Forecasting total population in Yemen using Box-Jenkins ARIMA models

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Abstract

Using annual time series data on total population in Yemen from 1960 to 2017, we model and forecast total population over the next 3 decades using the Box – Jenkins ARIMA technique. Diagnostic tests such as the ADF tests show that Yemen annual total population is neither I (1) nor I (2) but for simplicity purposes, the researcher has assumed it is I (2). Based on the AIC, the study presents the ARIMA (10, 2, 0) model as the best model. The diagnostic tests further indicate that the presented model is indeed stable and its residuals are stationary in levels. The results of the study reveal that total population in Yemen will continue to rise sharply in the next three decades and in 2050 Yemen's total population will be approximately 52 million people. In order to benefit from an increase in total population in Yemen, 4 policy recommendations have been suggested for consideration by policy makers in Yemen.

Key Words: Forecasting, Population, Yemen

JEL Codes: C53, Q56, R23

INTRODUCTION

The modern Republic of Yemen came into being in 1990 when North Yemen and South Yemen merged. Since unification the country has been modernizing and opening up to the outside world, but Yemen still maintains much of its tribal character and old ways. The Republic of Yemen lies at the southwestern tip of the Arabian Peninsula, bordering Saudi Arabia in the north, the Arabia Sea and Indian Ocean in the South, the Red Sea in the west and the Sultanate of Oman in the east. Total land area is about 527970 sq km with mostly desert climate. The population of Yemen grows by 3.45% per annum, one of the highest growth rate in the world (Jamada II, 2005). As the 21st century began, the world's population was estimated to be almost 6.1 billion people (Tartiyus *et al*, 2015). Projections by the United Nations place the figure at more than 9.2 billion by the year 2050 before reaching a maximum of 11 billion by 2200. Over 90% of that population will inhabit the developing world (Todaro & Smith, 2006).

The first population census conducted in 1994 under the Republic of Yemen shows that the population was 15831757 persons. It has increased by 58% in the last 20 years to reach about 25 million in 2013. The growing population will put more pressure on the country to provide social services and public utilities, as well as expand the labour market. Yemen households consist of an average of 6.7 people. A large proportion of the Yemeni population is (44%) is under age of 15. Only 8% of households are headed by women (MOPHP-CSO (Yemen)-PAPFAM & ICFI, 2015). The problem of population growth is basically not a problem of numbers but that of human welfare as it affects the provision of welfare and development. The consequences of rapidly growing population manifests heavily on species extinction, deforestation, desertification, climate change and the destruction of natural ecosystems on one hand; and unemployment, pressure on housing, transport traffic congestion, pollution and infrastructure security and stain on amenities (Dominic *et al*, 2016). In Yemen, just like in any other part of the world, population modeling and forecasting is quite important for policy dialogue. This study endeavors to model and forecast population of Yemen using the Box-Jenkins ARIMA technique.

REVIEW OF PREVIOUS STUDIES

Table 1

Author(s) / Year	Country	Period	Methodology	Major Findings
Zakria & Muhammad (2009)	Pakistan	1951 – 2007	ARIMA Models	ARIMA (1, 2, 0) is the best model
Haque *et al* (2012)	Bangladesh	1991 – 2006	Logistic Population Model (LPM)	The LPM has the best fit for population growth in Bangladesh
Beg & Islam (2016)	Bangladesh	1965 – 2003	Autoregressive Time Trend Model (ATTM)	Downward population growth for Bangladesh for the extended period up to 2043
Ayele & Zewdie (2017)	Ethiopia	1961 – 2009	ARIMA Models	ARIMA (2, 1, 2) Model is the best model

MATERIALS & METHODS

ARIMA Models

ARIMA models are often considered as delivering more accurate forecasts then econometric techniques (Song *et al*, 2003b). ARIMA models outperform multivariate models in forecasting performance (du Preez & Witt, 2003). Overall performance of ARIMA models is superior to that of the naïve models and smoothing techniques (Goh & Law, 2002). ARIMA models were developed by Box and Jenkins in the 1970s and their approach of identification, estimation and diagnostics is based on the principle of parsimony (Asteriou & Hall, 2007). The general form of the ARIMA (p, d, q) can be represented by a backward shift operator as:

$$\emptyset(B)(1-B)^d POP_t = \theta(B)\mu_t \ldots \ldots \ldots \ldots \ldots [1]$$

Where the autoregressive (AR) and moving average (MA) characteristic operators are:

$$\emptyset(B) = \left(1 - \emptyset_1 B - \emptyset_2 B^2 - \cdots - \emptyset_p B^p\right) \ldots \ldots \ldots \ldots \ldots [2]$$

$$\theta(B) = \left(1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_q B^q\right) \ldots \ldots \ldots \ldots \ldots [3]$$

and

$$(1 - B)^d POP_t = \Delta^d POP_t \ldots \ldots \ldots \ldots \ldots \ldots [4]$$

Where $\emptyset$ is the parameter estimate of the autoregressive component, θ is the parameter estimate of the moving average component, Δ is the difference operator, d is the difference, B is the backshift operator and μ_t is the disturbance term.

