International Journal of Agricultural Technology 2016 Vol. 12(6): 973-982
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Assessing the Impact of Exchange Rate on Major Agricultural Export Commodities of Thailand

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Chalermpon, J., Sukprasert, P., Chulaphan, W. and Sriariyawat, S. (2016). Assessing the impact of exchange rate on major agricultural export commodities of Thailand. International Journal of Agricultural Technology 12(6):973-982.

Abstract The purpose of this study is to measure the impact of exchange rate on major agricultural export commodities of Thailand using time series analysis over the period of January 2001 to December 2013. A seasonal autoregressive integrated moving average with exogenous (SARIMA-X) is modeled to detect the impact of Thai currency fluctuations on export supplies for natural rubber, rice, tapioca, poultry and fishery. After identifying trend and seasonal stationarities, SARIMA(p,d,q)(P,D,Q)s is performed for tapioca and poultry as well as SARMA(p,q)(P,Q)s for natural rubber, rice and fishery. The results show that exchange rate significantly impacts on rice, tapioca, poultry and fishery, but it seems not to have a significant impact on natural rubber even though the time lag effect is included. Policymakers should, therefore, consider the appropriate policies based on these empirical findings to manage the risks on export supplies and national income concerning the fluctuations of exchange rates.

Keywords: Impact assessment, Agricultural exports, Seasonal ARIMA, Time series analysis, Exchange rate, Thailand

Introduction

Agricultural sector has successfully increased its importance in many emerging economies with the closed connection to trade activities. Initiating a competitive agricultural sector is becoming a leading strategy of economic development. In Thailand, agriculture is a profitable sector of Thai economy while the Thai farmers are recognized as the nation's "backbone" who feed the whole country. Agricultural sector of Thailand, therefore, is represented as the national food supply and income generation. Thai government realizes on this truth and takes actions by including agricultural development into a national economic and social development plan.

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Thailand is top of the world in producing and exporting agricultural commodities such as natural rubber, rice, tapioca, vegetables, tropical fruits, fish, shrimps, cuttlefish and poultry. In 2013, Thailand generated 22,709 million USD from agricultural export commodities. It accounts for 9.94% on trade revenue and for 13.65% on GDP. Agricultural export reflects the average income of 9.43% per year after the economic crisis since 1997.

Even though the Thai agricultural exports has increased its volume during the last ten years, there are factors that negatively affect agricultural exports, such as, global economic crisis, trade barrier between regions, natural disasters, political issue and other macroeconomic factors. Over the last few years, exchange rate is considered as a competitive factor on the exports because it can indicate a comparative advantage of a country. The relative price is basically devalued during the appreciation period comparing to the competitor prices. The appreciation of Thai currency in 2013, on an average of 5.44% relative to 2012, has greatly affected on the export value and trade ability of agricultural export commodities. The growth of agricultural export commodities has dramatically declined by 3.16% in 2013. According to the results from the appreciation in recent years, Thai government launched the policies to stabilize the national currency aiming to protect the national loss especially agricultural export sector.

The empirical studies based on the hypothesis that exchange rate has a negative relationship with the exports of agricultural commodities are showed by numerous scholars. Baek and Koo (2009) studied the bilateral trade of the United States (U.S.) and ten major trading partners, namely, Canada, Mexico, Japan, the Netherlands, Korea, Italy, Australia, Taiwan, Indonesia and France using the autoregressive distributed lag (ARDL) model to present short-run and long-run relationships among the variables. This study found that agricultural exports are highly sensitive to exchange rate in long-run relationship based on quarterly time series analysis from 1975:Q4 to 2004:Q4. The finding from Kim *et al.*'s (2004) explored that the exchange rate has a significant impact on the U.S. agricultural trade with Canada under the Canada-U.S. Free Trade Agreement (CUSTA) using quarterly time series analysis covering the period of 1983:Q4 to 2000:Q1. Moreover, May (2010) studied the impact of real exchange rate volatility on five heavily traded agricultural commodities of Thailand, namely, maize, rice, rubber, sugar and tapioca using daily and monthly time series analysis over the 1981 to 2006 period. The results confirmed that exchange rate generally affected agricultural commodity exports with negative impact.

