Comparing the Fixed and the Time Varying Parameter Model in Forecasting the Inflation Rate of Malaysia

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Abstract:
Inflation is one of the most substantial elements in the analysis of a country's economy. It describes the general increment of the price of goods and services in a country. The interaction between inflation and economic growth are closely related. A high inflation rate would bring a negative impact on a country. Economists agreed that price stability is a prerequisite for a country's rapid growth and important for a balanced development mechanism. Great economic decision can be made with a good forecasting values associated with low forecast errors. This research aimed to identify the best model in forecasting inflation using the Consumer Price Index (CPI) data as an indicator of inflation. Three models were considered based on univariate and multivariate time series. Models based on the fixed parameter and the time-varying parameter were also considered. The best model chosen is based on out-of-sample forecasting framework starting from January 2009 until December 2012, while the model was fitted for period January 1997 to December 2008. The starting point of comparison is Naive Model acting as benchmark while the other models, Autoregressive Distributed Lag (ADL), and Time-Varying Parameter (TVP) model were carried out. The results showed that, TVP Model outperformed all the other competed models. Thus, it is the best model to forecast inflation in Malaysia.

Keywords: *Consumer price index, inflation, time-varying parameter*

1 Introduction

The rise in the cost of living due to the increase the prices of food, goods, services, housing, and education is an inflation phenomenon. Inflation is a general increment in the price level of goods and services over a time period. Consequently, the same amount of money can buy fewer goods and services today compared to yesterday, thus creating hardship to the people as the purchasing power diminishes over time. In this regard, the Consumer Price Index (CPI) is the common measure of inflation which measures the prices of a basket of goods considered as daily necessities for daily needs. CPI is defined as "measures the percentage change through time in the cost of purchasing a basket of goods and services representing the average pattern of purchases made by a particular population group in a specified time period" (Department of Statistics, 2010).

Since inflation affects the economic growth of a nation, it is vital to keep the inflation rate low and stable even though it is impossible to achieve a zero inflation rate as it is dependable on the world's economy. In the period of low inflation, people are motivated to buy durable goods as assets, such as houses or properties since the interest rates are low, which are

indirectly reduced the cost of borrowing. Therefore, this period also stimulates businesses to invest in new technologies in order to boost the productivity level so that they
can remain competitive. Inflation may also bring a negative impact because it reduces the quality of life; as people are forced to work overtime or do extra work to support their families. This situation will lead to pressure and expose people to social problems, such as corruption, fraud, and neglecting their responsibility. In addition, high inflation may give negative impact on business and companies, especially the lenders. Furthermore, people living on fixed income like the disabled and retirees would also be affected, as their purchasing power is reduced by their fixed income.

Due to its negative impact, forecasting inflation is vital and the most crucial part in the nation's economy. The inflation rate is often seen as an important indicator of the economy wellness. With accurate forecast values, the government could better have a plan in managing the uncertainty of inflation in future. Besides that, a country's economic growth can also be measured and the existing economic issues could be remedied in order to increase the standard of living of the people. Forecasting inflation is in need to Malaysia in order to serve as a guideline for the government and monetary institutions for a developed nation by the year 2020. Accurate forecast value is substantial and prominent for a better action. On the contrast, a wrong forecast value would lead to the wrong decision making.

Rumler and Valderrama (2010) mentioned that there were several studies that were carried out in forecasting inflation. Furthermore, there were numerous forecasting models that have been developed and applied in recent years. Various models were applied by researchers in forecasting inflation and comparing the performance of the forecast value; the results were based on time varying assumption which were generally better as compared to the models based on fixed parameter estimation (D'Agostino et al., 2011; Barnett et al., 2012; and Lanne and Luoto, 2013). However, in some cases, this assumption is violated. Hence, comparing the forecast performance and selecting the best model of inflation in Malaysia is the main purpose of this research.

