t) + 0.1749Log(EXMP_t) - 2.3116Log(THA_t) + 0.4362Log(ER_t) + 1.4254Log(CIF/FOB_t)$ $(-2.02)^{*}\quad (3.4)^{***}\quad (2.34)^{**}\quad (3.95)^{***}\quad (0.57)\quad (-1.92)^{*}\quad (3.26)^{***}\quad (6.49)^{***}$ $Log(GDP_{1t}) = 4.2562 + 0.0229Log(FDI_{1t}) + 0.0154Log(MS_{1t}) + 0.167Log(EX_{1t}) - 0.0957Log(IN_{1t}) + 0.8027POP_{1t} + 1.2343Log(IMGS_{1t}) + 0.3832Log(HE_{1t})$ $(3.79)^{***}\quad (0.54)\quad (0.15)\quad (1.64)\quad (-2.9)^{***}\quad (3.52)^{***}\quad (2.66)^{**}\quad (2.26)^{**}$ $+ 0.4094Log(GNI_{1t}) + 0.2677HC_{1t} + 0.4118Log(AG_{1t}) + 1.1472Log(OP_{1t})$ $(1.78)^{*}\quad (4.28)^{***}\quad (1.32)\quad (3.1)^{***}$ $Log(GDP_{2t}) = 8.2959 + 0.0236Log(FDI_{2t}) + 0.0773Log(MS_{2t}) + 0.1973Log(EX_{2t}) + 0.1088Log(IN_{2t}) + 0.0396POP_{2t} - 1.2081Log(IMGS_{2t}) + 0.0551Log(HE_{2t})$ $(23.27)^{***}\quad (1.87)^{*}\quad (4.15)^{***}\quad (6.97)^{***}\quad (13.38)^{***}\quad (7.4)^{***}\quad (-10.06)^{***}\quad (6.72)^{***}$ $+ 1.1845Log(GNI_{21t}) + 0.0812HC_{2t} + 0.974Log(AG_{2t}) + 0.9493Log(OP_{2t})$ $(36.55)^{***}\quad (3.15)^{***}\quad (12.04)^{***}\quad (9.0)^{***}$ $Log(GDP_{3t}) = 9.6005 + 0.0322Log(FDI_{3t}) + 0.4518Log(MS_{3t}) + 0.3721Log(EX_{3t}) + 0.1188Log(IN_t) + 0.2586POP_{3t} - 0.8715Log(IMGS_{3t}) + 0.0063Log(HE_{3t})$ $(18.34)^{***}\quad (0.84)\quad (3.44)^{***}\quad (3.28)^{***}\quad (2.43)^{**}\quad (1.33)\quad (-1.37)\quad (0.05)$ $+ 1.9643Log(GNI_{3t}) + 0.1437HC_{3t} - 2.496Log(AG_{3t}) + 0.7195Log(OP_{3t})$ $(4.72)^{***}\quad (3.16)^{***}\quad (-4.55)^{***}\quad (1.78)^{*}$ $Log(GDP_{4t}) = 7.3259 + 0.018Log(FDI_{4t}) + 0.1295Log(MS_{4t}) - 0.1318Log(EX_{4t}) - 0.0619Log(IN_{4t}) - 0.0078POP_{4t} - 0.2773Log(IMGS_{4t}) - 0.0948Log(HE_{4t})$ $(26.37)^{***}\quad (2.1)^{**}\quad (4.79)^{***}\quad (-7.54)^{***}\quad (-7.5)^{***}\quad (-0.3)\quad (-4.1)^{***}\quad (-0.99)$ $+ 1.1638Log(GNI_{4t}) + 0.0792HC_{4t} - 0.1581Log(AG_{4t}) + 0.02Log(OP_{4t})$ $(22.58)^{***}\quad (2.77)^{**}\quad (-9.66)^{***}\quad (0.92)$ $R^2 = 0.8826$ Breusch-Pagan test= 10.169 (p-value: 0.809) Engle-Granger test= −2.035*** (−8.48)

Notes: t-values are in parentheses. * indicates 90% confidence level. ** indicates 95% confidence level. *** indicates 99% confidence level
Subscripts of i=1 indicates Thailand data, i=2 indicates Vietnam data, i=3 indicates India data, and i=4 indicates U.S. data, respectively.

