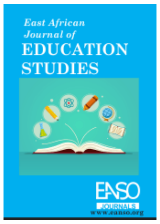
East African Journal of Education Studies, Volume 8, Issue 2, 2025
Article DOI: https://doi.org/10.37284/eajes.8.2.3333



East African Journal of Education Studies
eajes.eanso.org
Volume 8, Issue 2, 2025
Print ISSN: 2707-3939 | Online ISSN: 2707-3947
Title DOI: https://doi.org/10.37284/2707-3947

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation

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Article DOI: https://doi.org/10.37284/eajes.8.2.3333

Date Published:

16 July 2025

Keywords:

ARIMA, Out-of-school, Primary-age Children, Burkina Faso.

ABSTRACT

We empirically unmask a persistent challenge of out-of-school primary-age children in Burkina Faso. Utilising time-series data from the World Bank spanning 1971 to 2023, we apply the Autoregressive Integrated Moving Average (ARIMA) modelling technique to analyse trends in the percentage of primary-age children not enrolled in school. The Dependent Variable is Children out of school (% of primary school age), while moving average (MA) and autoregressive (AR) components function as independent variables. Parameter estimation using Conditional Least Squares reveals a statistically significant MA (6) coefficient of -0.817231, suggesting that approximately 82% of the shock in current out-of-school rates is explained by past errors. AR (1) coefficient of -0.565318 indicates that about 57% of the variation is influenced by its immediate past value. We find a strong trend of educational exclusion and thus recommend that policymakers design timely and data-driven interventions aimed at achieving universal primary education and meeting Sustainable Development Goal 4 (SDG 4) targets in Burkina Faso.

APA CITATION

Rwamparagi, K. W. & John, N. P. J. (2025). Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation. *East African Journal of Education Studies*, *8*(*2*), 1114-1130. https://doi.org/10.37284/eajes.8.2.3333

CHICAGO CITATION

Rwamparagi, Kagarura Willy and Nahabwe Patrick Kagambo John. 2025. "Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation". *East African Journal of Education Studies* 8 (2), 1114-1130. https://doi.org/10.37284/eajes.8.2.3333

HARVARD CITATION

Rwamparagi, K. W. & John, N. P. J. (2025) "Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation". *East African Journal of Education Studies*, 8(2), pp. 1114-1130. doi: 10.37284/eajes.8.2.3333

IEEE CITATION

K. W., Rwamparagi & N. P. J., John "Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation". *EAJES*, vol. 8, no. 2, pp. 1114-1130, Jul. 2025.

MLA CITATION

Rwamparagi, Kagarura Willy & Nahabwe Patrick Kagambo John "Unmasking the Curse of out-of-School Primary-Age Children in Burkina Faso: an Empirical Investigation". *East African Journal of Education Studies*, Vol. 8, no. 2, Jul. 2025, pp. 1114-1130, doi:10.37284/eajes.8.1.3333

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

INTRODUCTION

Access to primary education is widely recognised as a cornerstone for sustainable development and poverty alleviation (UNESCO, 2015). However, many developing countries, particularly in Sub-Saharan Africa, continue to grapple with high rates of out-of-school children, undermining progress toward universal education goals. In Burkina Faso, this challenge has persisted for decades, with an average of 62% of primary school-age children remaining out of school since the 1970s (World Bank, 2023). This enduring educational exclusion poses significant threats to human capital development, gender equity, and long-term socio-economic transformation.

Several interrelated factors contribute to this crisis, including poverty, conflict, child labour, gender disparities, and inadequate educational infrastructure (UNICEF, 2019; Avenstrup et al., 2006). Burkina Faso's situation is further exacerbated by political instability and recurrent security threats, which have forced school closures in many regions (Human Rights Watch, 2022). Despite numerous policy interventions and international assistance, the country continues to register some of the highest out-of-school rates globally, raising urgent questions about the effectiveness of current educational strategies.

The research problem addressed in this study is the persistently high percentage of out-of-school primary-age children in Burkina Faso, which reflects a systemic and multidimensional crisis. While previous studies have explored determinants of school enrollment using cross-sectional or qualitative approaches (Kattan & Burnett, 2004; Filmer, 2005), limited efforts have been made to apply time-series forecasting methods to model and predict trends in school exclusion.

The rationale for the study lies in the need for data-driven forecasting tools that can support educational planning and early-warning systems. By employing the autoregressive integrated moving average (ARIMA) modelling technique, the study seeks to uncover temporal patterns in educational exclusion and generate actionable insights for policymakers. Our findings will contribute to the literature on education in fragile contexts and support Burkina Faso's efforts to achieve Sustainable Development Goal 4, ensuring inclusive and equitable quality education for all.

