THE ANALYSIS OF INDONESIA INFLATION DATA USING BOX-JENKINS MODELS

Suparti[a], Budi Warsito[b], Moch. Abdul Mukid[b]

Department of Statistics, Faculty of Sciences and Mathematics, Diponegoro University, Semarang, Indonesia
[a]E-mail: supartisudargo@yahoo.co.id
[b]E-mail: budiwrst2@gmail.com
[c]E-mail: mamukid@yahoo.com

ABSTRACT

Inflation is a sustained increase in the general price level of goods and services in an over a period of time. Inflation's effects on an economy are various and can be simultaneously positive and negative. Negative effects of inflation include an increase in the opportunity cost of holding money and uncertainty over future inflation which may discourage investment and savings. The aims of this research are to analyze the Indonesia inflation data using Box-Jenkins models and to find the best model based on the smallest Mean Squared Error (MSE). Then by using this model, the inflation value of some period ahead will be predicted. Based on the historical data of Indonesia year-on-year inflation data from December 2006 until December 2013, known that the best Box-Jenkins model is subset ARIMA ([1,12],1,0). The MSE of the model reach into 0.274 and the MAPE is equal 4.36%. The prediction inflation in 2014 is 4.28%.

Keywords: Inflation, Indonesia, subset ARIMA, MSE, MAPE.

1. INTRODUCTION

Inflation is a sustained increase in the general price level of goods and services in an economy over a period of time. When the general price level rises, each unit of currency buys fewer goods and services. Consequently, inflation reflects a reduction in the purchasing power per unit of money – a loss of real value in the medium of exchange and unit of account within the economy. A chief measure of price inflation is the inflation rate, the annualized percentage change in a general price index (normally the consumer price index) over time.

Inflation's effects on an economy are various and can be simultaneously positive and negative. Negative effects of inflation include an increase in the opportunity cost of holding money, uncertainty over future inflation which may discourage investment and savings, and if inflation were rapid enough, shortages of goods as consumers begin hoarding out of concern that prices will increase in the future. Positive effects include ensuring that central banks can adjust real interest rates (to mitigate recessions), and encouraging investment in non-monetary capital projects.

Economists generally believe that high rates of inflation and hyperinflation are caused by an excessive growth of the money supply. However, money supply growth does not necessarily cause inflation. Some economists maintain that under the conditions of a liquidity trap, large monetary injections are like "pushing on a string". Views on which factors determine low to moderate rates of inflation are more varied. Low or moderate inflation may be attributed to fluctuations in real demand for goods and services, or changes in available supplies such as during scarcities, as well as to changes in the velocity of money supply measures; in particular the MZM ("Money Zero Maturity") supply velocity. However, the consensus view is that a long sustained period of inflation is caused by money supply growing faster than the rate of economic growth.

It is important to make an inflation prediction for some period ahead in order to reduce the uncertainty of bussines and government condition. Therefore, a good model is very requiried, especially a model with high accuration in predicting. The inflation is a time series data which in general has a particular model. A method for modeling of time series data is the classical parametric models such as autoregressive models (AR), moving average models (MA) or a mixed model (ARIMA) which has been developed by Box and Jenkins since 1970. Unfortunately, in modeling with a parametric model, there are some assumptions that must be required, for instances the data must be stationary, the model's error should be white noise and normally distribution.

Reference [1] shows the best Box-Jenkins model of Indonesia inflation using data from 1998 until 2008 is AR(2). By this model, prediction inflation in 2009 was 10.48%. Unfortunately, the prediction was far enough from the actual inflation, which the value was 2.78%. Having remodel using year-on-year inflation from december 2006 until december 2011, there were not any Box-Jenkins model that appropriate. It due to some of identified Box-Jenkins models did not satisfy all classical assumptions. Motivated by these conditions, have used a kernel regression as an alternative model of Indonesia inflation data. By using this model prediction inflation in 2012 and

2013 were 4.46% and 4.45% [2]. The prediction in 2012 was close enough with the actual inflation, which the value was 4.30%. Unfortunately, in 2013 Indonesia government has raised electricity tariff and fuel fosil price in which have increased the inflation rate significantly was equal to 8.38% . So the prediction inflation in 2013 was far enough from the actual inflation.

