

Debt-to-pay-debt syndrome in Uganda

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Abstract

This study investigates debt-to-pay-debt syndrome in Uganda from 1980 to 2022 using a quantitative approach with ARIMA modelling to evaluate public debt sustainability. Balanced time series data from the World Bank is analysed with public debt (% of GDP) as the dependent variable, incorporating autoregressive (AR) and moving average (MA) components as independent variables. Parameter estimation is conducted using Maximum Likelihood Estimation (MLE), with diagnostic tests ensuring model robustness. Results show that the AR(1) coefficient (0.350489), is positive and statistically significant, meaning that 35% of the current year's debt is used to service the previous year's debt. This finding confirms the persistence of the debt-to-pay-debt cycle in Uganda. The estimated ARIMA (1, 1, 11) model is both covariance stationary and invertible, making it reliable for forecasting public debt trends over the next decade. Forecasts suggest that the debt-to-pay-debt pattern will continue unless corrective measures are taken. The study recommends implementing comprehensive debt management policies to reduce reliance on new borrowing. This includes enforcing stricter fiscal rules and promoting revenue diversification through emerging sectors such as digital economies, agricultural value addition, mineral resources, and oil and gas.

Keywords

ARIMA modelling, debt-to-pay-debt syndrome, public debt

JEL: E66.

Introduction

Public debt management is a critical issue in Uganda, where rising debt levels have led to growing concerns about the sustainability of borrowing practices. In recent decades, Uganda has relied increasingly on external and domestic borrowing to finance development projects and meet budgetary requirements (World Bank, 2022). While such financing can stimulate economic growth, an overreliance on debt especially if borrowed to repay existing debt can create a debt-to-pay-debt syndrome, where resources are increasingly directed toward debt servicing rather than development initiatives. This cycle of borrowing to meet debt obligations not only strains public finances but also raises questions about the long-term sustainability of Uganda's debt (IMF, 2023).

Despite substantial literature on public debt sustainability in developing economies, few studies address the specific patterns and implications of a debt-to-pay-debt cycle within Uganda's unique macroeconomic context (Fenochietto & Pessino, 2013). Prior research often focuses on debt-to-GDP ratios or fiscal deficits as indicators of debt sustainability, but these metrics may overlook underlying debt patterns, such as frequent refinancing, that signal more nuanced vulnerabilities in fiscal health (Pattillo et al., 2002). Furthermore, while many studies apply cross-sectional analyses, there is limited use of time series approaches like the ARIMA model to capture the temporal dynamics of Uganda's debt over a long horizon (Bua et al., 2014).

This study aims to fill this gap by employing an ARIMA modelling approach to analyze Uganda's debt patterns from 1980 to 2022. ARIMA modelling is particularly well-suited for this investigation, as it captures the autoregressive and moving average processes of debt accumulation, providing insights into the sustainability of debt without overemphasizing static metrics (Box et al., 2015). By examining these temporal patterns, the study can uncover signs of debt sustainability or distress based on Uganda's historical debt trends, offering a more comprehensive understanding of the debt-to-pay-debt cycle and its implications.

The rationale for this research is grounded in the need for evidence-based policy recommendations that can support Uganda's fiscal sustainability. Understanding the underlying patterns of public debt accumulation provides critical insights for policymakers as they work to balance the financing needs of development with the risks of debt dependency. This study, therefore, aims to contribute to the discourse on debt management and sustainability in Uganda, offering a structured approach to assess debt sustainability through ARIMA modelling and shedding light on potential strategies to mitigate the risks associated with cyclical borrowing practices (MoFPED, 2023).

Literature Review

The global debt landscape highlights diverse patterns of borrowing and debt sustainability, especially in developing nations.

Globally, many studies focus on the relationship between debt and economic growth, illustrating both potential benefits and risks associated with public debt (Reinhart & Rogoff, 2010). Debt can support growth when well-managed, but excessive debt often constrains it due to rising interest burdens and limited fiscal flexibility (Panizza & Presbitero, 2013). Several developed countries have demonstrated success in balancing debt with growth through well-established financial markets and fiscal discipline, contrasting with the growing debt burdens seen in emerging and developing economies (World Bank, 2022). In contexts similar to Uganda, public debt is often linked to financing development projects, yet high borrowing costs and reliance on external financing increase susceptibility to debt distress (IMF, 2023).