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 58 observations of annual total population in Yemen. All the data was gathered from the World Bank.

Diagnostic Tests & Model Evaluation

Stationarity Tests: Graphical Analysis

Figure 1

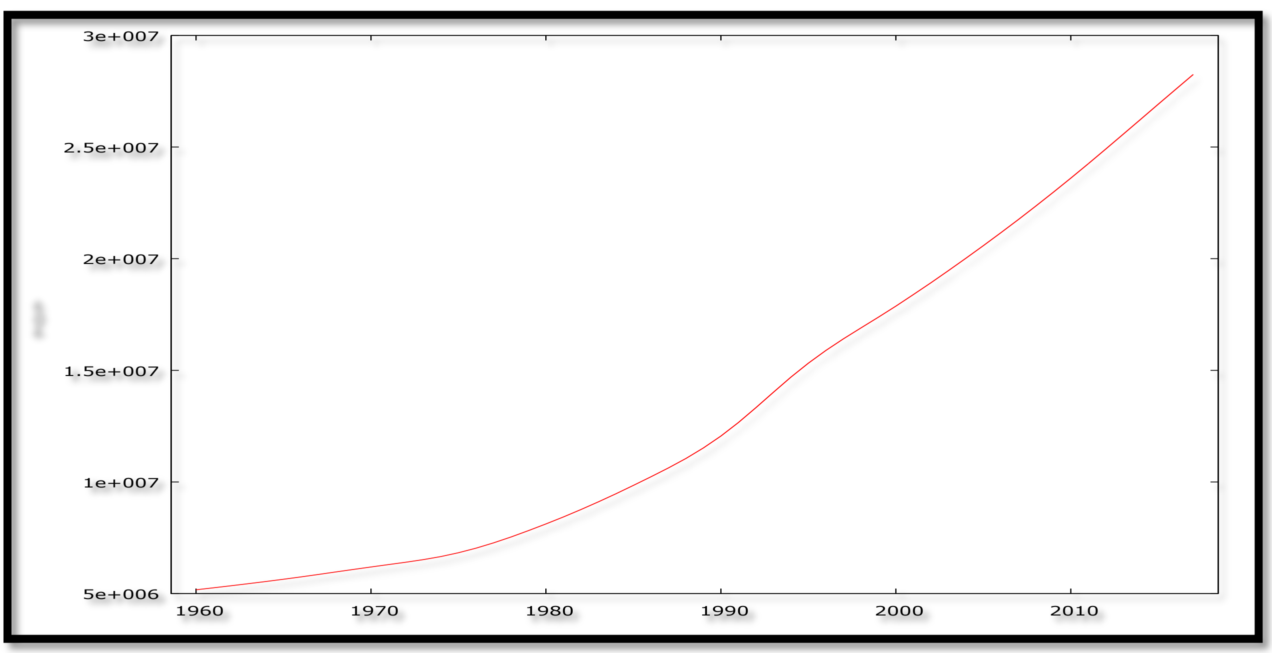
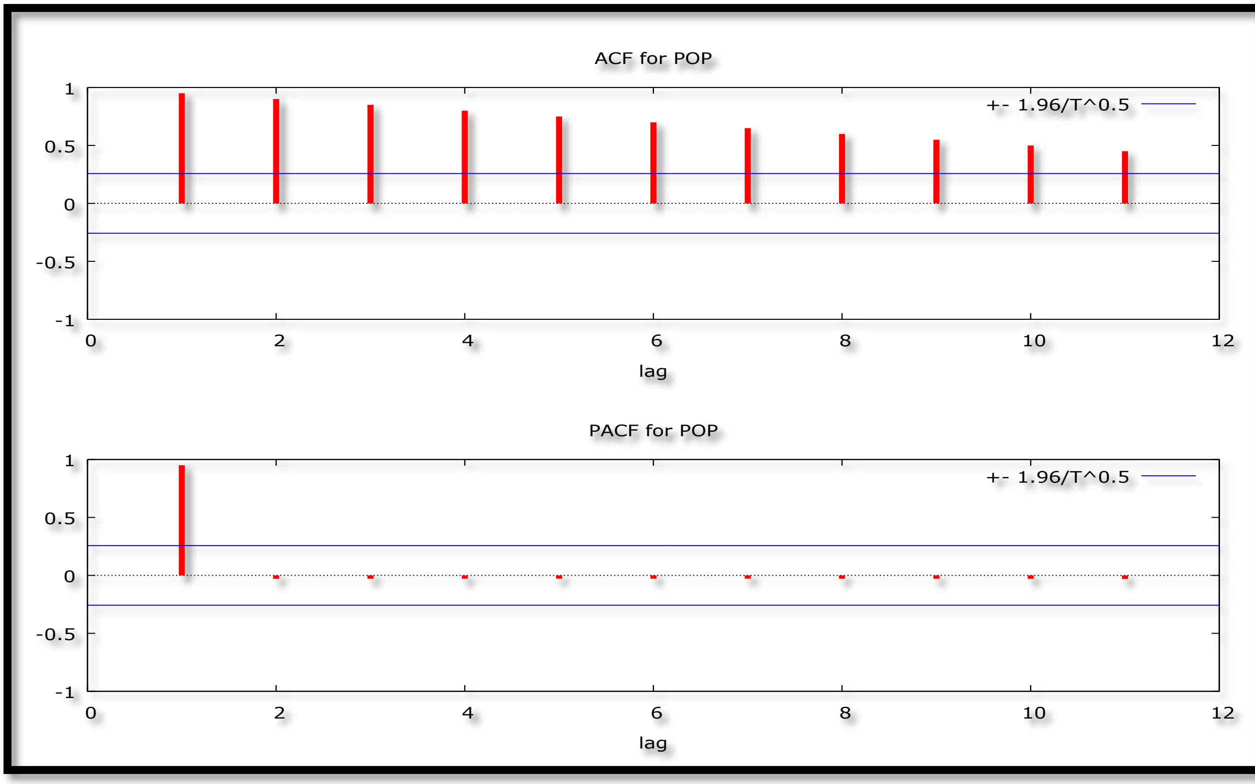