LITERATURE REVIEW

Globally, out-of-school children remain a central concern in pursuit of Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education for all by 2030 (UNESCO, 2015). As of 2022, an estimated 244 million children and youth globally were out of school, with primary-age children accounting for a significant portion (UNESCO, 2022). Studies attribute this phenomenon to socioeconomic inequality, child labour, poor school infrastructure, and armed conflict (Lewin, 2009; Sabates et al., 2010). In many low-income countries, insufficient education financing and fragile institutional capacity undermine schooling efforts, especially among rural and marginalised populations (World Bank, 2018).

Sub-Saharan Africa bears the highest burden of out-of-school children globally, with over 20% of primary school-age children not attending school as of 2021 (UNICEF, 2022). Regional studies indicate that poverty, gender inequality, early marriage, and linguistic barriers significantly contribute to this crisis (Bashir et al., 2018; Gove & Cvelich, 2011). Armed conflicts, especially in the Sahel region, have exacerbated educational exclusion by causing mass displacement and destruction of schools (NRC, 2021). Forecasting models and time series analyses remain underutilised in this context, limiting policymakers' ability to anticipate and plan for education needs effectively (Asim et al., 2017).

Burkina Faso has consistently ranked among the worst-performing countries in terms of education access. Historical data shows that since the 1970s,

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

the country has experienced an average of 62% of primary-age children being out of school (World Bank, 2023). Localised barriers include socio-cultural practices, inadequate teacher deployment, insecurity due to terrorism, and geographic inaccessibility of schools (Human Rights Watch, 2022). Despite various government interventions, such as the 10-Year Basic Education Development Plan (PDDEB), progress has remained sluggish and uneven (Ministère de l'Éducation Nationale, 2019).

Our study is grounded in the Human Capital Theory, which posits that education is a critical investment in individual productivity and national economic growth (Becker, 1964). By failing to provide universal primary education, Burkina Faso potentially undermines its long-term human capital formation and economic competitiveness. Additionally, the Right to Education Framework, as established under international human rights law, frames access to education as a legal and moral obligation of the state (Tomasevski, 2006).

The conceptual framework guiding the study situates the percentage of out-of-school primary-age children as the dependent variable. Independent variables are the moving average (MA) and autoregressive (AR) components of error terms and past observations, which help capture temporal patterns and forecast future values. This framework allows for the empirical detection of persistence and shocks in the trend of educational exclusion, offering valuable insights for planning and intervention design.

DATA AND METHODS

We adopt a quantitative, time-series research design, tailored to investigate temporal patterns and underlying dynamics in the proportion of out-of-school primary-age children in Burkina Faso. Rationale for employing a time-series approach lies in its ability to capture long-term trends, seasonality, and stochastic behaviours in single-variable data over time (Gujarati & Porter, 2009). By focusing on historical trajectories, the research aims to uncover systematic patterns that may inform future policy interventions.

We utilise data sourced from the World Bank's World Development Indicators (WDI) database, a globally recognised and methodologically consistent source for macroeconomic and social statistics. The variable of interest is the percentage of primary school-age children out of school in Burkina Faso, measured annually from 1971 to 2023. The data span 53 years and provide a robust empirical basis for longitudinal analysis.

Given the nature of time-series data, we use complete annual observations from 1971 to 2023, comprising a census of available secondary data rather than a sampled subset. This approach ensures comprehensive coverage of the study period and increases the statistical power of the analysis (Enders, 2014). Time-series structure inherently controls for temporal ordering and autocorrelation, which are critical when analysing socio-educational phenomena over extended periods.

To model the underlying dynamics of out-of-school children over time, we employ the Autoregressive Integrated Moving Average (ARIMA) modelling technique. ARIMA models are particularly suited for time-series data with trend and autocorrelation components and allow for both autoregressive (AR) and moving average (MA) parameters, as well as differencing to address non-stationarity (Box et al.,2008). The general form of an ARIMA(p,d,q) model is expressed as:

$$Y_t = c + \sum_{i=1}^{p} \boldsymbol{\phi}_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t \quad \ldots\ldots (1)$$

Where;

Y_t is gold reserves at time t

c is a constant term

ε_t is white noise at time t

$\boldsymbol{\phi}_i$ are the coefficients of the autoregressive terms

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θ_j Are the coefficients of the moving average terms

p = Number of lagged AR terms

d = Number of differences required to make the series stationary

q = Number of lagged MA terms (Box & Jenkins 1976; Wooldridge, 2013)

