



Will QE Change the dependence between Baht/Dollar Exchange Rates and Price Returns of AOT and MINT?

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Abstract : This paper used the C-vine copula model to analyze the dependence between the returns of the Baht/Dollar exchange rates, and two stock prices in the travel and tourism sectors of the stock market of Thailand, under the second round and the third round of quantitative easing programs (QE2 and QE3). The results show that the degree of dependence which is measured by Kendall's tau correlation between the Baht/Dollar exchange rates, and the stock prices of AOT and MINT under the QE2 program is stronger than under the QE3 program.

Keywords : C-vine copula; QE; exchange rates; Thailand stock market

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1 Introduction

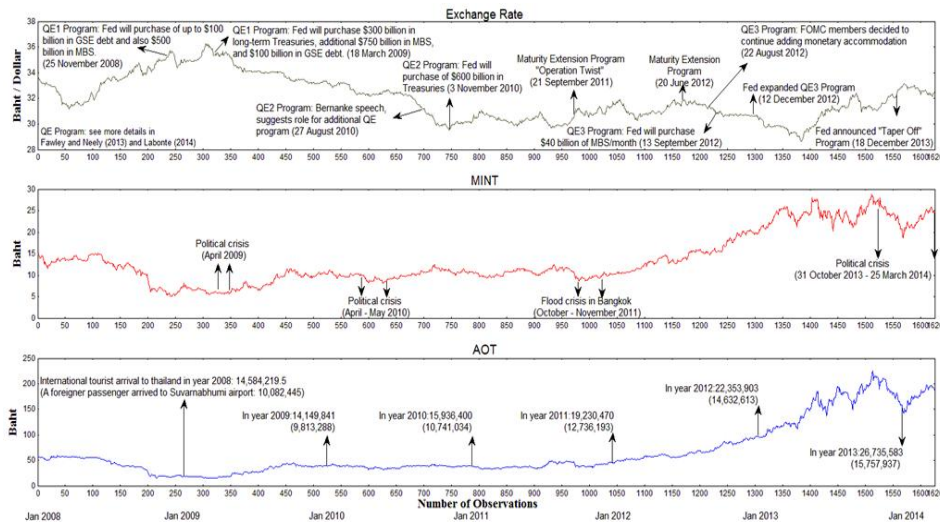
The growth of travel and tourism sector in Thailand has resulted in the growth of other businesses related to this industry. This phenomenon has produced a financial increase on the stock prices of these companies, such as the MINT and the AOT: this is shown in Figure 1. The AOT is the stock price of Airports of Thailand Public Company Limited that is in Transportation sector, the MINT is the stock price of Minor International Public Company Limited that is in Travel & Leisure sector. The two stock prices are related to the travel and tourism industry. However, the rise of these stock prices might have been caused by other factors but not from its fundamental. There are a lot of factors affecting stock prices in the financial markets such as economic factors, political factors, etc. For example, an important unconventional monetary policy used by the US Federal Reserve to stimulate the economy, or the Federal Reserves program of large-scale asset purchases – it is called quantitative easing (QE).

It is well known that the dollar exchange rates are widely used in the international financial transactions. Neely [1] showed that the Fed's QE in 2008-2009 had significantly reduced international long-term bond yields and the spot value of the dollar. Similarly, Fawley and Neely [2] exhibited that the purchasing short-term securities by the QE program can have an effect on the exchange rates and stock prices. The Fed's QE announcement led to depreciations in the nominal effective exchange rates of the US dollar [3]. Fratzscher et al. [4] found that the QE2 pushed up the equity prices worldwide and led to a depreciation on the US dollar. Likewise, the US Dollar against the Thai Baht had depreciated during QE1 and QE2 [5]; [6]. As this program has affected global financial markets worldwide, the Federal Reserve decided to continue a third round of quantitative easing, QE3 (it was announced on 13 September 2012). However, the QE3 program had declined when it was compared to the QE2 program by the Fed who announced a tapering of some of quantitative easing policies (a reduction on monthly asset purchase) [7]; [8].