Figure 1 above indicates that the Yemen POP variable is not stationary since it is trending upwards over the period 1960 – 2017. This basically shows that the mean and varience of POP is changing over time.

The Correlogram in Levels

Figure 2



The ADF Test

Table 2: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	0.289857	0.9754	-3.574446	@1%	Not stationary
			-2.923780	@5%	Not stationary
			-2.599925	@10%	Not stationary

Table 3: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-2.521067	0.3171	-4.161144	@1%	Not stationary
			-3.506374	@5%	Not stationary
			-3.183002	@10%	Not stationary

Table 4: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values	Conclusion

POP	0.924660	0.9028	-2.614029	@1%	Not stationary
			-1.947816	@5%	Not stationary
			-1.612492	@10%	Not stationary

The Correlogram (at 1st Differences)

Figure 3

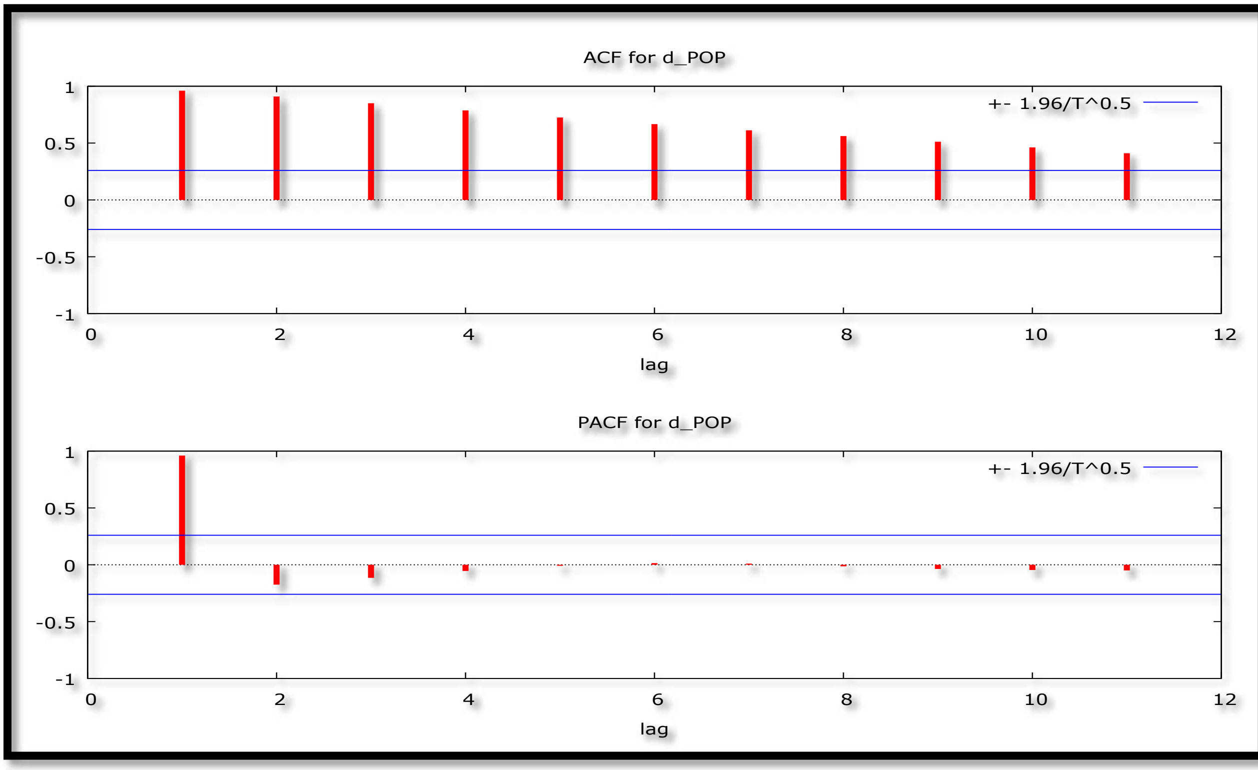


Table 5: 1st Difference-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-1.570884	0.4895	-3.574446	@1%	Not stationary
			-2.923780	@5%	Not stationary
			-2.599925	@10%	Not stationary