Within Africa, the relationship between public debt and economic growth is complex. Studies suggest that, while debt has financed critical infrastructure and growth projects, rising debt-to-GDP ratios in many African nations have led to fiscal stress and unsustainable borrowing practices (Bua et al., 2014). Countries like Kenya, Ghana, and Zambia face rising debt-service obligations, primarily due to external borrowing, which strains government resources and limits social investment (Mbate, 2013).

Regionally, debt crises have triggered concerns about a debt trap, where countries rely on new borrowing to repay old debt. This scenario, which matches Uganda's debt-to-pay-debt syndrome, has been highlighted by researchers as a recurring challenge in Sub-Saharan Africa (Fenochietto & Pessino, 2013). Pan-African organizations, including the African Development Bank (AfDB), have emphasized the need for sustainable debt strategies, urging governments to diversify financing sources and improve debt management.

In Uganda, studies indicate that public debt has financed essential sectors, including infrastructure, health, and education, yet it has also raised sustainability concerns. Uganda's debt-to-GDP ratio has increased significantly over the past two decades, and scholars argue that the country risks entering a debt trap if current borrowing trends persist (MoFPED, 2023). Research within Uganda often highlights external debt reliance, fluctuating exchange rates, and debt servicing as factors contributing to this cycle (Musiita et al. 2021). Local scholars stress that without fiscal reforms and improved debt management practices, Uganda may struggle to meet the debt obligations limiting its capacity for future borrowing.

The debt-to-pay-debt syndrome, where new debt is continually acquired to service existing obligations, has significant economic consequences for Uganda. One primary concern is the erosion of fiscal stability, as the government becomes locked in a cycle of debt repayment that constrains budgetary resources (Tanzi, 1990). Instead of financing productive investments in infrastructure, health, and education, a substantial portion of the national budget is redirected towards debt service payments, limiting long-term economic growth (World Bank, 2022). This debt cycle exacerbates Uganda's reliance on external loans, heightening vulnerability to interest rate fluctuations, foreign exchange risk, and global economic downturns, which could further strain the economy and

reduce the government's capacity to address pressing domestic needs (Kasekende & Atingi-Ego, 2003).

Additionally, the debt-to-pay-debt cycle often leads to compromised social services and infrastructure development, as funds that could otherwise support these areas are allocated to debt servicing (IMF, 2023). This situation can fuel public dissatisfaction and reduce confidence in the government's fiscal management (Bukonya & Muhumuza, 2017). Furthermore, high levels of public debt may discourage private sector investment, as fears of potential tax increases or inflationary pressures rise to counterbalance government debt obligations (Akitoby et al., 2018). In the long term, this cycle may harm Uganda's creditworthiness and limit its access to favorable financing, ultimately hindering sustainable development and risking a prolonged debt trap that could take years or even decades to resolve (Collier, 2007).

The Debt Overhang Theory is central to this study. It posits that when a country's debt level becomes excessively high, expected debt servicing burdens discourage further investment, as investors anticipate future taxes and inflation (Krugman, 1988). Uganda's debt structure, where increasing debt obligations potentially deter private investment, aligns with this theory. Additionally, the Debt Laffer Curve suggests that beyond a certain threshold, additional debt leads to diminishing returns, reducing economic growth and creating a self-perpetuating debt cycle (Krugman, 1988). For Uganda, this implies that increasing debt may hamper long-term economic growth.

The conceptual framework for this study positions public debt as the dependent variable, influenced by both autoregressive (AR) and moving average (MA) factors as independent variables, through ARIMA modelling. This framework considers that historical patterns and recent fluctuations in debt are shaped by previous debts and economic shocks. ARIMA modelling is appropriate for capturing temporal patterns, enabling the study to forecast debt sustainability based on Uganda's debt history and macroeconomic context (Box & Jenkins, 1976). Through this framework, the study aims to analyze Uganda's debt-to-pay-debt syndrome, providing insights into debt sustainability and offering data-driven recommendations for managing Uganda's debt more sustainably.

Data and Methods

This study employs a quantitative research design to investigate Uganda's debt-to-pay-debt syndrome and assess the sustainability of public debt from 1980 to 2022. The quantitative approach is appropriate for capturing trends, forecasting debt trajectories, and determining the macroeconomic factors influencing public debt in Uganda (Gujarati & Porter, 2009). The study uses Uganda's debt (% of GDP) data from 1980 to 2022, sourced from the World Bank database (World Bank, 2023a), which provides reliable and comprehensive records of Uganda's public debt and related macroeconomic indicators over the years. No additional sampling was necessary as

the study period and dataset comprehensively cover the target variable across the full period of interest.