Figure 1 displays a timeline of the QE programs with the changes in the Baht/Dollar exchange rates, the changes in the stock prices of AOT and MINT with regards to the number of international tourist arrivals to Thailand at Suvarnabhumi airport [9], and the major events that had an effect on the tourist arrivals. This figure shows that although there were negative factors which had affected Thailand's tourism in recent years, the number of tourist arrivals to Thailand still had an increase in growth. Also, the prices of AOT and MINT have kept on rising as well. This reflects the strong fundamentals of the travel and tourism sectors in Thailand. However, the rise of both stock prices may be affected from the Fed's QE programs as these programs could generate the liquidity of US dollar onto the world economy.

Thus, in this paper we focused on the relationship between the exchange rates (Baht/Dollar) and both stock prices under the operation of QE programs. We divided the analyses into two periods. It is made during the QE2 program and during the QE3 program. The illustration of relationship between these variables

Figure 1: The Baht/Dollar exchange rates and the stock prices of AOT and MINT during 1/1/2008 to 25/3/2014



in each period may help the investors manage the risk with greater security in portfolio management. In the globalization economy, the monetary policy of one country can affect the capital market and financial market across the world.

For analyzing the relationship between the exchange rates (Baht/Dollar) and the two stock prices of the AOT and the MINT in each period, the canonical vine (C-vine) copula model was used to measure the dependency. Moreover, this model can measure the manner in which how the volatility of the Baht/Dollar exchange rate returns influence the dependence between the two stock price returns.

The C-vine model can represent the dependence structure between random variables by decomposing a multivariate distribution into a cascade of pair-copulas [10]; [11]; [12]. The finding results will provide a better understanding with regards to the dependence structure between the Baht/Dollar exchange rate returns and two stock price returns; the AOT and the MINT which are in the travel and tourism sectors. The remainders of this work is organized as followed: part two is the dependence analysis method, part three describes the data that were used in this study, and part four provides the empirical findings of the dependence structure analyses in the QE2 program and the QE3 program. Finally, part five provides the conclusion and policy implication.

2 Dependence Analysis

The dependence structure of random variables is modeled by copulas. Firstly, we have to find the marginal distributions through the ARMA-GARCH models for each return series: the Baht/Dollar exchange rates (EX), the two stock prices – AOT and MINT – that are related to travel and tourism.

2.1 Marginal Distribution Model

The ARMA-GARCH model [13] is chosen to filter the marginal distributions of log-return data series in this study. This model can capture the important characteristic of financial returns volatility such as fat tails. The ARMA(p,q)-GARCH(1,1) model for each log-return data series (y_t) can be written as the following:

$$y_t = a_0 + \sum_{i=1}^p a_i y_{t-i} + \sum_{i=1}^q b_i \varepsilon_{t-i} + \varepsilon_t \quad (2.1)$$

$$\varepsilon_t = z_t \sqrt{h_t}, z_t \sim Dist. \quad (2.2)$$

$$h_t = \omega_t + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (2.3)$$

The ARMA(p,q) process is displayed in (2.1), where y_{t-i} is an autoregressive term of y_t and ε_t is a residual, then defines this residual as the product between the conditional variance h_t and a random variable z_t in (2.2). The residual ε_t will be standardized by $\varepsilon_t = z_t \sqrt{h_t}$ to be a standardized residual z_t . The z_t is assumed to follow an appropriate distribution function. The GARCH(1,1) process is displayed in (2.3), where $\omega_t > 0$, $\alpha \geq 0$, $\beta \geq 0$ are sufficient to ensure that the conditional variance $h_t > 0$. The $\alpha \varepsilon_{t-1}^2$ represents the ARCH term and α refers to the short-run persistence of shocks, while βh_{t-1} represents the GARCH term and β refers to the contribution of shocks to the long-run persistence ($\alpha + \beta$).

2.2 Copulas

Measuring of dependence by using copulas has more flexibility than simple linear correlation. The copulas can estimate the joint distributions as well as the transformation invariant correlations without assuming linear correlation [14]. This property is suitable for financial return data that might be nonlinear and having an asymmetric relationship. Moreover, the copula function can tell us more information about the degree of dependence and the dependence structure that we want to investigate in this study. The fundamental theorem of copula is the Sklar's theorem [15].

