Chapter 4

Result

In this chapter will find out relationship between export volumes volatility and exchange rate volatility of Thailand by using Unit root test, Univariate GARCH and Multivariate GARCH model respectively.

4.1 Result from unit root test

The test of null hypothesis of t-test at levels nonstationarity is performed using the Augmented Dickey-Fuller (ADF) test of unit roots. In addition, this result reports the critical values at the 1%, 5% and10% levels significance. There are three model of testing unit root which are intercept, intercept and trend and none that is without intercept and without trend. The results are shown as follow;

Table 4.1 Augmented Dicky-Fuller (ADF) Test Results for logarithm of export volumes and logarithm of exchange rate at level; Letting lnX_t denote the export volumes and lne_t denote the exchange rate

Levels						
	ADF Test Statistics					
Variable	**None**	**p-lag**	**Intercept**	**p-lag**	**Intercept & Trend**	**p-lag**
$\mathbf{lnX_t}$	1.82	12	0.02	12	-3.94**	12
$\mathbf{lne_t}$	0.43	4	-4.95**	4	-4.71***	4

Source : From Calculated
Note : ** Significant at the 5 % level.
*** Significant at the 1 % level.
Selecting the minimum lag length (P-lag) under SIC condition

The result of lnX_t shows the ADF statistic value is -3.94. The ADF tests reject null hypothesis. It found that lnX_t is stationary at time trend and intercept with 12 lags. Notice here that t-statistic value is less than the critical values. The series are individually integrated of order zero, I(0).

For exchange rate (lne_t) has an intercept with 4 lags. The ADF statistic value is -4.95 which less than critical value, implying the series are individually integrated of order zero, I(0). The ADF Test Statistic of variables at level is less than MacKinnon statistic, means that both variables are stationary. Valid inference in GARCH models requires stationary.

The test of null hypothesis of (t-test) at levels nonstationarity is performed using the Philip-Perron test of unit roots**.** The results are shown as follow;

Table 4.2 Philip-Perron (PP) Test Results for logarithm of export volumes and logarithm of exchange rate at level; letting lnX_t denote the export volumes and lne_t denote the exchange rate.

	Levels					
	PP Test Statistics					
Variable	**None**	**p-lag**	**Intercept**	**p-lag**	**Intercept & Trend**	**p-lag**
lnX_t	1.56	0	-1.97	1	-4.50 ***	1
lne_t	0.49	0	-3.51***	1	-3.09	1

Source: From Calculated

Note: *** Significant at the 1 % level

Selecting the minimum lag length (P-lag) under SIC condition

The result of lnX_t, which exhibits a time trend and intercept with 1 lag. The PP tests reject the null hypothesis. The PP statistic value is -4.50 which less than critical value, implying the series are individually integrated of order zero, I(0).

For exchange rate (lne_t) has an intercept with 1 lag. The PP tests reject the null hypothesis. The PP statistic value is -3.51which less than critical value, implying the series are individually integrated of order zero, I(0). The PP Test Statistic of variables at level is less than MacKinnon statistic, means that both variables are stationary.

The test of null hypothesis at levels of stationarity is performed using the KPSS test of unit roots**.** The results are shown as follow;

Table 4.3 KPSS Test Results for logarithm of export volumes and logarithm of exchange rate at level; Letting $\ln X_t$ denote the export volumes and $\ln e_t$ denote the exchange rate

Levels				
	KPSS LM- Statistics			
Variable	**Intercept**	**p-lag**	**Intercept & Trend**	**p-lag**
$\ln X_t$	1.29	0	0.06***	0
$\ln e_t$	0.31*	0	0.26	0

Source : From Calculated
Note : * Significant at the 10 percent.
*** Significant at the 1 percent.

In contrast, the result of $\ln X_t$ KPSS tests accept the null hypothesis which exhibits a time trend and intercept series without lag. It shows KPSS LM-test value is 0.06 which less than critical value, implying the series are individually integrated of order zero, I (0).

For exchange rate ($\ln e_t$) has an intercept without lag. The KPSS LM-test value is 0.31 which less than critical value; Stationary cannot be rejected at 5% level. Non-stationary can be rejected at 5% level for intercept series, implying the series are individually integrated of order zero, I(0). The KPSS Test Statistic of variables at level is less Kwiatkowski-Phillips-Schmidt-Shin statistic, means that both variables are stationary.

