Predicting inflation in Sri Lanka using ARMA models

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25 February 2019

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ABSTRACT

This research uses annual time series data on inflation rates in Sri Lanka from 1960 to 2017, to model and forecast inflation using ARMA models. Diagnostic tests indicate that S is I(0). The study presents the ARMA model (1, 0, 0) [or simply AR (1) process] for forecasting inflation rates in Sri Lanka. The diagnostic tests further imply that the presented optimal ARMA (1, 0, 0) model is not only stable but also suitable. The results of the study apparently show that S will be approximately 8.17% by 2020. Policy makers and the business community in Sri Lanka are expected to take advantage of the anticipated stable inflation rates over the next decade.

Key Words: Forecasting, Inflation, Sri Lanka

JEL Codes: C53, E31, E37, E47

INTRODUCTION

Inflation is the sustained increase in the general level of prices and services over time (Blanchard, 2000). The negative effects of inflation are widely recognized (Fenira, 2014). An increase in the general price level causes a reduction in the purchasing power of money. Inflation reflects a reduction in the purchasing power per unit of money – a loss o real value in the medium of exchange and unit of account within the economy (Walgenbach *et al*, 1973). Inflation exerts a constraining effect on the key drivers of growth. The price increase reduces consumption and therefore production and employment. It exerts an inhibitory effect on investment, due to the rise of the nominal wages and the prices of raw materials, both in local and foreign currency. Inflation also contributes to the deterioration of the trade balance when the prices of domestic goods and services rise more than those of foreign competitors. To this are added its negative effects on social activity because of the deterioration of the purchasing power (Fenira, 2014).

Therefore, inflation is considered to be a major economic problem in transition economies and thus fighting inflation and maintaining stable prices is the main objective of monetary authorities (Jesmy, 2010).

Inflation plays a key role in macroeconomic analysis (Jesmy, 2010). It is now generally accepted that keeping low and stable rates of inflation is the primary objective of central banks (Hector & Valle, 2002). Forecast of central macro variables, inflation in particular plays an important part in policy framing and policy guidance (Jesmy, 2010). Inflation forecasts and projections are also often at the heart of economic policy decision-making, as is the case for monetary policy, which in most industrialized economies is mandated to maintain price stability over the medium term (Buelens, 2012). Economic agents, private and public alike; monitor closely the evolution of prices in the economy, in order to make decisions that allow them to optimize the use of their resources (Hector & Valle, 2002). Decision-makers hence need to have a view of the likely future path of inflation when taking measures that are necessary to reach their objective (Buelens, 2012). If the central bank had a powerful inflation-forecasting model, it could be able to take pre-emptive actions that reproduce the economic dynamics (Jesmy, 2010). The fundamental aim of monetary policy, both in Sri Lanka and elsewhere, continues to be the maintenance of a low and stable rate of inflation. This study seeks to model and forecast annual rates of inflation in Sri Lanka based on ARMA models.

LITERATURE REVIEW

Popoola *et al* (2017) modeled and forecasted inflation rate in Nigeria using Box-Jenkins ARIMA models with a data set ranging over the period January 2006 to December 2015 and showed that the ARIMA (0, 1, 1) model was the best model for forecasting inflation rate in Nigeria. Nyoni (2018) analyzed inflation in Zimbabwe using GARCH models with a data set ranging over the period July 2009 to July 2018 and showed that there is evidence of volatility persistence for Zimbabwe's monthly inflation data. Nyoni (2018) modeled and forecasted inflation in Kenya using ARIMA and GARCH models and employed annual time series data over the period 1960 – 2017 and showed that the ARIMA (2, 2, 1) model, the ARIMA (1, 2, 0) model and the AR (1) – GARCH (1, 1) model are good models that can be used to forecast inflation in Kenya. Nyoni & Nathaniel (2019), based on ARMA, ARIMA and GARCH models; investigated inflation in Nigeria using time series data on inflation rates from 1960 to 2016 and concluded that the ARMA (1, 0, 2) model is the best model for forecasting inflation rates in Nigeria. In the case of Sri Lanka, Jesmy (2010); analyzed inflation using ARIMA models with a data set covering the period January 1953 – December (2009) and revealed that the ARIMA (1, 1, 2) model is the best model in forecasting inflation in Sri Lanka. Recently, once again in Sri Lanka, Haalisha & Jahufer (2018) modeled and forecasted inflation rates using SARIMA models and employed a data set ranging over the period January 1988 – July 2017 and established that the ARIMA $(1, 1, 0)(0, 0, 1)_{12}$ is the optimal model for forecasting inflation in Sri Lanka.

