Understanding Inflation Dynamics in the kingdom of Eswantini: A Univariate Approach

Hapanyengwi, Hamadziripi Oscar and Mutongi, Chipo and Nyoni, Thabani

Zimbabwe Open University, Harare City Council, University Of Zimbabwe

18 June 2019

Understanding Inflation Dynamics in the Kingdom of Eswatini: A Univariate Approach

Nyoni, Thabani
Department of Economics
University of Zimbabwe
Harare, Zimbabwe
Email: nyonithabani35@gmail.com

Hamadziripi Oscar Hapanyengwi
MBA (ZOU), BAcc (UZ), Full CIS, currently studying with ACCA, PhD Candidate (UNISA)
(oscarhapa@gmail.com, +263772592442)
Zimbabwe Open University

Dr. Chipo Mutongi
PhD, MSc, MBA, BA, HND-LIS, Dip-Edu, Dip-LIS, Dip-P Magnt, Dip- Salaries Admn.
Zimbabwe Open University, Midlands State University
Contact Details
mutongic@gmail.com, (+263712529824,+263772422812)

ABSTRACT

This research uses annual time series data on inflation rates in the Kingdom of Eswatini from 1966 to 2017, to model and forecast inflation using the Box – Jenkins ARIMA technique. Diagnostic tests indicate that the H series is I (1). The study presents the ARIMA (0, 1, 1) model for predicting inflation in the Kingdom of Eswatini. The diagnostic tests further imply that the presented optimal model is actually stable and acceptable for predicting inflation in the Kingdom of Eswatini. The results of the study apparently show that inflation in the Kingdom of Eswatini is likely to continue on an upwards trajectory in the next decade. The study basically encourages policy makers to make use of tight monetary and fiscal policy measures in order to control inflation in the Kingdom of Eswatini.

Key Words: Eswatini, Forecasting, Inflation

JEL Codes: C53, E31, E37, E47

INTRODUCTION

Inflation is the sustained increase in the general level of prices and services over time (Blanchard, 2000). Inflation is an increase in domestic prices of the commodities relatively more than increase in the prices of commodities globally (Ayub *et al*, 2014). Inflation is the rate at which the general level of prices for goods and services is rising and, consequently, the purchasing power of currency is falling (Ramlani & Suhaimi, 2017). Inflation is a situation where prices persistently increase with money losing its value (Islam *et al*, 2017). As we can see, there are many definitions on inflation as there are academicians with most concluding the inflation erodes the purchasing value of money (Khumalo *et al*, 2017). The negative effects of inflation are widely recognized (Fenira, 2014). Inflation is one of the central terms in macroeconomics (Enke & Mehdiyev, 2014) as it harms the stability of the acquisition power of the national currency, affects economic growth because investment projects become riskier, distorts consuming and saving decisions, causes unequal income distribution and also results in difficulties in financial intervention (Hurtado *et al*, 2013). Inflation trends for Swaziland (now Kingdom of Eswatini) show that between 1980 – 2013 inflation rates averaged at 10% with the highest inflation rates experienced in 1983 and 1987 reaching 20.5% and 20.3% respectively. The major shocks of inflation in Swaziland originate from the behavior of world food and oil prices. Being a net importer of commodities, the country's inflation trends continue to show volatility (Mkhatshwa *et al*, 2015) and this is also confirmed in figure 1 below.

As the prediction of accurate inflation rates is a key component for setting the country's monetary policy, it is especially important for central banks to obtain precise values (Mcnelis & Mcadam, 2004). To prevent the aforementioned undesirable outcomes of price instability, central banks require proper understanding of the future path of inflation to anchor expectations and ensure policy credibility; the key aspects of an effective monetary policy transmission mechanism (King, 2005). 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). To avoid adjusting policy and models by not using an inflation rate prediction can result in imprecise investment and saving decisions, potentially leading to economic instability (Enke & Mehdiyev, 2014). In this study, we seek to model and forecast inflation in the Kingdom of Eswatini using ARIMA models. The most important part of this study is that it is the first of its kind in the case of the Kingdom of Eswatini and is envisaged to assist policy makers in executing prudent macroeconomic policies in the Kingdom of Eswatini.