4.2 Result of Univariate GARCH of logarithm of export volumes

Table 4.4 The univariate GARCH of logarithm of export volumes: Mean equation

	Coefficient	Standard Error	z-Statistic	Prob.
C	12.6951	0.1833	69.2354	0.0000
AR(1)	0.952195	0.0134	70.9685	0.0000

This estimation result corresponds to the following specification of ARIMA that shows AR(1) model, since its coefficients are statistically significant at 5% level.

Table 4.5 Univariate GARCH of logarithm of export volumes: Variance equation

	Coefficient	Standard Error	z-Statistic	Prob.
C	0.0001	$6.65*10^{-5}$	2.0719	0.0383
Residual $(-1)^2$	0.1833	0.0107	17.012	0.0000
Residual $(-2)^2$	-0.2550	0.0212	-11.982	0.0000
GARCH(-1)	1.0529	0.0005	1829.90	0.0000

Akaike info criterion	-2.1274
Schwarz criterion	-1.9902
Inverted AR Roots	0.95

The result from the GARCH model of export volumes which shows univariate GARCH (2,1) and coefficients are significant at 5% level. This result illustrates the least

AIC = -2.13 and SIC = -1.99. Furthermore, Inverted AR Roots is 0.95 which is less than 1 indicating that model has convert property.

Using the information in table 4.5 it can be written the fitted GARCH equation as

GARCH = $0.0001+0.1833*\text{Residual}(-1)^2- 0.2550*\text{Residual}(2)^2+1.0530*\text{GARCH}(-1)$

Table 4.6 Lagrange multiplier test for ARCH

Obs*R-squared	$8.40*10^{-5}$
Prob. Chi-Square(1)	0.9926

Note **residual** = ε_{t-i}

Garch = σ^2_{t-i}

More specifically, the test statistic for ARCH effects is calculated as TR^2**,** where T is the number of observations and R^2 is the coefficient of determination from the lagged squared errors regression. The test statistic is distributed as a χ^2 which is estimated from TR^2 ($8.40*10^{-5}$). The p-value represents the probability that the null hypothesis of no ARCH is accepted in this data at 0.9927

4.5 Univariate GARCH of Exchange rate

Table 4.7 Univariate GARCH of logarithm of exchange rate: Mean equation

	Coefficient	Standard Error	z-Statistic	Probability
Constant	3.6952	0.0216	170.2982	0.0000
AR(1)	0.9232	0.0082	112.0623	0.0000

This estimation result corresponds to the following specification of ARIMA that shows AR(1) model which t-statistic rejects null hypothesis of coefficient at 5% level.

Table 4.8 The univariate GARCH of logarithm of exchange rate: Variance equation

Constant	0.0004	$8.81*10^{-5}$	4.6589	0.0000
Residual $(-1)^2$	0.7704	0.1564	4.9235	0.0000
Residual $(-2)^2$	0.6515	0.14767	4.4118	0.0000
GARCH(-1)	-0.8781	0.0905	-9.6988	0.0000

Akaike info criterion	-4.5861
Schwarz criterion	-4.4490
Inverted AR Roots	0.92

The result from the GARCH model of exchange rate which shows univariate GARCH (2,1) and coefficients are significant at 5% level. This result illustrates the least AIC = -4.59 and SIC = -4.45. Furthermore, Inverted AR Roots is 0.92 which is less than 1 indicating that model has convert property.

Using the information in table 4.8 it can be written the fitted GARCH equation as

GARCH = 0.0004+0.7705* Residual $(-1)^2$+0.6515* Residual$(-2)^2$-0.8781* GARCH(-1)

Table 4.9 Lagrange multiplier test for ARCH

Obs*R-squared	0.0212
Prob. Chi-Square(1)	0.8841

Note **residual** = ε_{t-i}

Garch = σ^2_{t-i}

More specifically, the test statistic for ARCH effects is calculated as TR^2, where T is the number of observations and R^2 is the coefficient of determination from the lagged squared errors regression. The test statistic is distributed as a χ^2 which is estimated from TR^2 (0.0212).