2 Literature Review

In Malaysia, the CPI is usually used as a key indicator describing the economic wellness and inflation measurement (Yusoff, 2004). In addition, the CPI could also be used as proxy for general inflation. Previous studies that used CPI as inflation indicator were Sacerdoti and Xiao (2001), Katrin et al. (2008), and Zhang (2012). Adetiloye and Adekunle (2010) stated that the role of the exchange rate in the Nigerian economy has bounced on the routine of Nigerians similar to inflation rate. Katrin et.al (2008) assumed that inflation can be divided into a long-term and a short-term components. They concluded that in the long term which in four years or extended period, money growth is significant towards inflation. According to Horvath (2009), the interest rate is substantially controlled by the central bank and when admitting for time-varying parameter specification, the degree of interest rate falls considerably with time. On the other hand, interest rate is quite useful in predicting future inflation development. Korobilis and Koop (2012) used several predictors in the analysis comprising of three months Treasury Bill Rate (TBILL), which is the interest rate and money supply (M1). The study has shown that the interest rate and money are being particularly relevant and significant at some forecast horizon and for some measures of inflation. In addition, interest rate is a good predictor in certain period when the forecasting model evolves over times until the inflation becomes less volatile.

D'Agostino *et al*. (2011) proposed several models in their research, including Naive and Time Varying Parameter (TVP) models. The main objective of their research is to forecast and compare model performance for unemployment rate, price inflation, and interest rate by allowing for time variation parameter. Mean Square Forecast Error (MSFE) was used to evaluate forecast accuracy among all the models and Naive Model is a benchmark model. The result of their research summarised that the model based on time variation is the best model since its MSFE value is the lowest. In addition, their model produced good forecast at all horizons for all variables used. Korobilis and Koop (2012) used Mean Absolute Forecast Error (MAFE) and Mean Squared Forecast Error (MSFE) in evaluating performance of the forecast and compared with several models include TVP and random walk.

Buelens (2012) used several models, including Autoregressive (AR) model, Autoregressive Distributed Lag (ADL) model and Naive model as a benchmark. One of the objective of his research is assessing the forecasting performance of direct and indirect Euro area inflation forecasting models. Two information criterion, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) value were used in selecting the parsimonious models. In order to find the most relevant independent variables, ADL model past through the pre-fitting process which many variables including lag of dependent and independent variables were included and the insignificant variables were removed from model. The best model determined by the lowest value of AIC and SIC was retained and used for evaluation part. Therefore, Buelens (2012) concluded that for direct forecast, the Naive Model is rapidly outperformed by other models while ADL is the best model when forecasting for shorter and longer horizons with the smallest value of error compared to benchmark models. Naive model performed comparatively well at below 12 months horizons while ADL is better when forecasting in longer horizons.

Barnett *et al*. (2012) in their study used several variables, including inflation and the three-month Treasury Bill Interest Rates to compare the performance of forecast values. They assumed that the time-varying parameter model will improve the forecast accuracy. Quarterly data for all variables were used and seasonality component was removed for inflation series. Their research used Root Mean Square Error (RMSE) in evaluating the forecast performance among different models. The findings of their research proved that, models with time varying parameter exactly improved the forecast accuracy since it outperforms AR model (benchmark) and other model used.