Let F be an n-dimensional distribution function with marginal distributions F_1, \dots, F_n . Then there exists a copula C for all $x = (x_1, \dots, x_n)' \in [-\infty, \infty]^n$, given by

$$F(x) = C(F_1(x_1), \dots, F_n(x_n)) \tag{2.4}$$

If F_1, \dots, F_n are continuous, then C is unique. Conversely, if C is a copula and F_1, \dots, F_n are distribution functions, then the above function $F(x)$ in equation (2.4) is a joint distribution function with marginal distribution F_1, \dots, F_n . C can be interpreted as the distribution function of an n -dimensional random variable on $[0, 1]^n$ with uniform margins [16].

Table 1: Characteristics of Copula Families

Name	Pair-copula function	Parameter range
Gaussian	$C(u, v; \rho) = \Phi_G(\Phi^{-1}(u), \Phi^{-1}(v); \rho)$ $= \int_{-\infty}^{\phi^{-1}(u)} \int_{-\infty}^{\phi^{-1}(v)} \frac{1}{2\pi\sqrt{(1-\rho^2)}} \times \left[\frac{-(s^2-2\rho st+t^2)}{2(1-\rho^2)} \right] ds dt$	$\rho \in (-1, 1)$
Student's T	$C^T(u, v; \rho, \nu) = \int_{-\infty}^{T_\nu^{-1}(u)} \int_{-\infty}^{T_\nu^{-1}(v)} \frac{1}{2\pi\sqrt{(1-\rho^2)}} \times$ $\left[1 + \frac{(s^2-2\rho sT+T^2)}{\nu(1-\rho^2)} \right]^{-\frac{\nu+2}{2}} ds dT$	$\rho \in (-1, 1),$ $\nu > 2$
BB6	$C(u, v; \theta, \delta) = 1 - (1 - \exp\{-[(-\log(1 - (1 - u)^\theta))^\delta + (-\log(1 - (1 - v)^\theta))^\delta]^{1/\delta}\})^{1/\theta}$	$\theta \in [1, \infty)$ $\delta \in [1, \infty)$
BB7	$C(u, v; \theta, \delta) = 1 - (1 - [(1 - (1 - u)^\theta)^{-\delta} + (1 - (1 - v)^\theta)^{-\delta} - 1]^{-1/\delta})^{1/\theta}$	$\theta \in [1, \infty),$ $\delta \in (0, \infty)$

Source: Joe [17], Trivedi and Zimmer [18], Nelson [19].

Table 1 presents the copula families that are used in this study. There are two elliptical copulas, the Gaussian (Normal) copula and the Student's T copula. The advantage of elliptical copulas is that they can specify different levels of correlation between the marginals and they allow for equal degrees of negative and positive dependence. As a range of parameters is $\rho \in (-1, 1)$ so it can be flexibly fitted to the data. The Gaussian copula is tail independent while the Student's T copula is symmetric tail dependence. Moreover, we selected two-parameters of copula families: the BB6 and the BB7. They can be used for capturing more than one type of dependence, such as one parameter for the lower tail dependence and one for the upper tail dependence. These are asymmetric dependence. The BB6 is Joe-Gumbel, thus it can capture the upper tail dependence and it is an extreme value copula. The BB7 is Joe-Clayton. It can capture both of the lower tail dependence (Clayton) and the upper tail dependence (Joe), and it is an extreme value copula. We also used the rotated copula for asymmetric dependence, the BB6 and the BB7, such as the rotated 180° that can capture the positive dependence, and the rotated 90° , the rotated 270° that can capture the negative dependence. These are the justifications for choosing these copula families.

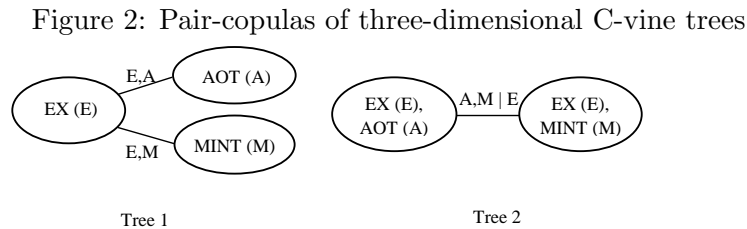
2.3 C-vine Copula

Modeling dependence in high dimension by the standard multivariate copulas are inflexible because they do not allow for different dependence structures between pairs of variables [20]. While the vine copula model crosses over this restriction it can illustrate the multivariate copulas through the graphical models. The multivariate copulas are constructed from a cascade of bivariate copulas (called pair-copulas). As a result, we are able to select bivariate copulas from a wide range of families.