The objective of this study is to measure the impact of exchange rate on major agricultural export commodities of Thailand using monthly time series analysis from January 2001 to December 2013. The remainders of this study are organized as follows. Next section provides the information about data, variables and econometrics. The major agricultural export commodities are represented as natural rubber, rice, tapioca, poultry and fishery. The methodology consists of two time series econometric approaches. First, the trend and seasonal unit roots are utilized to test for a stationarity in each variable. Second, the SARIMA-X model is performed to assess the impact sizes of exogenous variable on five major agricultural export commodities. Then, the empirical results are showed for the statistical analyses. Finally, the conclusions and related policy implications are provided in the last section.

Data, variables and econometrics

Data and variables

The data used in this study is a monthly time series from January 2001 to December 2013. The descriptive variables are presented in Table 1. Real effective exchange rate (REER) index from the Bank of Thailand is used as the exchange rate variable. Export quantities, in terms of kilograms, of natural rubber, rice, tapioca, poultry and fishery from the Customs Department are represented for the major agricultural export commodities of Thailand. All the variables are converted to natural logarithms.

Table 1. The descriptive variables

Variable	Description
LREER	Real effective exchange rate index
LQ_WRUB	Natural rubber (Harmonize code: 4001)
LQ_WRICE	Rice (Harmonize code: 1006)
LQ_WTAP	Tapioca products (Harmonize code: 350510)
LQ_WPOU	Poultry products (Harmonize code: 160232)
LQ_WFISH	Fishery products (Harmonize code: 03)

Note: The real effective exchange rate (REER) of Thailand is weighted using Thai Baht and trading partners' currencies (21 countries) with depended on its shared contribution, adjusted for the effects of inflation. The increase in REER describes the strength of Thai Baht relative to a basket of other currencies.

Econometrics

The seasonal autoregressive integrated moving average (SARIMA) model is applied to detect the impact of exogenous variable (X) based on Box and Jenkins's (1970) and Box *et al.*'s (1994) procedures. Before performing SARIMA-X, it needs to indicate the stationarity of time series because the results cannot be relied on the testing of non-stationary process (Granger and Newbold 1974). The Augmented Dickey-Fuller (ADF) unit root of Dickey and Fuller (1979, 1981) are employed to identify the order of integration in each variable, namely, LREER, LQ_WRUB, LQ_WRICE, LQ_WTAP, LQ_WPOU and LQ_WFISH.

$$\Delta Y_t = \alpha_0 + \delta T + \beta_1 Y_{t-1} + \sum_{i=1}^{p} \beta_2 \Delta Y_{t-i} + \varepsilon_t \qquad (1)$$

Where Δ is the differencing order, Y_t is the observed time series, α_0 is the constant, T is the time trend, ε_t is the error term, p is the autoregressive (AR) optimal lag selection based on the lowest value of the Schwartz information criterion (SIC) and, α_0, δ and β are the parameters to be estimated. The null (H_0) and alternative (H_A) hypotheses for the existence of unit root in variable Y_t are: $\beta_1 = 0$ for stationary time series and $\beta_1 < 0$ for non-stationary time series. If the statistical results of hypothesis testing for the ADF unit root cannot be rejected at level, then the differencing orders or I(d) must be taken until the variables are stationary.

However, the agricultural export commodities usually consist of seasonal component. To avoid a spurious result from the seasonal effect, the non-seasonal(Trend) and seasonal differencing operators in multiplicative form $(1 - L)(1 - L^{12})Y$ should be replaced in Eq. (1) instead of using ΔY_t to verify the seasonal order of integration or I(D) (Huang and Min 2002; Lai and Lu 2005).