LITERATURE REVIEW

Nyoni (2018) examined inflation in Zimbabwe using GARCH models with a data set ranging over the period July 2009 to July 2018 and established that there is evidence of volatility persistence for Zimbabwe's monthly inflation data. Nyoni (2018), in another African study; examined inflation in Kenya using ARIMA and GARCH models and relied on annual time series data over the period 1960 – 2017 and found out 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. Sarangi *et al* (2018) investigated the consumer price index using Neural Network models with 159 data points and revealed that ANNs are better methods of forecasting CPI in India. Nyoni & Nathaniel (2019), based on ARMA, ARIMA and GARCH models; studied inflation in Nigeria using time series data on inflation rates from 1960 to 2016 and found out that the ARMA (1, 0, 2) model is the best model for forecasting inflation rates in Nigeria. It is quite clear from the reviewed literature that no similar study has been done in the Kingdom of Eswatini although the aspects of inflation in the Kingdom of Eswatini have been covered by a few authors such as Khumalo *et al* (2017) and Salami (2018).

LITERATURE REVIEW

MATERIALS & METHODS

Box – Jenkins ARIMA Models

One of the methods that are commonly used for forecasting time series data is the Autoregressive Integrated Moving Average (ARIMA) (Box & Jenkins, 1976; Brocwell & Davis, 2002; Chatfield, 2004; Wei, 2006; Cryer & Chan, 2008). For the purpose of forecasting inflation rate in the Kingdom of Eswatini, ARIMA models were specified and estimated. If the sequence $\Delta^d H_t$ satisfies an ARMA (p, q) process; then the sequence of H_t also satisfies the ARIMA (p, d, q) process such that:

$$\Delta^d H_t = \sum_{i=1}^{p} \beta_i \Delta^d H_{t-i} + \sum_{i=1}^{q} \alpha_i \mu_{t-i} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

which we can also re – write as:

$$\Delta^d H_t = \sum_{i=1}^{p} \beta_i \Delta^d L^i H_t + \sum_{i=1}^{q} \alpha_i L^i \mu_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where Δ is the difference operator, vector $\beta \in \mathbb{R}^p$ and $\alpha \in \mathbb{R}^q$.

The Box – Jenkins Methodology

The first step towards model selection is to difference the series in order to achieve stationarity. Once this process is over, the researcher will then examine the correlogram in order to decide on the appropriate orders of the AR and MA components. It is important to highlight the fact that this procedure (of choosing the AR and MA components) is biased towards the use of personal judgement because there are no clear – cut rules on how to decide on the appropriate AR and MA components. Therefore, experience plays a pivotal role in this regard. The next step is the estimation of the tentative model, after which diagnostic testing shall follow. Diagnostic checking is usually done by generating the set of residuals and testing whether they satisfy the characteristics of a white noise process. If not, there would be need for model re – specification and repetition of the same process; this time from the second stage. The process may go on and on until an appropriate model is identified (Nyoni, 2018).