ARIMA, or Autoregressive Integrated Moving Average, is the analysis approach, chosen for its ability to identify trends in time series data and forecast future values based on historical trends (Box et al., 2015). ARIMA's structure, incorporating autoregressive (AR) and moving average (MA) components, makes it suitable for analyzing the cyclical nature (Hamilton, 1994) of Uganda's public debt over time.

The ARIMA (p, d, q) model specification is as follows:

$$Y_t = \mu + \varepsilon_t + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q} \quad (1)$$

Where Y_t is the value of the series at time t

μ is the mean of the series

ε_t is white noise

$\phi_1, \phi_2, \dots, \phi_p$ are the coefficients of the AR (p) component

$\theta_1, \theta_2, \dots, \theta_q$ are the coefficients of the MA (q) component

p is the order of the autoregressive part, representing the number of past values considered

q is the order of the moving average part, indicating the number of past errors considered

d is the number of differences required to make the series stationary (Box & Jenkins, 1976; Nahabwe & Kagarura, 2025)

Maximum Likelihood Estimation (MLE) is used to estimate model parameters, ensuring efficiency and accuracy in predicting debt sustainability (Lütkepohl, 2005). Maximum Likelihood Estimation process holds that for a given set of observations $X = \{x_1, x_2, \dots, x_n\}$ and assuming they follow a probability distribution with parameter θ , the likelihood function $L(\theta)$ is given by:

$$L(\theta) = P(X | \theta) = \prod_{i=1}^n f(x_i | \theta) \quad (2)$$

Where;

$f(x_1 | \theta)$ is the probability density function of the observed data point x_i given parameter θ

Thus

$$\hat{\theta} = \text{argmax} \ell(\theta) \quad (\text{Greene, 2018; Nahabwe \& Kagarura, 2025}).$$

Diagnostic tests, such as the Augmented Dickey-Fuller test for stationarity (Dickey & Fuller, 1979) and the model selection process using the Akaike Information Criterion (AIC) (Akaike, 1974), are used to validate the model's suitability. Using ARIMA modelling is particularly advantageous for studying debt sustainability, as it allows for analyzing past debt behavior to make reliable forecasts (Enders, 2014).

This method captures Uganda's debt trends, facilitating a robust assessment of whether current debt levels are sustainable. Additionally, ARIMA modelling's ability to handle non-stationary data aligns well with economic time series, where trends and

fluctuations often vary over time (Stock & Watson, 2015). This model's analytical rigor offers a strong foundation for drawing policy-relevant conclusions regarding Uganda's debt trajectory and guiding debt management strategies.

Results

This section presents findings from the study on investigating debt-to-pay-debt Syndrome in Uganda: An ARIMA Modelling Approach to Public Debt Sustainability, addressing the research objectives and questions. Maximum Likelihood Estimation (MLE) is applied for parameter estimation, complemented by diagnostic tests to ensure model robustness and validity.

Descriptive statistics are computed for the main variable (Appendix 1), shedding light on its central tendency and variability. The mean debt-to-GDP ratio is 45.50098%, indicating that, on average, Uganda's public debt comprised nearly 46% of the GDP over the study period. The median of 42.77013% is slightly lower than the mean, suggesting a modest positive skewness in the data. This implies that while the debt burden was often around 42 - 45%, some years experienced significantly higher debt levels.

The maximum debt-to-GDP ratio recorded is 103.2858% (1992), indicating that in the most extreme year public debt exceeded the country's GDP. The minimum of 10.99649% (2009), reflects periods of relatively low debt burdens, possibly due to prudent fiscal management or external debt relief. The wide range of 92.29 percentage points underscores the volatility in Uganda's debt levels over the years.

The standard deviation of 22.71552% highlights substantial variability in the debt-to-GDP ratio. This level of fluctuation suggests that Uganda's public debt experienced significant shifts, likely influenced by economic policies, borrowing practices, and global financial conditions.