Table 6: 1st Difference-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-1.406411	0.8465	-4.161144	@1%	Not stationary
			-3.506374	@5%	Not stationary
			-3.183002	@10%	Not stationary

Table 7: 1st Difference-without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	0.745622	0.8721	-2.614029	@1%	Not stationary
			-1.947816	@5%	Not stationary
			-1.612492	@10%	Not stationary

Figures above, i.e. 2 and 3 and tables above, i.e. 2 to 7 show that the Yemen POP series is not stationary in levels and in first differences.

The Correlogram in (2nd Differences)

Figure 4

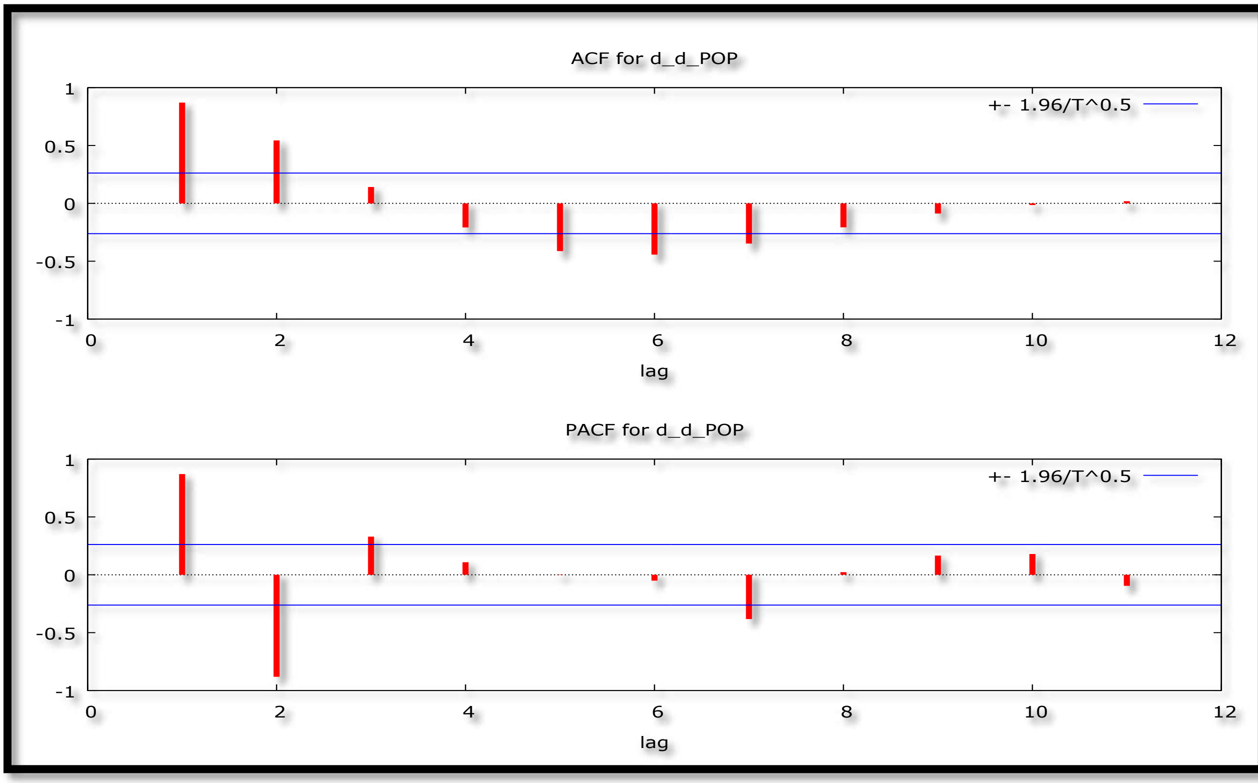


Table 8: 2nd Difference-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-2.357536	0.1590	-3.574446	@1%	Not stationary
			-2.923780	@5%	Not stationary
			-2.599925	@10%	Not stationary

Table 9: 2nd Difference-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-2.592497	0.2854	-4.161144	@1%	Not stationary
			-3.506374	@5%	Not stationary
			-3.183002	@10%	Not stationary

Table 10: 2nd Difference-without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
POP	-1.443601	0.1372	-2.614029	@1%	Not stationary
			-1.947816	@5%	Not stationary
			-1.612942	@10%	Not stationary

Figure 4 and tables 8 – 10 illustrate that the Yemen POP series is not stationary even after taking second differences. This is a feature of sharply upwards trending series. However, the researcher will assume that the Yemen POP series is I (2).

