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The Appropriate Model and Dependence Measures of Thailand's Exchange Rate and Malaysia's Exchange Rate: Linear, Nonlinear and Copulas Approach

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The specific objective aims to forecast a single market bridging the development gap among members of ASEAN that find itself facing important financial opportunities. The selection of several mixed forecasting consisting of linear model, nonlinear models and copulas approach was experimented of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage during the specific period. The results of the study confirmed that the Autoregressive-linear model (AR-linear Model) was suggested as appropriate models for forecasting is an appropriate model to forecast for Thailand's exchange rate and for Malaysia's exchange rate during the periods of 2008-2011. Based on experimented copula approach, the dependence measures are very small between returns in percentage of Thailand's exchange and Malaysia's exchange. The linear approach should be used when global economy affected by World's financial crisis. Moreover, the currencies of both countries did not strong enough to challenge that there was a relationship between the exchange rate return in percentage of Thailand and that of Malaysia is not strong.

Keywords: *Linear; Nonlinear; Copulas; Exchange Rate; Thailand; Malaysia*

Introduction

The Association of Southeast Asian Nations (ASEAN) takes part in an important role in these countries consisting of Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei, Burma (Myanmar), Cambodia, Laos, and Vietnam. ASEAN aims to step up the economic growth, social progress, and cultural development among of members. In 2015, ASEAN has target to be a single market and production base (Charting Progress towards regional Economic Integration, 2009). The economic development gap among members of ASEAN will be established as the ASEAN Economic Community (AEC). However, the research question is that how does a single market bridging the development gap among members of ASEAN find itself facing important financial opportunities. From Mohd and Zaidi (2006) found that currency movement among of three ASEAN countries (Malaysia, Singapore and Thailand) showed with the possibilities of nonlinearity.

Research Objective

The specific objective aims to forecast a single market bridging the development gap among members of ASEAN that find itself facing important financial opportunities. The selection of several mixed forecasting consisting of linear model, nonlinear models and copulas approach were experimented of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage during the specific period.

Scope of this research

The selected data used in forecasting were the historical daily data during the periods of 2008 to 2011. The selections of several mixed forecasting were experimented of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage during the specific period.

The research framework and methodology

The research framework and methodology used in this research are those used by Antonio and Fabio Di Narzo (2008) and presented in their paper entitled "Nonlinear autoregressive time series models in R using tsDyn version 0.7" in which both the linear and nonlinear approaches were estimated by R-project. Moreover, the copula concept used in this research follows that in Sklar's theorem (Sklar, 1959).

Autoregressive-linear model (AR-linear Model)

The basic linear models is AR (m) model and can be written as shown in equation (1).

$$y_{t+s} = \phi + \phi_0 y_t + \phi_1 y_{1-d} + ... + \phi_m y_{t-(m-1)d} + \varepsilon_{t+s} \quad (1)$$

The equation (1) represents the AR (m) model and yt is time series data at time t, Φ is parameter and coefficient of yt in the model. In addition, ε is error term of this equation.

Self-Exciting Threshold Autoregressive Model (SETAR Model)

The general Self-Exciting Threshold Autoregressive Model or SETAR model can be written as shown in equation (2).

$$y_{t+s} = \begin{cases} \phi_1 + \phi_{10} y_t + \phi_{11} y_{t-d} + ...+ \phi_{1L} y_{t-(L-1)d} + \varepsilon_{t+s} & z_t \le th \\ \phi_2 + \phi_{20} y_t + \phi_{21} y_{t-d} + ...+ \phi_{2H} y_{t-(H-1)d} + \varepsilon_{t+s} & z_t > th \end{cases} \quad (2)$$

The equation (2) represents the SETAR models and yt is time series data at time t, Φ is parameter and coefficient of equation (2). In addition, ε is error term of this equation and Zt is a threshold variable in the model. The L represents lower regime of model and H is represented the higher regime of the model.

Logistic Smooth Transition Autoregressive Model (LSTAR Model)

The general Logistic Smooth Transition Autoregressive Model or LSTAR model can be written in equation (3).

(3) $$y_{t+s} = \begin{array}{l}(\phi_1 + \phi_{10} y_t + \phi_{11} y_{t-d} + \dots\dots\dots + \phi_{1L} y_{t-(L-1)d})(1 - G(z_t, \gamma, th)) \\ +(\phi_2 + \phi_{20} y_t + \phi_{21} y_{t-d} + \dots\dots\dots + \phi_{2H} y_{t-(H-1)_d})G(z_t, \gamma, th) + \varepsilon_{t+s}\end{array}$$

The equation (3) represents the LSTAR model and yt is time series data at time t, Φ is parameter and coefficient of equation (3). In addition, ε is error term of this equation and Zt is a threshold variable in the model. The L represents lower regime of model and H represents the higher regime of the model. Moreover, G is the logistic function and Φ, γ, th are parameters to be computed.