We estimate parameters using the conditional least squares (CLS) method, employing Gauss-Newton/Marquardt steps for optimisation. The CLS method minimises the sum of squared residuals and provides efficient parameter estimates, particularly in the presence of autocorrelation and heteroskedasticity (Hamilton, 1994). The Gauss-Newton/Marquardt algorithm is suitable for non-linear optimisation problems, ensuring convergence to a local minimum and improving estimation accuracy (Marquardt, 1963; Wooldridge, 2013). The CLS estimator for the regression coefficients is given by the following formula:

$$\hat{\theta} = \underset{\theta}{\operatorname{argmin}}[\sum_{t=1}^{n}(y_t - \hat{y}_t(\theta))^2] \quad \text{...(2)}$$

Where:

$\hat{\theta}$ represents the estimated parameter vector (which includes both AR and MA parameters in ARIMA).

y_t represents the actual observed value of the dependent variable at time t

$\hat{y}_t(\theta)$ represents the model's predicted value at time t based on the parameter estimates θ

n is the number of observations. (Hamilton, 1994).

Prior to estimation, stationarity is assessed using the Augmented Dickey-Fuller (ADF) test. The best-fitting ARIMA model is selected based on the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). Estimation of model parameters was performed using Conditional Least Squares (CLS), a robust method appropriate for estimating ARIMA parameters in relatively short or medium-length time series (Makridakis et al. 1998). Diagnostic checks, including residual autocorrelation (Ljung–Box Q test) and normality, were conducted to validate model adequacy.

Use of ARIMA and conditional least squares is well-justified in time-series research, particularly when the goal is to uncover hidden patterns and forecast trends in social indicators (Hyndman & Athanasopoulos, 2018). Unlike cross-sectional or panel models, ARIMA focuses exclusively on a single country's longitudinal data, making it ideal for country-specific policy analysis. Furthermore, ARIMA accommodates non-stationarity and autocorrelated disturbances, the common challenges in socio-educational data spanning multiple decades (Stock & Watson, 2015).

RESULTS AND THEIR DISCUSSION

Descriptive analysis of the out-of-school children (% of primary school age) in Burkina Faso over the period 1971–2023 (Appendix 1) reveals alarming insights. The mean percentage of out-of-school primary-age children stands at 61.99%, while the median is 67.05%, indicating that over half of the children in this age category have persistently been excluded from the formal education system. The maximum value recorded is 89.72% (1971), suggesting a peak in educational exclusion, while the minimum of 24.27% (2018) reflects a historical low point in recent decades. The standard deviation of 21.83 indicates considerable variability in the data, which reflects the instability and inconsistent educational policy outcomes over the study period.

The negative skewness (-0.399) suggests a slight left-tailed distribution, meaning relatively fewer years experienced very low rates of exclusion, whereas the kurtosis of 1.70 denotes a platykurtic distribution, less peaked than a normal distribution, indicating light tails and fewer extreme deviations. The Jarque-Bera statistic (5.11) and associated p-value (0.0777) imply that the null hypothesis of normality cannot be rejected at the 5% significance level, thereby validating the suitability of

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

parametric time-series modelling (Gujarati & Porter, 2009). Stationarity tests using Augmented Dickey-Fuller show the original series is non-stationary (p>0.05) in level and in first difference but achieves stationarity upon second differencing (p<0.05). Consequently, an ARIMA (1,2,6) model is identified as the best fit based on model selection criteria (AIC=299090; SC=4.413812; H-QC = 4.342777).

Inferential statistics using model output are estimated as follows:

Results of ARIMA (1,2,6) model (Appendix 5)

$\widehat{Children\_out\_of\_school}_t$ = 0.073792 - 0.5653AR(1) - 0.8172MA(6) …..................… (3)

Hence,

$$\hat{\theta}_{CLS} = \begin{bmatrix} 0.073792 \\ -0.5653 \\ -0.8172 \end{bmatrix}$$

Constant term in ARIMA (1,2,6) model is estimated at 0.073792 with a p-value of 0.3658, indicating that it is statistically insignificant. This suggests that, once the autoregressive and moving average components are accounted for, there is no consistent drift or deterministic trend in the change of out-of-school children over time. AR (1) coefficient is -0.5653 and statistically significant (p = 0.0000), indicating that changes in the number of out-of-school primary-age children are inversely related to the previous year's changes. Such dynamics may be indicative of reactive policy interventions or societal responses that attempt to correct previous year's increases or decreases in out-of-school rates, albeit temporarily. MA(6) coefficient is -0.8172 (p = 0.0000), signifying a strong and statistically significant moving average effect at the sixth lag. This result highlights that shocks or fluctuations in the out-of-school rate six years prior continue to have a prolonged influence on the current values. This suggests policy inertia or structural lag, where education system responses to crises or reforms take several years to materialise fully.