2. LITERATURE REVIEW

2.1 Inflation Measure

The indicators are often used to measure the rate of inflation is the Consumer Price Index (CPI). CPI change from time to time shows the price movement of a package of goods and services consumed by the public. Since July 2008, a package of goods and services in the CPI basket has been done on the basis of Cost of Living Survey (SBH) 2007 conducted by the Central Statistics Agency (BPS) [3]. By the way, the targeted inflation which has determined by the Indonesia government at period 2013-2015 were 4.5%, 4.5% and 4% respectively. The standart deviation of those target was 1% [4].

2.2 Time Series Analysis

A time series is a sequence of data points, measured typically at successive points in time spaced at uniform time intervals. Time series analysis comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. Time series forecasting is the use of a model to predict future values based on previously observed values. Time series data have a natural temporal ordering. This makes time series analysis distinct from cross-sectional studies, in which there is no natural ordering of the observations. Parametric modeling of time series data developed by Box and Jenkins includes modeling Autoregressive (AR), Moving Average (MA) and a model mixture of AR and MA models known as Autoregressive Integrated Moving Average (ARIMA) [5].

2.3 Autoregressive Integrated Moving Average Model (ARIMA)

Autoregressive integrated moving average model with three parameters (p,d,q) is written as ARIMA (p,d,q). If d = 0 and q = 0, then the model is autoregressive orde p that can be abbreviated as AR (p). If p = 0 dan d = 0, then the model is moving average orde q which can be noted as MA (q). The general form of ARIMA model can be expressed as an equation $\phi_p(B)(1-B)^d Z_t = \theta_0 + \theta_q(B)a_t$, where $\phi_p(B) = \left(1 - \phi_1 B - \cdots - \phi_p B^p\right)$ is an AR operator and $\theta_p(B) = \left(1 - \theta_1 B - \cdots - \theta_p B^p\right)$ is an MA operator. The d parameter shows that the process not stationer. If d = 0 the process has reached stationarity condition.

2.4 Subset ARIMA Model

Reference [6] said that a subset of ARIMA model that can not be expressed as a general form is called as subset ARIMA . As an example subset ARIMA ([1,4],0,[1,12]) can be written as

$$(1 - \varphi_1 B - \varphi_5 B^5) Z_t = (1 - \theta_1 B - \theta_{12} B^{12}) a_t$$

If in autocorrelation or partial autocorrelation plot, lags that out of the limit not started at first, second, and so on, for instances appeared at first and fifth lags on PACF plot and at first and twelft lags on ACF plot, then the model can be identified as subset ARIMA model in combination of AR([1]), AR([5]), MA([1]) or MA([12]).

2.5 Goodness of Fit Model

Mean Absolute Percentage Error (MAPE) is an average of all error percentage between actual and predicted value. A model is feasible if its MAPE value lower than 10% and is quite feasible if its MAPE value lies between 10% and 20% [7]. The formulae of MAPE is expressed below

$$MAPE = \sum_{t=1}^{m} \frac{\left|Y_t - \hat{Y}_t\right| / Y_t}{m} .100\%$$

where Y_t is actual data at time t, $\hat{Y}_t$ is predicted data at time t, and m is number of predicted data.

3. METHODOLOGY

This research is an applied of statistics in economy area. The Indonesia year-on-year inflation data from 2006 until 2013 were obtained from Indonesia Bank. In order to reach the goals of the research, there are for steps that will be conducted. First, construct AR, MA, or ARIMA model of Indonesia inflation data. Second, determine the MSE and MAPE value of all model, then decide the best model based on the smallest MSE. Finally, make inflation prediction of some period ahead and determine the MAPE from prediction and actual data. The prediction results are compared with actual data and will be used to evaluate the inflation target set by the government.

