



## A Comparison of the Forecasting Accuracy in the Rate of Changes of Security Prices in Thailand, Using Arima Models

Kanokkarn Snae Namahoot<sup>1\*</sup> and Viphasiri Jantasri<sup>2</sup>

<sup>1\*</sup>Faculty of Business, Economics and Communications, Naresuan University

<sup>2</sup>Faculty of Business Administration, Kasetsart University

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### Abstract

This article aims to compare the performance of the appropriate forecasting accuracy in the rate of changes of security prices in the resource groups, by using the Arima model (0,0,0) to (3,3,3). Its purpose is to analyze the most accurate performance model, with the MAE (Mean Absolute Error) and the square root of RMSE (Root Mean Square Error). This research investigated the quarterly data of resource group, dated from 1 January 2004 to 31 December 2020, totaling 3,200 days from 30 companies to create an effective forecasting model. The research results show that the Arima model (3,1,1) yields the lowest mean absolute error MAE value of 14.22. It is considered that the derived forecast from genuine data is as accurate as 85.78 percent. The square root of RMSE (Root Mean Square Error) has the lowest RMSE value of 27.95, which assumes that the derived forecast from the actual data is as accurate as 72.05 percent. Therefore, this model is suitable for forecasting the stock price in the resource group.

**Keywords:** 1) Arima Model 2) Forecasting Models 3) Forecastion Accuracy

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<sup>1\*</sup> Assistant Professor, Department of Business Administration; E-mail: kanokkarnn@nu.ac.th

<sup>2</sup> Lecturer; E-mail: a.viphasiri@gmail.com



## Introduction

The investment in securities has an important role to the domestic economy in several countries. It is estimated about 80-90% of Gross Domestic Product (GDP). Therefore, investors need more information. Currently, the diversity of businesses in the stock market industry is one of the factors that investors focus on, such as the size of the business and the type of business. This can be regarded as the factor that determines the differences of each industry. Consequently, it is also associated with both inevitable major changes and minor changes in the business. As a consequence, the economy has divergent changes in different directions and also with different patterns (The Stock Exchange of Thailand, 2020).

The analysis of investment securities has played a role in investor decision-making since the establishment of the Stock Exchange in 1975. Securities analysis has been widely acceptable from the past to the present. The Arima model is one of many common models to forecast securities prices (The Stock Exchange of Thailand, 2010).

In this regard, the principle of stock trading analysis can be considered as an important factor to help in decision making in order to seek profit opportunities. Recently, investors have a wide variety of analytical options. The first approach is fundamental analysis, which refers to an approach that analyzes both domestic and international economic and political conditions. It consists of an analysis of the conditions of each industry and the performance of each company to find the appropriate stock prices assessment

for investors (The Stock Exchange of Thailand, 2015a).

According to the change in the price of the securities, macro factors are used to analyze as external factors that the business cannot control while micro-factors are internal factors that businesses can control.

If the business owners can handle with any changes that affect the business, definitely it will result in the financial statements, performance and the financial position of the business in a good direction. Therefore, investors often examine the potential of management or the risk analysis to consider the future trend of each business.

Historical statistical data are studied to investigate the behavior of stock prices in the past. This can help to forecast trends or behaviors of stock price movements in the past, short-term, medium-term and long-term. Price level and trading volume are applied as the main data to analyze which is more convenient and time-saving analysis than fundamental analysis that requires data collection in various fields (The Stock Exchange of Thailand, 2015b).

In the stock market, the resource industry is considered as the group with the highest market capitalization (The Stock Exchange of Thailand, 2021). This industry is important in determining the change in securities prices. There is also sufficient information that can be analyzed by means of forecasting the changes in prices. The analysis is popular among investors because information is easy to understand, interpret and compare to information of each business.



The financial ratios can be divided into four groups: liquidity ratios, Activity Ratios, Profitability Ratios and Leverage Ratios.

The research study found that Return on asset (ROA) Return on Equity (ROE) Dividend Payout Ratio (DPR) ratio Debt to Equity Ratio (DE) Price to Earnings Ratio (PE) Price to Book Value Ratio (P/BV) and earnings per share (EPS) were factors affecting stock price changes (Patcharanat, 2017). All of them were in accordance with the Arima model analysis theory, developed in 1994 by Box, et al. (1994).

Basically, the Arima model is a method that provides a good short-term forecast value or it is suitable for forecasting a short period in advance. However, this model requires a quite long range of data (Gairaa, et al., 2016). The Arima model (p,d,q) (Afeef, et al, 2018) consists of three main parts: Auto Regressive (AR(p)) Integrated (I(d)) process and Moving Average (MA(q)) model.

Additionally, the Arima model is a method that provides good short-term forecasting, because the mean square error (MSE) of the forecast is lower than other methods (Shen and Shen, 2016), including, trend analysis, exponential smoothing method and multiple regression methods and so on. Although, there are multiplex steps during the equation preparation and forecasting, it is less complicated than the macro model in form of a system of multilayer equations.

