AI-Guided Econometrics with Stata on WAMZ Data: An Estimation of ARDL on SURE Model

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Framing

WAMZ Single-Currency Goal

The West African Monetary Zone seeks to introduce the Eco as a second regional currency. Rigorous convergence assessment is essential to minimise asymmetric shocks and ensure viability across its six member states.

- The Gambia
- Ghana
- Guinea, Liberia, Nigeria, Sierra Leone

AI-Econometrics Motive

Traditional methods struggle with complex panel data. AI offers a path to robust, automated analysis.

Manual Specification

- Heterogeneous data
- Small samples
- Policy diversity
- Subjective bias

AI-Guided Approach

- Automated selection
- Enhanced accuracy
- Theoretical rigour
- Reproducible results

Research Objectives

- Develop AI-guided ARDL-SURE framework
- Examine 2000-2023 convergence patterns
- Assess monetary-union feasibility
- Demonstrate STATA 11 implementation
- Deliver evidence-based policy guidance for West African integration

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Theory & Lit

Optimum Currency Area

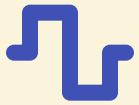
The theoretical benchmark by Mundell, McKinnon, and Kenen outlines pre-conditions for a viable currency union, guiding WAMZ's evaluation.

- Symmetric Shocks
- Factor Mobility
- Fiscal Discipline
- Inflation Convergence
- Exchange-Rate Stability

Empirical Evidence

Fiscal Divergence

Agbeyegbe (2008) highlights persistent fiscal imbalances across ECOWAS.



Inflation Sync

Rana (2007) notes limited synchronization of inflation patterns.

Sporadic Compliance

ECOWAS reports show only sporadic achievement of convergence targets.

Conclusion: A need for deeper coordination and rigorous empirical monitoring.

03

Method

AI-Guided Workflow

A five-step pipeline to automate and enhance econometric analysis, reducing bias and improving reproducibility.

1. Data Preprocessing
2. ML Variable Selection
3. Lag Optimization (AIC/BIC)
4. Automated Diagnostics
5. NLP Interpretation

ARDL Equation

Captures within-country short- and long-run dynamics for each WAMZ member, allowing for mixed I(0)/I(1) variables.

$$Y_{it} = \alpha_i + \sum_{j=1}^{p_i} \beta_{ij} Y_{i,t-j} + \sum_{k=0}^{q_i} \gamma_{ik} X_{i,t-k} + \varepsilon_{it}$$

SURE System

Jointly estimates equations across countries, exploiting cross-equation error correlations to improve efficiency and capture spillovers.

$$E[\varepsilon_{it}\varepsilon_{jt}] = \sigma_{ij}$$

Variable Definitions

Primary Criteria

INF: Inflation rate ⩽ 5%

BDGDP: Budget deficit / GDP ⩽ 3%

RESIMP: External reserves / Imports ⩾ 3 months

Secondary Criteria

DEBTGDP: Debt / GDP ⩽ 70%

CBFIN: Central bank financing ⩽ 10%

EXRVOL: Exchange rate volatility ±10%

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Data

Sample Description

Annual 2000–2023 panel data for six WAMZ countries, sourced from reputable international and regional institutions.

World Bank WDI

IMF IFS

AfDB

ECOWAS

Central Banks

Descriptive Statistics Highlights

Country	Mean INF (%)	Mean RESIMP (months)	Fiscal Volatility
Ghana	**12.4**	2.8	**High**
Guinea	**15.2**	1.4	Medium
Nigeria	11.8	**6.5**	Medium
Liberia	8.9	2.9	**High**

Cross-country heterogeneity confirms partial convergence and need for differentiated policy tracks.

Descriptive Highlights

Highest Inflation

Ghana & Guinea

Strongest Reserves

Nigeria

Most Fiscal Volatility

Liberia & Ghana

Conclusion: Significant cross-country heterogeneity confirms partial convergence.

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STATA 11 Code

STATA 11 Setup & Panel Declare

```
* Set working directory and load data cd "C:\WAMZ_Analysis"
use "WAMZ_Convergence_Data.dta", clear * Declare panel xtset
country_id year, yearly * Generate time trend gen time_trend =
year - 2000 tabulate country, gen(country_dum) // country
dummies
```

Note: Verify `country_id` alignment and variable names before proceeding.