The vine copulas were used in many studies. For example, Sriboonchitta et al. [21] used both of the C-vine and the D-vine to analyze the financial risk and comovement of stock markets in three countries from the ASEAN region: Indonesia, Philippine and Thailand. Similarly, Puarattanaarunkorn and Sriboonchitta [22] used the C-vine and the D-vine to examine the dependence between the tourist arrivals to Thailand from China, Korea, and Japan. Kiatmanaroch and Sriboonchitta [23] used the C-vine copula to find the dependence structure between the exchange rates, palm oil prices, and crude oil prices. The C-vine copula model provided evidence that the exchange rates were an important variable that governed the interactions in the dependence structure between palm oil price and crude oil price.

In this study, we wanted to measure the dependence between the Baht/Dollar exchange rates and two stock prices. We also wanted to examine how the volatility of the Baht/Dollar exchange rate returns influence the relationship between the two stock price returns – AOT and MINT– under two programs of quantitative easing; the QE2 and the QE3, which are an unconventional monetary policy operation of the US Federal Reserve.

The C-vine copula might be an advantage since we can locate the exchange rate variable at the first root node of C-vine tree and the other variables are linked to it. After that, we will get a conditional pair-copula (A,M| E) that can tell us about the influence of the exchange rate variable on the dependence between two stock price returns. Thus, the C-vine copula model allows us to define the relationship structure between variables according to the objective of study. Therefore, this study used the C-vine copula to examine the dependence between these variables. This is shown in Figure 2.



Let $X = (X_1, X_2, X_3) \sim F$ with marginal distribution functions F_1, F_2, F_3 and their density functions f_1, f_2, f_3 in the three-dimensional C-vine, which was proposed as follows (see [12]).

$$f(x_1, x_2, x_3) = f(x_1) \cdot f(x_2) \cdot f(x_3) \cdot c_{1,2}(F_1(x_1), F_2(x_2)) \cdot c_{1,3}(F_1(x_1), F_3(x_3)) \cdot c_{2,3|1}(F_{2|1}(x_2 | x_1), F_{3|1}(x_3 | x_1)) \quad (2.5)$$

where $c_{1,2}$, $c_{1,3}$, and $c_{2,3|1}$ denote the densities of bivariate copulas $C_{1,2}$, $C_{1,3}$, and $C_{2,3|1}$, respectively. $F_{2|1}$ and $F_{3|1}$ are the marginal conditional distributions that can be derived from $F_{2|1}(x_2 | x_1) = \frac{\partial C_{21}(F_2(x_2), F_1(x_1))}{\partial F_1(x_1)}$ and $F_{3|1}(x_3 | x_1) = \frac{\partial C_{31}(F_3(x_3), F_1(x_1))}{\partial F_1(x_1)}$.

For the estimation of C-vine copula, the maximum likelihood was used to estimate the parameters of copulas.

$$\sum_{t=1}^T \log[c_{1,2}(F_1(x_{1,t}), F_2(x_{2,t})) \cdot c_{1,3}(F_1(x_{1,t}), F_3(x_{3,t})) \cdot c_{2,3|1}(F_{2|1}(x_{2,t} | x_{1,t}), F_{3|1}(x_{3,t} | x_{1,t}))]. \quad (2.6)$$

3 Data

We divided the dependence analysis into two periods of quantitative easing (QE) of the US Federal Reserve. The first period in this study is the QE2 program (27/8/2010-21/8/2012), this program started from by Bernanke (Former Fed Chairman) who suggested that the role for additional QE should take further action. The second period is the QE3 program (22/8/2012-25/3/2014). It was started by the Federal Open Market Committee (FOMC) members who decided to continue adding monetary accommodation.

The daily data series of the Baht/Dollar exchange rates, the stock prices of AOT and MINT, were obtained from Thomson Reuters Datastream database were used.

The definitions of the variables are as followed: the Baht/Dollar exchange rates (EX) is a closing spot rates, the AOT is the stock price of Airports of Thailand Public Company Limited that is in Transportation sector, the MINT is the stock price of Minor International Public Company Limited that is in Travel & Leisure sector. The two stock prices are related to the travel and tourism industry.

Each data series was transformed into the log-return ($\ln P_t - \ln P_{t-1}$), before it was used for analysis.