Researchers intend to test the efficient and accurate forecasting of the rate of change of security prices in the resource group of the Stock Exchange of Thailand. The data was analyzed as a real data set of the rate of

change in the resource group with the Arima model. This model consists of a combination (Combination) of time series data 3 techniques:

Autoregressive, Combined-Integration, mean absolute error (MAE) and the root mean square error (RMSE). Researchers attempt to create the precise and accurate model to present the least error in securities forecasting and show the direction of future securities prices. Consequently, it helps to develop the efficiency of securities investment selection in the pursuit of profits for investors.

### Objectives of Research

The specific objective of the study is to test the efficiency and accuracy of the rate of change of securities in the resource group of the Stock Exchange of Thailand. The model combines three techniques for time series data: the distance value of the dependent variable, the mean absolute error (MAE) and the square root of RMSE (Root Mean Square Error) to analyze by using the Arima method.

### Related Literature

#### 1. Financial Ratio Analysis

Financial ratio analysis is the analysis of financial statement to find relationship between one variable and another variable. The financial ratio can be divided into 4 types including liquidity ratio, risk ratio, profit efficiency ratio, and operating efficiency ratio. The financial ratio shall be used to compare with historical data or standard ratio or average ratio of industry. This provides financial status, strengths and weaknesses, and trends of the company in the future (Drake and Fabozzi,



2012). As a result, the management team has more efficient plan for financial management. Financial ratio analysis is the analysis of data in financial statements to determine relationship between one item and another. There are four types of financial ratios which are liquidity ratio, risk ratio, profit efficiency ratio, and operating efficiency ratio.

**1.1 Liquidity Ratio**

**1.1.1 Current Ratio**

Current Ratio = Current Asset (CA) / Current Liability (CL)

Company has the ability to pay off short-term debt. If the calculated value is high it reflects that the company has current assets such as cash, debtors and inventories more than short-term debt.

**1.1.2 Quick Ratio or Acid Test Ratio**

Quick Ratio = Current Asset - Inventory / Current Liabilities

The ratio measures current asset after deducting inventory, which is a short-term asset with lowest liquidity. This can show the real liquidity of a company. Normally, the quick ratio of 1:1 is acceptable.

**1.1.3 Account Receivable Turnover**

A/R Turnover = Net Credit Sales or Total Sale / Average Account Receivable

Average Account Receivable = (Beginning Account Receivable Balance + Ending Account Receivable Balance) / 2

If the calculated value is high, it shows the ability of the company's efficiency in changing receivables to cash.

**1.1.4 Average Collection Period**

**Period**

Average Collection Period = 365 / Average Account Receivable

The average collection period is lower, it is better for the company. It shows either a short or long collection period. This means the quality of debtors, the efficiency of receivable collection, and credit policy.

**1.1.5 Inventory Turnover**

Inventory Turnover = Cost of good sold (COGS) / Average Inventory

Average Inventory = (Beginning InventoryBalance+EndingInventoryBalance)/2

If the inventory turnover is high, it shows the company's ability to manage sales quickly.

**1.1.6 Average Inventory Period**

Average Inventory Period = 365 / Inventory Turnover

If the average Inventory Period is short, it is good for the company.

**1.2 Profitability Ratio**

**1.2.1 Gross Profit Margin**

Gross Profit Margin (%) = Net Sales - Cost of Good Sold (or Sales - COGS) / Net Sales

Gross Profit Margin = Gross Profit / Net Sales

If gross Profit Margin is higher, it is better for the company.

**1.2.2 Operating Profit Margin**

Operating Profit Margin (%) = Operating Profit Margin / Net sales



If operating Profit Margin is higher, it is better for the company.

Net profit Margin

$$\text{1.2.3 Net Profit Margin (\%)} = \frac{\text{Net Profit}}{\text{Net Sales}}$$

If net Profit Margin is higher, it is better. It shows the company's efficiency to make profit after deducting total cost and tax.

#### 1.2.4 Return on Equity (ROE)

Return on Equity (%) = Net Profit / Equity

If return on equity is higher, it shows a higher ratio of return of owner's investment. It also shows the efficiency of profitability.

### 1.3 Efficiency Ratio

#### 1.3.1 Return on Asset (ROA)

Return on Asset (%) = Net Profit / Total Assets

This ratio can measure profitability of total asset. If the ratio is higher, it shows higher efficiency of total asset usage.

#### 1.3.2 Return on Fixed Asset (ROFA)

Return on Fixed Asset = Net Profit / Fixed Assets

#### 1.3.3 Fixed Asset Turnover

Fixed Asset Turnover = Net Sales / Fixed Asset

If the ratio is higher, it shows better business operation.