Table 5. Continued

Model	Simultaneous Equation Estimates
1.2	$Log(EXP_t) = -23.266 + 0.7757Log(CR4_t) + 0.146Log(OIL_t) + 0.7462Log(EXWP_t) + 0.3474Log(EXMP_t) - 2.7269Log(THA_t) + 0.324Log(ER_t) + 1.336Log(CIF/FOB_t)$ $(-2.32)^{**}\ (3.57)^{***}\ (1.95)^{*}\ (2.92)^{***}\ (1.08)\ (-2.26)^{**}\ (2.36)^{**}\ (5.81)^{***}$ $Log(GDP_{1t}) = 45.6232 + 4.1846Log(FDI_{1t}) + 0.5157Log(MS_{1t}) + 10.2621Log(EX_{1t}) - 0.1819Log(IN_{1t}) + 0.5978POP_{1t} + 0.4921Log(IMGS_{1t}) + 0.548Log(HE_{1t})$ $(3.09)^{***}\ (2.74)^{**}\ (2.76)^{**}\ (2.71)^{**}\ (-4.41)^{***}\ (2.93)^{***}\ (1.13)\ (3.56)^{***}$ $+ 0.9165Log(GNI_{1t}) + 0.1144HC_{1t} - 0.0149Log(AG_{1t}) + 0.4143Log(OP_{1t}) + 1.1232Log(FDI_{1t} \times EX_{1t})$ $(3.77)^{***}\ (1.64)\ (-0.05)\ (1.13)\ (2.75)^{**}$ $Log(GDP_{2t}) = 9.023 + 0.8966Log(FDI_{2t}) + 0.0585Log(MS_{2t}) + 2.1587Log(EX_{2t}) + 0.1098Log(IN_{2t}) + 0.0395POP_{2t} - 1.28741Log(IMGS_{2t}) + 0.057Log(HE_{2t})$ $(21.66)^{***}\ (26.71)^{***}\ (3.29)^{***}\ (27.38)^{***}\ (13.62)^{***}\ (7.56)^{***}\ (-10.7)^{***}\ (6.97)^{***}$ $+ 1.1887Log(GNI_{21t}) + 0.0751HC_{2t} + 0.9606Log(AG_{2t}) + 1.0039Log(OP_{2t}) + 0.2545Log(FDI_{2t} \times EX_{2it})$ $(37.5)^{***}\ (3.0)^{***}\ (11.92)^{***}\ (9.58)^{***}\ (24.25)^{***}$ $Log(GDP_{3t}) = 15.9457 + 0.7909Log(FDI_{3t}) + 0.6631Log(MS_{3t}) + 1.5467Log(EX_{3t}) + 0.1872Log(IN_t) + 0.3176POP_{3t} + 0.0082Log(IMGS_{3t}) + 0.5054Log(HE_{3t})$ $(9.05)^{***}\ (3.57)^{***}\ (5.78)^{***}\ (2.92)^{***}\ (4.65)^{***}\ (2.17)^{**}\ (0.02)\ (3.13)^{***}$ $+ 1.817Log(GNI_{3t}) + 0.1526HC_{3t} - 2.96Log(AG_{3t}) + 1.5633Log(OP_{3t}) + 0.2201Log(FDI_{3t} \times EX_{3t})$ $(5.83)^{***}\ (4.44)^{***}\ (-6.81)^{***}\ (4.19)^{***}\ (3.64)^{***}$ $Log(GDP_{4t}) = 9.2899 + 0.1511Log(FDI_{4t}) + 0.1169Log(MS_{4t}) + 0.6549Log(EX_{4t}) - 0.0616Log(IN_{4t}) - 0.0265POP_{4t} - 0.2329Log(IMGS_{4t}) - 0.0428Log(HE_{4t})$ $(3.83)^{***}\ (0.74)\ (3.8)^{***}\ (1.04)\ (-7.57)^{***}\ (-0.71)\ (-2.39)^{**}\ (-0.36)$ $+ 1.1584Log(GNI_{4t}) + 0.0653HC_{4t} - 0.1518Log(AG_{4t}) + 0.0161Log(OP_{4t}) + 0.0476Log(FDI_{4t} \times EX_{4t})$ $(21.74)^{***}\ (1.95)^{*}\ (-8.25)^{***}\ (0.75)\ (3.83)^{***}$ $R^2 = 0.8825$ Breusch-Pagan test= 11.343 (p-value: 0.7279) Engle-Granger test= -2.026^{***} (−8.14)