4. RESULTS AND DISCUSSION

4.1 Indonesia Inflation

The inflation data used in this study is year-on-year inflation data from December 2006 until December 2013 that the dynamics of change can be seen in Figure 1 below.

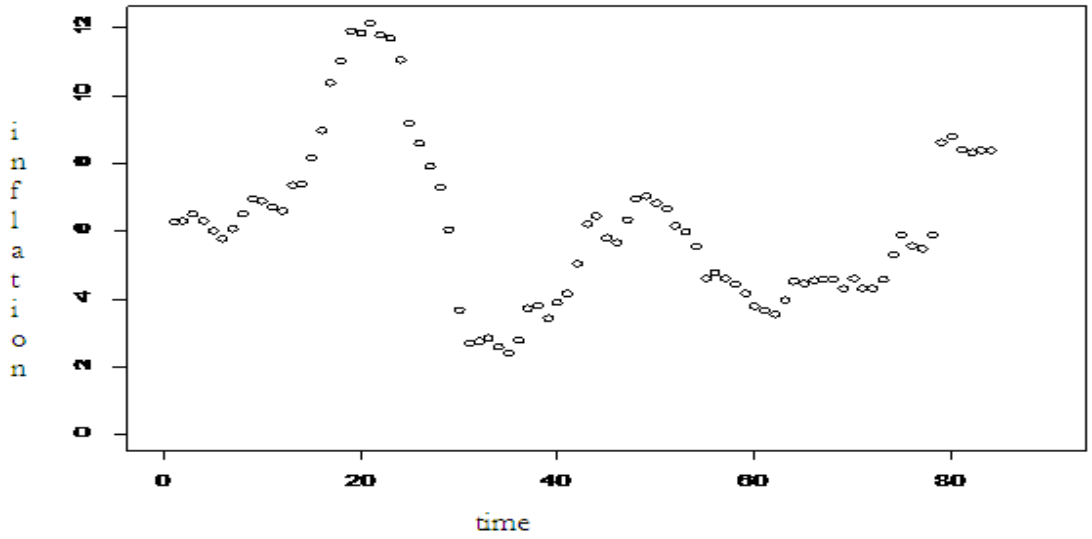

Figure 1: Indonesia Inflation Data from December 2006 until December 2013

Figure 1 is the Indonesia inflation data from December 2006 until December 2013. The figure show that the minimum inflation was 2.41 % occured in November 2009 and the maximum inflation was 12.14 % happened in September 2008. During the period, average inflation reached into 6.194%. The maximum inflation appeared on 2008 because there was monetery crisis in Indonesia. It was important to known that in the early of 2013, Indonesia government had raisen the electricity basic tariff gradually and in the middle of 2013, they also bring up the price of fuel oil. .

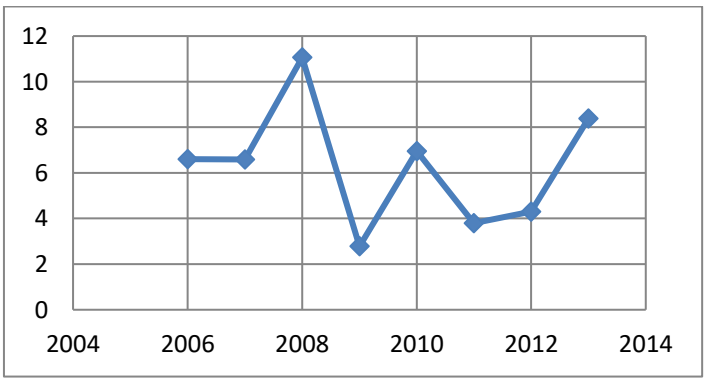

Figure 2: General Inflation

Effects from the government policies were increased the inflation rate started in February 2013. The increasing of inflation rate in February until Juny 2013 was caused by the rising of the electricity basic tariff but not greater than the inflation in July 2013. The main cause was increasing the price of fosil fuel. In order to know the impacts of both policies, we should give more attention to the inflation in all sectors.