The adjusted R-squared value of 0.2276 indicates that approximately 23% of the variation in the first-differenced out-of-school rate is explained by the model. While modest, this is acceptable in social science research involving complex, long-term time series data (Stock & Watson, 2015). The Durbin-Watson statistic of 2.0161 is close to the ideal value of 2, suggesting that residuals are not autocorrelated, thereby affirming model reliability in capturing the underlying structure. Ljung-Box Q-statistic (p = 0.064) supports the null hypothesis of no autocorrelation in the residuals at the 5% level, reinforcing the adequacy of the model's fit. Furthermore, the stationarity of AR and MA roots (Appendix 7) confirms that the model is covariance stationary, a prerequisite for valid inference in time series modelling.

ARIMA (1,2,6) model simulation for 1971-2050 (Appendices 9 & 10) reveals fluctuating trends in out-of-school primary-age children in Burkina Faso, indicating long-term instability and delayed effects of shocks. The need for second differencing suggests structural volatility in school attendance due to economic and conflict-related disruptions (Winthrop & Kharas, 2018; Human Rights Watch, 2022). The model highlights the lasting impact of crises on education, emphasising the importance of building resilient education systems and sustained policy interventions to prevent long-term exclusion (UNESCO, 2015; Bashir et al., 2018; Avenstrup et al., 2006). However, tests for residual normality (Appendix 8) reveal deviations from normal distribution, which may affect inference precision. While this does not invalidate the model, it suggests caution in interpreting significance levels and may reflect the non-Gaussian nature of real-world education data in fragile contexts (Enders, 2015).

Our empirical results align with regional trends where countries in the Sahel region, including Burkina Faso, continue to face systemic obstacles in achieving universal primary education. Key barriers such as poverty, gender inequality, limited rural infrastructure, and insecurity have been repeatedly

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

cited in policy reports and academic research (UNESCO, 2022). The persistently high mean rate (62%) of out-of-school primary-age children in Burkina Faso is starkly higher than the global average of 8% in low- and middle-income countries (UNICEF, 2021), highlighting the depth of exclusion. This divergence indicates that while global efforts have significantly reduced exclusion elsewhere, Burkina Faso remains trapped in education stagnation. Furthermore, the negative AR(1) and significant MA(6) terms imply that while short-term gains may be made, likely in response to targeted interventions, they are often reversed or eroded over time. This supports the view that education policies in Burkina Faso have lacked sustained impact, possibly due to short-lived political commitments, fragile funding, or social instability (Haavik et al., 2022).

Novelty of these findings lies in the application of ARIMA time-series modelling, which has been underutilised in educational development research, especially for long-run assessments in Sub-Saharan Africa. Most previous studies focus on cross-sectional or short-term evaluations, whereas this analysis captures historical inertia and long-term volatility in education participation. It provides a quantitative historical lens spanning over five decades (1971-2023), offering a rare longitudinal perspective on the education exclusion crisis in Burkina Faso. By employing a rigorous ARIMA(1,2,6) model, it unearths both short-term policy responsiveness and long-term structural inertia, thus expanding the analytical tools available for education policy analysis in developing contexts. The study establishes that lagged effects of up to six years are statistically significant, revealing the temporal persistence of educational shocks and underscoring the need for consistent, multi-year investments in educational reform.

LIMITATIONS

Despite offering valuable insights into the long-term dynamics of primary-age children out of school in Burkina Faso, this study is not without limitations. These constraints pertain to the research design, data source, sample period, and analytical methods, each of which may have affected the robustness or generalizability of the findings. Firstly, the time-series research design, while effective for analysing long-term trends, inherently limits causal inference. The study does not incorporate covariates or exogenous variables that could influence out-of-school rates, such as household income, conflict, policy shifts, or gender norms. As such, the model captures statistical associations rather than causal mechanisms (Enders, 2015).

Secondly, we based exclusively on annual national-level data from the World Development Indicators (WDI), which, while reliable, lacks granular disaggregation by region, gender, or socioeconomic status. This limitation restricts the ability to uncover within-country disparities that are often critical in understanding the root causes of educational exclusion (UNESCO, 2022). In a context like Burkina Faso, marked by regional inequalities and security-related disruptions, aggregated national data may mask important localised dynamics (UNICEF, 2021).

Thirdly, while the ARIMA model is well-suited for capturing time-dependent patterns and addressing non-stationarity, it may not be the most appropriate tool for modelling structural breaks or non-linear shocks, such as those caused by conflict, pandemics, or major reforms. ARIMA assumes linearity and fixed parameters over time, which may not hold in real-world contexts where education systems experience abrupt policy changes or disruptions (Gujarati & Porter, 2009).