The p-value represents the probability that the null hypothesis of no ARCH is accepted in this data at 0.8841

4.3 Result of Multivariate GARCH

Table 4.10 Multivariate GARCH

Variable	Coefficience	Standard Error	T-Stat	Significant
1. C(1)	0.0132	0.0001	83.91	0.0000
2. C(2)	0.0005	0.0000	29.54	0.0000
3. A{1}(1,1)	0.4233	0.0038	110.61	0.0000
4. A{1}(1,2)	-0.1515	0.0000	$-4.7*10^7$	0.0000
5. A{1}(2,1)	-0.0284	0.0019	-14.55	0.0000
6. A{1}(2,2)	0.3783	0.0039	95.41	0.0000
7. A{2}(1,1)	0.5517	0.0046	119.17	0.0000
8. A{2}(1,2)	0.1297	0.0000	$4.8*10^7$	0.0000
9. A{2}(2,1)	0.0134	0.0000	$1.6*10^9$	0.0000
10. A{2}(2,2)	0.1553	0.0033	46.39	0.0000
11. B(1,1)	-0.5010	0.0038	-129.10	0.0000
12. B(1,2)	-1.5783	0.0136	-115.99	0.0000
13. B(2,1)	0.0815	0.0031	25.56	0.0000
14. B(2,2)	-0.3146	0.0081	-38.81	0.0000
15. DCC(1)	0.3912	0.0024	162.51	0.0000
16. DCC(2)	0.6086	0.0024	250.05	0.0000

The estimated coefficients and standard errors are presented in Table 4.10. It can be written the fitted MGARCH matrix as;

$$\begin{bmatrix}\sigma_{\ln X,t}\\ \sigma_{\ln e,t}\end{bmatrix} = \begin{bmatrix}0.0132\\(0.0001)\\0.0005\\(0.0000)\end{bmatrix} + \begin{bmatrix}0.4233 & -0.1515\\(0.0038) & (0.0000)\\-0.0284 & 0.3783\\(0.0019) & (0.0039)\end{bmatrix}\begin{bmatrix}\varepsilon^2_{\ln X,t-1}\\ \varepsilon^2_{\ln e,t-1}\end{bmatrix} + \begin{bmatrix}0.5517 & 0.1297\\(0.0046) & (0.0000)\\0.0134 & 0.1553\\(0.0000) & (0.0033)\end{bmatrix}\begin{bmatrix}\varepsilon^2_{\ln X,t-2}\\ \varepsilon^2_{\ln e,t-2}\end{bmatrix} + \begin{bmatrix}-0.5010 & -1.5783\\(0.0038) & (0.0136)\\0.0815 & -0.3146\\(0.0031) & (0.0081)\end{bmatrix}\begin{bmatrix}\sigma_{\ln X,t-1}\\ \sigma_{\ln e,t-1}\end{bmatrix}, \quad (24)$$

The conditional variance equations incorporated in the multivariate GARCH methodology effectively capture the volatility and cross volatility among the export volumes and exchange rate, indicating the presence of strong GARCH effects. Multivariate GARCH (2,1) shows the cross correlation coefficient of one period lagged of shock (t-1) $a_{\ln X_{(t-1)},\ln e_{(t-1)}}, a_{\ln e_{(t-1)},\ln X_{(t-1)}}$ = -0.15, -0.028, the cross correlation coefficient of shock (t-2) $a_{\ln X_{(t-2)},\ln e_{(t-2)}}, a_{\ln X_{(t-2)},\ln e_{(t-2)}}$ = 0.13, 0.01. Specifically, the covariance $b_{\ln X_{(t-1)},\ln e_{(t-1)}}, b_{\ln e_{(t-1)},\ln X_{(t-1)}}$, that appear in (24) are -1.58 and 0.08 significant at 5% level.

The estimated coefficients of time vary correlation equation are presented

$$\rho_t = \frac{\exp(q_t)}{1+\exp(q_t)},\ q_t = 0.3912\rho_{t-1} + 0.6086\frac{\varepsilon_{\ln X,t-1}\varepsilon_{\ln e,t-1}}{\sqrt{\sigma_{\ln X,t-1}\sigma_{\ln e,t-1}}},$$

The final step of Multivariate GARCH model is to investigate the time-varying property of the conditional correlation of the two series ($\ln X_t$ and $\ln e_t$). This result demonstrates the superiority of the DCC model, the coefficient estimates of DCC (1) and DCC (2) in the last step of DCC model are positive at 5 % level.

Therefore the conditional correlation matrix is clearly not constant over time. All of the significant coefficients are smaller than 0.05 except null hypothesis.