Evaluation of ARIMA models (without a constant)

Table 11

Model	AIC	U	ME	MAE	RMSE	MAPE
ARIMA (1, 2, 1)	1162.581	0.01867	852.93	4689.2	7190.2	0.039448
ARIMA (1, 2, 0)	1208.130	0.028836	1195.5	6701.8	11151	0.056933
ARIMA (0, 2, 1)	1231.736	0.039183	5408.1	9985.4	13732	0.087434
ARIMA (2, 2, 1)	1116.738	0.012974	1512.3	3443.9	4623.2	0.030322
ARIMA (3, 2, 1)	1110.82	0.011763	887.32	3099.5	4289.2	0.027383
ARIMA (4, 2, 1)	1112.799	0.011756	879.11	3098	4288.4	0.027362
ARIMA (5, 2, 1)	1114.665	0.011713	854.37	3088.1	4283.3	0.027226
ARIMA (6, 2, 1)	1108.818	0.011007	710.86	2837.3	3966.3	0.025118
ARIMA (2, 2, 0)	1130.302	0.015377	2065.4	3956.9	5348.1	0.034992
ARIMA (3, 2, 0)	1108.868	0.011769	912.06	3107.3	4290.7	0.027432
ARIMA (4, 2, 0)	1110.829	0.011765	892.61	3101.3	4289.4	0.027397
ARIMA (5, 2, 0)	1112.668	0.011713	855.65	3088.3	4283.4	0.027228
ARIMA (6, 2, 0)	1114.631	0.011716	839.45	3084.7	4282.1	0.0272
ARIMA (7, 2, 1)	1099.283	0.0099294	930.84	2545	3538	0.022635
ARIMA (8, 2, 1)	1096.748	0.0092395	607.33	2431.9	3381.7	0.021513
ARIMA (9, 2, 1)	1098.732	0.009407	606.54	2434.6	3381.1	0.021536
ARIMA (10, 2, 1)	1096.387	0.0089871	554.07	2333.6	3238.8	0.020784
ARIMA (7, 2, 0)	1105.442	0.010784	1092.2	2793.7	3839.2	0.024656
ARIMA (8, 2, 0)	1095.844	0.0093616	686.29	2506.3	3416	0.022023
ARIMA (9, 2, 0)	1097.398	0.0092945	649.04	2464.4	3401.9	0.021725
ARIMA (10, 2, 0)	**1095.318**	0.009041	553.2	2404.8	3269.8	0.021202

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 consider the minimum AIC in order to choose the best model for forecasting total population in Yemen. Therefore, the ARIMA (10, 2, 0) model is carefully selected.

Residual & Stability Tests

ADF Tests of the Residuals of the ARIMA (10, 2, 0) Model

Table 12: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-6.207839	0.0000	-3.584743	@1%	Stationary
			-2.928142	@5%	Stationary
			-2.602225	@10%	Stationary

Table 13: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-6.241041	0.0000	-4.175640	@1%	Stationary
			-3.513075	@5%	Stationary
			-3.186854	@10%	Stationary

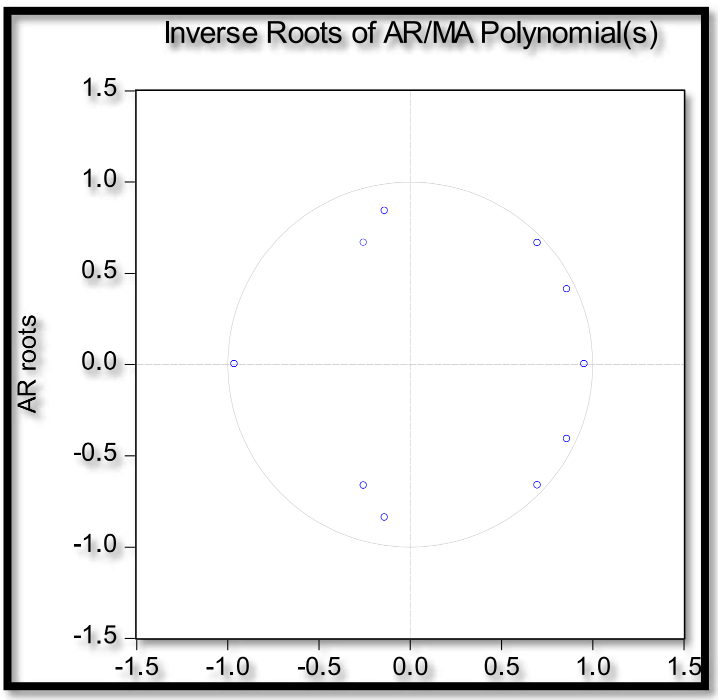
Table 14: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
R_t	-6.203022	0.0000	-2.617364	@1%	Stationary
			-1.948313	@5%	Stationary
			-1.612229	@10%	Stationary

Tables 11 – 13 indicate that the residuals of the chosen optimal model, the ARIMA (10, 2, 0) model; are stationary.