#### 1.3.4 Total Asset Turnover

Total Asset Turnover (Times) = Sales / Total Assets

If the ratio is higher, it shows efficiency of total assets compared with sales. If the ratio is low, it shows excess of company's asset.

### 1.4 Leverage Ratio or Financial Ratio

#### 1.4.1 Debt / Equity Ratio

Debt / Equity Ratio (Times) = Total Debt / Total Equity

This ratio shows sources of fund whether it comes from debt or owner's equity. If the ratio is lower, it is better. It means lower risk of debt.

#### 1.4.2 Interest Coverage

Interests coverage ratio (Times) = (Net profit + Tax - Interest) / Interest

It measures a company's ability to pay interest on a loan. If the ratio is high, it shows higher ability of the company to pay interest.

#### 1.4.3 Dividend Payout

Dividend Payout Ratio = Dividend / Share / Earning per share (EPS)

It shows the company's policy to pay dividends. This is one of the basic tools of securities analysis and it can be used for financial statement analysis (Afeef, et al., 2018).

## 2. Forecasting techniques and related theories

### Forecasting techniques

A forecasting method is used to predict the future. Current or historical data such as sales data, trends, seasonality, cycle, and irregular variation are collected to build predictive model. Forecasting is widely used in research on economic and social issues

For example, forecasting related to demand of product price, temperature, and rainfall (Lorchirachoonkul and Jitthavech, 2005; Suwanwongse, 1992; Thammawijaya, 2017).

In this regard, the main forecasting techniques can be divided into two types: qualitative forecasting techniques and quantitative techniques (Box, et al., 1994).

Quantitative forecasting can be divided into two main groups: time series forecasting and casual forecasting. Time series forecasting can be known as naïve approach, exponential smoothing approach, bayesian approach. Causal forecasting is recognized as regression analysis approach, econometric approach and input-output approach.

There are also several popular modern forecasting techniques such as Artificial Neural Network approach: ANN, Genetic Algorithms approach: GA, fuzzy logic approach. In this research, the forecasting techniques would illustrate ARIMA with Exogenous Variable: ARIMAX (Gairaa, et al., 2016; Shen and Shen, 2016)

**ARIMA Model (AutoRegressive Integrated Moving Average)**

The model is popular and it is good for short term forecast due to lower Mean Square Error (MSE) compared to other methods, including trend analysis, exponential smoothing, and multiple regression. In addition, the equation and the forecast are less complicated than multiple equations. ARIMA model was developed by George E.P. Box and Gwilym M. Jenkins in 1970. The model will provide the forecasting value in short-term or it is appropriate to use for future forecast in short period of time (Afeef, et al., 2018; Gairaa, et al., 2016). The forecast have to use long-term data. ARIMA model has 3 main parts, namely Auto Regressive (AR(p)), Integrated Process (I(d)),

and Moving Average (MA(q)) with the following details:

**2.1 Auto Regressive (AR(p))**

Auto Regressive is the model showing that the observed value  $y_t$  is determined by the value of  $y_{t-1}, \dots, y_{t-p}$  or the observed value before  $p$ . The process or AR (p) is the process or system of Auto Regressive, which has the order of  $p$  under the following equation:

$$AR(p) \text{ is } x_t = \mu + \phi_1 x_{(t-1)} + \phi_2 x_{(t-2)} + \dots + \phi_p x_{(t-p)} + \epsilon_t$$

Which

- $\mu$  is constant term
- $\phi$  is parameter
- $\epsilon$  is discrepancy at time

For AR (1), it can be written in the equation as follows:

$$x_t - \phi_1 x_{(t-1)} = \mu + \epsilon_t$$

For AR (2), it can be written in the equation as follows:

$$x_t = \mu + \phi_1 x_{(t-1)} + \phi_2 x_{(t-2)} + \epsilon_t$$

**2.2 Moving Average (MA(q))**

The Moving Average (MA(q)) is the model showing the observed value  $v_t$ , which is determined from deviation value  $\epsilon_{t-1}, \dots, \epsilon_{t-q}$  or the earlier error value. MA (q) system is the process or system of Moving Average that has  $q$  ranking.

$$MA(Q) \text{ is } x_t = \mu + \epsilon_t - \theta_1 \epsilon_{(t-1)} - \theta_2 \epsilon_{(t-2)} - \dots - \theta_q \epsilon_{(t-q)}$$

Where

- $\mu$  is constant term
- $\theta$  is the average of moving parameter at
- $\epsilon$  is the error at time

For MA(1), it can be written in the



equation as follow:

$$x_t = \mu + (1 - \theta) \varepsilon_t$$

For MA(2), it can be written in the equation as follow:

$$x_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2}$$

### 2.3 Auto Regressive Moving Average (ARMA(p,q))

Auto Regressive Moving Average (ARMA (p,q)) is the model combining Auto Regressive and Moving Average. ARMA(p,q) is the process or system of Auto Regressive, with ranking at p and Moving Average with ranking at q. The equation is in the following form:

ARMA(p,q) model:

$$\Delta y_t = \delta + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \dots - \theta_q \varepsilon_{t-q}$$

Process of Integrated (I(d)) is the difference of time series between current data and previous data backed for d periods. ARIMA needs to analyze time series data with the stationary only. For Nonstationary analysis, the data needs to be changed to stationary first by finding the difference of time series data before setting the ARIMA model. Normally, the difference for the ranking d can be written from of I(d) as follow:

$$I(d) \text{ is } \Delta_d x_t = \Delta_{(d-1)}(x_t - x_{t-1}) \text{ or } [(1-B)]^d x_t$$

Where

- $\varepsilon_t$  is the error at time t
- $(1-B)^d x_t$  is the difference at d
- B is backward shift operation

### 2.5. Autoregressive integrated moving average model (ARIMA)

For the above details, the Auto Regressive, Moving Average, and Integrated can be used together and they can determine the general model of Arima, which can be used for estimation as follow:

### ARIMA(p,d,q)

$$\Delta^d y_t = \delta + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \dots + \phi_p \Delta y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \dots - \theta_q \varepsilon_{t-q}$$

Where

- $y_t$  is the value under time series at time
- d is the number of times that the raw observations are differenced (the degree of differencing)
- p is the number of lag observations included in the model (the lag order)
- q is the size of the moving average window (the order of moving average)
- $\delta$  is Constant Term
- t is time
- $\Delta^d$  is the difference at d
- $\phi_1, \dots, \phi_p$  is parameter of Auto regressive
- $\theta_1, \dots, \theta_q$  is parameter of Moving average
- $\varepsilon_t$  is the process of white noise,

which is the error at time t under the assumption that the error for different time is random sample, that is independent. The distribution has the average at zero and the variance is stable.

### Related research

There are researches related to investment in both the stock market and other forecasting as follows:

The study of the relationship between financial ratios and the price of banking securities listed on the Singapore Stock Exchange. They examined by using the financial

ratio factor such as Loan to Deposit Ratio (LDR), Non-performing loan (NPL), Debt to Equity Ratio (DE), Return on Equity (ROE) and the book value per share (BVPS).

It applied the quarterly time series from Q1 2003 to Q4 2016, a total of 56 quarters. Multiple regression analysis was used at 90.00, 95.00 and 99.00 percent confidence levels.

The results showed that factors related to the stock price of Singapore's banking. Five ratios play a role in the stock price. Non-performing loan did not generate total loans income.

The book value per share was the most correlated with an inverse correlation and positive correlation, followed by, Debt to Equity Ratio, Return on Equity and Loan to Deposit Ratio, respectively (Patcharanat, 2017).

Comparably, Thai and Indonesian researches have been studied the impact of financial ratios on the stock price of securities listed on the stock exchange. The comparative studies were aimed to find the most powerful financial ratio that affected to share prices in each country. They applied fundamental analysis methods and the concept of accounting profit to determines the price of securities

The variables were used in the study 1) Earnings Per Share (EPS), 2) Return on asset (ROA), 3) Return on equity (ROE), 4) Debt to Equity Ratio (D/E), 5) Earnings per Share Ratio (P/E) Average Inventory Period Price to The book value per share (BVPS).

The results of the analysis revealed that in 2011 - 2015, the variable Earnings per share, Return on Equity and Price to The book value per share had correlation with the stock

price in the same direction. While Earnings per share affected the stock price the most. According to standardized regression coefficients showed that Earnings per share had the greatest influence on stock price changes. If Earnings per share changes 1 unit would cause the stock price to change in the same direction by 0.91 unit (Wanaset, 2016).

Kriengsak (2009) studied the forecasting of securities prices and stock market indexes by using a neural network model to compare with the Arima model. The objective was to compare the forecasting results from Neural network model and Arima model. They collected data from the Stock Exchange of Thailand (SET Index), SET50 Index and the daily closing price of the SET50 securities during the period 1 January 2005 to 31 December 2007.

The study was divided into two parts: The first study examined the most predictively accurate neural network model. Then the most precise model would be compared to the Arima model, by testing with the SET Index and the SET50 index. The result was the co-active neuro-fuzzy inference system model with 50 inputs. This model presented the best average forecasting accuracy, compared to other neural network models. While the ARIMA model (1,1,0) showed the most accurate forecasting results.

The second part of the study applied the model from the first study to forecast the SET Index and SET50 Index and individual stock prices in the SET50 group. It was found that the neural network model was more accurate forecasts than the Arima model, 42 out of 51 samples. They represented 82.36 percent of the samples. Meanwhile the Arima model had



a predictive accuracy of 17.64% more than the neural network model. The neural network model had a limitation for forecasting performance if the incoming data was volatile and had a high standard deviation.