Moreover, the model's modest adjusted R-squared value (0.23) implies that a substantial portion of the variation remains unexplained. This suggests that omitted variables such as government spending on education, teacher availability, or cultural attitudes could improve model accuracy if included. Additionally, while the Jarque-Bera test revealed non-normality in residuals, the implications for

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

statistical inference are unclear, especially given the relatively small sample size (n = 53). Non-normality in residuals can reduce the reliability of p-values and confidence intervals, potentially affecting hypothesis testing (Stock & Watson, 2015).

Finally, the exclusive use of quantitative methods means the study lacks qualitative insights into the lived experiences of affected children and households. A mixed-methods approach could have provided richer contextual understanding and triangulated the quantitative findings with human-centred narratives (Creswell, 2014).

CONCLUSION AND RECOMMENDATION

Conclusion

Our findings reveal an entrenched and persistent nature of educational exclusion in Burkina Faso, specifically among primary school-age children. The issue transcends temporary setbacks or data anomalies and instead represents a chronic development challenge rooted in structural and systemic impediments. Our study has shown that while time-series techniques like ARIMA are powerful in identifying patterns and forecasting educational exclusion, the underlying issue reflects deep-seated socio-economic, political, and institutional barriers that cannot be addressed through surface-level interventions alone. It is a manifestation of both historical neglect and contemporary instability, echoing what scholars refer to as “the long emergency” of education in low-income, conflict-prone settings (Winthrop & Kharas, 2018).

From a developmental lens, the persistence of high out-of-school rates undermines broader goals of human capital formation, economic mobility, and sustainable development. The exclusion of children from foundational education jeopardises the intergenerational transfer of knowledge, skills, and opportunity, thus trapping communities in cycles of poverty and marginalisation (World Bank, 2018). Moreover, the inability to enrol and retain children in school is symptomatic of broader governance issues ranging from inadequate resource allocation to weak education sector coordination and planning (UNESCO, 2022). These complex layers of failure call for a multi-sectoral response, integrating education with health, social protection, and peacebuilding efforts.

Ultimately, our study underscores the urgent need for targeted, evidence-based, and forward-looking policies that do not merely respond to short-term fluctuations but proactively reshape the educational landscape. It affirms the relevance of long-term modelling in understanding social challenges that unfold over decades, particularly in under-researched settings like Burkina Faso. Importantly, this research contributes methodologically to the education policy discourse by illustrating the utility of time-series analysis in contexts where data scarcity often limits longitudinal research. The future of Burkina Faso’s development will depend heavily on the capacity of its institutions, partners, and communities to break the cycle of educational exclusion and build inclusive, resilient systems of learning.

Recommendations

Given the persistence and recurrence of high out-of-school rates among primary-age children in Burkina Faso, national education policy must prioritise long-term, adaptive planning frameworks. The significant autoregressive and moving average patterns found in the study suggest that reactive, short-lived policies are insufficient. Therefore, the Ministry of National Education and Literacy (MENA) should adopt a National Education Early Warning System (NEEWS) to monitor trends and predict enrollment shortfalls, enabling preemptive interventions (UNESCO, 2022). Moreover, policy harmonisation between education, social protection, and internal security sectors is vital, especially in conflict-affected rural zones where school abandonment is highest (Winthrop & Kharas, 2018).

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

Empirical evidence from the ARIMA (1,2,6) model highlights the importance of addressing both immediate and historical shocks affecting school attendance. In this regard, the government, with support from development partners, should implement multi-year school re-engagement programmes targeted at chronically excluded communities. These programmes should combine conditional cash transfers, community-based education models, and mobile classrooms, particularly in internally displaced and nomadic populations (UNICEF, 2021). Additionally, parent sensitisation campaigns focused on the economic and social value of education, especially for girls, should be expanded, as cultural attitudes remain significant barriers to schooling.

Our study confirms the utility of long-term time-series approaches like ARIMA in modelling education exclusion trends. However, future research could explore multivariate time-series models such as Vector Autoregression (VAR) or ARIMAX to integrate exogenous shocks like conflict intensity, public education spending, and child labour rates. Moreover, mixed-methods studies incorporating community narratives and administrative data can enrich understanding of the causality behind exclusion trends. Finally, establishing open-access educational exclusion dashboards based on real-time data can improve policy responsiveness and accountability (World Bank, 2018).