The skewness of 0.444713 indicates a moderate positive skew. This means that while most debt levels are clustered around the mean, there are instances of higher-than-average debt, which pull the distribution slightly to the right. The kurtosis of 2.867082 is close to the normal distribution's reference value of 3. This suggests that the data distribution has a moderate peak with no extreme outliers.

The Jarque-Bera statistic of 1.449002 and a probability of 0.484566 indicate that the debt-to-GDP data follows a normal distribution. Since the p-value is greater than 0.05, the null hypothesis of normality cannot be rejected, supporting the suitability of ARIMA modelling for this dataset.

The sum of 1956.542 represents the cumulative debt-to-GDP ratios over 43 years. The sum of squared deviations of 21671.78 reflects the overall dispersion of the data from the mean. The dataset consists of 43 observations, corresponding to each year from 1980 to 2022.

Appendix 2 and Appendix 3 present the results of unit root tests, which indicate that the public debt series is non-stationary at level but becomes stationary after first

differencing. This finding suggests that the series is integrated of order one, I(1). Consequently, this confirms the appropriateness of using an ARIMA (Auto-Regressive Integrated Moving Average) model to analyze public debt sustainability.

The ARIMA model estimation focuses on both autoregressive (AR) and moving average (MA) components in the context of Uganda's public debt. The estimated ARIMA (1, 1, 11) model results are as follows:

Results of the ARIMA (1, 1, 11) model (Appendix 4)

$$DEBT_t = 0.024197 + 0.350489AR(1) + 0.298046MA(11) \quad (3)$$

Hence

$$\hat{\theta} = \begin{bmatrix} 0.024197 \\ 0.350489 \\ 0.298046 \end{bmatrix}$$

The constant term (0.024197) represents the baseline level of Uganda's public debt independent of AR and MA components. AR(1) coefficient, 0.350489 being positive and statistically significant, indicates that past debt values have a considerable effect on current debt levels. Specifically, it indicates that approximately 35% of the current year's debt is directed towards servicing the previous year's debt, thus perpetuating Uganda's debt-to-pay-debt syndrome.

MA (11) coefficient, 0.298046 being positive and statistically insignificant, implies that there is limited predictive impact on Uganda's debt at this lag. Sigma-Squared (84.56624), reflects the error variance in the model, suggesting variability in debt influenced by unexplained factors.

Additionally, the Adjusted R-squared value is 0.155293, indicating a moderate explanatory power of the model, while the Durbin-Watson statistic of 2.016654 suggests no strong autocorrelation in the residuals, validating the model's reliability in explaining Uganda's public debt trends.

The histogram of residuals for the ARIMA (1, 1, 11) model (Appendix 7) shows a kurtosis value of 3.267978, a Jarque-Bera statistic of 0.940757, and a p-value of 0.624766. These results suggest that the residuals are approximately normally distributed, indicating the robustness and suitability of the ARIMA model for forecasting public debt trends in Uganda.

The Ljung-Box Q statistic/ test results (Appendix 5) indicate that we fail to reject the null hypothesis, suggesting that the residuals of the ARIMA (1, 1, 11) model are white noise. This outcome confirms that there is no significant autocorrelation within the residuals, validating the model's adequacy.

Further diagnostics of the ARIMA (1, 1, 11) structure (Appendix 6) reveal that the AR and MA roots are covariance stationary and invertible, as they lie within the unit circle. This is a critical condition for the model's reliability in forecasting. Forecasts of Uganda's debt-to-pay-debt trajectory for the upcoming decade are provided in Appendix 7 and Appendix 8, offering a projected outlook on public debt sustainability in the country.

Discussion

This study investigates Uganda's public debt dynamics within the framework of the debt-to-pay-debt syndrome, examining its sustainability through ARIMA modelling. By focusing on debt sustainability from 1980 to 2022, the study provides unique insights into Uganda's debt structure, comparing these with prior research on public debt sustainability, specifically in developing economies.

Previous studies on debt sustainability, such as Aizenman and Jinjarak (2009), reveal that debt accumulation in developing countries often arises from the need to finance short-term economic goals, particularly in infrastructure and social services. Similar to findings by Presbitero (2012), our analysis demonstrates that Uganda's debt reliance has periodically intensified, particularly in response to external shocks and economic slowdowns, resulting in temporary debt financing of prior debt obligations. The ARIMA model forecasts suggest that without structural adjustments, debt may continue to rise in a self-sustaining cycle, in line with Presbitero's findings that external debt exposure increases when fiscal policies rely on debt-financed growth.