Chayanin and Nat (2017) illustrated a comparison of the accurate forecasting from a hybrid of Arima with the neural network model and a hybrid of Arima with the support vector machine model. They attempted to forecast the closing stock price of Siam Commercial Bank Public Company Limited (SCB) with model Arima (0,1,1), Arima (0,1,2), Arima (1,1,0), Arima (1,1,1), Arima (1,1,2), Arima (2,1,0), Arima (2,1,1) and Arima (2,1,2). The square root of RMSE (Root Mean Square Error) was applied to compare models. The model with the lowest RMSE was considered the best model.

The results showed that a hybrid model between Arima and the support vector machine model had the highest forecasting accuracy in a time series dataset in the case of model simulations, Arima (0,1,2), Arima (1,1,1) and Arima (2,1,2) models. At the same time, a hybrid Arima and Neural Network models provided the highest forecast accuracy in the time series data set, in the case of Arima (0,1,1) model, Arima (1,1,0) model, Arima (1,1,2) model, Arima (2,1,0) model, and Arima (2,1,1). Moreover, real data of the weekly closing stock price of SCB was used with a time-series consistent with the Arima model (1,1,1). The results showed that a hybrid model between ARIMA and the support vector machine model had the highest forecast accuracy. They were consistent with the results from the simulation dataset.

According to the literature review, researchers therefore chose to study the rate of change of security prices in the resource group (Wanaset, 2016; Charoenbhantraks, 2017; Ge, et al., 2016) and compared the forecasting accuracy of the Arima model (Dhakonlayodhin and Areepong, 2018).

### Scope of the Study

The data was used to test the performance of the forecasting accuracy of the security prices change in the resource group. It was collected from the actual data set of the rate of change of closing security prices. Quarterly data was gathered from January 1, 2004 to December 31, 2020, in a total of 30 resource groups. This industry had high capital market and it was in demand among investors in the stock market (The Stock Exchange of Thailand, 2021). The sequential data analysis was performed with the Arima model. A total of 64 simulations were used, ranging from model (0,0,0) to model (3,3,3).

### Methodology

Researchers collected time series data of stock trading in the Stock Exchange of Thailand. Since resource group involved with the daily life of the people in Thailand, it was also regarded as a group of securities with the highest market capital compared to other securities in Thailand. Moreover, it had a large number of service centers and covers in many areas. The analyzed data was an actual data set of the rate of change of the closing price, using quarterly statistics for the past 15 years from January 1, 2004 to December 31, 2020.

There are 3,200 days in total from a total of 30 companies. Data was analyzed sequentially. 64 Arima models were simulated, ranging from model (0,0,0) to model (3,3,3).

**The operation steps are as follows.**

**Step 1** Download the actual closing security price data and calculate the rate of change from the Stock Exchange of Thailand website. Select historical trading data of securities in resource groups and set it quarterly during October 1, 2004 - December 31, 2020 from the online SET information system or SETSMART (SET market analysis and reporting tool).

**Step 2** Prepare the data (scan) to be able to enter the forecasting process. Select only the information that is necessary for analysis, namely the rate of change of securities prices in Thailand’s resource group.

**Step 3** Take all the information enter statistics program to create a database (data base) for analysis.

**Step 4** Variables must be consistent with the rate of change of security prices in Thailand’s resource group with quarterly time series data.

**Step 5** Choose a forecasting model and forecasting process. The Arima model consists of three techniques: AR, I, and MA. In common, all techniques work together to manage data interference in an attempt to minimize error values as much as possible. As soon as the data is reliable, the forecasting process has more efficient.

**5.1 A stationary test**

Testing the unit root of data helps to verify that the data is stable. By considering the

stationary of the data, the analysis is based on a comparison of the augmented Dickey-Fuller (ADF) statistic with the MacKinnon critical statistic of 1%, 5% and 10% of the model. If the ADF statistic is greater than the MacKinnon critical, then accept the null hypothesis (H0) and reject (H1).

**5.2 Identification**

Stationary time series are analyzed to find a suitable model (p,d,q) for the time series. The autocorrelation is in the range [1,-1] based on a sample of time series with backwards in time, **k** units, as follows:

$$r_k = \frac{\sum_{t=1}^{n-k} (y_t - \bar{y})(y_{t+k} - \bar{y})}{\sum_{t=1}^n (y_t - \bar{y})^2}$$

Partial Autocorrelation:  $\hat{\phi}_{kk}$  is a measurement of the relationship at each time period with backwards in time, **k** units. Then consider values of partial autocorrelation rely on a sample of time series with backwards in time time, **k** units.

$$\hat{\phi}_{kk} = \begin{cases} r_k \sum_{j=1}^{k-1} (\hat{\phi}_{(k-1)j} r_{k-j}) \\ 1 - \sum_{j=1}^{k-1} \hat{\phi}_{(k-1)j} r_j \end{cases}$$

Each model must be reviewed  $r_k$   $\hat{\phi}_{kk}$  altogether at once. Generally, figure is examined, called the plotted “correlogram”. After  $r_k$   $\hat{\phi}_{kk}$  plotting, then it can be identified how the model should have a form (p,d,q). The value Autocorrelation Function (ACF) and Partial Autocorrelation (PACF) will be criteria to build the model. ACF and PACF must be considered at the 95 percent confidence interval (Box, et al., 2015).