An autoregressive integrated moving average (ARIMA) model was originally introduced by Box and Jenkins (1970). The ARIMA(p,d,q) consists of three components, namely, 1) autoregressive process or AR(p), 2) moving average process or MA(q), and 3) order of integration or I(d). The model is presented in Eq. (2).

$$\left(1 - \sum_{i=1}^{p} \beta_i L^i\right)(1 - L)^d Y_t = \alpha_0 + \left(1 + \sum_{j=1}^{q} \gamma_j L^j\right)\varepsilon_t \qquad (2)$$

Where d is the order of integration, L is the time lag operator, β_i is the autoregressive parameters and γ_j is the moving average parameters.

This study applies seasonal ARIMA model in order to detect the impacts of exogenous variables. In addition, the structure of SARIMA(p,d,q)(P,D,Q)s consists of three seasonal components, namely, 1) seasonal autoregressive process or SAR(P), 2) seasonal moving average process or SMA(Q), and 3) seasonal order of integration or I(D). After that, the exogenous (LREER) is determined as the explanatory variable to measure the impact size on the observed time series. The stationarity on exogenous is also considered before performing SARIMA-X as presented in Eq. (3).

$$\left(1-\sum_{i=1}^{p}\beta_i L^i\right)(1-L)^d\left(1-\sum_{i=1}^{P}\beta_i L^{is}\right)(1-L^s)^D Y_t = \alpha_0+\left(1+\sum_{j=1}^{q}\gamma_j L^j\right)\left(1+\sum_{j=1}^{Q}\gamma_j L^{js}\right)\varepsilon_t+\mathbf{X}' \qquad (3)$$

Where $\mathbf{X}'$ is the exogenous variable, contains stationary process. The time lag length of exogenous variable is considered for lag one ($LREER_{t-1}$) and lag two ($LREER_{t-2}$) in order to present the previous impacts within two months. To avoid the autocorrelation problem, this study utilizes the Ljung-Box Q-statistics (Q_{LB}) to indicate the appropriate model of selected SARIMA(p,d,q)(P,D,Q)s and SARIMA-X.

Empirical results

The results in Table 2 present the ADF unit root tests for a trend and seasonal stationarity testing of six variables, namely, exchange rate (LREER), natural rubber (LQ_WRUB), rice (LQ_WRICE), tapioca (LQ_WTAP), poultry (LQ_WPOU) and fishery (LQ_WFISH), respectively. The trend unit root model includes the constant (α_0) and no-time trend effect (T) in testing. The random walk with no constant (α_0) and time trend effect (T) is modeled for the seasonal unit root. The optimal lag length is identified using the lowest value of the SIC benchmark. The significant level to justify a calm of a statistically significant effect is when the p-value turns out to be less than 10% significant levels. The t-statistics is employed including the ordinary least squares (OLS) estimator. For the rejection of the null hypothesis, the MacKinnon's (1996) critical values are used as the reference.

The trend stationarity testing of LQ_WRUB, LQ_WRICE and LQ_WFISH in Table 2 indicates that the variables are statistically significant at 10% level. It means that these three variables are rejected the null hypothesis of non-stationary in the level containing unit root, stationary I(0) process. In addition to the statistical results of LREER, LQ_WTAP and LQ_WPOU show that all the variables cannot be rejected the null hypothesis of non-stationary in the level and then the first differencing order needs to be performed. At the first differencing order, LREER, LQ_WTAP and LQ_WPOU are found to be statistically significant at 10% level containing unit root, stationary I(1) process. Turning to the seasonal stationary test, the seasonal order of LQ_WRUB, LQ_WRICE and LQ_WFISH are found to be integrated at order zero. The seasonal order of one is found to be stationary for LQ_WTAP and LQ_WPOU. Based on Table 2 results, SARIMA(p,1,q)(P,1,Q)s is constructed for LQ_WTAP and LQ_WPOU as well as SARMA(p,q)(P,Q)s for LQ_WRUB, LQ_WRICE and LQ_WFISH.