A unique aspect of this study is its application of ARIMA modelling to predict future debt behavior, setting it apart from studies that rely solely on historical or cross-sectional analysis (Reinhart & Rogoff, 2010). This approach provides dynamic insights into potential future debt paths, enabling policymakers to anticipate debt trajectories and consider preventative interventions. The results indicate that Uganda's debt levels may remain unsustainable without significant changes in fiscal and economic policies, resonating with Gupta et al. (2005), who found that sustainable debt management requires structural fiscal reforms.

In contrast with studies focusing solely on developed economies, our findings suggest that Uganda's reliance on debt is compounded by macroeconomic volatility, an observation also made by Ndikumana and Boyce (2011) in their examination of Sub-Saharan Africa. Our analysis extends these insights by illustrating how ARIMA's time-series model can reveal specific growth phases and downturns, unique to Uganda's economic cycle. Furthermore, this research reveals that debt servicing demands in Uganda are highly sensitive to macroeconomic stability factors, such as foreign investment inflows and inflation, factors less emphasized in studies on stable economies (Clements et al., 2003).

Limitations

This study on Uganda's debt sustainability using an ARIMA modelling approach has several limitations. First, the reliance on historical data from the World Bank, while comprehensive, may limit the scope to past trends, potentially missing more recent developments in public debt influenced by emerging economic or political factors (World Bank, 2022). Additionally, the use of ARIMA modelling assumes linear relationships and stationarity, which may oversimplify the complexities of public debt dynamics in Uganda (Box & Jenkins, 1976).

The sample period, 1980-2022, provides valuable long-term insights but may overlook short-term fluctuations or structural breaks due to major economic reforms or shocks (Hamilton, 1994). Furthermore, while ARIMA models are effective for time-series forecasting, they may not fully capture the causal mechanisms driving debt accumulation or sustainability, limiting the interpretive depth regarding factors contributing to Uganda's debt-to-pay-debt cycle (Enders, 2015). These constraints highlight the need for future studies to integrate additional models, such as structural vector autoregression or cointegration techniques, to enhance understanding of debt sustainability in similar contexts (Engle & Granger, 1987).

The study on Uganda's debt-to-pay-debt syndrome has shed light on the intricate dynamics of public debt sustainability through the lens of ARIMA modelling, underscoring the importance of understanding the structural factors that contribute to debt accumulation and the management challenges involved (Lütkepohl, 2005). By employing a robust quantitative framework, the research elucidates the critical role of historical debt behaviors in shaping future fiscal outcomes (World Bank, 2023b). The findings suggest that Uganda's reliance on existing debt to finance new obligations may pose significant risks to its economic stability and long-term growth prospects (IMF, 2022). Moreover, the insights from this study underscore the need for a multifaceted approach to debt management for policymakers, incorporating fiscal reforms and strategic investments that bolster revenue generation while mitigating adverse effects of rising public debt (Reinhart & Rogoff, 2010). This research contributes to a deeper understanding of debt sustainability in Uganda, paving the way for future studies to explore the complex interplay between economic variables and public finance management in the region (Lütkepohl, 2005; IMF, 2022).

Conclusion

The study on Uganda's debt-to-pay-debt syndrome has shed light on the intricate dynamics of public debt sustainability through the lens of ARIMA modelling. It highlights the importance of understanding the structural factors that contribute to the accumulation of debt and cause challenges associated with its effective managing. By employing a robust quantitative framework, the research elucidates the critical role of past debt behaviors in shaping future fiscal outcomes. The findings suggest that

Uganda's reliance on existing debt to finance new obligations may pose significant risks to its economic stability and long-term growth prospects. Moreover, the insights gained from this study emphasize the necessity for policymakers to adopt a multifaceted approach to debt management, incorporating comprehensive fiscal reforms and strategic investments that enhance revenue generation while mitigating the adverse effects of rising public debt. Ultimately, this research contributes to a deeper understanding of debt sustainability in Uganda, paving the way for future studies to explore the complex interplay between economic variables and public finance management in the region.