**5.2 The estimation of the parameters**

of the model must be under conditions for the Best Model are as follows:

1. The coefficient of determi-



nation (R-squared) indicates that the proportion of variance in the dependent variable that can be explained by the independent variable. If the value is high, a model will be considered a good model.

2. Durbin Watson Statistic is testing whether independent variables have a relationship within themselves or not... Usually if a value is in a range between 1.5 – 2.5, indicates that they are independent. Therefore, the model is no autocorrelation detected.

3. Schwarz information criterion

If data consistency has a small value, the model is the most suitable.

### 5.3 Diagnostic model-checking

When a model is defined and parameters are estimated, validation must be checked regularly to ensure that a given pattern is appropriate, by examining a correlogram of the value of the standard deviation and testing the Ljung-Box Q-Statistic. If values have Chi-square distribution and have degrees of freedom. It is assumed to be white noise characteristics, which means the model has no autocorrelation. Consequently, the time series has been approved and is suitable for forecasting. Next (Box, et al., 2015).

### 5.4 Forecasting

Examine appropriate models for forecasting security prices in the banking sector in Thailand.

**Step 6** Evaluate, compare model and summarize the result of time series forecasting of the actual closing stock price data in the Stock Exchange of Thailand. See how much of a difference of the standard deviation by considering the actual data compare to the

data obtained. According to this research, two criteria were used to compare the efficiency as follows:

1. The mean absolute error (MAE)
2. The root means square error (RMSE)

The suitable values are considered effective in forecasting as reported by the criteria of the mean absolute error and the root mean squared error. The standard deviation should be close to zero. For that reason, the model is suitable for forecasting (Box, et al., 1994).

## Results

There was a performance testing of forecasting accuracy of security prices in resource groups with Arima model. Quarterly time series data as secondary data was collected from agencies such as securities companies, the Stock Exchange of Thailand and SETSMART from January 1, 2004 to December 31, 2020. There were 3,200 days of data collection, from a total of 30 companies. The results of the data analysis were as follows.

### Arima model

A total of 64 Arima models were analyzed, ranging from models (0,0,0) to (3,3,3). The results of the study were summarized as follows.

#### 1. The results of the unit root test by ADF method

At the level it showed that all 3 data sets were not stable. Therefore, the researcher found the first difference (1<sup>st</sup> Difference) (Table No. 1).

**Table No. 1** The results of the unit root test

Variables	Lag	ADF Test	Mackinnon Critical Value			Test Level	Result
			1%	5%	10%		
			The rate of change in the price of the resource group.	1	-67.925		

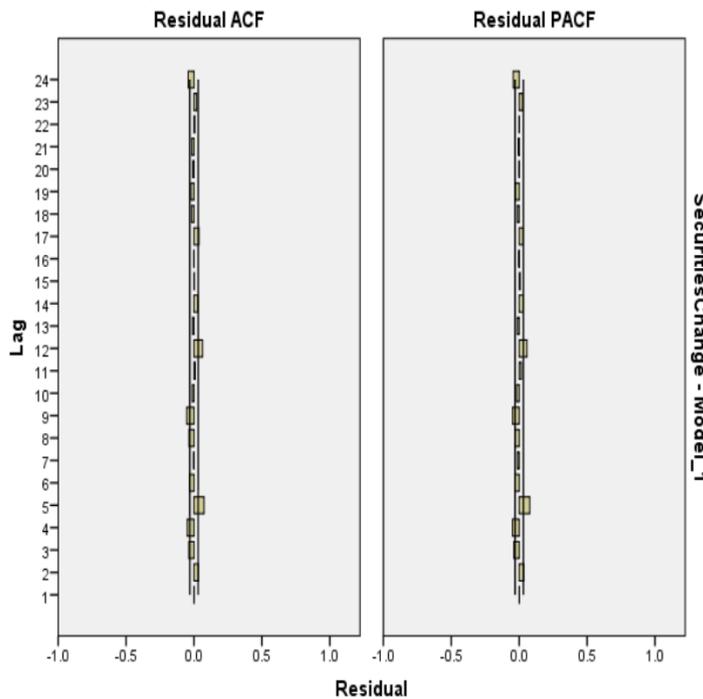
Note: All test variables were converted to Logarithm form before testing.

