Comparison of ARIMA and Singular Spectrum Analysis in Forecasting the Philippine Inflation Rate

By

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Presented by

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Rationale

- Forecasting inflation rate is important (Doloriel, Salvaleon, Ronquillo, and Estal, (2014) for the following reasons: (a) it guides economic policy makers in their policy-decision making; (b) it gives baseline reference for owners and business administrators in their financial projections; and (c) workers impute inflation forecasts help determine wages that they ask from their employers.
- Methods for modeling and forecasting time series such as ARIMA models suffer from parametric restrictions (stationarity and normality). Although the transformation of a non-stationary series by differencing or detrending is possible, a large amount of information is lost by such data transformation. SSA does not depend on any parametric model for the trend or oscillations and does not make any assumptions about the signal or the noise component of the data (Hassani, Soofi, & Zhigljavsky, 2013).

Objectives

This study primarily aims to forecast the Philippine inflation rate by comparing two different forecasting methods. Specifically, this study sought to:

1. Describe the characteristics of the monthly inflation rate in the Philippines.
2. Compare the forecast accuracy of the Box-Jenkins model and Singular Spectrum Analysis.
3. Provide monthly forecasts of inflation rate for the years 2019 to 2020 using the most accurate method obtained from the second objective.

Methods | Data and Analyses

- The data utilized in this study is the monthly inflation rate based on the 2012 CPI. The data consist of 72 observations ranging from January 2013 to December 2018.
- The data was divided into two sets, the in-sample data set consisting 58 observations. This data set was used for model development in the Box-Jenkins Approach. The same set of observations was used in the decomposition and reconstruction stages of Singular Spectrum Analysis. The remaining 14 observations served as out-of-sample data set and was utilized for forecast evaluation.
- To compare which among two methods is better, the root mean squared error (RMSE) will be computed for both methods.