AI Lag Search

```
* Install ARDL package capture ssc install ardl, replace * Lag search via information criteria ardl
inf bdgdp resimp debtgdp cbfin exrvol, maxlag(4) aic ardl inf bdgdp resimp debtgdp cbfin exrvol,
maxlag(4) bic ardl inf bdgdp resimp debtgdp cbfin exrvol, maxlag(4) hqic // ML-guided selection
```

AI-assisted selection via AIC, BIC, and HQIC for optimal model specification.

Unit Root Tests

```
* Install PP test ssc install pperron foreach var of varlist inf bdgdp resimp
debtgdp cbfin exrvol { di "ADF & PP tests for `var'" dfuller `var', lags(1)
trend pperron `var', trend }
```

Result: All series are I(1), confirming the appropriateness of the ARDL approach.

Country ARDL Loop

```
* Loop over countries levelsof country, local(cty) foreach c of local cty { preserve
keep if country=="`c'" ardl inf bdgdp resimp debtgdp cbfin exrvol, maxlag(2 2 2 2
2 2) ec estimates store ardl_`c' ardlbounds restore }
```

Estimates long- and short-run coefficients for each member state.

SURE Estimation

```
* Reshape to wide form reshape wide inf bdgdp resimp debtgdp cbfin exrvol, i(year) j(country_id) *
Estimate SURE system sureg (inf1 bdgdp1 resimp1) (inf2 bdgdp2 resimp2) (inf3 bdgdp3 resimp3) ///
(inf4 bdgdp4 resimp4) (inf5 bdgdp5 resimp5) (inf6 bdgdp6 resimp6), corr small dfk
```

Jointly estimates equations to account for cross-country error correlations.

Post-Estimation Diagnostics

```
xttest3 // heteroskedasticity xtserial inf bdgdp resimp debtgdp cbfin
exrvol // serial corr xtcsd, pesaran // cross-dependence estat correlation
// SURE residual corr
```

Confirms model stability and validates the SURE specification.

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Findings

Unit Root & Cointegration

ADF & PP Tests

All variables are I(1)

Integrated of order one

→

ARDL Bounds Test

F-stats > I(1) bound

for all countries

Conclusion: Long-run equilibrium relationships exist. ✓

Long-Run Coefficients

Fiscal Deficit → Inflation

+

A positive and significant nexus across all members.

Reserves → Inflation

-

A negative link, indicating a stabilizing effect.

Key Insight: Fiscal discipline and reserve adequacy are crucial for price stability.