Stability Test of the ARIMA (10, 2, 0) Model

Figure 5



Since the corresponding inverse roots of the characteristic polynomial lie in the unit circle, it shows that the chosen ARIMA (10, 2, 0) model is stable.

FINDINGS

Descriptive Statistics

Table 15

Description	Statistic
Mean	13471000

Median	11287000
Minimum	5172100
Maximum	28250000
Standard deviation	7277100
Skewness	0.53191
Excess kurtosis	-1.0821

As shown above, the mean is positive, i.e. 13471000. The wide gap between the minimum (i.e 5172100) and the maximum (i.e. 28250000) is consistent with the observation that the Yemen POP series is sharply trending upwards over the period 1960 – 2017. The skewness is 0.53191 and the most essential characteristic is that it is positive, meaning that the Yemen POP series is positively skewed and non-symmetric. Excess kurtosis is -1.0821; showing that the Yemen POP series is not normally distributed.

Results Presentation[1]

Table 16

ARIMA (10, 2, 0) Model:

$$\Delta^2 POP_{t-1} = 2.3\Delta^2 POP_{t-1} - 2.2\Delta^2 POP_{t-2} + 1.1\Delta^2 POP_{t-3} - 0.3\Delta^2 POP_{t-4} + 0.7\Delta^2 POP_{t-5} + 1.2\Delta^2 POP_{t-6} - 1.3\Delta^2 POP_{t-7} + 0.8\Delta^2 POP_{t-8} - 0.5\Delta^2 POP_{t-9} + 0.2\Delta^2 POP_{t-10} \dots \dots [5]$$

Variable	Coefficient	Std. Error	z	p-value
AR (1)	2.30088	0.128683	17.88	0.0000***
AR (2)	-2.18499	0.330094	-6.619	0.0000***
AR (3)	1.10861	0.432238	2.565	0.0103**
AR (4)	-0.252452	0.413608	-0.6104	0.5416
AR (5)	0.749173	0.346496	-2.162	0.0306**
AR (6)	1.56186	0.348357	4.484	0.0000***
AR (7)	-1.32833	0.416786	-3.187	0.0014***
AR (8)	0.761239	0.434938	1.75	0.0801*
AR (9)	-0.5100562	0.332144	-1.537	0.1243
AR (10)	0.249772	0.129915	1.923	0.0545*

Table 17

Year	Actual POP	Fitted	Residual
1962	5351799.00	5348867.00	2932.00
1963	5446063.00	5445728.47	334.53
1964	5543339.00	5542753.47	585.53
1965	5643643.00	5643416.57	226.43
1966	5748588.00	5746720.63	1867.37

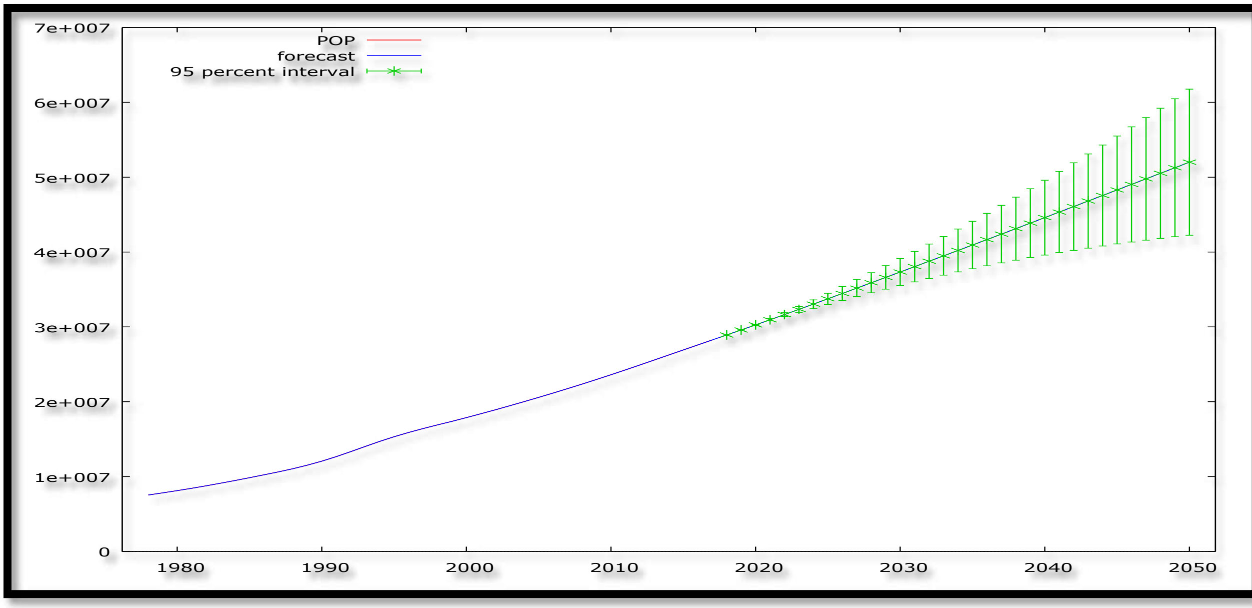
[1] *The *, ** and *** means significant at 10%, 5% and 1% levels of significance; respectively.*