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Article DOI: https://doi.org/10.37284/eajes.8.2.3333

APPENDICES

Appendix 1: Descriptive Statistics

	Children out of school (% of primary school age)
Mean	61.99375
Median	67.0457
Maximum	89.72072
Minimum	24.26662
Std. Dev.	21.82986
Skewness	-0.399407
Kurtosis	1.705524
Jarque-Bera	5.109581
Probability	0.077709
Sum	3285.669
Sum Sq. Dev.	24780.24
Observations	53

Appendix 2: Unit Root Test, Children_out_of_School (in Level)

Null Hypothesis: CHILDREN_OUT_OF_SCHOOL has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.998996	0.9350
Test critical values:	1% level	-4.148465	
	5% level	-3.500495	
	10% level	-3.179617	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CHILDREN_OUT_OF_SCHOOL)
Method: Least Squares
Date: 05/21/25 Time: 02:28
Sample (adjusted): 1973 2023
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHILDREN_OUT_OF_SCHOOL(-1)	-0.060192	0.060253	-0.998996	0.3229
D(CHILDREN_OUT_OF_SCHOOL(-1))	0.620589	0.165458	3.750727	0.0005

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

C	5.160098	6.093620	0.846803	0.4014
@TREND("1971")	-0.061755	0.087880	-0.702722	0.4857

R-squared	0.244640	Mean dependent var	-0.930194
Adjusted R-squared	0.196426	S.D. dependent var	2.402054
S.E. of regression	2.153257	Akaike info criterion	4.447025
Sum squared resid	217.9163	Schwarz criterion	4.598541
Log likelihood	-109.3991	Hannan-Quinn criter.	4.504924
F-statistic	5.073997	Durbin-Watson stat	1.982827
Prob(F-statistic)	0.003989		

Appendix 3: Unit Root Test, Children_out_of_School (in First difference)

Null Hypothesis: D(CHILDREN_OUT_OF_SCHOOL) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.452500	0.3495
Test critical values:	1% level	-4.148465	
	5% level	-3.500495	
	10% level	-3.179617	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CHILDREN_OUT_OF_SCHOOL,2)
Method: Least Squares
Date: 05/21/25 Time: 02:27
Sample (adjusted): 1973 2023
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CHILDREN_OUT_OF_SCHOOL(-1))	-0.401978	0.163906	-2.452500	0.0179
C	-0.892809	0.648705	-1.376293	0.1751
@TREND("1971")	0.023611	0.020514	1.151003	0.2554

R-squared	0.137730	Mean dependent var	0.198338
Adjusted R-squared	0.101802	S.D. dependent var	2.271960
S.E. of regression	2.153212	Akaike info criterion	4.428821
Sum squared resid	222.5435	Schwarz criterion	4.542458
Log likelihood	-109.9349	Hannan-Quinn criter.	4.472245
F-statistic	3.833504	Durbin-Watson stat	1.971728
Prob(F-statistic)	0.028539		

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

Appendix 4: Unit Root Test, Children_out_of_School (in Second difference)

Null Hypothesis: D(CHILDREN_OUT_OF_SCHOOL,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.732633	0.0000
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CHILDREN_OUT_OF_SCHOOL,3)
Method: Least Squares
Date: 05/21/25 Time: 02:19
Sample (adjusted): 1974 2023
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CHILDREN_OUT_OF_SCHOOL(-1),2)	-1.412950	0.145177	-9.732633	0.0000
C	-0.664174	0.649783	-1.022147	0.3119
@TREND("1971")	0.032583	0.020962	1.554344	0.1268

R-squared	0.669579	Mean dependent var	0.130770
Adjusted R-squared	0.655519	S.D. dependent var	3.630958
S.E. of regression	2.131101	Akaike info criterion	4.409279
Sum squared resid	213.4549	Schwarz criterion	4.524001
Log likelihood	-107.2320	Hannan-Quinn criter.	4.452966
F-statistic	47.62141	Durbin-Watson stat	1.979307
Prob(F-statistic)	0.000000		

Appendix 5: Results of ARIMA(1, 2, 6) Model
Dependent Variable: DDCHILDREN_OUT_OF_SCHOOL
Method: ARMA Conditional Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/21/25 Time: 02:41
Sample (adjusted): 1974 2023
Included observations: 50 after adjustments
Failure to improve likelihood (non-zero gradients) after 23 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1968 1973

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C		0.080798	0.913291	0.3658
AR(1)	-0.565318	0.125159	-4.516816	0.0000

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MA(6)	-0.817231	0.072342	-11.29673	0.0000

R-squared	0.259121	Mean dependent var	0.202305
Adjusted R-squared	0.227594	S.D. dependent var	2.294848
S.E. of regression	2.016865	Akaike info criterion	4.299090
Sum squared resid	191.1840	Schwarz criterion	4.413812
Log likelihood	-104.4773	Hannan-Quinn criter.	4.342777
F-statistic	8.219068	Durbin-Watson stat	2.016057
Prob(F-statistic)	0.000869		

Inverted AR Roots	-.57			
Inverted MA Roots	.97	.48-.84i	.48+.84i	-.48+.84i
	-.48-.84i	-.97		