Neural Network Models (NNT Model)

The form of the neural network model was used for estimation in this research and can be explained by equation (4).

(4) $$y_{t+s} = \beta_0 + \sum_{j=1}^{D} \beta_j g(\gamma_{0j} + \sum_{i=1}^{m} \gamma_{ij} y_{t-(i-1)d})$$

The equation (4) represents the NNT model and yt is time series data at time t the βo is parameter of equation 4. In addition, D is a hidden units and activation function g.

Additive Autoregressive model (AAR Model)

The generalized non-parametric additive model (Generalized Additive Model) or AAR model can be written as shown in equation (5).

(5) $$y_{t+s} = \mu + \sum_{i=1}^{m} s_i(y_{t-(i-1)d})$$

The equation (5) represents the generalized non-parametric additive model and yt is time series data at time t. Si are smooth functions represented by penalized cubic regression.

Dependence Measures and Copulas

The general properties of dependence measures can be explained by the 4 items properties shown below (Embrechts, Lindskog, and McNeil (2003)):

1. δ (X,Y) = δ (Y,X).
2. -1≤ δ (X, Y) ≤ 1.
3. δ (X,Y) = 1 if X and Y are comonotonic; as well as δ (X,Y) = -1 if X and Y are comonotonic.
4. If T is exactly monotonic, then
5. δ (T(X),Y) = { δ (X,Y), T = increasing or - δ (X,Y), T = decreasing

Normally, the Pearson linear correlation fits only the first two properties but the rank correlation measures Spearman's rho and Kendall's tau fits all of the 4 properties. Therefore, the Copulas uses the Spearman's rho and Kendall's tau to calculate the dependence measures between X and Y which are random variables.

Data description

Figure (1a) presents the historical daily data of Thailand's exchange return in percentage during the periods of 2008 to 2011. And table (1a) shows the descriptive statistics of Thailand's exchange return in percentage from the period of 2008 to 2010.

Moreover, figure (2a) presents Thailand's nominal exchange from the period of 2008 to 2011.

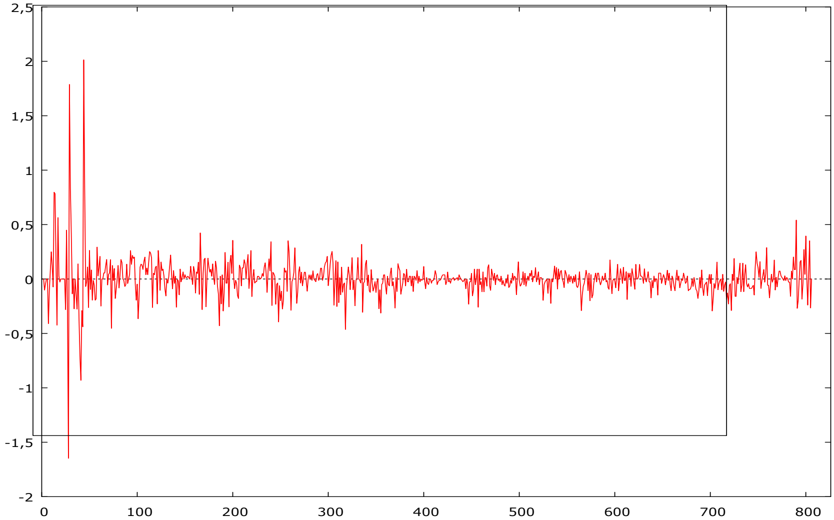

Figure 1a: The historical daily data of Thailand's exchange return in percentage during the periods of 2008 to 2011

Table 1a: The descriptive statistics of Thailand's exchange return in percentage from the period of 2008 to 2010

Item	Thailand's exchange return in percentage
Mean	0.0017399
Median	0.000000
Maximum	2.0136
Minimum	-1.6472
Std. Dev.	0.18062
Skewness	2.1367
Kurtosis	41.126
Number	806