Data Collection

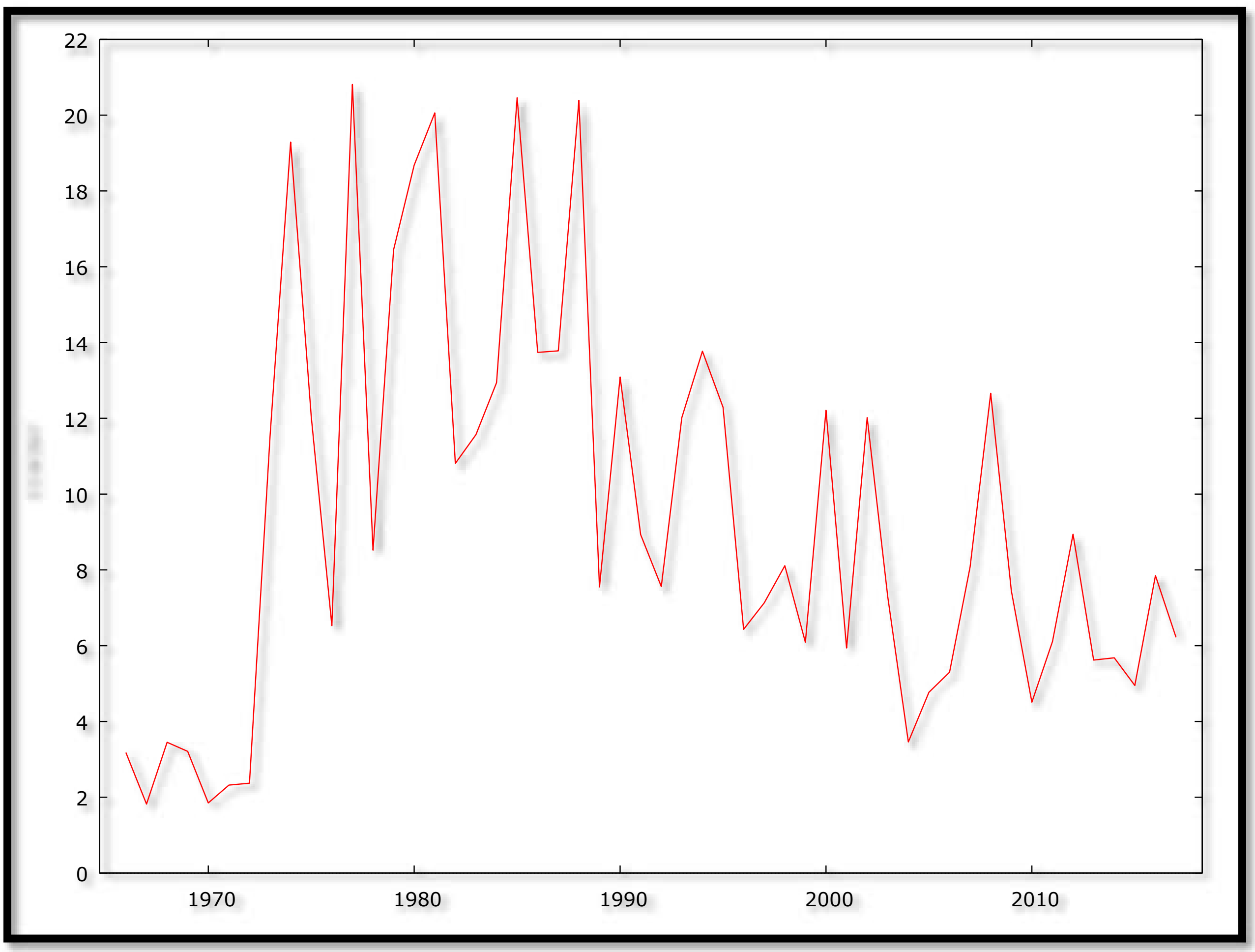
This study is based on a data set of annual rates of inflation in the Kingdom of Eswatini (ESWINF or simply H) ranging over the period 1966 – 2017. All the data was gathered from the World Bank.