Table 2 presents the descriptive statistics of log-return data series in the QE2 program. All data series show asymmetric and non-normal distribution by showing excess kurtosis. The EX1 series exhibit positive skewness while the AOT1 and MINT1 series show negative skewness. The null hypothesis of normality of the Jarque-Bera tests are rejected in all the data series.

Similarly, all data series in the QE3 program also exhibit non-normal distribution by the null hypothesis of normality of the Jarque-Bera tests had been rejected.

Table 2: Descriptive Statistics of Log-return Data Series in QE2 program

	EX1	AOT1	MINT1
Mean	5.23E-06	0.0010	0.0007
Median	0.0000	0.0000	0.0000
Maximum	0.0110	0.0937	0.0674
Minimum	-0.0102	-0.1377	-0.0754
Std. Dev.	0.0030	0.0191	0.0200
Skewness	0.1652	-0.1083	-0.0479
Kurtosis	3.7536	10.24	4.3285
Jarque-Bera (p-value)	14.62 (0.0007)	1132.44 (0.0000)	38.29 (0.0000)
Observations	518	518	518

The EX2 and the AOT2 series show negative skewness. The MINT2 show positive skewness. All series also show the excess kurtosis. This is demonstrated in Table 3.

Table 3: Descriptive Statistics of Log-return Data Series in QE3 program

	EX2	AOT2	MINT2
Mean	8.47E-05	0.0026	0.0011
Median	0.0000	0.0000	0.0000
Maximum	0.0147	0.0989	0.0912
Minimum	-0.0227	-0.1084	-0.0857
Std. Dev.	0.0034	0.0258	0.0249
Skewness	-0.5695	-0.1574	0.0587
Kurtosis	8.9861	4.6995	4.2536
Jarque-Bera (p-value)	642.05 (0.0000)	51.66 (0.0000)	27.41 (0.0000)
Observations	415	415	415

The comparison of skewness and kurtosis values between the QE2 and the QE3 show that there has been a change in the statistics between two programs; particularly on the data series of the EX and the MINT. The skewness of the EX changed from the positive value in the QE2 to a negative value in the QE3: this means that there is a greater probability of large decreases in returns in the QE3. This is converse to the skewness of the MINT. It changed from the negative value in the QE2 to the positive value in the QE3, which means that there is a probability of increases in returns in the QE3.

4 Dependence Structure Analyses in QE2 program and QE3 program

Analyses of the dependence structure in the QE2 program and the QE3 program through C-vine copulas require marginal models for each return data series. First, we used ARMA(p,q)-GARCH(1,1) to filter the marginals for each return series. Table 4 presents an appropriate marginal model for each return series, which is selected according to the AIC values.

Table 4: Appropriate marginal model for each return series in QE2 and QE3 program

	Variable	Marginal model with Appropriate Residual Distribution
QE2	EX1	ARMA(2,2)-GARCH(1,1) with Skewed Student-T Residual
	AOT1	ARMA(1,0)-GARCH(1,1) with Skewed Student-T Residual
	MINT1	ARMA(1,0)-GARCH(1,1) with Student-T Residual
QE3	EX2	ARMA(2,2)-GARCH(1,1) with Student-T Residual
	AOT2	ARMA(1,0)-GARCH(1,1) with Student-T Residual
	MINT2	ARMA(0,0)-GARCH(1,1) with Student-T Residual

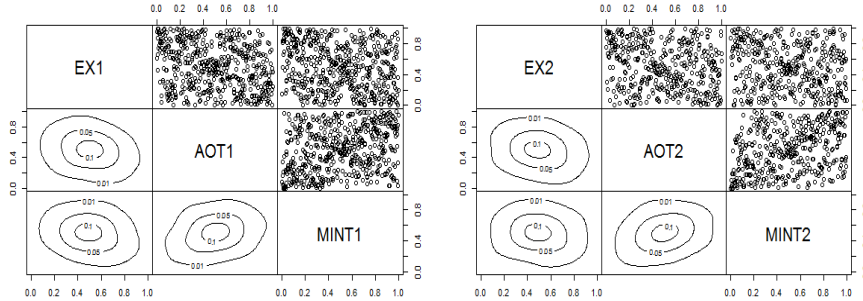
Next, the standardized residuals from an appropriate ARMA(p,q)-GARCH(1,1) model are transformed into the uniform $[0,1]$ by using the empirical distribution function $F_n(x) = \frac{1}{n+1} \sum_{i=1}^n 1(X_i \leq x)$, where $X_i \leq x$ is the order statistics and 1 is the indicator function, then we get the marginals. We used $n+1$ in the empirical distribution function to avoid difficulties occurring from the unboundedness of the log-likelihood, $\log c_\theta(u_1, \dots, u_n)$, as some of the uniform data, u_i , tend to one [24]. The transformed data are used in the Kolmogorov-Smirnov (K-S) test for uniformity $[0,1]$ and the Box-Ljung test for serial correlation. The results of K-S test and the Box-Ljung test show that all marginals are uniform and i.i.d. Therefore, our marginals were not mis-specified and can be used for the C-vine copula model.