3   Research Methods

For this study, CPI in monthly frequency was used as the inflation indicator in all estimations with year 2010 as a base year (2010=100). The three variables used to forecast inflation were interest rate, exchange rate and broad money. All data on a monthly basis starting from January 1997 until December 2012 with 192 observations were obtained from the Department of Statistics Malaysia (DOSM) and Bank Negara Malaysia. The independent variables in this study were interest rate, exchange rate, and broad money, which were found to be significant in previous research on inflation (Katrin *et al.*, 2008; Adetiloye and Adekunle, 2010); Korobilis and Koop, 2012). Basically, when interest rate, exchange rate, and broad money increase, CPI would also increase. Data were analysed by E-Views software since all variables used in this study based on time series. Prior to estimation, all variables under investigation had a unit root and became stationary after the first difference as shown in Figure 1.
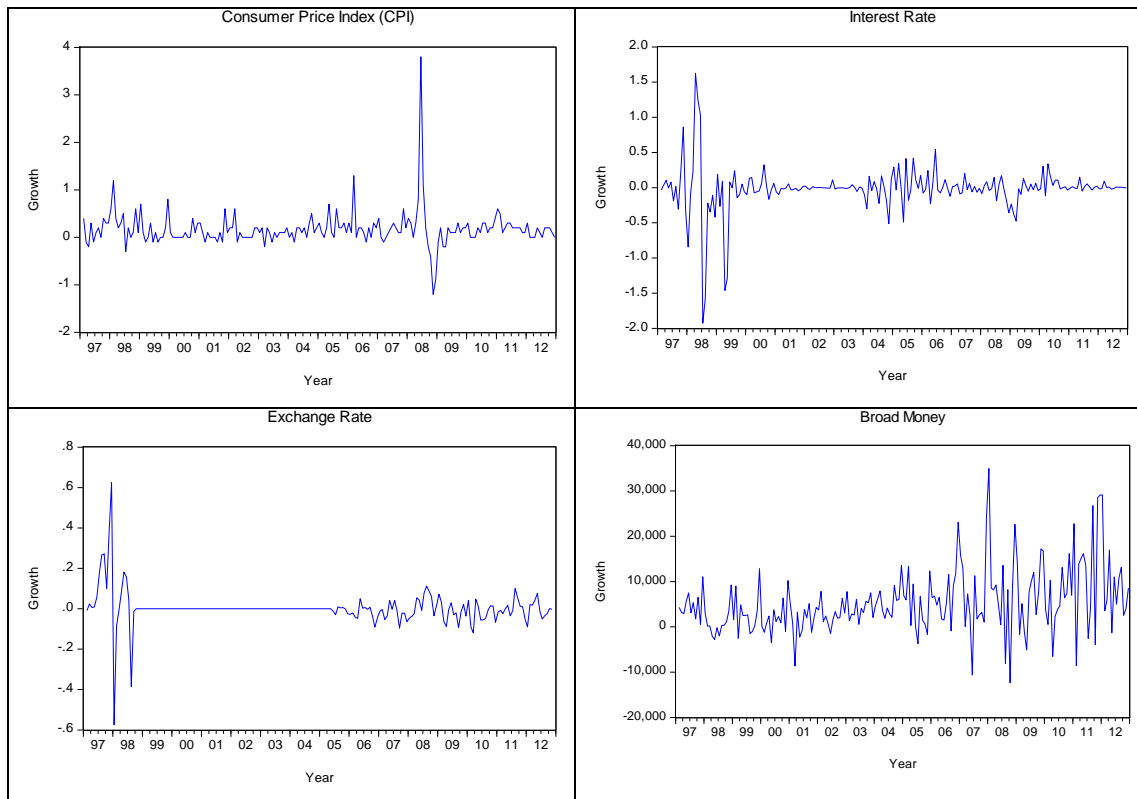
Figure 1: Plots of Data Series in the First Difference.

In order to explore the best forecasting model, the models forecast performance need to be evaluated by using several accuracy measurements. Data series were divided into two parts; known as: 1) the estimation part in fitting the model; and 2) the evaluation part in evaluating the model. In the estimation part, about 75% of the data series were used in estimating the model. The remaining 25% of the data in the evaluation part were employed in evaluating the models forecast performance.

In the estimation part, the first 144 observations were used in estimating the models and the common statistical measurement in selecting the parsimonious models which were the Akaike's Information Criterion (AIC) and the Schwarz Information Criterion (SIC) (Diebold, 2008). The Durbin-Watson (DW) statistical test which was commonly used test for serial correlation was also analysed. A model is good when the Durbin-Watson approximate is 2. In the evaluation part, the remaining 48 data points were used in the analysis. The Naive Model was used as the benchmark model and as the basis for comparing with two other models, the ADL and TVP model. Since, each model produced different forecast values even at the same horizon and data set, evaluating the models were the most crucial part in this research. In order to evaluate the models, five error measurements were used and the models with the smallest values of error measurements were chosen as the best model.