MATERIALS & METHODS

ARMA Models

For the purpose of forecasting rates of inflation in SriLanka, ARMA models were specified and estimated. A general ARMA (p, q) model is specified as follows:

$$S_t = \alpha_1 S_{t-1} + \alpha_2 S_{t-2} + \cdots + \alpha_p S_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \cdots + \beta_q \varepsilon_{t-q} \ldots \ldots \ldots \ldots \ldots .. [1]$$

Where:

S_t rates of inflation in SriLanka at time t;

ε_t is the error term at time t;

$\varepsilon_{t-1} \ldots \ldots \ldots \ldots . \varepsilon_{t-q}$ are past errors;

$S_{t-1} \ldots \ldots \ldots \ldots . S_{t-p}$ are past rates of inflation in SriLanka;

$\alpha_1 \ldots \ldots \ldots \ldots . \alpha_p$ and $\beta_1 \ldots \ldots \ldots \ldots . \beta_q$ are estimation parameters.

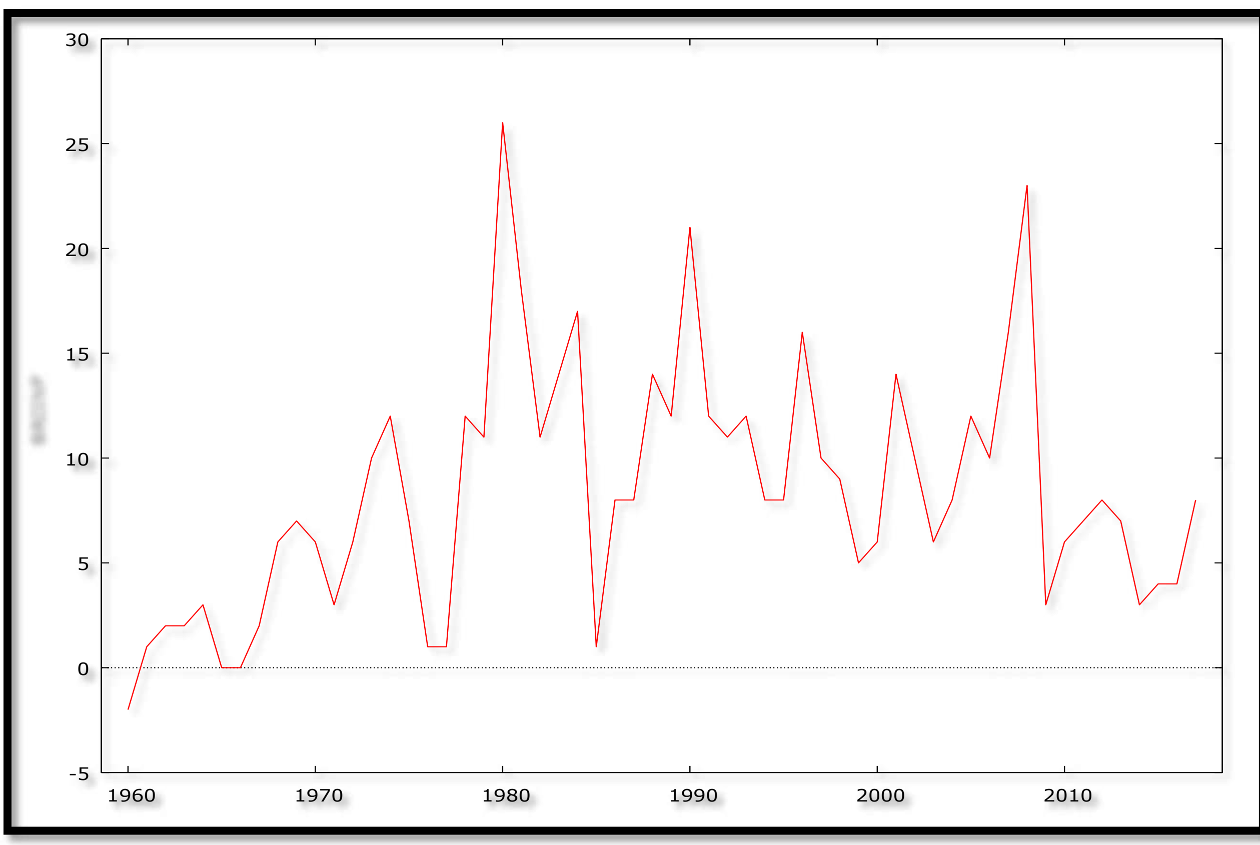
Data Collection

This study is based on a data set of annual rates of inflation in SriLanka (SRIINF or simply S) ranging over the period 1960 – 2017. All the data was gathered from the World Bank.