Figure 3 displays the scatter plots of the three bivariate marginals, EX–AOT, EX–MINT, and AOT–MINT in the QE2 program (Left) and in the QE3 program (Right). The data shows the clustering in both the upper and the lower tail dependences. The pair-plots of EX–AOT, EX–MINT show negative dependence in both the QE2 and the QE3 programs. The pair-plots of AOT–MINT show positive dependence in both programs.

To find the dependence structure between marginals of the EX, AOT, and MINT, we used various copula families such as Guassian, Student's T, BB6 (Joe-Gumbel) and its rotated copula, BB7 (Joe-Clayton) and its rotated copula. An appropriate copula family for each pair-copula is selected by using the AIC criterion and a goodness-of-fit test of the Cramér-von Mises (CvM) statistic.

We first present the results obtained from the QE2 data and followed this with

Figure 3: Scatter plots of EX–AOT, EX–MINT, and AOT–MINT in QE2 program (Left) and in QE3 program (Right)

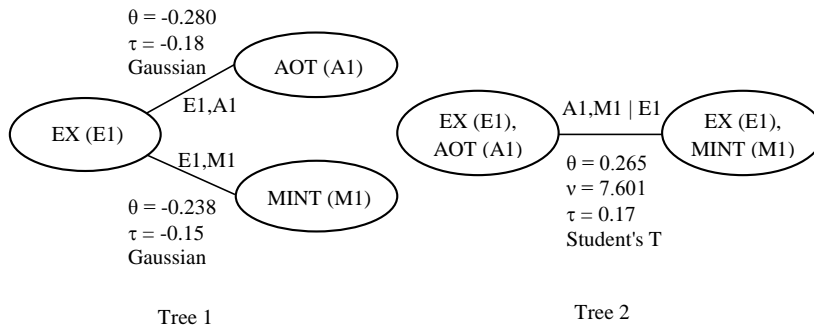


the QE3.

4.1 Dependence Structure in QE2 program

Figure 4 and Table 5 display the dependence structure analysis of C-vine copula in the QE2 program.

Figure 4: C-vine trees with appropriate copula family, dependence parameter and Kendall’s tau correlation in QE2 program



For the first pair-copula of EX1–AOT1, there exists a relatively small negative dependence. The Gaussian copula is an appropriate dependence structure with copula parameter is -0.280 and Kendall’s tau correlation (τ) is -0.18. This implies that the Baht/Dollar exchange rate returns and stock price returns of AOT are slightly related in opposite direction.

Table 5: Appropriate Dependence Structure by C-vine copula in QE2

Pair-copula	Appropriate copula family	Parameter	p-value	τ	T^L	T^U	AIC	p-value of CvM
E1,A1	Gaussian	$\theta = -0.280$	0.000	-0.18	0	0	-40.22	0.22
E1,M1	Gaussian	$\theta = -0.238$	0.000	-0.15	0	0	-28.04	0.77
A1,M1 E1	Student's T	$\theta = 0.265$ $\nu = 7.601$	0.000 0.010	0.17	0.053	0.053	-41.95	0.48

The second pair-copula is EX1–MINT1. The results also show that there exists a relatively small negative dependence. The Gaussian copula is chosen to describe the dependence structure with copula parameter is -0.238 and Kendall's tau correlation is -0.15. This result is similar to the result of the first pair-copula that the Baht/Dollar exchange rate returns and stock price returns of MINT are slightly related in opposite direction.