Diagnostic Tests & Model Evaluation

Stationarity Tests

Graphical Analysis

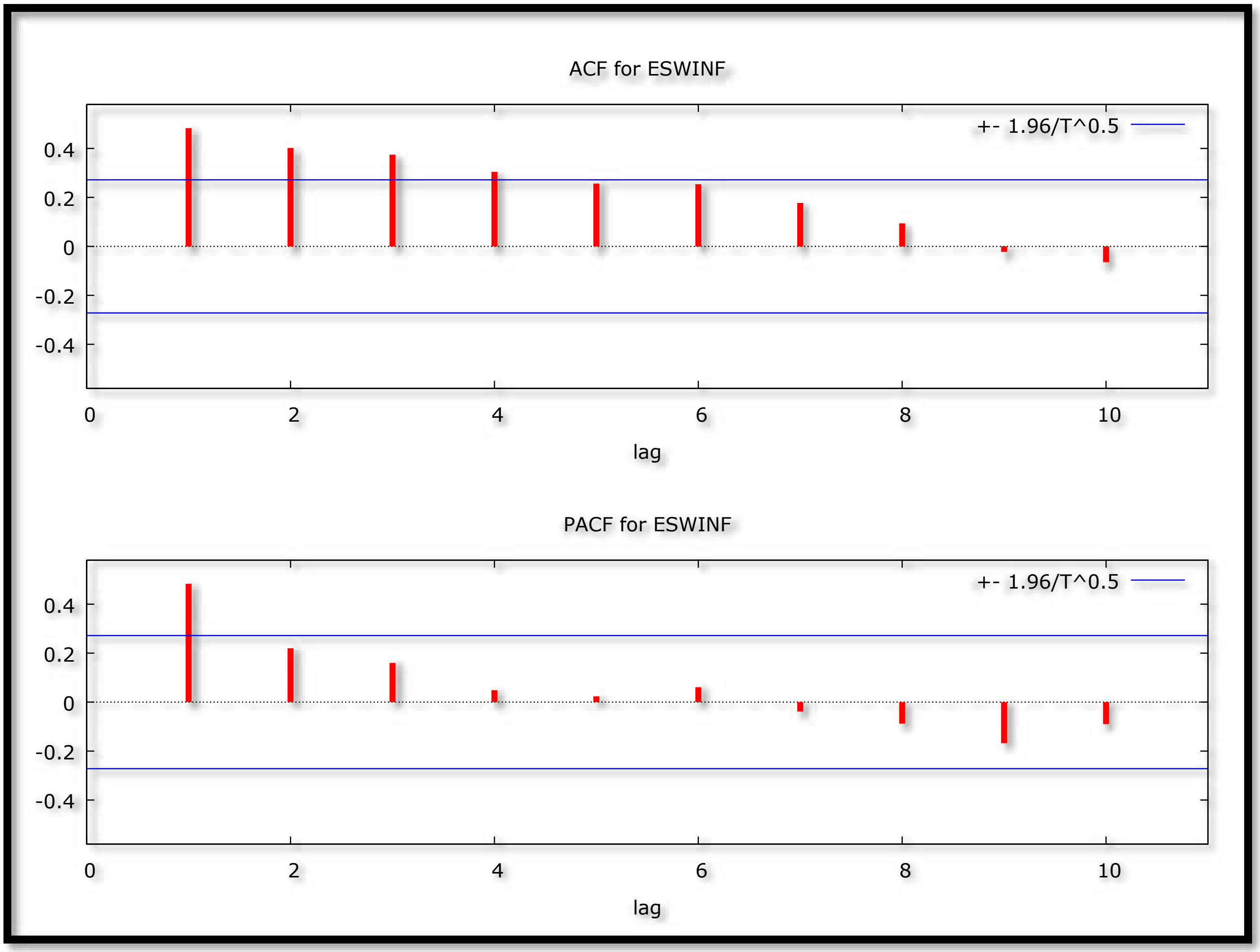
Figure 1



The graph above shows inflation trends in the Kingdom of Eswatini. As shown, inflation is now following a particular trend and thus difficult to tell whether it is stationary or not, hence the need for formal tests using the following steps:

The Correlogram in Levels

Figure 2



The ADF Test in Levels

Table 1: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-2.951802	0.0466	-3.568308	@1%	Not stationary
			-2.921175	@5%	Stationary
			-2.598551	@10%	Stationary

Table 2: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-4.281793	0.0070	-4.148465	@1%	Stationary
			-3.500495	@5%	Stationary
			-3.179617	@10%	Stationary