Table 2. The results of ADF unit root tests

Variable	I(0)	I(1)	I(D)
	t-statistics	t-statistics	t-statistics
LREER	-1.208 (1)	-9.796* (0)	
LQ_WRUB	-6.229* (0)		-7.927* (0)
LQ_WRICE	-4.275* (3)		-3.538* (3)
LQ_WTAP	-2.357 (3)	-10.483* (2)	-21.017* (0)
LQ_WPOU	-1.924 (1)	-17.847* (0)	-12.724* (1)
LQ_WFISH	-2.890* (1)		-3.731* (1)

* denotes the statistical significance at 10% level.
Note: I(0) and I(1) refer to the order of integration for a trend unit root test. I(D) refers to the seasonal order of integration for a seasonal unit root test. The MacKinnon's (1996) critical values for a rejection of the null hypothesis at the 10% level of a trend and seasonal unit root are found to be at -2.576 and -1.615, respectively. The optimal lags in parentheses are selected based on the lowest value of the Schwartz information criterion (SIC).

Next, the correlogram specification is run on the order of its integration to find out the parts of AR(p), MA(q), SAR(P) and SMA(Q). In this study, the first-to-fifth lag length of the autocorrelation function (ACF) and partial autocorrelation function (PACF) are initially determined to present the numbers of MA(q) and AR(p) lags, respectively. Furthermore, the seasonal lag lengths at every lag of 12 months are examined as the seasonal patterns (s = 12) of $SMA(Q)_{12}$ and $SAR(P)_{12}$.

Table 3. The results of selected SARIMA (p,d,q)(P,D,Q)s

Coefficient	Dependent variable				
	Q_WRUB	Q_WRICE	Q_WTAP	Q_WPOU	Q_WFISH
Constant	0.003	-0.003	-0.001	-0.002	-81.147
AR(1)	0.587*		-0.596*	-0.817*	0.999*
AR(2)				-0.450*	
AR(3)		0.590*			
MA(1)		0.379*		0.557*	-0.633*
MA(2)		0.378*	-0.284*		
MA(4)					-0.156*
SAR(12)	-0.202*				-0.419*
SAR(24)	-0.212*				
SMA(12)	-0.876*	-0.893*	-0.922*	-0.918*	
R^2	0.573	0.730	0.623	0.550	0.546
D.W.	2.039	1.941	1.912	1.991	1.931
SIC	-1.650	-0.299	-1.481	-2.003	-1.786
Q_{LB}	1.652	1.823	1.725	1.655	1.311

* denotes the statistical significance at 10% level.

The selected SARIMA (p,d,q)(P,D,Q)s in Table 3 are estimated using the OLS estimation. There are excluded for the insignificant parameters, except the constant term. The most appropriate SARIMA(p,d,q)(P,D,Q)s in each variable are presented as these followings: $SARIMA(1,1,2)(0,1,1)_{12}$ for LQ_WTAP, $SARIMA(2,1,1)(0,1,1)_{12}$ for LQ_WPOU, $SARMA(1,0)(2,1)_{12}$ for LQ_WRUB, $SARMA(3,2)(0,1)_{12}$ for LQ_WRICE and $SARMA(1,4)(1,0)_{12}$ for LQ_WFISH. Based on the residual diagnostic test, the Q_{LB} statistics indicate that all the selected models of SARIMA(p,d,q)(P,D,Q)s are not statistically significant to reject the null hypothesis of no autocorrelation. It means that the models used in Table 3 do not have any autocorrelation problems.

To measure the impacts of exogenous on the selected SARIMA(p,d,q)(P,D,Q)s, the stationarity needs to be confirmed on the exogenous variable as well. The results of ADF unit root tests in Table 2 show that LREER contains unit root, stationary I(1) process. The exogenous in terms of the first differencing order ($\Delta LREER_t$) is included. Moreover, this study considers the first and second time lag ($\Delta LREER_{t-1}$ and $\Delta LREER_{t-2}$) to present the dynamic effects on the observed variables.