From Table No. 1, Results of unit root test was at level. After comparing ADF statistic with Mackinnon critical at 1.00%, 5.00 and 10.00 of the time series at different levels, it was found that the ADF statistic was significantly less than the Mackinnon critical value. A significant 90% indicated that the time series data is stable. Therefore, it could forecast.

**2. Formatting**

According to the correlogram of the time series data at the 1st difference (1<sup>st</sup> Difference), it was found that the data was white noise. Since the data depended on the

random error it could not define the format model. Therefore, the correlogram of the second difference (2nd Difference) of the data was considered. It was found that data was stable and able to find the form of the model. By defining the model for the p-rank of the autoregressive model and the q-rank of the Moving Average model, which was created by the values of Autocorrelation Function (ACF) and Partial Autocorrelation (PACF). Values must beyond the 95.00% confidence interval, AR (1) and MA (1) of the model would be obtained. The most suitable model was ARIMA (3,1,1).



**Picture No. 1** shows a correlogram of the rate of change in a resource group.

### 3. Estimation

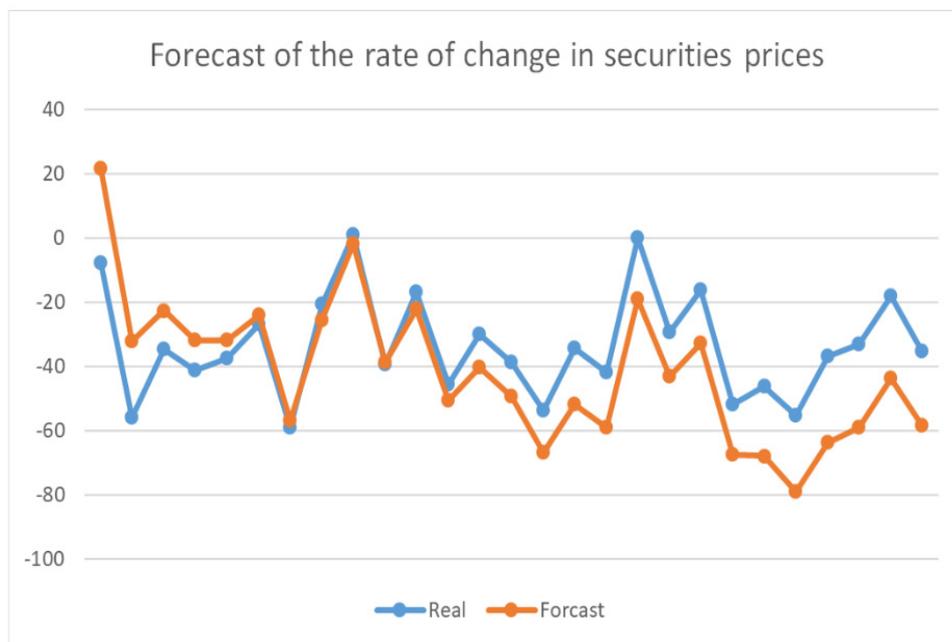
**Table No. 2** Coefficients and statistical values of the ARIMA model (3,1,1).

Variable	Coefficient	t-statistic	Probability
c	0.042	0.453	0.000
AR(1)	0.104	4.455	0.000
MA(1)	0.934	95.407	0.000
R-squared		0.670	
Schwarz information criterion		6.838	
Durbin-Watson stat		2.143	

From Table No. 2, it was found that the coefficient of ARIMA (3,1,1) was 0.042 which had a t-statistic significantly different from zero at the 0.05 level. R-squared was equal to 0.670 so it showed that 67% of the independent variables were able to describe dependent variables. The Durbin-Watson stat was 2.143, with values approaching 2 indicating that the model had no autocorrelation problem. The Schwarz information criterion was 2.143.

It illustrated data consistency, as a result it was considered as a suitable model for further forecasting.

Therefore, it showed that the graph revealed seasonality. The Arima (3,1,1) model provided low standard deviation, accordingly the data set was reliable. Shown in Picture No. 1.



**Picture No. 1** shows a comparison of forecasting graphs between real price change data and the rate of change of the forecast price

**4. Diagnostics checking**

The validation procedure applied a

Q-statistic to test for statistical properties of white noise.

**Table No. 4** Arima model verification

Suitable model	The value of the statistic	
	Q-statistic (Lag 18)	Probability (Lag 18)
ARIMA (3,1,1)	15.873	0.797

From Table No. 4, the calculated Q values were lower than the critical value of the chi-square at a significance level of 0.10 [Prob < 0.10]. Model ARIMA (3,1,1). showed that standard deviation of the model is white noise. In other words, the standard deviation was normal distribution. The average was zero and the variance is constant. As a result, the model was validated and suitable for further forecasting the rate of change in the price of securities in the resource group.