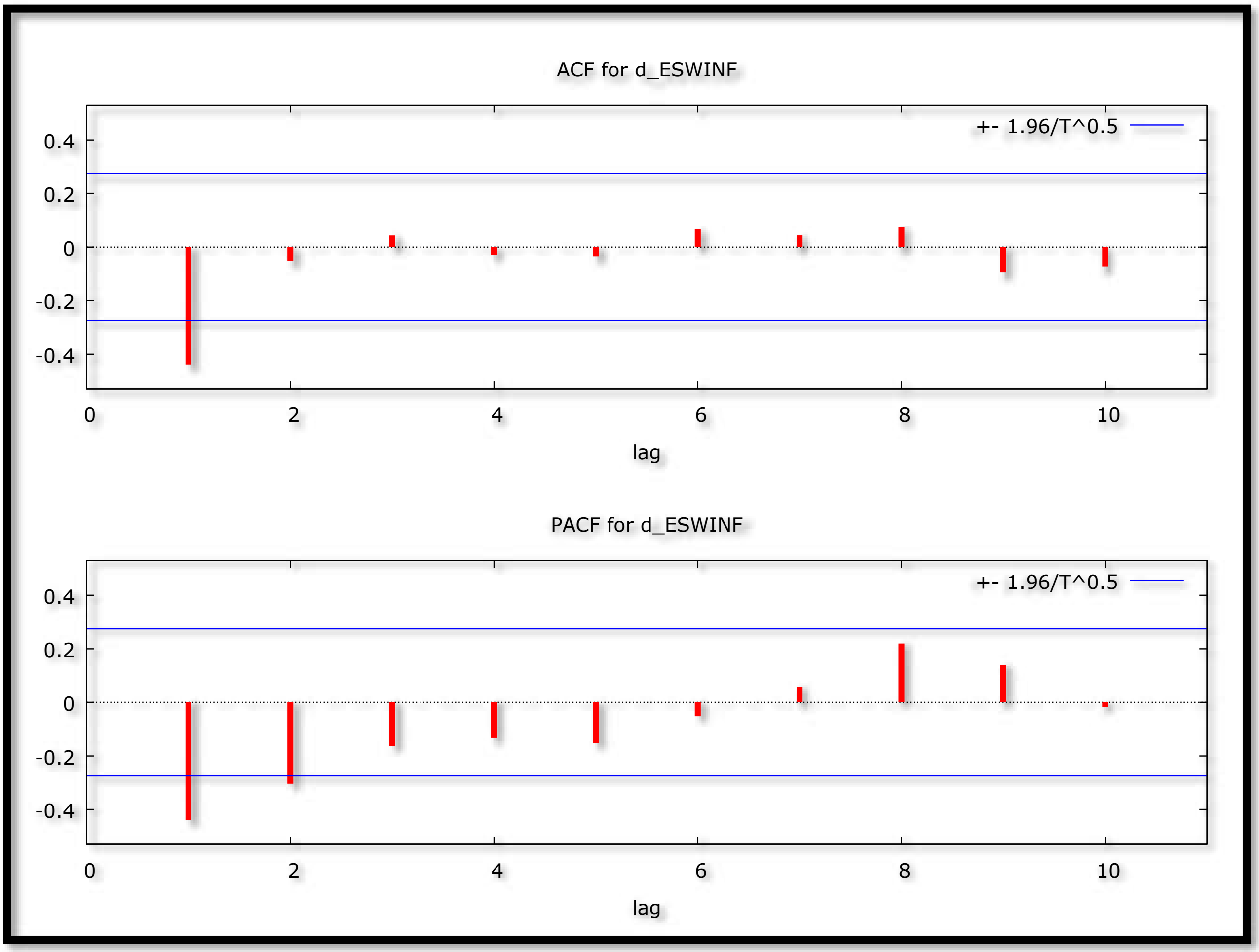
Table 3: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-0.706418	0.4057	-2.613010	@1%	Not stationary
			-1.947665	@5%	Not stationary
			-1.612573	@10%	Not stationary

Figure 2 and tables 1 – 3 reveal that the series under analysis are not stationary in levels.