Recommendations

Based on the findings of this study regarding Uganda's debt-to-pay-debt syndrome, several key recommendations are made for policymakers, practitioners, and researchers (Reinhart & Rogoff, 2010). The Ugandan government should implement comprehensive debt management policies that focus on reducing reliance on debt, which includes establishing stricter fiscal rules that limit borrowing to essential projects with high returns on investment (IMF, 2022). Strengthening the legal and institutional framework for public debt management will enhance transparency and accountability in borrowing practices (World Bank, 2023b).

To alleviate the pressure of public debt, it is crucial to diversify revenue sources beyond traditional tax bases, which can be achieved through the development of new sectors, such as digital economies, the oil sector and green technologies sector, to generate additional tax revenues (Lütkepohl, 2005). Furthermore, enhancing the efficiency of tax collection mechanisms can increase government revenue without raising tax rates (IMF, 2022). The government should also invest in capacity-building programs for financial management within public institutions: training for government officials on effective debt management strategies and fiscal planning can improve Uganda's ability to manage its public debt sustainably (World Bank, 2023b).

Future research could explore additional macroeconomic factors influencing public debt sustainability in Uganda, such as political stability and external economic shocks, with enhanced data collection on debt dynamics and economic indicators for a more nuanced understanding of Uganda's debt drivers (Reinhart & Rogoff, 2010). Strengthening regional economic cooperation could provide mutual benefits in debt management; collaborating with neighboring countries on fiscal policies and sharing best practices can help Uganda adopt more effective strategies for debt sustainability and economic resilience (IMF, 2022). Further research employing longitudinal approaches is recommended to scrutinize the long-term effects of public debt on Uganda's economic growth and development, providing a comprehensive understanding of the impacts of past borrowing practices and guiding future policy decisions (World Bank, 2023b).

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Appendix 1

Descriptive statistics

	DEBT (% of GDP)
Mean	45.50098
Median	42.77013
Maximum	103.2858
Minimum	10.99649
Std. Dev.	22.71552
Skewness	0.444713
Kurtosis	2.867082
Jarque-Bera	1.449002
Probability	0.484566
Sum	1956.542
Sum Sq. Dev.	21671.78
Observations	43

Appendix 2

Unit root test, DEBT (in Level)

Null Hypothesis: DEBT has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.216984	0.2036
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

* MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DEBT)

Method: Least Squares

Date: 12/16/24 Time: 10:12

Sample (adjusted): 3 43

Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEBT(-1)	-0.149331	0.067358	-2.216984	0.0327
D(DEBT(-1))	0.419845	0.147164	2.852901	0.0070
C	6.604286	3.409892	1.936802	0.0602
R-squared	0.220689	Mean dependent var		-0.246602
Adjusted R-squared	0.179673	S. D. dependent var		10.64343
S. E. of regression	9.639955	Akaike info criterion		7.440066
Sum squared resid	3531.292	Schwarz criterion		7.565449
Log likelihood	-149.5213	Hannan-Quinn criter.		7.485723
F-statistic	5.380519	Durbin-Watson stat		2.120715
Prob(F-statistic)	0.008760			

Appendix 3

Unit root test, DEBT (in First difference)

Null Hypothesis: D(DEBT) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.341623	0.0013
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

* MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DEBT,2)

Method: Least Squares

Date: 12/16/24 Time: 10:14

Sample (adjusted): 3 43

Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DEBT(-1))	-0.653214	0.150454	-4.341623	0.0001
C	-0.178387	1.579544	-0.112936	0.9107
R-squared	0.325839	Mean dependent var		-0.049895
Adjusted R-squared	0.308553	S. D. dependent var		12.16096
S. E. of regression	10.11224	Akaike info criterion		7.512921
Sum squared resid	3988.039	Schwarz criterion		7.596510
Log likelihood	-152.0149	Hannan-Quinn criter.		7.543359
F-statistic	18.84969	Durbin-Watson stat		2.006925
Prob(F-statistic)	0.000097			

Appendix 4

Results of the ARIMA (1, 1, 11) model

Dependent Variable: D(DEBT)

Method: ARMA Maximum Likelihood (OPG - BHHH)