1967	5858638.00	5859834.08	-1196.08
1968	5971407.00	5972987.95	-1580.95
1969	6083619.00	6083437.11	181.89
1970	6193810.00	6193050.00	760.00
1971	6300554.00	6301214.18	-660.18
1972	6407295.00	6403391.57	3903.43
1973	6523452.00	6520740.43	2711.57
1974	6661566.00	6658591.55	2974.45
1975	6830692.00	6829798.69	893.31
1976	7034868.00	7034424.78	443.22
1977	7271872.00	7270659.47	1212.53
1978	7536764.00	7533607.38	3156.62
1979	7821552.00	7821651.41	-99.41
1980	8120497.00	8118534.00	1963.00
1981	8434017.00	8430492.58	3524.42
1982	8764621.00	8766017.45	-1396.45
1983	9111097.00	9111929.64	-832.64
1984	9472170.00	9470725.54	1444.46
1985	9847899.00	9845673.74	2225.26
1986	10232733.00	10236725.18	-3992.18
1987	10628585.00	10618935.42	9649.58
1988	11051504.00	11045472.41	6031.59
1989	11523267.00	11519018.09	4248.91
1990	12057039.00	12058023.99	-984.99
1991	12661614.00	12657667.89	3946.11
1992	13325583.00	13334698.50	-9115.50
1993	14017239.00	14020424.28	-3185.28

1994	14692686.00	14699803.74	-7117.74
1995	15320653.00	15319590.21	1062.79
1996	15889449.00	15886668.84	2780.16
1997	16408954.00	16410718.16	-1764.16
1998	16896210.00	16902789.04	-6579.04
1999	17378098.00	17374284.32	3813.68
2000	17874725.00	17876420.82	-1695.82
2001	18390135.00	18393825.48	-3690.48
2002	18919179.00	18914687.98	4491.02
2003	19462086.00	19461068.02	1017.98
2004	20017068.00	20018479.55	-1411.55
2005	20582927.00	20584155.81	-1228.81
2006	21160534.00	21161272.30	-738.30
2007	21751605.00	21750903.52	701.48
2008	22356391.00	22348860.05	7530.95
2009	22974929.00	22973520.64	1408.36
2010	23606779.00	23603868.38	2910.62
2011	24252206.00	24251446.90	759.10
2012	24909969.00	24910901.73	-932.73
2013	25576322.00	25578462.45	-2140.45
2014	26246327.00	26246815.78	-488.78
2015	26916207.00	26916469.71	-262.71
2016	27584213.00	27583081.81	1131.19
2017	28250420.00	28251170.35	-750.35

Forecast Graph

Figure 6



Predicted Total Population

Table 18

Year	Prediction	Std. Error	95% Confidence Interval
2018	28916856.83	3238.390	28910509.71 - 28923203.96
2019	29586975.03	14299.445	29558948.64 - 29615001.43
2020	30263711.05	37517.680	30190177.75 - 30337244.35
2021	30948328.62	75847.822	30799669.62 - 31096987.62
2022	31640706.40	130910.209	31384127.10 - 31897285.69
2023	32339818.67	201672.643	31944547.56 - 32735089.79
2024	33044077.24	285054.080	32485381.51 - 33602772.97
2025	33752117.98	377405.576	33012416.65 - 34491819.32
2026	34463290.13	475936.523	33530471.68 - 35396108.57
2027	35177349.52	578933.659	34042660.40 - 36312038.64
2028	35893925.15	686031.832	34549327.46 - 37238522.83
2029	36612393.63	797904.907	35048528.75 - 38176258.51
2030	37331924.63	915740.360	35537106.50 - 39126742.75
2031	38051683.51	1040531.265	36012279.71 - 40091087.32

2032	38771229.59	1172958.543	36472273.09 - 41070186.09
2033	39490886.77	1313396.527	36916676.88 - 42065096.66
2034	40211663.74	1462151.525	37345899.41 - 43077428.07
2035	40934842.84	1619580.113	37760524.15 - 44109161.53
2036	41661476.96	1786231.211	38160528.12 - 45162425.80
2037	42392006.79	1962637.153	38545308.65 - 46238704.92
2038	43126083.89	2149071.303	38913981.53 - 47338186.24
2039	43862755.64	2345283.336	39266084.77 - 48459426.51
2040	44600882.06	2550531.040	39601933.08 - 49599831.04
2041	45339561.29	2763726.132	39922757.60 - 50756364.97
2042	46078344.46	2983799.613	40230204.68 - 51926484.24
2043	46817238.76	3209995.197	40525763.79 - 53108713.74
2044	47556512.34	3442079.201	40810161.07 - 54302863.60
2045	48296443.73	3680269.369	41083248.31 - 55509639.14
2046	49037142.47	3925067.308	41344151.91 - 56730133.03
2047	49778552.27	4176985.245	41591811.63 - 57965292.92
2048	50520568.36	4436373.791	41825435.51 - 59215701.21
2049	51263188.00	4703319.215	42044851.73 - 60481524.27
2050	52006578.29	4977712.504	42250441.05 - 61762715.52