Diagnostic Tests & Model Evaluation

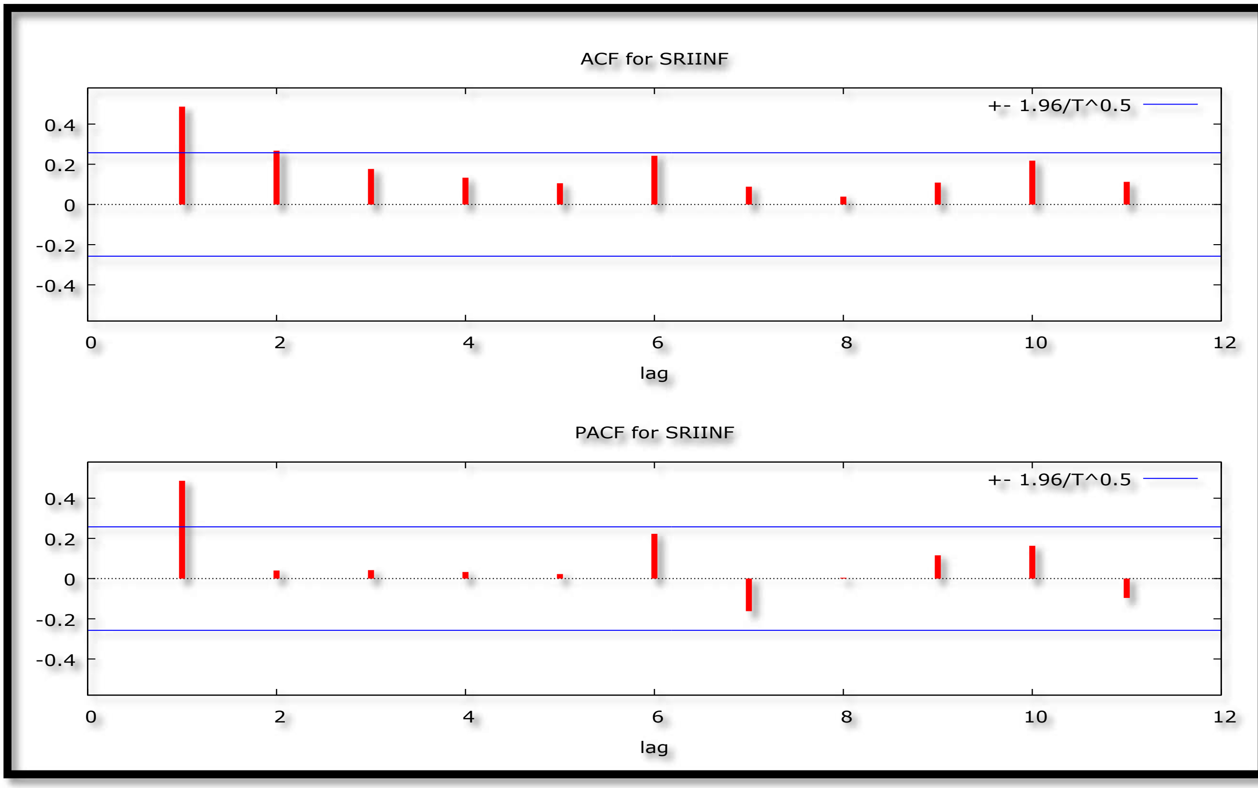
Stationarity Tests: Graphical Analysis

Figure 1



The Correlogram in Levels

Figure 2



The ADF Test

Table 1: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
S	-4.525613	0.0005	-3.550396	@1%	Stationary
			-2.913549	@5%	Stationary
			-2.594521	@10%	Stationary

Table 2: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
S	-4.550868	0.0030	-4.127338	@1%	Stationary
			-3.490662	@5%	Stationary
			-3.173943	@10%	Stationary

Table 3: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
S	-2.131550	0.0328	-2.606163	@1%	Non-stationary
			-1.946654	@5%	Stationary
			-1.613122	@10%	Stationary

Figures 1 and 2 and tables 1 – 3 show that S is an I (0) variable.

Evaluation of ARMA models (with a constant)

Table 4

Model	AIC	ME	MAE	RMSE
ARMA (1, 0, 1)	360.3411	0.11344	3.6189	5.0778
ARMA (2, 0, 2)	363.2629	0.30407	3.5489	5.0263
ARMA (1, 0, 0)	**358.5444**	0.088978	3.6161	5.0867
ARMA (0, 0, 1)	362.4442	0.032289	3.9272	5.2446