Table 4. The results of selected SARIMA-X models

Coefficient	Dependent variable				
	Q_WRUB	Q_WRICE	Q_WTAP	Q_WPOU	Q_WFISH
Constant	0.004	-0.001	0.001	-0.001	-151.555
$\Delta LREER_t$	0.138		-0.764*		1.236*
$\Delta LREER_{t-1}$	-0.724				
$\Delta LREER_{t-2}$	-0.129	-1.521*		-0.710*	
AR(1)	0.601*		-0.586*	-0.789*	0.999*
AR(2)				-0.469*	
AR(3)		0.609*			
MA(1)		0.402*		0.513*	-0.636*
MA(2)		0.393*	-0.260*		
MA(4)					-0.169*
SAR(12)	-0.217*				-0.422*
SAR(24)	-0.232*				
SMA(12)	-0.880*	-0.895*	-0.932*	-0.938*	
R^2	0.583	0.736	0.635	0.565	0.560
D.W.	2.044	1.919	1.937	2.007	1.947
SIC	-1.551	-0.287	-1.478	-2.001	-1.779
Q_{LB}	1.205	1.405	0.973	1.474	0.538

* denotes the statistical significance at 10% level.

After the empirical examination, the most appropriate models of SARIMA-X are presented in Table 4. The residual diagnosis shows that all the models avoid from autocorrelation effects using the Q_{LB} statistics. The impacts of exogenous are found to be statistically significant in four variables, namely, LQ_WRICE, LQ_WTAP, LQ_WPOU and LQ_WFISH. The impact sizes in each variable can be measured by -1.521%, -0.764%, -0.710% and 1.236% as it increased in 1% of LREER, respectively. However, LQ_WRUB is only one variable that is not detected any impacts from the exogenous variables.

Concluding remarks

This study utilizes time series analysis to measure the impact of Thai currency fluctuations on the major agricultural export commodities, namely, natural rubber, rice, tapioca, poultry and fishery. The time series covers the period of January 2001 to December 2013, 156 samples are observed. The Box and Jenkins's (1970) and Box *et al.*'s (1994) procedures, SARIMA(p,d,q)(P,D,Q)s with exogenous is applied to meet the research objectives. The analysis of impact assessment shows that rice, tapioca, poultry and fishery are significantly affected by the appreciation and depreciation of Thai currency, except natural rubber. The response of tapioca and fishery sensitively reacts to the fluctuations of exchange rates in the current period. Moreover, rice and poultry respond to the shock from previous time of two months. To measure the impact sizes, this study points out to rice commodity that is greatly impacted by 1.521% decreased its exportation if the appreciation increased by 1%. Therefore, the appreciation will cause the relative price and competitiveness of Thai rice industry. This because of the export price of Thailand is higher than other exporter countries. For the natural rubber, this study cannot significantly detect any impacts from the exchange rate. This circumstance can be explained by the demand and supply of the domestic and world markets which are the major factors that contribute to the exports of natural rubber. Interestingly, fishery commodity is not affected by the appreciation of Thai currency, but it positively responds to the exportation due to an increase in demands from the domestic and world markets.

In the empirical conclusion, policymakers should particularly provide the appropriate policies and implications to minimize the risks from fluctuations of exchange rates on agricultural export commodities. The results from this study suggest that the policymakers should take tapioca products into consideration in order to promptly launch supporting policies when the shocks of exchange rates occur following by rice and poultry, respectively. In addition, the exports of rice commodity must be concerned as the highest impact size from five commodities in order to reduce the size of its impact within two months. To promote the exportation, fishery products should be initially considered during the appreciation period. Thus, the policymakers should intensively consider these suggestions for minimizing the impact of exchange rate on the export supplies and national income.

Acknowledgement

We would like to thank Ms. Tapee Vatcharangkool and Ms. Suprama Rojanaburanon from the Office of Agricultural Economics for their invaluable comments.

The first author would like to acknowledge the Royal Thai Government Scholarship (Public Sector Innovation Scholarship).

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(Received: 10 October 2016, accepted: 31 October 2016)