MODELLING AND FORECASTING THE PREDICTABILITY OF STOCK MARKET RETURN IN ASIAN COUNTRIES BY USING HYBRID ARIMA-GARCH MODELS

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DEDICATION

This thesis is dedicated to my parents, who taught me not to give up for every obstacles I have faced. It is also dedicated to my sisters, who support me to pay full focus on my studies.

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ABSTRACT

Predictability of the stock market return has been a crucial topic over a decade. The ability to forecast and predict the stock market price allows investors to make investment decisions at the lowest risk and also allows policy makers to evaluate development of stock markets as to design rules and regulations. Thus, this study was conducted to serve two main purposes. First of all, hybrid models was developed between Autoregressive Integrated Moving Average (ARIMA) model and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) family model for daily stock market data. In GARCH family models, there are GARCH, EGARCH and TGARCH where GARCH is symmetric model and EGARCH and TGARCH are asymmetric models. As hybridization of ARIMA model with different GARCH family models have different level of performances, each of the established hybrid models are evaluated using AIC, MAE, RMSE as well as MAPE to identify the outperformed model. In this study, daily stock prices of nine Asian countries (China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand) are being used. EViews and R studio software act as the tools to perform the analysis. Results show that hybrid ARIMA-EGARCH model outperformed. On the other hand, identification of the calendar effects of all the nine Asian countries is the second concern of this study. The results show that each of the Asian countries have different calendar effects.

ABSTRAK

Kebolehan ramalan pulangan pasaran saham menjadi topik yang amat penting selama satu dekad kerana keupayaan ramalan harga pasaran saham membolehkan pelabur membuat keputusan pelaburan dengan risiko terendah. Selain itu, para pembuat dasar juga mendapat manfaat untuk menilai perkembangan pasaran saham dan bagi tujuan mereka bentuk peraturan. Oleh kerana itu, kajian ini dijalankan untuk dua tujuan utama. Pertama sekali, model hibrid telah dibangunkan antara model keluarga Autoregresif Bersepadu Purata (ARIMA) dan model keluarga Generalized Autoregressive Conditional Heteroscedasticity (GARCH) untuk data pasaran saham harian. Dalam model keluarga GARCH, terdapat GARCH, EGARCH dan TGARCH di mana GARCH adalah model simetri dan EGARCH serta TGARCH adalah model asimetrik. Oleh sebab hibridisasi model ARIMA dengan model keluarga GARCH yang berlainan mempunyai tahap prestasi yang berbeza, setiap model hibrid yang ditubuhkan dinilai dengan AIC, MAE, RMSE serta MAPE untuk mengenalpasti model yang mengatasi model lain. Dalam kajian ini, harga saham harian sembilan Negara Asia (China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand) telah digunakan. Perisian EViews dan R studio digunakan sebagai alat untuk melakukan analisis kajian ini. Keputusan analisis menunjukkan bahawa model hibrid ARIMA-TGARCH lebih baik. Sebaliknya, pengenalpastian kesan kalendar dari sembilan negara Asia adalah tujuan kedua kajian ini. Hasilnya menunjukkan bahawa setiap negara mempunyai kesan kalendar yang berbeza.

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LIST OF ABBREVIATIONS

ACF	-	Autocorrelation Functions
ADF	-	Augmented Dicker-Fuller
AIC	-	Akaike Information Criterion
AME	-	Absolute Mean Error
AR	-	Autoregressive Process
ARCH	-	Autoregressive Conditional Heteroscedasticity
ARMA	-	Autoregressive Moving Average
ARIMA	-	Autoregressive Integrated Moving Average
BIC	-	Bayesian Information Criterion
EGARCH	-	Exponential Generalized Autoregressive Conditional Heteroscedasticity
EViews	-	Econometrics Views
GARCH	-	Generalized Autoregressive Conditional Heteroscedasticity
JB	-	Jarque-Bera
LM	-	Lagrange Multiplier
MA	-	Moving Average
MAE	-	Mean Absolute Error
MAPE	-	Mean Absolut Percentage Error
OLS	-	Ordinary Least Square
PACF	-	Partial Autocorrelation Functions
RMSE	-	Root Mean Square Error
SSE	-	Sum of Square
TGARCH	-	Threshold Generalized Autoregressive Conditional Heteroscedasticity