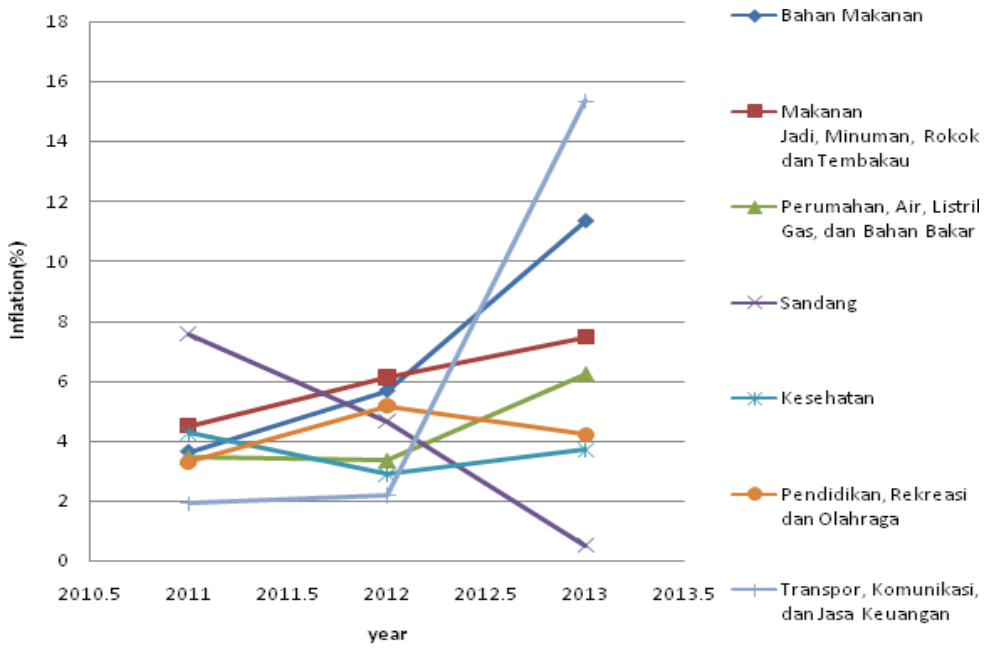

Figure 3. Comparing the inflation rate at 7 sectors

Figure 3 explain that transportation, comunication, and financial services, and groceries sectors were two of the most affected sectors due to rising electricity basic tariff and fuel oil. In contrast, clothing sector was the only sector that experienced deflation during the three years.

4.2 Box-Jenkins Model of Indonesia Inflation Data

One of the assumptions that the Box-Jenkins model can be used are the data to be stationary in the mean and variance. Figure 1 shows that the inflation data is not stationary in the variance because visually the data fluctuate in most of every observation points. From Figure 4, we knew that the rounded value (λ) equal 0.50. Therefore, in order to satisfy the stationarity assumption in the variance, it was important to transform the data by using squared root transformation.

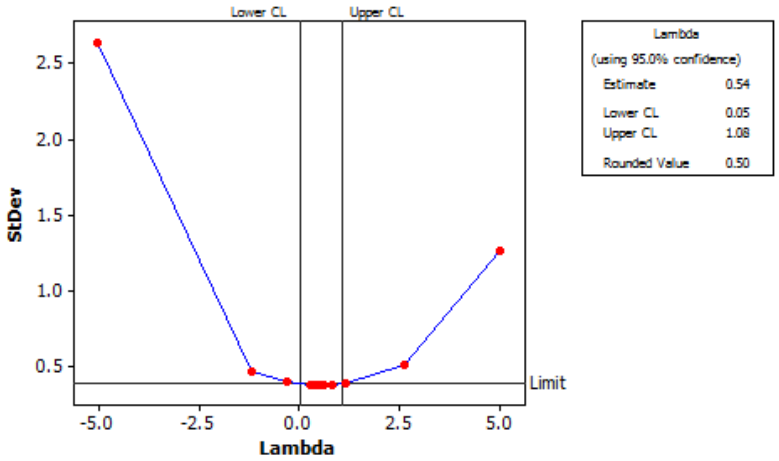

Figure 4: Box-Cox Transformation of Indonesia Inflation Data

After performing square root transformation, we need to conduct a Dickey-Fuller test to knew wether the data satisfied stationary in the mean or not. From the statistic Dickey-Fuller, we conclude that the data was not stationary in the mean. Hence, differencing was needed. Fortunately, after once differencing the assumption finally was satisfied.