The Correlogram (at 1st Differences)

Figure 3



ADF Test in 1st Differences

Table 4: 1st Difference-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-11.09986	0.0000	-3.658308	@1%	Stationary
			-2.921175	@5%	Stationary
			-2.598551	@10%	Stationary

Table 5: 1st Difference-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-11.06988	0.0000	-4.152511	@1%	Stationary
			-3.502373	@5%	Stationary
			-3.180699	@10%	Stationary

Table 6: 1st Difference-without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
H	-11.20923	0.0000	-2.612033	@1%	Stationary
			-1.947520	@5%	Stationary
			-1.612650	@10%	Stationary

Figure 3 and tables 4 – 6 show that H is stationary after taking first differences and hence an I (1) variable.

Evaluation of ARIMA models (without a constant)

Table 7

Model	AIC	U	ME	MAE	RMSE	MAPE
ARIMA (1, 1, 1)	302.8946	0.92059	0.18408	3.3558	4.4244	38.142
ARIMA (1, 1, 0)	307.7511	0.94553	0.099102	3.6414	4.7453	41.814
ARIMA (0, 1, 1)	**300.8982**	0.92064	0.1848	3.3524	4.4247	38.094
ARIMA (2, 1, 1)	304.6421	0.91987	0.17763	3.3732	4.4122	38.262

A model with a lower AIC value is better than the one with a higher AIC value (Nyoni, 2018). Theil's U must lie between 0 and 1, of which the closer it is to 0, the better the forecast method (Nyoni, 2018). The study will only consider the AIC as the criteria for choosing the best model for predicting inflation in the Kingdom of Eswatini. Therefore, the ARIMA (0, 1, 1) model is selected.

Residual & Stability Tests

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

Table 8: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.006808	0.0000	-3.568308	@1%	Stationary
			-2.921175	@5%	Stationary
			-2.598551	@10%	Stationary

Table 9: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.273609	0.0000	-4.152511	@1%	Stationary
			-3.502373	@5%	Stationary
			-3.180699	@10%	Stationary

Table 10: without intercept and trend & intercept

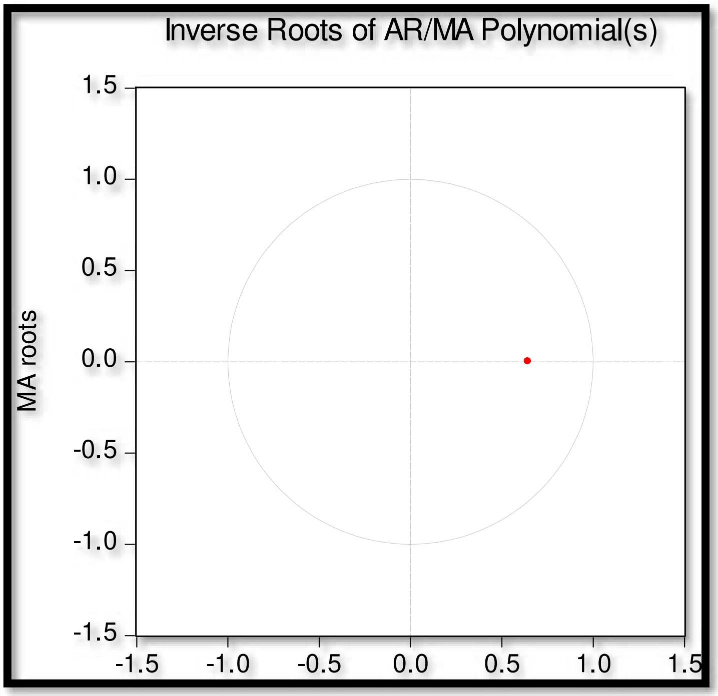
Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-7.063770	0.0000	-2.612033	@1%	Stationary
			-1.947520	@5%	Stationary

		-1.612650	@10%	Stationary

Tables 8, 9 and 10 show that the residuals of the ARIMA (0, 1, 1) model are stationary and hence the ARIMA (0, 1, 1) model is suitable for forecasting inflation in the Kingdom of Eswatini.

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

Figure 4



Since the corresponding inverse roots of the characteristic polynomial lie in the unit circle, it illustrates that the chosen ARIMA (0, 1, 1) model is indeed stable and suitable for predicting inflation in the Kingdom of Eswatini over the period under study.