ARMA (0, 0, 2)	361.9388	0.051347	3.741	5.1413
ARMA (1, 0, 2)	361.406	0.30679	3.5491	5.0312
ARMA (2, 0, 1)	361.3744	0.29287	3.5571	5.0318

A model with a lower AIC value is better than the one with a higher AIC value (Nyoni, 2018). The study will consider the AIC in order to choose the best model for modeling and forecasting inflation rates in Sri Lanka. Thus, the ARMA (1, 0, 0) model is selected.

Residual & Stability Tests

ADF Tests of the Residuals of the ARMA (1, 0, 0) Model

Table 5: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.659892	0.0000	-3.552666	@1%	Stationary
			-2.914517	@5%	Stationary
			-2.595033	@10%	Stationary

Table 6: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.652772	0.0000	-4.130526	@1%	Stationary
			-3.492149	@5%	Stationary
			-3.174802	@10%	Stationary

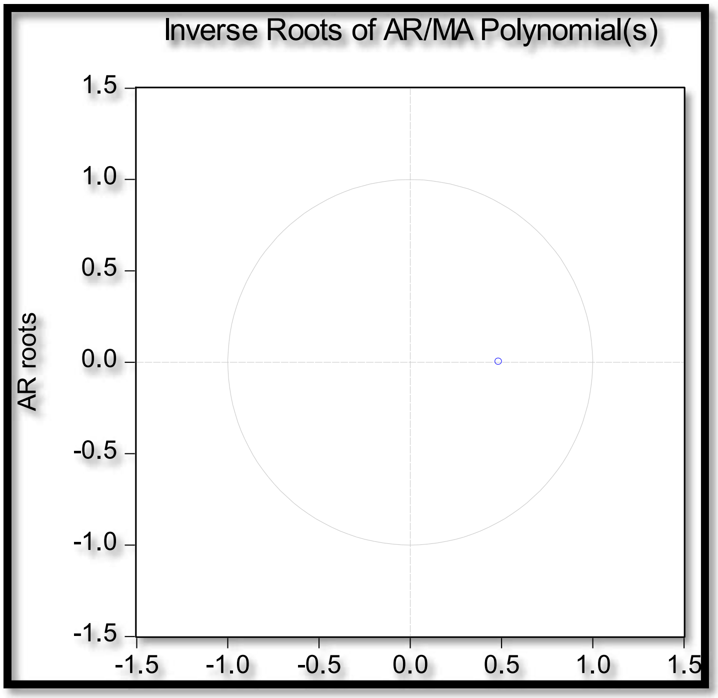
Table 7: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.730684	0.0000	-2.606911	@1%	Stationary
			-1.946764	@5%	Stationary
			-1.613062	@10%	Stationary