Table 5. Continued

Model	Simultaneous Equation Estimates
1.3	$Log(EXP_t) = -20.9604 + 0.7593Log(CR4_t) + 0.141Log(OIL_t) + 0.6537Log(EXWP_t) + 0.4766Log(EXMP_t) - 2.435Log(THA_t) + 0.3449Log(ER_t) + 1.3535Log(CIF/FOB_t)$ $(-2.1)^{**}\ (3.5)^{***}\ (1.91)^{*}\ (2.58)^{***}\ (1.5)\ (-2.03)^{*}\ (2.53)^{**}\ (5.89)^{***}$ $Log(GDP_{1t}) = 50.4567 + 4.641Log(FDI_{1t}) + 0.6109Log(MS_{1t}) + 11.3473Log(EX_{1t}) - 0.1848Log(IN_{1t}) + 0.5011POP_{1t} + 0.2421Log(IMGS_{1t}) + 0.5846Log(HE_{1t})$ $(3.44)^{***}\ (3.06)^{***}\ (3.34)^{***}\ (3.02)^{***}\ (-4.52)^{***}\ (2.5)^{**}\ (0.58)\ (3.94)^{***}$ $+1.0669Log(GNI_{1t}) + 0.0717HC_{1t} - 0.2199Log(AG_{1t}) - 0.1782Log(OP_{1t}) + 1.243Log(FDI_{1t} \times EX_{1t})$ $(4.56)^{***}\ (1.06)\ (-0.75)\ (-0.51)\ (3.07)^{***}$ $Log(GDP_{2t}) = 14.0986 + 0.9011Log(FDI_{2t}) + 0.0603Log(MS_{2t}) + 2.1714Log(EX_{2t}) + 0.1109Log(IN_{2t}) + 0.04016POP_{2t} - 1.30331Log(IMGS_{2t}) + 0.05761Log(HE_{2t})$ $(19.06)^{***}\ (26.89)^{***}\ (3.39)^{***}\ (27.59)^{***}\ (13.79)^{***}\ (7.69)^{***}\ (-10.84)^{***}\ (7.05)^{***}$ $+1.193Log(GNI_{21t}) + 0.0716HC_{2t} + 0.9683Log(AG_{2t}) + 1.0176Log(OP_{2t}) + 0.2562Log(FDI_{2t} \times EX_{2it})$ $(37.68)^{***}\ (2.89)^{***}\ (12.02)^{***}\ (9.72)^{***}\ (24.46)^{***}$ $Log(GDP_{3t}) = 16.0663 + 0.8044Log(FDI_{3t}) + 0.6489Log(MS_{3t}) + 1.6181Log(EX_{3t}) + 0.1892Log(IN_t) + 0.2756POP_{3t} + 0.0082Log(IMGS_{3t}) + 0.5197Log(HE_{3t})$ $(9.12)^{***}\ (3.64)^{***}\ (5.66)^{***}\ (3.05)^{***}\ (4.7)^{***}\ (1.89)^{*}\ (0.33)\ (3.22)^{***}$ $+1.7193Log(GNI_{3t}) + 0.1501HC_{3t} - 2.8891Log(AG_{3t}) + 1.6476Log(OP_{3t}) + 0.2258Log(FDI_{3t} \times EX_{3t})$ $(5.56)^{***}\ (4.37)^{***}\ (-6.67)^{***}\ (4.44)^{***}\ (3.74)^{***}$ $Log(GDP_{4t}) = 9.2744 + 0.1518Log(FDI_{4t}) + 0.1155Log(MS_{4t}) + 0.6553Log(EX_{4t}) - 0.0608Log(IN_{4t}) - 0.025POP_{4t} - 0.2361Log(IMGS_{4t}) - 0.0377Log(HE_{4t})$ $(3.83)^{***}\ (0.74)\ (3.76)^{***}\ (1.04)\ (-7.48)^{***}\ (-0.67)\ (-2.42)^{**}\ (-0.31)$ $+1.1577Log(GNI_{4t}) + 0.0668HC_{4t} - 0.1513Log(AG_{4t}) + 0.0168Log(OP_{4t}) + 0.0477Log(FDI_{4t} \times EX_{4t})$ $(21.73)^{***}\ (1.99)^{*}\ (-8.23)^{***}\ (0.78)\ (0.83)$ $Log(CR4_t) = 2.1433 + 0.5736Log(MS_{1t}) + 0.2435Log(MS_{2t}) + 0.2817Log(MS_{3t}) + 0.1226Log(MS_{4t}) + 0.3195Log(GDP_{1t}) + 0.3161Log(GDP_{2t})$ $(3.09)^{***}(18.72)^{***}\ (10.64)^{***}\ (26.89)^{***}\ (2.45)^{**}\ (7.58)^{***}\ (4.68)^{***}$ $+0.7321Log(GDP_{3t}) + 0.1773Log(GDP_{4t}) - 0.1511Log(FDI_{1t}) + 0.1389Log(FDI_{2t}) - 0.0211Log(FDI_{3t}) + 0.0133Log(FDI_{4t})$ $(12.01)^{***}\ (10.14)^{***}\ (-17.11)^{***}\ (6.91)^{***}\ (-1.52)\ (1.93)^{*}$ $R^2 = 0.8819$ Breusch-Pagan test= 18.001 (p-value: 0.6489) Engle-Granger test= −2.019*** (−7.75)