LIST OF SYMBOLS

$\emptyset_p$	-	AR polynomial
θ_q	-	MA polynomial
ε_t	-	Error term at time *t*
δ	-	Constant term
λ	-	Minimum residual mean square error value
Δ	-	Lag order of the autoregressive process
H_0	-	Null hypothesis
H_1	-	Alternative hypothesis
$\hat{\theta}$	-	Tested time series
ε_{t-i}^2	-	Past squared return
σ_{t-j}^2	-	Past of conditional variance
α_0	-	Mean of the volatility
α_i	-	Size effect
β_j	-	Degree of volatility persistence
γ_i	-	Sign effect
n	-	Sample size
$\hat{\rho}_k^2$	-	Squared sample autocorrelation at lag k
d	-	Amount of differencing
p	-	Autoregressive part order
q	-	Moving average part order
D_{dt}	-	Dummy variables for each day of the week respectively
γ_1	-	Coefficient γ_1 to γ_5 represent the size and direction of the day of the week effect on volatility

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In general, stock market is defined as a collection and presentation of information from the market where activities such as buying, selling and issuance of shares of publicly-held companies take place. Stock market of a country normally reflects the economic condition, therefore, modeling and forecasting the stock market becomes very popular. Investors, financial analysts as well as the researchers are craving for the forecast results as a guide for their investment activities. Most of the forecasting activities involves the usage of the past data, therefore, the historical stock market returns become functional at this point. Different countries have different figures on stock market due to distinct of economic situation particularly. Hence, applying the same forecast model on different countries will not be practical at this point.

Stock market data is commonly constructed as time series data with volatility. Volatility of the data basically indicates the unpredictability and the uncertainty in the stock market. There are many factors that affect the fluctuations of the stock market for example, the economic growth, political issues as well as natural and man-made disasters. There are two focuses in this study. It includes identifying the best model to forecast the stock market performance as well as identifying the calendar effects of stock market to formulate an effective trading strategy.

1.1 Background of the Study

In the aspect of stock market, the topic of calendar anomalies or calendar effects had been widely discussed by many researchers over the period of almost half a decade. One of the best known calendar anomalies is day-of-the-week effects. Day-of-the-Week effect literally explains the stock price in specific day having the tendency of achieving higher price compared to the others. For instance, when a country is having a Monday effect on stock market, it simply means that particular country's stock market is more likely to have higher price on Monday compared to the others trading days. Day-of-the-week effect was reviewed and stated that stock market had a negative returns on Monday and positive return on Friday (Kumar, 2017). In stock market, "positive return" refers to getting back more money in return than what the investor has invested. In contrast, "negative return" means investors are getting less money as return. As different countries are having different calendar effects, this study will analyze and compare the calendar effects of nine different Asia countries.

Volatility modelling and forecasting has been a crucial task in financial market as it held the attention of academics and practitioners over the last two decades (H. Zhang & Li, 2010). Most of the financial and economic applications are assigning their focus on the volatility of the stock market because the volatility helps to assess the risk and provide crucial information for investment purposes. A higher volatility simply means that a value can potentially deviates over a large range of values. In short, the higher the volatility, the riskier the security. In this study, the composite index of the stock market for nine different Asia countries (China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand) will be used as the sample. The reason why these data were selected, mainly because this study have the interest to find out their respective models and compare the calendar effects between all the countries.