Appendix 6: Ljung-Box Q Statistic/Test
Date: 05/21/25 Time: 02:47
Sample: 1971 2023
Included observations: 50
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.093	-0.093	0.4550	
.*| . |	.*| . |	2	-0.180	-0.190	2.2044	
. |*. |	. |*. |	3	0.150	0.117	3.4433	0.064
. |*. |	. |*. |	4	0.135	0.135	4.4806	0.106
.*| . |	.*| . |	5	-0.153	-0.087	5.8412	0.120
. |*. |	. |*. |	6	0.143	0.158	7.0468	0.133
.*| . |	.*| . |	7	-0.113	-0.180	7.8248	0.166
. | . |	. | . |	8	-0.009	0.036	7.8297	0.251
. | . |	. | . |	9	0.004	-0.055	7.8306	0.348
. |*. |	. |*. |	10	0.150	0.157	9.2992	0.318
.*| . |	.*| . |	11	-0.135	-0.067	10.521	0.310
. | . |	.*| . |	12	-0.064	-0.088	10.804	0.373
. |*. |	. |*. |	13	0.148	0.143	12.349	0.338
. | . |	. | . |	14	0.025	-0.052	12.394	0.415
.*| . |	. | . |	15	-0.097	0.062	13.098	0.440
.*| . |	**| . |	16	-0.094	-0.234	13.770	0.467
. | . |	. | . |	17	-0.058	-0.057	14.038	0.523
.*| . |	.*| . |	18	-0.090	-0.163	14.689	0.547
.*| . |	.*| . |	19	-0.097	-0.160	15.475	0.561
. | . |	. | . |	20	-0.041	-0.002	15.621	0.619
. |*. |	. |*. |	21	0.095	0.085	16.428	0.629
. | . |	. |*. |	22	0.017	0.179	16.456	0.688
. | . |	.*| . |	23	-0.042	-0.099	16.624	0.734
.*| . |	. | . |	24	-0.067	-0.054	17.079	0.759

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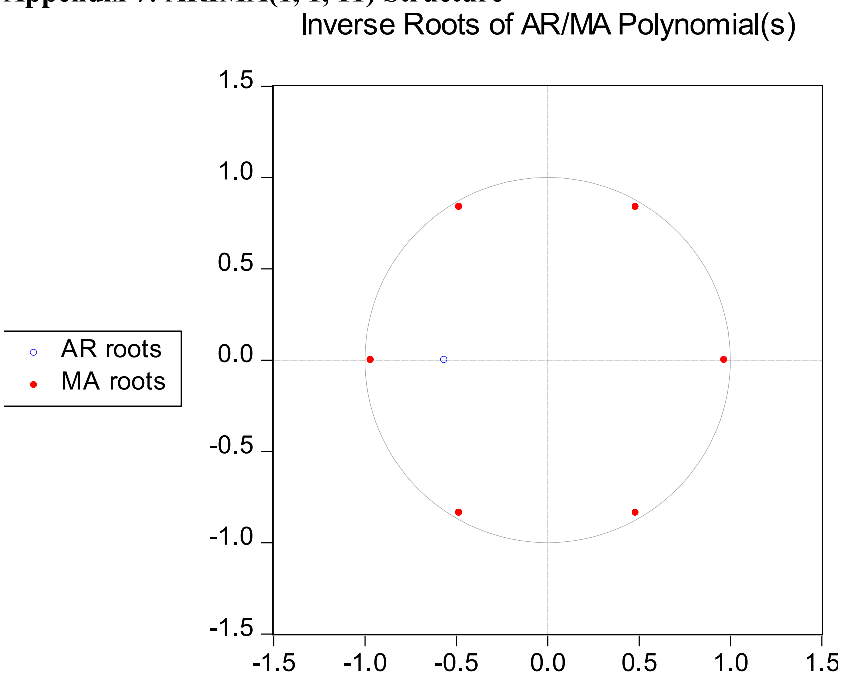
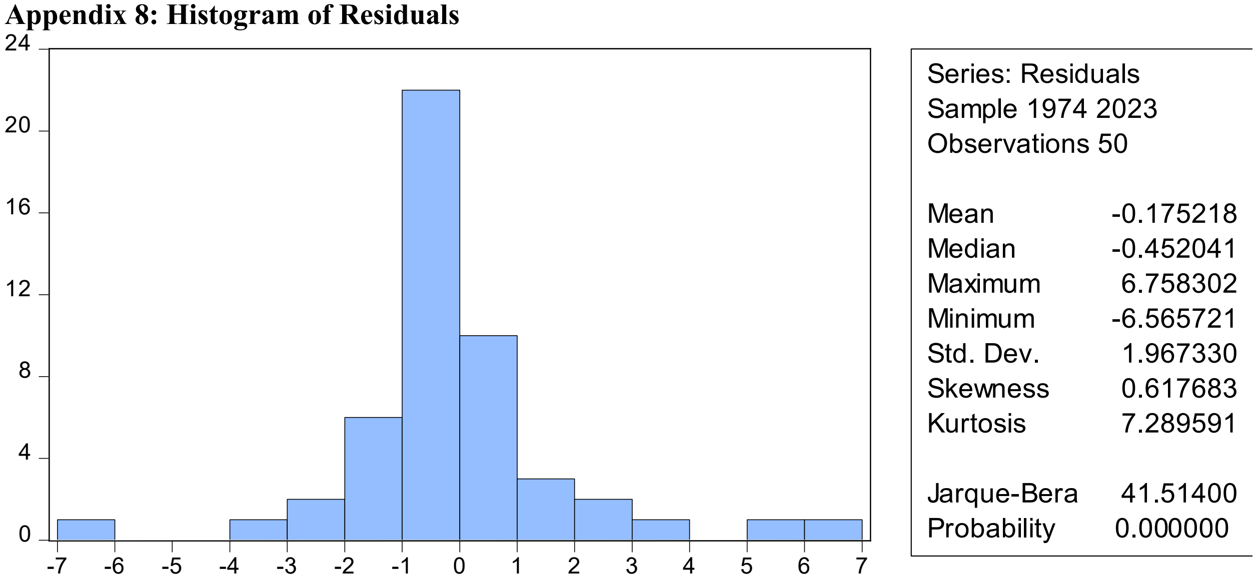
Appendix 7: ARIMA(1, 1, 11) Structure