Date: 12/16/24 Time: 10:37

Sample: 2 43

Included observations: 42

Convergence achieved after 19 iterations

Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024197	3.069880	0.007882	0.9938
AR(1)	0.350489	0.125571	2.791170	0.0082
MA(11)	0.298046	0.210971	1.412733	0.1659
SIGMASQ	84.56624	20.89924	4.046379	0.0002
R-squared	0.217100	Mean dependent var		-0.302604
Adjusted R-squared	0.155293	S. D. dependent var		10.51909
S. E. of regression	9.667883	Akaike info criterion		7.493369
Sum squared resid	3551.782	Schwarz criterion		7.658862
Log likelihood	-153.3608	Hannan-Quinn criter.		7.554029
F-statistic	3.512506	Durbin-Watson stat		2.016654
Prob(F-statistic)	0.024208			
Inverted AR Roots		.35		
Inverted MA Roots	.86+.25i	.86-.25i	.59+.68i	.59-.68i
	.13-.89i	.13+.89i	-.37-.81i	-.37+.81i
	-.75+.48i	-.75-.48i		-.90

Appendix 5

Ljung-Box Q statistic/ test

Date: 12/16/24 Time: 10:48

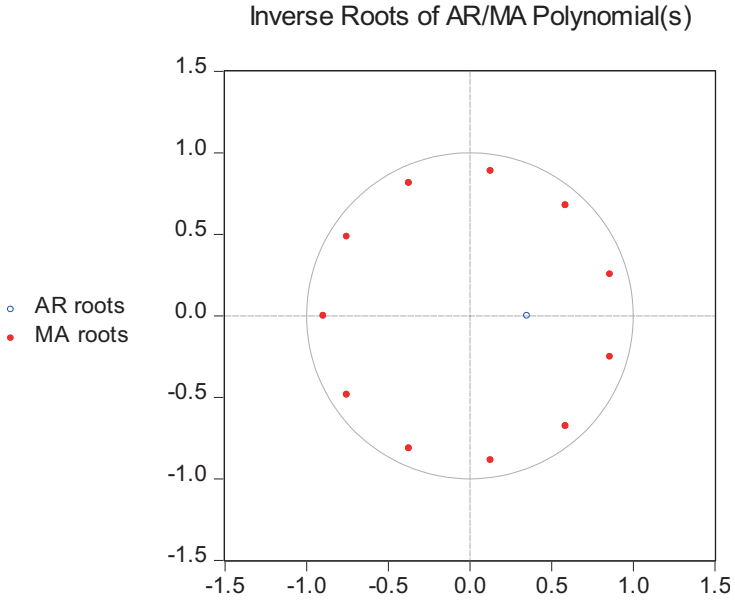
Sample: 1 43

Included observations: 42

Q-statistic probabilities adjusted for 2 ARMA terms

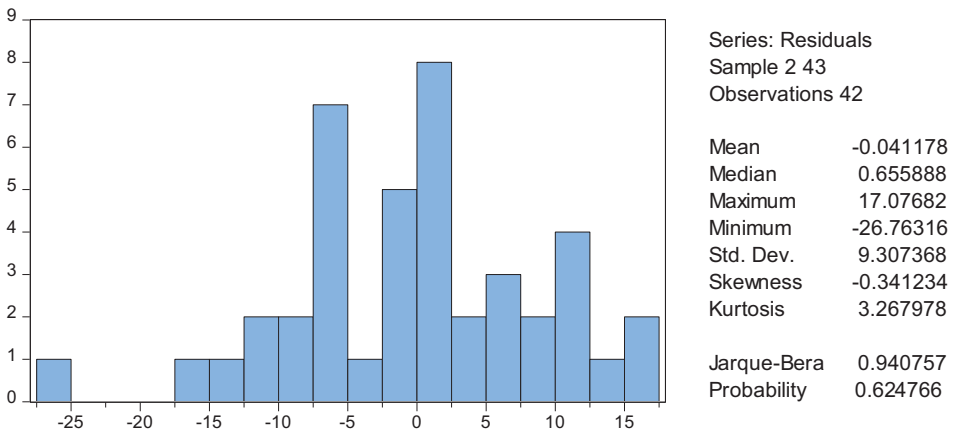
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. .	. .	1	-0.014	-0.014	0.0086	
. *	. *	2	0.131	0.131	0.8070	
. * .	. * .	3	-0.092	-0.090	1.2083	0.272
. .	. .	4	-0.037	-0.057	1.2764	0.528
. * .	. * .	5	-0.115	-0.095	1.9420	0.585
. .	. .	6	0.062	0.067	2.1369	0.711
. * .	. * .	7	-0.130	-0.115	3.0302	0.695
. .	. * .	8	-0.048	-0.090	3.1558	0.789
. .	. .	9	-0.048	-0.019	3.2846	0.857
. * .	. * .	10	-0.092	-0.105	3.7772	0.877
. .	. .	11	0.051	0.048	3.9329	0.916
. .	. .	12	0.049	0.033	4.0803	0.944
. .	. .	13	-0.005	-0.038	4.0816	0.967
. * * .	. * * .	14	-0.206	-0.252	6.8851	0.865
. * .	. * * .	15	-0.199	-0.252	9.6066	0.726
. .	. *	16	0.030	0.096	9.6717	0.786
. * .	. * .	17	-0.105	-0.137	10.485	0.788
. .	. * .	18	0.012	-0.118	10.496	0.839
. .	. .	19	-0.005	-0.060	10.497	0.881
. .	. * .	20	-0.022	-0.088	10.539	0.913