The Naive Model assumed that the current value of series at time t; are the future value, $t+1$. In the multivariate model of ADL, this model actually model of the correlation and not model of causation (Diebold, 2008). Therefore, the simplest procedure in selecting the variables included in the model was observed and correlated between the CPI and all the independent variables in this model. Data before differencing indicated that there were significant correlated between CPI with interest rate, exchange rate, and broad money. The final estimated ADL model was specified as follow:

$$dcpi = c + \phi_1 dcpi(-1) + \omega_1 dexchange\_rate(-1) + \omega_2 dbroad\_money(-1)$$
$$dcpi = 0.074061 + 0.351637 dcpi(-1) + 0.514723 dexchange\_rate +$$
$$0.00000819 dbroad\_money(-1)$$

where,

c is intercept

$dcpi$ is first difference of CPI,

$dcpi(-1)$ is first difference of lagged one of CPI

$dexchange\_rate(-1)$ is the first difference of lagged one of exchange rate

$dbroad\_money(-1)$ is the first difference of lagged one of broad money

4 Results and Discussion

All variables in equation above show the expected signs which are positive sign for lagged one of CPI growth, exchange rate growth, and broad money growth. These indicate that when all of these variables increase, the CPI will also increase. Prasertnukul et.al (2010) in their research clearly proved that the CPI is significantly influenced by their own lagged. The model was significant at 1% level of confidence and all coefficients generally significance to the model. Durbin Watson test were 1.9636 means that the errors were independent or no serial correlation. This model passed the homoscedasticity assumption, which means that this model has constant variance since p-value is greater than 5% level of significance. The results from this model lead to TVP model development.

In most modelling work, the common assumption taken refers to the constancy of the parameters in the model. In other words, models assume that the parameters estimated are constant, in the past as well as in the future. However, as we have seen in many instances such assumption may not be true in all occasion as a result of changes in the economic environments, hence affecting the parameter stability. Thus, TVP model were used to address this issue. TVP model was estimated using state space methods with Kalman filter consisted of two equations called observation equation and transition or state equation. Final estimated ADL model was implemented in the observation equation to identify the relationship between observed and unobserved variables. Besides, the transition or state equation captured the dynamics of the unobserved variables in the model that allowed parameters of the model changed throughout the fitting process.

Table 1: Error Measures for Evaluation Period (January 2009 – December 2012)

Model	MSE	RMSE	MAE	MAPE	Theil Coefficient
Naive	0.0402	0.2005	0.0188	73.3333	0.4284
ADL	0.0215	0.1467	0.1121	47.8417	0.3376
TVP	0.0203	0.1425	0.1088	46.6209	0.3338