Source: The Reuters data based

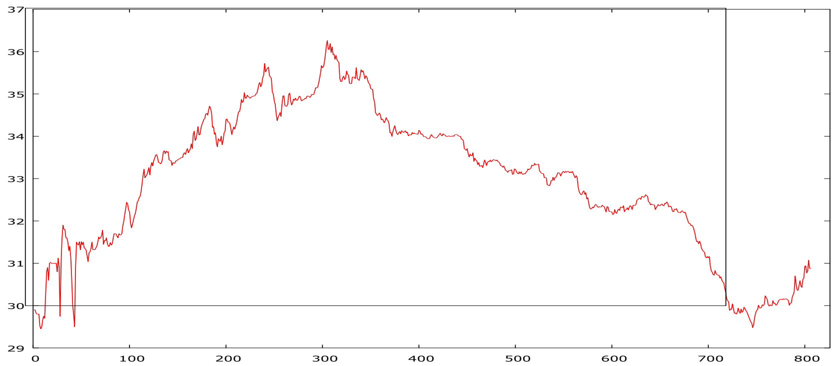

Figure 2a: Thailand's nominal exchange from the period of 2008 to 2011

Figure (1b) presents Malaysia's exchange return in percentage during the period of 2008 to 2010 by daily data. And table (1b) shows descriptive statistics of Malaysia's exchange return in percentage from the specific period. Moreover, figure (2b) presents Malaysia's nominal exchange from the period of 2008 to 2011.

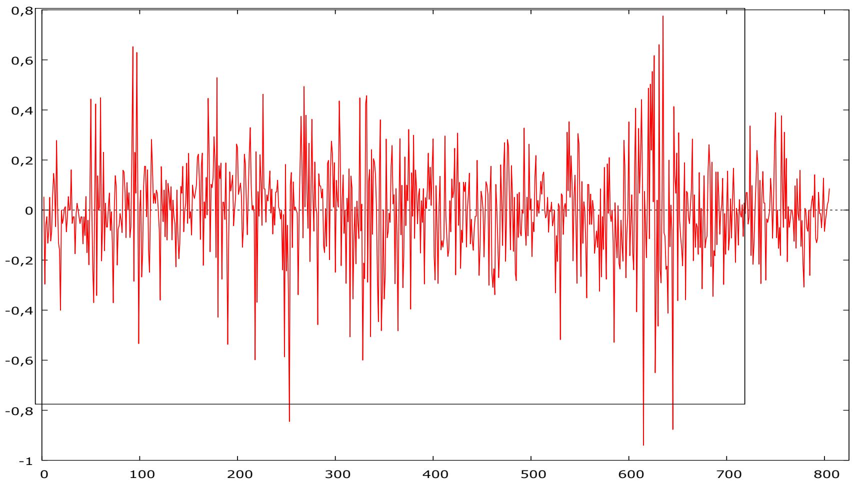

Figure 1b: The historical daily data of Malaysia's exchange return in percentage during the periods of 2008 to 2011

Source: The Reuters data based

Table 1b: The descriptive statistics of Malaysia's exchange return in percentage from the period of 2008 to 2010

Item	Malaysia's exchange return in percentage
Mean	-0.0041605
Median	0.000000
Maximum	0.77566
Minimum	-0.94036
Std. Dev.	0.19615
Skewness	-0.24013
Kurtosis	2.2359
Number	805

Source: The Reuters data based

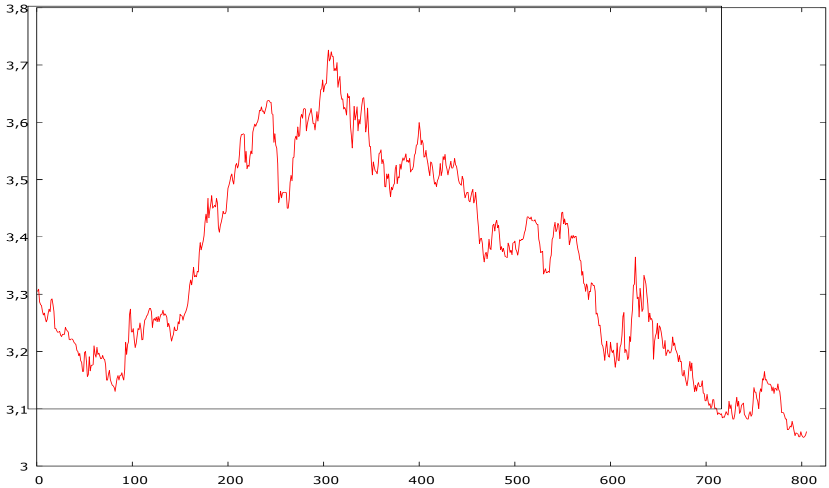

Figure 2b: Malaysia's nominal exchange rate from the period of 2008 to 2011

Source: The Reuters data based

Empirical results of research

The appropriate model of Thailand's exchange rate returns in percentage based on both AIC and BIC

Table (2a) presents the interpretation of forecast evaluation statistics of Thailand's exchange rate return in percentage estimated by linear and nonlinear approaches. The interpretation of forecast evaluation statistics found that the Neural Network Models is the appropriate model succeeded which minimizes AIC and BIC among all candidate models.