Appendix 6



ARIMA (1, 1, 11) structure

Appendix 7



Histogram of residuals

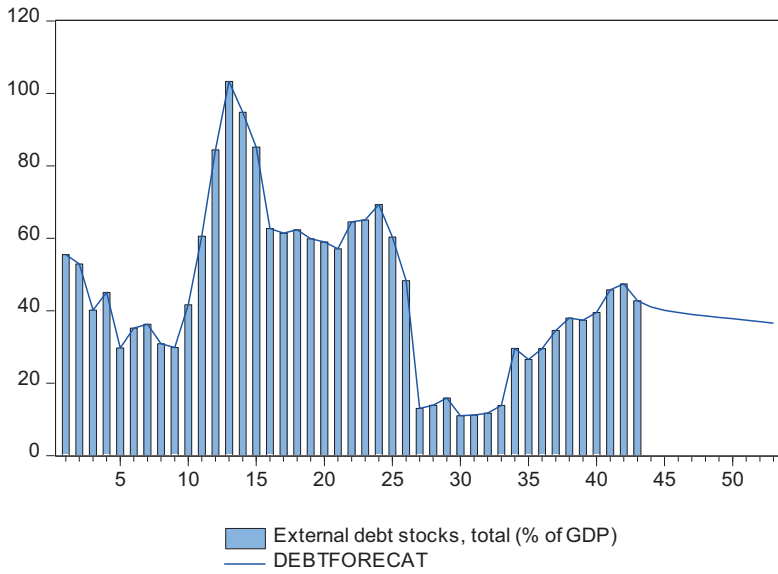
Appendix 8

Uganda's debt and debt forecast results

YEAR	DEBT	DEBTFORECAST
1980	55.47948	55.47948
1981	52.88081	52.88081
1982	40.15655	40.15655
1983	45.03978	45.03978
1984	29.71108	29.71108
1985	35.1896	35.1896
1986	36.26862	36.26862
1987	30.87331	30.87331
1988	29.8169	29.8169
1989	41.62183	41.62183
1990	60.53861	60.53861
1991	84.39234	84.39234
1992	103.2858	103.2858
1993	94.79607	94.79607
1994	85.143	85.143
1995	62.69789	62.69789
1996	61.38117	61.38117
1997	62.33245	62.33245
1998	59.86352	59.86352
1999	58.97978	58.97978
2000	57.08068	57.08068
2001	64.51833	64.51833
2002	65.06064	65.06064
2003	69.28701	69.28701
2004	60.32428	60.32428
2005	48.27787	48.27787
2006	13.03611	13.03611
2007	13.88832	13.88832
2008	15.8781	15.8781

YEAR	DEBT	DEBTFORECAST
2009	10.99649	10.99649
2010	11.15193	11.15193
2011	11.70571	11.70571
2012	13.82899	13.82899
2013	29.60292	29.60292
2014	26.52799	26.52799
2015	29.5509	29.5509
2016	34.53699	34.53699
2017	37.96673	37.96673
2018	37.40121	37.40121
2019	39.52434	39.52434
2020	45.76344	45.76344
2021	47.41451	47.41451
2022	42.77013	42.77013
2023	NA	41.01099
2024	NA	40.07974
2025	NA	39.47412
2026	NA	38.99659
2027	NA	38.56944
2028	NA	38.1621
2029	NA	37.76255
2030	NA	37.36608
2031	NA	36.97081
2032	NA	36.57601

Appendix 9



Graph showing Uganda's debt and debt forecast results