Figure 1. The Percentage of Rice Export on Real GDP

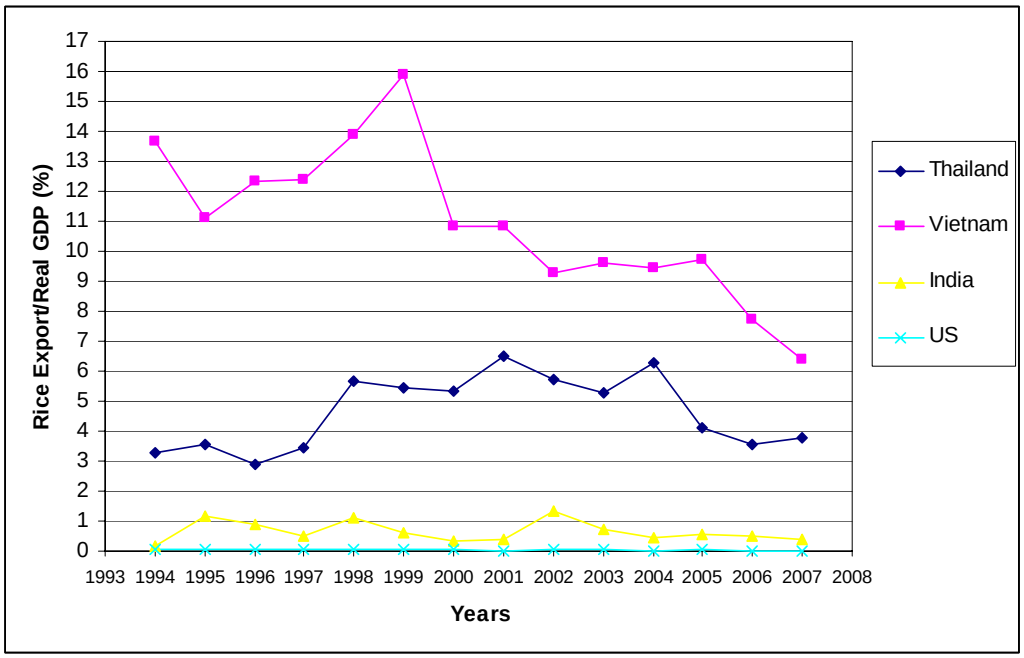
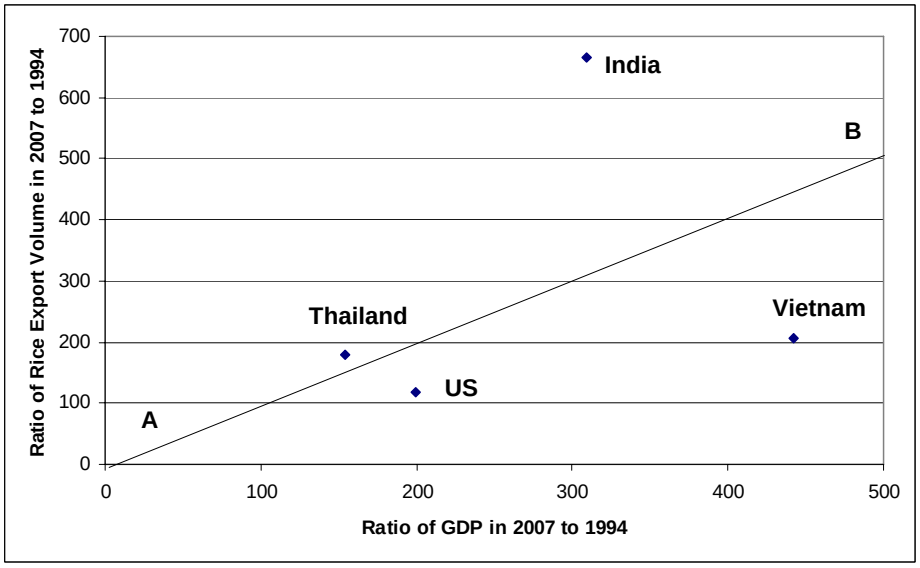


Figure 2. The Changes in GDP and Rice Export (1994=100)



Note: The line AB indicates the 45 degree line.