Model identification was the next step in analyzing the inflation data. By investigating the autocorrelation and partial autocorrelation plot it was known that some suitable models were subset ARIMA (0,1,[1,5,12,13,17]), ARIMA (0,1,[1,5,12,13,18]), ARIMA(0,1,[1,5,12,13,18,30]), ARIMA(0,1,[1,4,12,13,18,30]), ARIMA (0,1,[1,4,5,12,13,17,18,30]), ARIMA ([1,4],1,0), and ARIMA ([1,12],1,0). Further more, after parameter significancy checking, it was known that only ARIMA ([1,4],1,0), and ARIMA ([1,12],1,0) worth considering as an appropriate model. Table 1 show that ARIMA ([1,12],1,0) was the best model for Indonesia inflation data. The performance of the model yield a MSE equal 0.2784. Based on the actual and prediction inflation in January 2014 until August 2014 results the MAPE equal 4.36%. Because the MAPE lower than 10%, the subset ARIMA model ([1,12],1,0) is feasible to used for predicting. Figure 5 explain that the inflation prediction relatively close to the actual value. Further more, the pattern of both actual and prediction value was tend to the same. Table 2 is the comparison between actual and prediction inflation value during 2014.

Table 1: Assumption test on ARIMA ([1,4],1,0) and ARIMA ([1,12],1,0) residual

Model	Assumption test on residual		
	Normality	Homoskedasticity	Lag Independency
ARIMA ([1,4],1,0)	✓	✓	x
ARIMA ([1,12],1,0)	✓	✓	✓

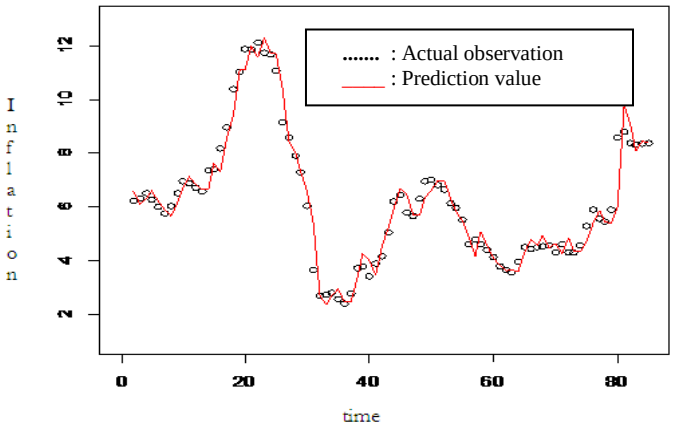

Figure 5: Actual and prediction of Indonesia Inflation Data

Table 2: Comparison between actual and prediction inflation from January until December 2014

Time	Actual Inflation	Predicted Inflation
January 2014	8.22	8.23
February 2014	7.75	7.76
March 2014	7.32	7.28
April 2014	7.25	7.31
May 2014	7.32	7.27
June 2014	6.70	7.14
July 2014	4.53	5.43
August 2014	3.99	3.74
September 2014		3.90
October 2014		4.23
November 2014		4.25
December 2014		4.28

5. CONCLUSIONS

It is important to make an inflation prediction for some period ahead in order to reduce the uncertainty of bussines and government condition. Therefore, a good model is very requiried, especially a model with high accuration in predicting. In case of Indonesia inflation data the suitable Box-Jenkins model is subset ARIMA ([1,12],1,0) which results prediction inflation in 2014 is 4.28%. Where Indonesia inflation target in 2014 which has determined by the Indonesia government is $(4.5 \pm 1)\%$.

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