Table 2a: The model selection of Thailand's exchange rate returns in percentage based on both AIC and BIC

Items	Autoregressive Linear Models (AR)	Self-Exciting Threshold Autoregressive models) (SETAR)	Logistic Smooth Transition Autoregressive models (LSTAR)	Neural Network Models (NNETs)	Additive Autoregressive models (AAR)
AIC	-2760.830	-2762.458	-2761.994	-2894.200	-2889.379
BIC	-2746.758	-2729.622	-2724.468	-2833.219	-2800.253

Source: From computed

Tables (3a) present the interpretation of forecast evaluation statistics of Thailand's exchange rate return in percentage is central on mean absolute percent error (MAPE(%)). The forecast evaluation statistics indicated that selected Autoregressive Linear Model (AR) is the best models to forecast the Thailand's exchange rate returns in percentage of exploration period, which minimizes MAPE (%) among all candidate models.

Table 3a: The Forecast Evaluation of Thailand's exchange rate returns in percentage based on Mean Absolute Percent Error (MAPE (%))

Items	Auto regressive Linear Models (AR)	Self-Exciting Threshold Autoregress ive models) (SETAR)	Logistic Smooth Transition Autoregress ive models (LSTAR)	Neural Network Models (NNETs)	Additive Autoregre ssive models (AAR)
MAPE (%)	1.030969	1.083535	1.073167	1.077130	1.100449

Source: From computed

The appropriate model of Malaysia's exchange rate returns in percentage based on both AIC and BIC

Table (2b) presents the interpretation of forecast evaluation statistics estimated by linear and nonlinear approaches. The function AIC and BIC can be used to compare all models fitted to the same data. Table (2b) showed the appropriate evaluation statistics of Malaysia's exchange rate returns in percentage. The Self-Exciting Threshold Autoregressive model found to be the appropriate model succeeded which minimizes AIC among all candidate models. However, the Autoregressive Linear Models is the appropriate model succeeded which minimizes BIC among all candidate models.

Table 2b: The model selection of Malaysia's exchange rate returns in percentage based on both AIC and BIC

Items	Auto regressive Linear Models (AR)	Self-Exciting Threshold Autoregress ive models) (SETAR)	Logistic Smooth Transition Autoregressive models (LSTAR)	Neural Network Models (NNETs)	Additive Auto regressive models (AAR)
AIC	-2619.086	-2622.011	-2613.606	-2615.151	-2592.686

BIC	-2605.017	-2589.184	-2576.089	-2554.187	-2503.584

Source: From computed

Tables (3b) present the interpretation of forecast evaluation statistics of Malaysia's exchange rate return in percentage is central on mean absolute percent error (MAPE(%)). The forecast evaluation statistics indicated that selected Autoregressive Linear Model (AR) is the best models to forecast the Thailand's exchange rate returns in percentage of exploration period because this model has a minimize value of MAPE(%).

Table 3b: The Forecast Evaluation of Malaysia's exchange rate returns in percentage based on Mean Absolute Percent Error (MAPE (%))

Items	Auto regressive Linear Models (AR)	Self-Exciting Threshold Autoregressive models) (SETAR)	Logistic Smooth Transition Autoregressive models (LSTAR)	Neural Network Models (NNETs)	Additive Auto regressive models (AAR)
MAPE (%)	1.006648	1.047415	1.015182	1.056384	1.016208

Source: From computed

The dependence measures of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage based on the Empirical copula approach

Table (2c) presents the dependence measure of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage during the period of 2008-2011based on the empirical copula estimated. The Kendall's tau statistics of dependence measure between Thailand's currency and Malaysia's currency is 0.08576576. In addition, the Spearman's tau statistics of dependence measure between Thailand's currency and Malaysia's currency is 0.1294213(see more detail in appendix A).