Methods | Box-Jenkins Approach

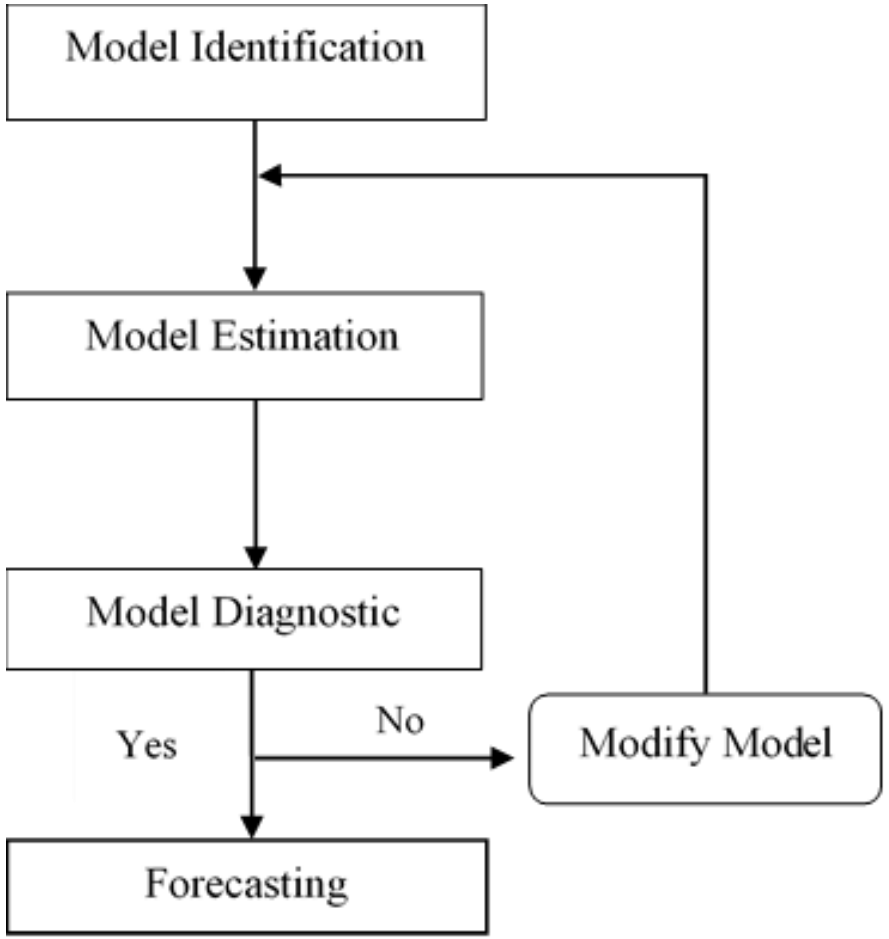

Figure 1. Procedure for Box-Jenkins Approach

Methods | Singular Spectrum Analysis

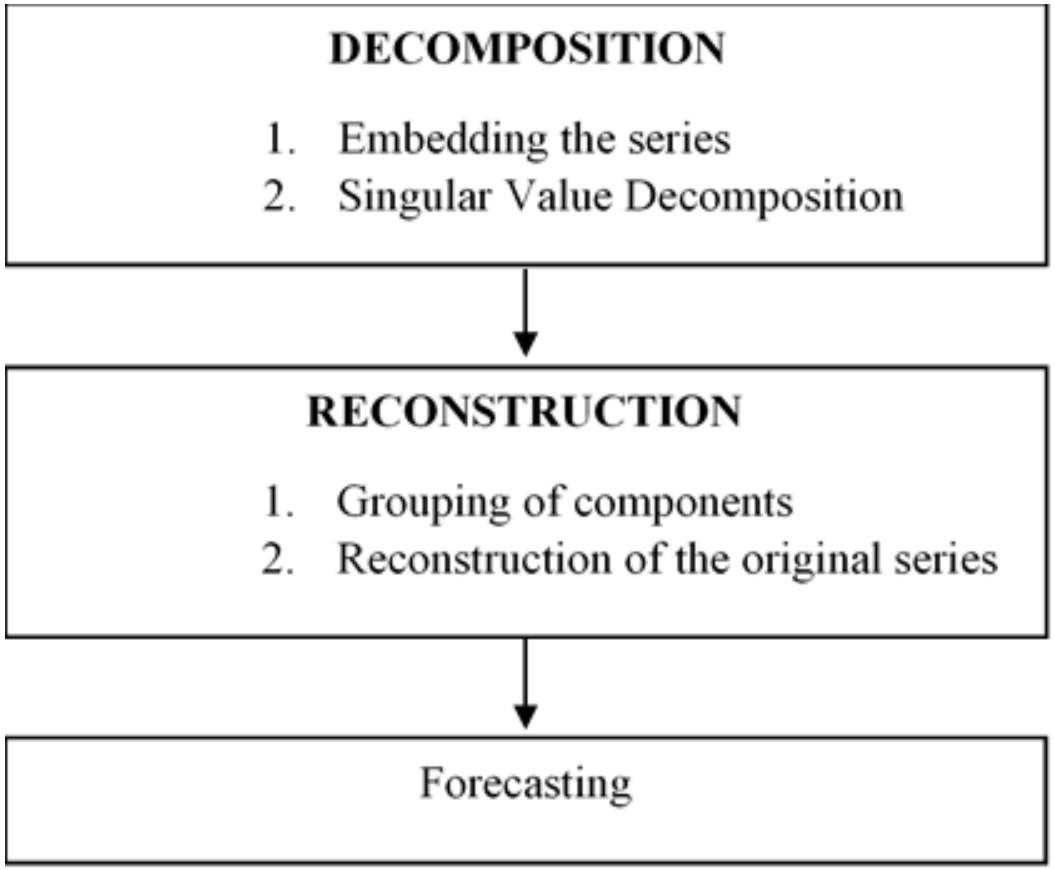

Figure 2. Procedure for Singular Spectrum Analysis

Results | Box-Jenkins Approach

Table 1. Parameter Estimates of the Chosen Model

Model Term	Estimate	Standard error	z-value	p-value
AR(1)	0.339	0.124	2.735	0.006
SMA(1)	-0.999	0.509	-1.961	0.049

ARIMA(1,1,0)×$(0,0,1)_{12}$ has the least AIC value among the tentative models. Its residuals behave like a white noise process while its forecast errors behave like a Gaussian white noise process. This model is used to forecast 14 observations to be compared with the out-of-sample data set.

Results | Singular Spectrum Analysis

- The optimal value of window length L is 25 and eigentriple r is 10. These parameters have the least out-of-sample RMSE.
- The window length $L = 25$ and eigentriple $r = 10$ resulted to a 25×34 Hankel matrix. This matrix was decomposed via Singular Value Decomposition (SVD).
- The scree plot of singular values and the w-correlation plot was examined to group components (see Figure 3)