The last conditional pair-copula is the AOT1–MINT1 given EX1 in Tree 2. This finding provides that the Student's T copula is chosen to describe the dependence structure of this pair-copula with copula parameter is 0.265 and the degree of freedom parameter is 7.601, a Kendall's tau correlation of 0.17, and the equal lower (T^L) and upper tail (T^U) dependences of 0.053. This implies that two stock price returns of AOT and MINT are slightly related in a same direction by given the Baht/Dollar exchange rate returns as a conditional variable. This Kendall's tau correlation by the conditional pair-copula, 0.17, is less than those that are obtained by using the bivariate copula analysis of AOT1–MINT1, which is 0.20. This implies that the Baht/Dollar exchange rate returns have an influence on the dependence between two stock price returns of AOT and MINT.

Table 6: Results of Bivariate Copula of AOT1–MINT1

Pair-copula	Appropriate copula family	Parameter	p-value	τ	T^L	T^U	AIC	p-value of CvM
A1,M1	BB7	$\theta = 1.054$ $\delta = 0.430$	0.000 0.000	0.20	0.200	0.070	-61.71	0.37

4.2 Dependence Structure in QE3 program

Figure 5 and Table 7 display the dependence structure analysis of C-vine copula in the QE3 program.

For the first pair-copula of EX2–AOT2, the Gaussian copula is chosen to describe the dependence structure in the QE3 program. There exhibits the negative dependence with the copula parameter is -0.209 and Kendall's tau correlation (τ)

Figure 5: C-vine trees with appropriate copula family, dependence parameter and Kendall's tau correlation in QE3 program

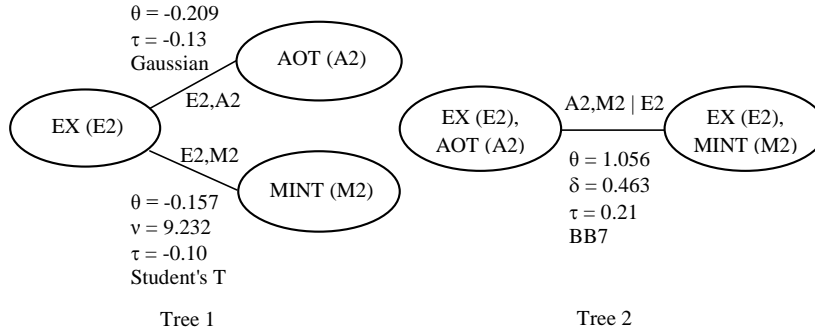


Table 7: Appropriate Dependence Structure by C-vine copula in QE3

Pair-copula	Appropriate copula family	Parameter	p-value	τ	T^L	T^U	AIC	p-value of CvM
E2,A2	Gaussian	$\theta = -0.209$	0.000	-0.13	0	0	-16.43	0.50
E2,M2	Student's T	$\theta = -0.157$ $\nu = 9.232$	0.001 0.042	-0.10	0.004	0.004	-9.20	0.19
A2,M2 E2	BB7	$\theta = 1.056$ $\delta = 0.463$	0.000 1.1E-08	0.21	0.224	0.072	-54.27	0.77

is -0.13. This means that the Baht/Dollar exchange rate returns and stock price returns of AOT are slightly related in opposite direction.

The second pair-copula of EX2–MINT2 provides that the Student's T copula is an appropriate copula with the copula parameter is -0.157 and the degree of freedom parameter is 9.232. The Kendall's tau correlation is -0.10. This means that the Baht/Dollar exchange rate returns and stock price returns of MINT are slightly related in opposite direction. In addition, the equal lower (T^L) and upper tail (T^U) dependences are 0.004.

The last conditional pair-copula is the AOT2–MINT2 given EX2, the BB7 (Joe-Clayton) copula that can capture asymmetric tail dependence, is chosen to describe the dependence structure. The two copula parameters are 1.056 and 0.463, a Kendall's tau correlation of 0.21, and the lower and upper tail dependences are 0.224 and 0.072, respectively. It can be seen that the lower tail dependence is stronger than the upper tail dependence. Thus, this indicates that there is a possible concurrent loss of events of two stock returns by given the Baht/Dollar exchange rate returns as a conditional variable. Moreover, the Kendall's tau correlation of the conditional pair-copula, 0.21, is less than those that is obtained by

using the bivariate copula analysis of AOT2–MINT2, which is 0.23. This implies that the Baht/Dollar exchange rate returns have an influence on the dependence between two stock price returns of AOT and MINT in the QE3 program.