FINDINGS

Descriptive Statistics

Table 11

Description	Statistic
Mean	9.3817
Median	7.965
Minimum	1.82
Maximum	20.81
Standard deviation	5.2816
Skewness	0.65632
Excess kurtosis	-0.40809

As shown above, the mean is positive, i.e. 9.3817%. The minimum is 1.82% and the maximum is 20.81%. The skewness is 0.65632 and the most striking characteristic is that it is positive, indicating that the inflation series is positively skewed and non-symmetric. Excess kurtosis was found to be -0.40809; implying that the inflation series is not normally distributed.

Results Presentation[1]

Table 12

ARIMA (0, 1, 1) Model: $\Delta H_{t-1} = -0.633991 \Delta H_{t-1}$ ……………………………………………………………………[3] P: (0.0000) S. E: (0.109971)				
Variable	Coefficient	Standard Error	z	p-value
MA (1)	-0.633991	0.109971	-5.765	0.0000***

Predicted Annual Inflation in the Kingdom of Eswatini

Table 13

Year	Prediction	Std. Error	95% Confidence Interval
2018	6.45	4.423	-2.21 - 15.12
2019	6.45	4.710	-2.78 - 15.69
2020	6.45	4.980	-3.31 - 16.22
2021	6.45	5.237	-3.81 - 16.72
2022	6.45	5.481	-4.29 - 17.20
2023	6.45	5.715	-4.75 - 17.66
2024	6.45	5.940	-5.19 - 18.10
2025	6.45	6.157	-5.61 - 18.52
2026	6.45	6.366	-6.02 - 18.93
2027	6.45	6.569	-6.42 - 19.33

Table 13 (with a forecast range from 2018 – 2027), clearly show that annual inflation rates in the Kingdom of Eswatini is expected to hover around 6.45% within the next decade. However, our 95% confidence interval indicates that inflation in the Kingdom of Eswatini is capable of shooting to as high as 19.33% per annum by 2027, ceteris paribus. Therefore, there is need for prudent macroeconomic policy formulation and implementation in order to maintain price stability in the Kingdom of Eswatini.

---

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

POLICY IMPLICATION & CONCLUSION

After applying the Box-Jenkins technique, the ARIMA framework was engaged to investigate annual inflation rates in the Kingdom of Eswatini over the study period. The study mostly planned to forecast inflation in the Kingdom of Eswatini for the upcoming period from 2018 to 2027 and the best fitting model was selected based on how well the model captures the stochastic variation in the data. The ARIMA (0, 1, 1) model, as indicated by the AIC statistic; is not only stable but also the most suitable model to forecast inflation for the next ten years. In general, inflation in the Kingdom of Eswatini; is likely to be hovering around 6.45% per annum over the forecasted period. Based on the results, policy makers in the Kingdom of Eswatini should engage more proper economic and monetary policies in order to fight such increase in inflation as reflected in the forecasts. In this regard, Central Bank of Eswatini is encouraged to rely more on contractionary monetary policy, which should be complimented by a tight fiscal policy stance. The Central Bank of Eswatini is expected to boost productivity through offering tax holidays to manufacturers amongst other incentives; this can also play a pivotal role in promoting macroeconomic stability in the country.

REFERENCES

[1] Ayub, G., Rehman, N. U., Iqbal, M., Zaman, Q & Atif, M (2014). Relationship between inflation and interest rate: evidence from Pakistan, *Research Journal of Recent Sciences*, 3 (4): 51 – 55.

[2] Blanchard, O (2000). Macroeconomics, 2nd Edition, *Prentice Hall*, New York.

[3] Box, G. E. P & Jenkins, G. M (1976). Time Series Analysis: Forecasting and Control, *Holden Day*, San Francisco.

[4] Brocwell, P. J & Davis, R. A (2002). Introduction to Time Series and Forecasting, *Springer*, New York.

[5] Buelens, C (2012). Inflation modeling and the crisis: assessing the impact on the performance of different forecasting models and methods, *European Commission*, Economic Paper No. 451.