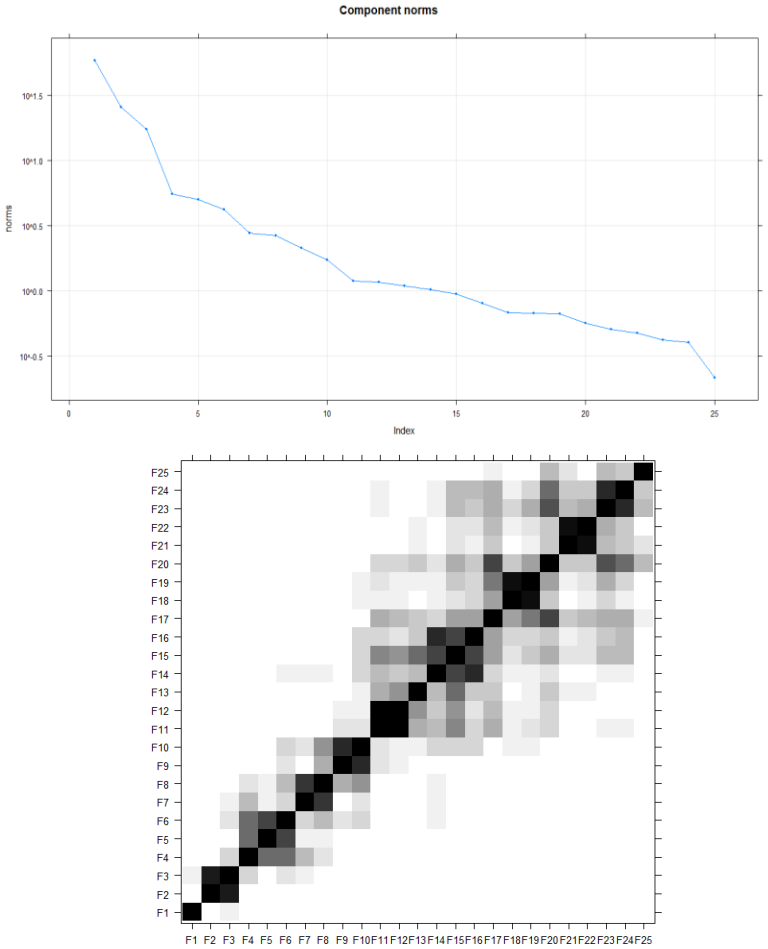

Figure 3. Scree Plot of Singular values and W-correlation Plot

Results | Singular Spectrum Analysis

- The first eigentriple (F1) is considered as the first group. The second (F2) and third (F3) eigentriples are highly correlated and are considered as the second group. The fourth (F4) until the tenth (F10) eigentriples are correlated and is considered as the last group. The eigentriples (from 11 to 25) can be associated to the inherent noise of the series.
- Recurrent forecasting was utilized to predict 14 observations to be compared with the out-of-sample data set.

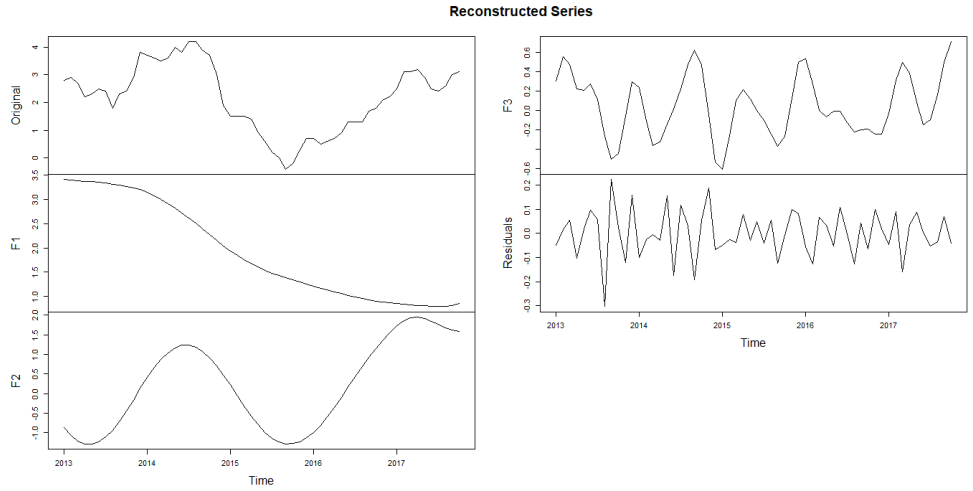

Figure 4. Plots of the Reconstructed Series

Results | Comparison of the Two Methods

Table 2. RMSE of ARIMA and SSA

Model	RMSE (In-sample)	RMSE (Out-of-sample)
ARIMA$(1,1,0)\times(0,0,1)_{12}$	0.22631	2.61352
SSA (L=25, r =10)	0.09736	1.01322

The two methods were compared based on their in-sample RMSE and out-of-sample RMSE. For both the in-sample and out-of-sample forecasts, the method with the smallest overall RMSE is Singular Spectrum Analysis. Hence, SSA outperformed ARIMA in terms of forecasting performance.