Table 17 shows the actual total population of Yemen, the fitted one as well as the residuals. The striking feature of table 17 is that the residuals are quite small, confirming the accuracy of the selected optimal model, the ARIMA (10, 2, 0) model as already hinted by the forecast evaluation statistics in table 11 above. Figure 6 (with a forecast range from 2018 – 2050) and table 18, clearly show that Yemen's total population is set to continue rising rapidly, in the next 3 decades. With a 95% confidence interval of 42250441 to 61762716 and a projected total population of 52006578 by 2050, the chosen ARIMA (10, 2, 0) model is consistent with the population projections by the UN (2015) which forecasted that Yemen's population will be approximately 47170000 by 2050.

Policy Implications

i. The government of Yemen ought to invest more in infrastructural development in order to cater for the expected increase in total population.

ii. The predicted increase in total population in Yemen justifies the need for more and bigger companies to provide for the anticipated increase in demand for goods and services in Yemen.
iii. The government of Yemen should take action so as to improve health service delivery in the country in order to ensure a healthier society, particularly in light of such a likely increase in total population.
iv. The consequences of the armed conflict on the Yemeni people are a fundamental concern. The need for political stability cannot be undermined in Yemen. The Yemen-Saudi Arabia conflict just liked any other armed conflict in Yemen; is condemned at all costs. Without political stability, Yemen's expected increase in total population is a threat to Yemen herself especially in light of the lack of the most basic survival means and high food prices currently obtaining in the country.

CONCLUSION

The study shows that the ARIMA (10, 2, 0) model is not only stable but also the most suitable model to forecast total population in Yemen for the next 3 decades. The model predicts that by 2050, Yemen's total population would be approximately, 52 million people. This is a warning signal to policy makers in Yemen, particularly with regards to infrastructural development, e.g schools and hospitals. These findings are essential for the government of Yemen, especially when it comes to long-term planning.

REFERENCES

[1] Asteriou, D. & Hall, S. G. (2007). Applied Econometrics: a modern approach, Revised Edition, *Palgrave MacMillan*, New York.

[2] Ayele, A. W & Zewdie, M. A (2017). Modeling and forecasting Ethiopian human population size and its pattern, *International Journal of Social Sciences, Arts and Humanities*, 4 (3): 71 – 82.

[3] Beg, A. B. M. R. A & Islam, M. R (2016). Forecasting and modeling population growth of Bangladesh, *American Journal of Mathematics and Statistics*, 6 (4): 190 – 195.

[4] Dominic, A., Oluwatoyin, M. A., & Fagbeminiyi, F. F (2016). The determinants of population growth in Nigeria: a co-integration approach, *The International Journal of Humanities and Social Studies*, 4 (11): 38 – 44.

[5] Du Preez, J. & Witt, S. F. (2003). Univariate and multivariate time series forecasting: An application to tourism demand, *International Journal of Forecasting*, 19: 435 – 451.

[6] Goh, C. & Law, R. (2002). Modeling and forecasting tourism demand for arrivals with stochastic non-stationary seasonality and intervention, *Tourism Management*, 23: 499 – 510.

[7] Haque, M., Ahmed, F., Anam, S., & Kabir, R (2012). Future population projection of Bangladesh by growth rate modeling using logistic population model, *Annals of Pure and Applied Mathematics*, 1 (2): 192 – 202.

[8] Jamada II (2005). Country Profile – Yemen, Republic of Yemen.

[9] MOPHP-SCO (Yemen)-PAPFAM & ICFI (2015). Yemen National Health and Demographic Survey 2013, Rockville, Maryland.

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

[11] 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.

[12] 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.

[13] Song, H., Witt, S. F. & Jensen, T. C. (2003b). Tourism forecasting: accuracy of alternative econometric models, *International Journal of Forecasting*, 19: 123 – 141.

[14] Tartiyus, E. H., Dauda, T. M., & Peter, A (2015). Impact of population growth on economic growth in Nigeria, *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, 20 (4): 115 – 123.

[15] Todaro, M & Smith, S (2006). Economic Development, 9th Edition, *Vrinda* Publications, New Delhi.

[16] United Nations (2015). World Population Prospects: The 2015 Revision, Key Findings and Advance Tables, *Department of Economic and Social Affairs*, Population Division, Working Paper No. ESA/P/WP/241.

[17] Zakria, M & Muhammad, F (2009). Forecasting the population of Pakistan using ARIMA models, *Pakistan Journal of Agricultural Sciences*, 46 (3): 214 – 223.