**5. Comparison of the Efficiency of Forecasting method**

Researchers examined ARIMA forecasting model and compared the forecasting accuracy of the rate of change of securities prices in the resource group 3 months in advance. It was found that the ARIMA (3,1,1) model was the best predictor, according to the lower MAE and RMSE values. For this reason, it was considered the most suitable model for forecasting. It is showed in Table No. 5.

**Table No. 5** Comparison of forecasting values using the ARIMA (3,1,1) model for forecasting the rate of change of securities in the resource group 3 months in advance (quarter).

Suitable model	MAE	RMSE
ARIMA (3,1,1)	14.222	27.955

From Table No. 5, the comparative forecasting data set, between the actual price change rate and the forecasting price change rate by the ARIMA model (3,1,1).

It revealed that the forecast value presented the lowest mean absolute error 14.222. It could be described that the forecasting data set and the actual data had an accuracy of  $100 - 14.222$  equal to 85.78%, given the root mean square error (RMSE) 27.955. The root means square error illustrated the difference between the forecast data and the actual data squared, had an accuracy of  $100 - 27.955$ , equal to 72.05%.

**Conclusion and Discussion**

The results of the analysis of 64 models of ARIMA (p,d,q) from (0,0,0) to (3,3,3). It was concluded that ARIMA (3,1,1) revealed the smallest value of the mean absolute error, 14.222. It could be explained as forecasting data and actual data were 85.78% accuracy while the smallest value of the root mean square error was 27.955.

Therefore, it could be described as the difference between the forecasting data of the price change rate in the resource group and the R-squared presented 72.05 percent accuracy. Consequently, the results of the



testing showed that ARIMA (3,1,1) had the smallest of the root mean square error.

This went along well with the comparative analysis of Sudhom (2009) which had examined the forecasting of security prices and stock market indices. This study presented both the Neural Network model and the Arima model to compare the SET Index and the SET50 Index. Eventually Arima Model provided the most accurate forecasting results.

However, it was noted that the neural network model was accurate in forecasting more than the Arima model, 42 out of 51 which represented 82.36 percent of the sample. While the Arima model was 17.64 percent more accurate in forecasting than the neural network model.

It could be assumed that the neural network model would be less accurate if incoming data was volatile and had a high standard deviation (Sudhom, 2009). But it was different from the research by Boonmana and Kulvanich (2017) that compared the accuracy of forecasting values derived from the Arima model with a hybrid model between Arima and Neural Network Hybrid models and a hybrid model between Arima and support vector machines to forecast the closing price of SCB.

It found that the Arima model and the support vector machine had the highest forecasting accuracy for forecasting in a time series dataset in the case of model simulations Arima (0,1,2), Arima (1,1,1) and Arima (2,1,2) models. A hybrid model of Arima and Neural Network models provided the highest forecast accuracy, in the time series data set, in the case of Arima

(0,1,1) model, Arima (1,1,0) model, Arima (1,1,2) model, Arima (2,1,0) model, and Arima (2,1,1)

For forecasting in the actual data set of the SCB weekly closing price with a time-series together with the Arima model (1,1,1). The results showed that a hybrid model of Arima and the support vector machine had the highest forecast accuracy in harmony with the results from the simulation dataset.

From this research, remarkably if the Arima model was smaller with small dataset, it showed a high mean absolute error. Particularly it was found that this research had the low mean absolute error due to the diversity of datasets and Arima models. Therefore, datasets and Arima model played important role for more efficient analysis.

The results of the above study reflect that the Arima model is accurate to forecast the price change of security price in the resource group. The research results can be utilized for investment planning of entrepreneurs and investors who are interested in investing in the stock market in Thailand's resource group. Moreover, government can use this model to formulate policies that could appropriately help to develop the resource group business.

### **Practical recommendations and future research**

The concept of Box, et al. (1994) with the Arima model is applied through detailed and accurate analysis. Independent variables are set to complete and adjust for the model in order to get the Best Model. Therefore, it can get maximum benefit. The suggestions are as follows:



The system developers of securities companies can use the model in this research to create a model for investment decisions, based on the rate of dividend payment and price to the book value per share (P/BVPS), respectively. Entrepreneurs and investors benefit in choosing the right investment in each company of the banking sector.

The government can use the research results for policy planning, as well as can formulate the resource business group strategy to support and promote investment. In particular, the dividend payout policy from this research reveals that the dividend payout ratio has influence on the stock price. Therefore, the

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dividend payment policy may be formulated to attract more investors to invest more.

#### **Research Limitations**

Further research should be examined more variety of analytical methods, such as decomposition in time-series, forecasting with a neural network method, decision tree method or other related methods. A variety of methods should be compared and investigate the lowest standard deviation values. Data must add more to make it better. Finally, an analysis of other industry groups should be conducted to measure the effectiveness of analytic tool in the study.



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