Results | Comparison of the Two Methods

Table 3. Out-of-sample Forecast

Actual Value	ARIMA Forecast	SSA Forecast
3	2.82	3.53
2.9	2.79	3.87
3.4	2.73	3.99
3.8	2.39	3.83
4.3	2.39	3.63
4.5	2.34	3.65
4.6	2.55	3.93
5.2	2.80	4.25
5.7	2.97	4.49
6.4	3.00	4.72
6.7	2.62	5.08
6.7	2.42	5.61
6	2.35	6.15
5.1	2.33	6.58

November 2017 – December 2018

Results

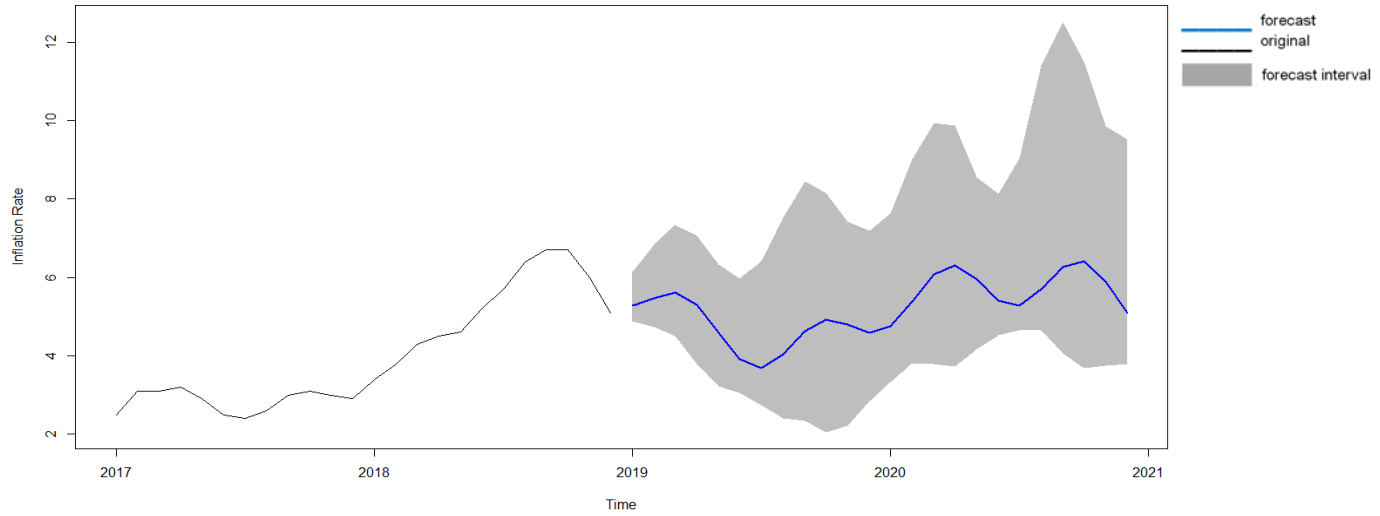

Figure 13. Plot of Original and Forecasted Values

The forecasted values as shown in Table 3 exhibits fluctuating characteristics. This is an indication that the monthly inflation rate will continue to fluctuate in the future. Most of the forecasted values are outside the government's target of 2% to 4% inflation. However, upon considering the confidence interval, there is still a possibility that future values will be within the target. That is, the lower limits meet the government target.

Conclusion and Recommendations

- The comparison of ARIMA and SSA in this study showed that SSA is superior in terms of forecasting performance. Hence, between these methods, SSA is more appropriate forecasting method for Philippine inflation rate.
- Policy makers and economic managers can use the results of this study as basis for economic policies and fiscal programs that try to control inflation within normal levels.
- Business owners and administrators can use the forecasted inflation rate as baseline reference for financial projections. This will help in their strategic plans and business operation.

Thank you for listening

Actual, SSA and ARIMA Forecast for 2019

Month	Actual	SSA Forecast	95% Low Conf.	95% High Conf.	ARIMA Forecast	95% Low Conf.	95% High Conf.
Jan	4.4	5.27	4.69	6.19	4.31	3.83	4.80
Feb	3.8	5.48	4.32	7.1	3.56	2.74	4.38
Mar	3.3	5.61	4.16	7.51	3.1	2.02	4.18
Apr	3.0	5.31	3.58	7.08	2.87	1.57	4.17
May	3.2	4.6	3.02	6.53	2.97	1.47	4.46
Jun	2.7	3.91	2.34	5.69	2.67	1	4.33
Jul	2.4	3.68	1.57	6.44	2.38	0.6	4.20
Aug	1.7	4.05	1.08	7.89	1.81	-0.2	3.77