Tables 5, 6 and 7 reveal that the residuals of the ARMA (1, 0, 0) model are stationary.

Stability Test of the ARMA (1, 0, 0) Model

Figure 3



Since the corresponding inverse roots of the characteristic polynomial lie in the unit circle, it illustrates that the chosen ARMA (1, 0, 0) model is indeed stable and is thus suitable for modeling and forecasting inflation rates in Sri Lanka.

FINDINGS

Descriptive Statistics

Table 8

Description	Statistic
Mean	8.3793
Median	8
Minimum	-2
Maximum	26
Standard deviation	5.8754
Skewness	0.72507
Excess kurtosis	0.52369

As shown above, the mean is positive, i.e. 8.3793%. The minimum is -2% and the maximum is 26%. The skewness is 0.72507 and the most striking characteristic is that it is positive, indicating that the inflation series is positively skewed and non-symmetric. Excess kurtosis is 0.52369; showing that the inflation series is not normally distributed.

Results Presentation[1]

Table 9

ARMA (1, 0, 0) Model:				
$S_t = 8.19567 + 0.506169S_{t-1} \dots \dots \dots [2]$ P: (0.0000) (0.0000) S. E: (1.30666) (0.113652)				
Variable	Coefficient	Standard Error	z	p-value
Constant	8.19567	1.30666	6.272	0.0000***
AR (1)	0.506169	0.113652	4.454	0.0000***

Predicted Annual Inflation

Table 10

Year	Actual	Prediction	Std. Error	95% Confidence Interval
2010	6.00	5.57		
2011	7.00	7.08		
2012	8.00	7.59		
2013	7.00	8.10		
2014	3.00	7.59		
2015	4.00	5.57		
2016	4.00	6.07		
2017	8.00	6.07		
2018		8.10	5.041	-1.78 - 17.98
2019		8.15	5.650	-2.93 - 19.22
2020		8.17	5.796	-3.19 - 19.53
2021		8.18	5.833	-3.25 - 19.62
2022		8.19	5.842	-3.26 - 19.64
2023		8.19	5.845	-3.26 - 19.65
2024		8.19	5.845	-3.26 - 19.65

[1] *The *, ** and *** means significant at 10%, 5% and 1% levels of significance; respectively.*

2025	8.19	5.846	-3.26 -	19.65
2026	8.20	5.846	-3.26 -	19.65
2027	8.20	5.846	-3.26 -	19.65

Table 10, with a forecast range of 10 years clearly shows that inflation rates in Sri Lanka may not exceed 9% within the next 10 years, ceteris paribus. With a 95% confidence interval of -3.19% to 19.53% and a predicted annual inflation rate of 8.17% by 2020, the chosen ARMA (1, 0, 0) model indicates that there will be price stability in Sri Lanka in 2020.

CONCLUSION

Accurate forecasting is useful for effective policy planning (Jesmy, 2010). The main aim of this study was to select the optimal ARMA model for modeling and forecasting inflation in Sri Lanka and the optimal model was selected based model identification statistics shown in table 4 above. As already shown, the optimal model is the ARMA (1, 0, 0) model and this model is expected to serve as an early warning signal to Sri Lankan policy makers, business leaders, investors and employers to cautiously prepare themselves and to make the right move to estimate the strength of the anticipated new economic scenario and to make prudent decisions feasible in their business activities.

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