[6] Chatfield, C (2004). The Analysis of Time Series: An Introduction, 6th Edition, *Chapman & Hall*, New York.

[7] Cryer, J. D & Chan, K. S (2008). Time Series Analysis with Application in R, *Springer*, New York.

[8] Enke, D & Mehdiyev, N (2014). A Hybrid Neuro-Fuzzy Model to Forecast Inflation, *Procedia Computer Science*, 36 (2014): 254 – 260.

[9] Fenira, M (2014). Democracy: a determinant factor in reducing inflation, *International Journal of Economics and Financial Issues*, 4 (2): 363 – 375.

[10] Hector, A & Valle, S (2002). Inflation forecasts with ARIMA and Vector Autoregressive models in Guatemala, *Economic Research Department*, Banco de Guatemala.

[11] Hurtado, C., Luis, J., Fregoso, C & Hector, J (2013). Forecasting Mexican Inflation Using Neural Networks, *International Conference on Electronics, Communications and Computing*, 2013: 32 – 35.

[12] Islam, R., Ghani, A. B. A., Mahyudin, F., & Manickam, N (2017). Determinants of factors affecting inflation in Malaysia, *International Journal of Economics and Financial Issues*, 7 (2): 355 – 364.

[13] Khumalo, L. C., Mutambara, E., & Kodua, A. A (2017). Relationship between inflation and interest rates in Swaziland revisited, *Banks and Banks Systems*, 12 (4): 218 – 226.

[14] King, M (2005). Monetary Policy: Practice Ahead of Theory, *Bank of England*.

[15] Mcnelis, P. D & Mcadam, P (2004). Forecasting Inflation with Think Models and Neural Networks, *Working Paper Series*, European Central Bank.

[16] Mkhatshwa, Z. S., Tijani, A. A., & Masuku, M. B (2015). Analysis of the relationship between inflation, economic growth and agricultural growth in Swaziland from 1980 – 2013, *Journal of Economics and Sustainable Development*, 6 (18): 189 – 204.

[17] Nyoni, T & Nathaniel, S. P (2019). Modeling Rates of Inflation in Nigeria: An Application of ARMA, ARIMA and GARCH models, *Munich University Library – Munich Personal RePEc Archive (MPRA)*, Paper No. 91351.

[18] Nyoni, T (2018). Modeling and Forecasting Inflation in Zimbabwe: a Generalized Autoregressive Conditionally Heteroskedastic (GARCH) approach, *Munich University Library – Munich Personal RePEc Archive (MPRA)*, Paper No. 88132.

[19] Nyoni, T (2018). Modeling and Forecasting Naira / USD Exchange Rate in Nigeria: a Box – Jenkins ARIMA approach, *University of Munich Library – Munich Personal RePEc Archive (MPRA)*, Paper No. 88622.

[20] Nyoni, T (2018). Modeling and Forecasting Inflation in Kenya: Recent Insights from ARIMA and GARCH analysis, *Dimorian Review*, 5 (6): 16 – 40.

[21] Nyoni, T. (2018). Box – Jenkins ARIMA Approach to Predicting net FDI inflows in Zimbabwe, *Munich University Library – Munich Personal RePEc Archive (MPRA)*, Paper No. 87737.

[22] Ramlan, H & Suhaimi, M. S. I. B (2017). The relationship between interest rates and inflation toward the economic growth in Malaysia, *Journal of Humanities, Language, Culture and Business*, 1 (1): 55 – 63.

[23] Salami, F. K (2018). Effect of interest rate on economic growth: Swaziland as a case study, *J. Bus. Fin. Aff.*, 7 (3): 1 – 5.

[24] Sarangi, P. K., Sinha, D., Sinha, S & Sharma, M (2018). Forecasting Consumer Price Index using Neural Networks models, *Innovative Practices in Operations Management and Information Technology* – Apeejay School of Management, pp: 84 – 93.

[25] Wei, W. S (2006). Time Series Analysis: Univariate and Multivariate Methods, 2^{nd} Edition, *Pearson Education Inc*, Canada.