In this study, Autoregressive Integrated Moving Average (ARIMA) will be applied for modeling purposes. However, this model has the disability of handling nonlinearity and volatility(Pai & Lin, 2005). Hence, in order to overcome this weakness, Generalized Autoregressive Conditional Heteroscedasticity (GARCH) family model is implemented to handle the volatility (Maria Caporale & Zakirova, 2017). Performance evaluations will be executed towards the hybrid models of ARIMA and GARCH family models for comparison.

1.2 Statement of the Problem

Over the past few decades, the calendar effect of stock market in different countries are not consistent which means the phenomena of volatility clustering in time series data varies in different sets of data(different countries). As the calendar effect of the stock market often acts as a guidance to allow investors to make profit, many methods and models were implemented to handle this kind of data in order to find out the calendar effect of stock market. In this study, Generalized Autoregressive Conditional Heteroscedasticity (GARCH) will be used to find out the calendar effects.

In terms of modelling, Autoregressive Integrated Moving Average (ARIMA) model is one of the popular model which has been extensively used in the field of finance and economic. The capability of handling non-stationary data is one of the reasons why ARIMA was widely used. A recent study used ARIMA to predict stock price due to its capability to produce short-term forecasts (Adebiyi, Adewumi, & Ayo, 2014). However, ARIMA has a major limitation where the condition of linearity of data must be fulfilled (P. G. Zhang, 2003).

In order to overcome the limitation of ARIMA model, GARCH family model is introduced. GARCH is popular and frequently applied while dealing with time series data with volatility or non-linearity. As the results, both the linearity and the non-linearity can be captured by the combination of both models.

In addition, asymmetric reactions of the volatility will be the second concern when GARCH family models are applied. GARCH model will be used for symmetric models whereas EGARCH and TGARCH model will be used for asymmetric models in this study.

Conclusively, the combination of ARIMA and GARCH models is implemented to sort out the appropriate model for forecasting. At the meantime, the performances of the hybrid models will be evaluated in order to enhance the accuracy of forecasting.

1.3 Objectives of the Study

The proposed objectives are stated as followed: -

(1) To apply a hybrid ARIMA-GARCH model, hybrid ARIMA-EGARCH, and ARIMA-TGARCH model for the stock market data from nine Asian countries.

(2) To compare the modelling and forecasting performances of ARIMA-GARCH, ARIMA-EGARCH, and ARIMA-TGARCH models for stock market from nine Asian countries.

(3) To identify the day-of-the-week effects of stock market in nine Asian countries.

1.4 Scope of the Study

The main focus of this study is to find out the appropriate forecast model for nine Asian countries (China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Thailand and Singapore) and their respective calendar effects. The composite index of all the nine countries were collected from the database of UTM library. The period of the data covers from year 1990 to year 2019. In terms of modelling, the hybridization of ARIMA model and GARCH family models will be used in order to handle non-stationary data and capture volatility of the stock market. AIC will be used to justify the performance of the model whereas RMSE, MAE and MAPE will be used to justify the performance of the forecasting.

1.5 Significance of the Study

This study models and forecasts the stock market by using hybrid ARIMA-GARCH, ARIMA-EGARCH models as well as ARIMA-TGARCH models. By overcoming the limitation of handling volatility data in ARIMA model, complying GARCH family models, it is hoped that the model will have a better performances for future usage.

In addition, the identification of calendar effect of stock market provides a clearer picture to investors on whether they can earn abnormal returns in the stock market. If the investors can identify the pattern of the volatility, it would be easier for them to make investment decisions based on the forecast results.

Moreover, this study will be an aid for policy makers to evaluate the developments in the stock markets as to design and execute the rules and regulations.

By having appropriate developments, market efficiency would be enhanced undoubtedly.

1.6 Outlines of the Study

This paper consists of five chapters and is organized as follows. Chapter 1 discusses the background of this research, problem statements, objectives, scope of study, and significance of study. Chapter 2 reviews relevant literatures and theoretical framework published by other scholars. Chapter 3 describes the research design, data collection and methodology. Chapter 4 reports the empirical results as well as the analysis and interpretation. Chapter 5 concludes with the findings and results.

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