Appendix 8: Histogram of Residuals



Appendix 9: Table Showing Children_out_of_School and its Forecast in Second Difference

YEAR	CHILDREN_OUT_OF_SCHOOL	DDCHILDREN_FORECAST
1971	89.72071838	
1972	89.33847809	
1973	88.95623779	0
1974	88.5739975	0
1975	88.1917572	0
1976	87.80951691	0
1977	87.31484222	-0.112434387
1978	86.8095932	-0.010574341

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1979	86.28462219	-0.019721985
1980	85.49555206	-0.264099121
1981	84.56465912	-0.141822815
1982	83.15971375	-0.474052429
1983	81.95001221	0.195243835
1984	80.6346817	-0.105628967
1985	78.66235352	-0.656997681
1986	76.84809875	0.158073425
1987	75.36547089	0.331626892
1988	74.9730835	1.090240479
1989	74.75177765	0.171081543
1990	74.5304718	1.42E-14
1991	73.75702667	-0.552139282
1992	73.3432312	0.359649658
1993	72.47889709	-0.450538635
1994	71.37735748	-0.237205505
1995	69.93347168	-0.342346191
1996	68.48958588	0
1997	67.04570007	0
1998	66.85179901	1.249984741
1999	66.18489075	-0.473007202
2000	64.82646942	-0.691513062
2001	63.70862961	0.240581512
2002	64.57163239	1.98084259
2003	62.15457916	-3.280056
2004	59.95325089	0.215724945
2005	55.10795975	-2.64396286
2006	51.5028801	1.240211487
2007	46.24406052	-1.653739929
2008	40.22764969	-0.757591248
2009	37.23252106	3.021282196
2010	40.58987045	6.352478027
2011	36.11151886	-7.835700989
2012	35.24419022	3.611022949
2013	34.43222046	0.055358887
2014	33.49003983	-0.130210876
2015	32.26116943	-0.286689758
2016	27.03043938	-4.001859665
2017	26.21941948	4.419710159
2018	24.26662064	-1.141778946
2019	25.66033936	3.346517563

Article DOI: https://doi.org/10.37284/eajes.8.2.3333

2020	28.40078926	1.346731186
2021	28.97104073	-2.170198441
2022	32.16556168	2.624269485
2023	41.89855957	6.538476944
2024		-3.336332246
2025		-0.565672779
2026		-1.634431095
2027		2.477805337
2028		-3.163448246
2029		-2.337709602
2030		1.437058723
2031		-0.696887639
2032		0.509471714
2033		-0.172505544
2034		0.213028816
2035		-0.00492089
2036		0.11829011
2037		0.048636653
2038		0.088013041
2039		0.06575284
2040		0.078336943
2041		0.071222917
2042		0.075244608
2043		0.072971072
2044		0.074256344
2045		0.073529756
2046		0.073940509
2047		0.073708303
2048		0.073839573
2049		0.073765364
2050		0.073807316

East African Journal of Education Studies, Volume 8, Issue 2, 2025
Article DOI: https://doi.org/10.37284/eajes.8.2.3333

Appendix 10: Graph Showing Simulated ARIMA (1, 2, 6) Model (1971-2050): Out-of-School Primary-Age Children in Burkina Faso