Referring to Table 1, it is clearly shown that ADL model outperforms the benchmark model for all error measures which were MSE, RMSE, MAE, MAPE, and Theil coefficient since the values of all error measures for ADL were lower than Naive model. TVP model forecast better than ADL model since all the error measures for TVP were smaller compared to error measures of ADL model. The finding therefore, were consistent with the result obtained by D'Agostino et.al (2011), Barnett et.al (2012), and Lanne and Luoto (2013) who concluded that TVP model are superior in corresponding to constant parameter model, ADL. Figure 2 shows the estimation part of CPI growth using Naive model, ADL model, and TVP model.
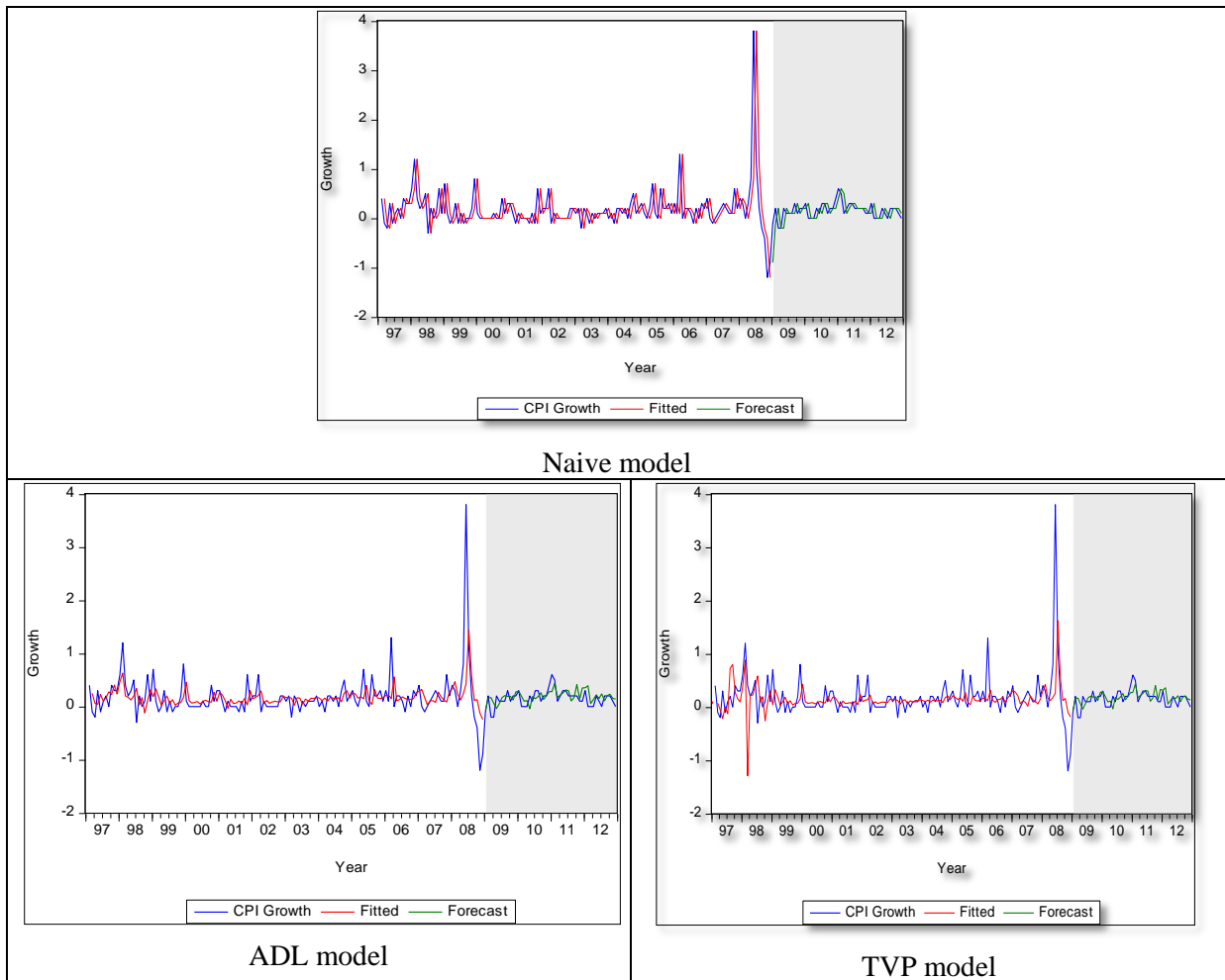

Naive model

ADL model

TVP model

Figure 2: Estimation and Evaluation Plot of CPI Growth using Several Model

5   Conclusion and Recommendation

In recent years, significant numbers of papers have been published pertaining to the assumption that the parameters estimated might be unstable because of the changes in economic environment or due to some sudden events that can impact the estimated model. These lead to the decision-making in considering TVP model in forecasting the Malaysia inflation rate. From the result obtained, this research concluded that TVP model successfully indicated improvement over fixed parameter model. TVP model is the best among all other competing models in forecasting Malaysia inflation rate with the values of error were the smallest. Valuable directions for future research highlighted to improve the findings of this research by using Artificial Neural Network (ANN) since it is powerful to capture parameter

changes or structural break. At the same time, it can remedy the effect of outliers in the observations, shocks and nonlinearity form that is induced by policy changes or large shocks.

In conjunction of this study, inflation and economic growth are associated means inflation and Small Medium Enterprise (SME) also related because inflation and SME was proved to be influenced each other since SME operate in all industries and economic sectors of country (Harvie and Lee, 2002). According to Malaysia statistics, more than 90% of all businesses comprised of manufacturing, services, and agriculture sectors with around 65% total employment provided by SME. Therefore, there is no doubt that SME have high impact towards economy and to evolve Malaysia becoming a high-income nation. In time of inflation rate was high, it affected the real economy and weakened the stock and property, financial sectors as well as SME because they were largely reliant upon the domestic market. When economy sturdy enough, this will encourage SME to further their growth and give excellent opportunities towards employment, produce productive entrepreneur and open up greater chances for technology transfer. Here, it has been proved that the accurate forecast values of inflation are very important because with that forecast figures, government, SME and party involved can create and produce better plan for future.

6   Bibliography

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