Table 2c: The dependence measure of Thailand's exchange rate and Malaysia's exchange rate during period of 2008-2011

Comparison of the correlation items based on empirical copula approach	Thailand's exchange rate and Malaysia's exchange rate (Dependence Coefficients)
Kendall's tau statistics	0.08576576
Spearman's rho statistics	0.1294213

Source: From computed

Discussion and Conclusions

The study aims to forecast a single market bridging the development gap among members of ASEAN that find itself facing important financial opportunities. The selection of several mixed forecasting consisting of linear model, nonlinear models and copulas approach and dependence measures were experimented of Thailand's exchange rate return in percentage and Malaysia's exchange rate return in percentage during the specific period. The results of the study confirmed that the Autoregressive-linear model (AR-linear Model) was suggested as appropriate models for forecasting is an appropriate model to forecast for Thailand's exchange rate and for Malaysia's exchange rate during the periods of 2008-2011. Based on experimented copula approach, the dependence measures are very small between returns in percentage of Thailand's exchange and Malaysia's exchange. The linear approach should be used when global economy affected by World's financial crisis. Moreover, the currencies of both countries did not strong enough to challenge that there was a relationship between the exchange rate return in percentage of Thailand and that of Malaysia is not strong. This is also true for.

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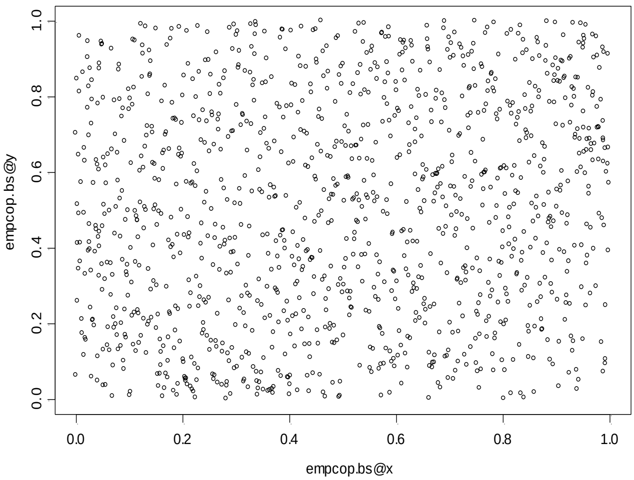
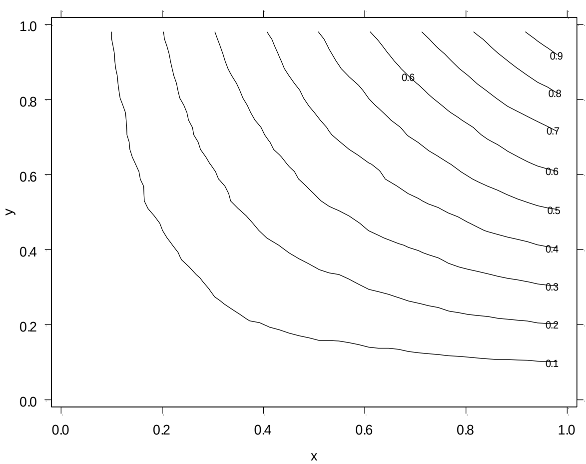
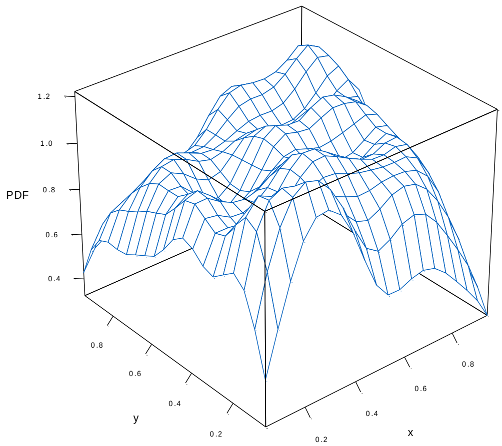
Appendix A

Empirical copula for Thailand's exchange rate (y) and Malaysia's exchange rate (x) based on calculated GPD marginal



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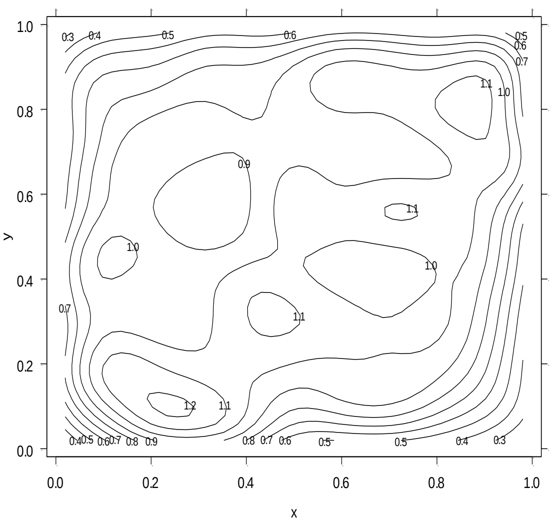
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