Table 8: Results of Bivariate Copula of AOT2-MINT2

Pair-copula	Appropriate copula family	Parameter	p-value	τ	T^L	T^U	AIC	p-value of CvM
A2,M2	BB7	$\theta = 1.101$ $\delta = 0.062$	0.000 9.9E-09	0.23	0.230	0.124	-64.38	0.32

4.3 Comparison of Dependence Structure between QE2 and QE3 programs

The dependence structure between the Baht/Dollar exchange rate returns and the stock price return of AOT (EX–AOT) has not been changed from the QE2 program to the QE3 program. The Gaussian copula that is the tail independence, is an appropriate copula family to describe the dependence structure for both programs.

For the Baht/Dollar exchange rate returns and the stock price return of MINT (EX–MINT), there is the structural change in the dependence from the Gaussian copula in the QE2 program to the Student’s T copula in the QE3 program. According to the evidence shown, this indicates that the dependence structure between EX–MINT has longer tails in the QE3 program by comparison with the QE2 program.

The conditional pair-copula, the AOT–MINT given Baht/Dollar exchange rates, also has the structural change in the dependence from the Student’s T copula in the QE2 program to the BB7 in the QE3 program. The dependence structure changed from the symmetric tails (Student’s T) to the asymmetric tails (BB7).

5 Conclusion and Policy Implication

This study used the C-vine copula model to examine the relationship between the Baht/Dollar exchange rates, and two stock prices in travel and tourism sectors–AOT and MINT– under the QE2 and the QE3 programs. Moreover, to analyze in which how the volatility of the Baht/Dollar exchange rate returns influence the dependence between two stock price returns.

The results show that the volatility of the Baht/Dollar exchange rate returns have an influence on the dependence between the price returns of AOT and the MINT in both the QE2 and QE3 programs.

When we compared the results between the QE2 and QE3 programs, we found that the degree of dependence between the Baht/Dollar exchange rate returns and

two stock price returns of AOT and MINT have been decreased from the QE2 program to QE3 program. As illustrated by the Kendall's tau correlation of the EX-AOT it has decreased from -0.18 in the QE2 to -0.13 in the QE3. Similarly, the EX-MINT has decreased from -0.15 in the QE2 to -0.10 in the QE3.

From the literature review, we have learned that the Fed has declined on the operation of stimulating the US economy in the QE3. Such an example is the reduction in asset purchases, which had an effect on the liquidity and the dollar exchange rates [7]; [8]. Therefore, the decreasing of the degree of dependence in the QE3 are corresponding to the tapering of some of the Fed's policies in the QE3.

This action was a signal to inform the investors that there's a weakening of the Thai Baht. However, a weakening of Thai Baht might be from other factors such as the US economy recovery, the political unrest in Thailand, and etc., which this study did not put into consideration.

According to this finding, the monetary policy makers of the public and private sectors, institutional investors, and other investors, should monitor the financial policy of the Fed closely. Since a changing of financial policy of the Fed in the timeline of QE2 and QE3, it can have an effect on the exchange rates and the stock prices of Thailand. This also includes the change of the Baht/Dollar exchange rates which is one of the variable that investors need to monitor, other than the fundamentals of investment conditions.

For the dependence structure, our results showed that there were some structural changes in the dependence in a pair-copula of EX-MINT. The dependence structure changed from the Gaussian copula in the QE2 to the Student's T copula in the QE3. This indicated that the dependence of EX-MINT had the longer tails. Therefore, the investors should be aware that there is more of a chance in facing a loss with the longer tails' structure in the QE3 when it is in comparison to the QE2. Moreover, investors should also realize that the volatility of Baht/Dollar exchange rate can be transmitted to the price return of MINT.

In summary, the empirical results indicate that the Fed's policies can affect the investment in the Stock Exchange of Thailand. Monitoring the monetary policies of the Fed and the direction of the change in exchange rates are what the policy makers require to pay close attention. A practical policy that would be deemed appropriate in this case is on issuing a warning for investment in the Stock Exchange of Thailand. However, there are other factors that can affect the price returns that are not included in our study. Noting that confounding effects might occur from hidden or unobserved factors.

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