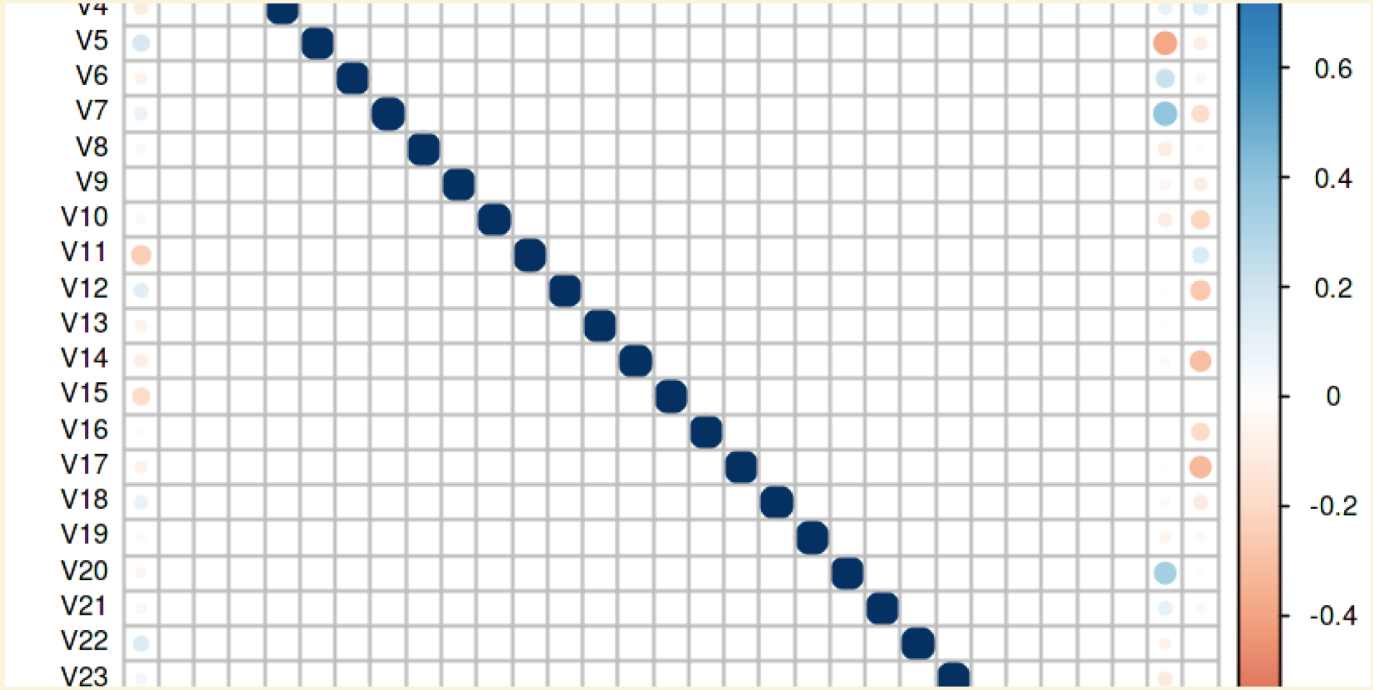
SURE Pooled Results

Parameter	Coefficient	Significance
BDGDP → INF	0.456	***
RESIMP → INF	-0.298	***
DEBTGDP → INF	0.123	***
CBFIN → INF	0.087	**
EXRVOL → INF	0.234	***

*** ppan>

Cross-Equation Correlation Matrix

Average correlation ≈ 0.67, indicating strong interdependence. Low values for fragile states (e.g., Guinea) suggest heterogeneous shock transmission.



Convergence Compliance (2000–2023)

Country	Primary %	Secondary %	Overall %
Nigeria	72.7	59.1	**66.9**
The Gambia	68.2	45.5	56.8
Ghana	54.5	36.4	45.5
Sierra Leone	50.0	31.8	40.9
Liberia	40.9	27.3	34.1
Guinea	31.8	22.7	**27.3**
Average	**53.0**	**37.1**	**45.1**

Convergence Compliance

Overall convergence compliance across WAMZ averages 45%, with primary criteria compliance at 53% and secondary criteria at 37%.

Nigeria leads with 66% compliance, while Guinea lags at 27%, reflecting significant heterogeneity in macroeconomic performance and policy outcomes.

The results indicate partial convergence, suggesting progress but highlighting persistent disparities and the need for further policy coordination.

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Policy & End

Policy Roadmap

A phased, multi-pronged approach to manage heterogeneity and sustain integration momentum.

IN-DEPTH ANALYSIS

Policy Roadmap

01 Fiscal Coordination

Establish a WAMZ Fiscal Council to enforce fiscal discipline, coordinate budget deficit targets, and ensure transparent public financial management across member states.

02 Monetary Policy Coordination

Develop a joint monetary policy framework focused on inflation targeting and exchange rate stability, leveraging Nigeria's leadership role for regional coordination.

03 External Reserve Management

Create a Regional Stabilization Fund or Reserve Pooling Mechanism to enhance collective financial resilience and mitigate external shocks.

04 AI-Based Monitoring

Invest in AI-driven economic surveillance systems to continuously monitor macroeconomic indicators and provide early warnings for policy adjustments.

Robustness & Limits

01 Robustness Checks

Alternative lag specifications, subsample analysis, and comparison with fixed effects, random effects, and GMM estimators confirm the robustness and reliability of the study's findings.

02 Study Limitations

Limitations include data gaps, potential structural breaks due to global crises, and the emphasis of machine learning algorithms on statistical fit over theoretical coherence.

03 Future Research

Future work could incorporate Bayesian extensions, high-frequency data, and institutional quality metrics to further refine the analysis and enhance policy relevance.

Robustness & Limits

✓ Robustness

- Stable results across alternative lags and estimators (FE/RE/GMM).
- Consistent findings in sub-sample analyses.

⚠ Limitations

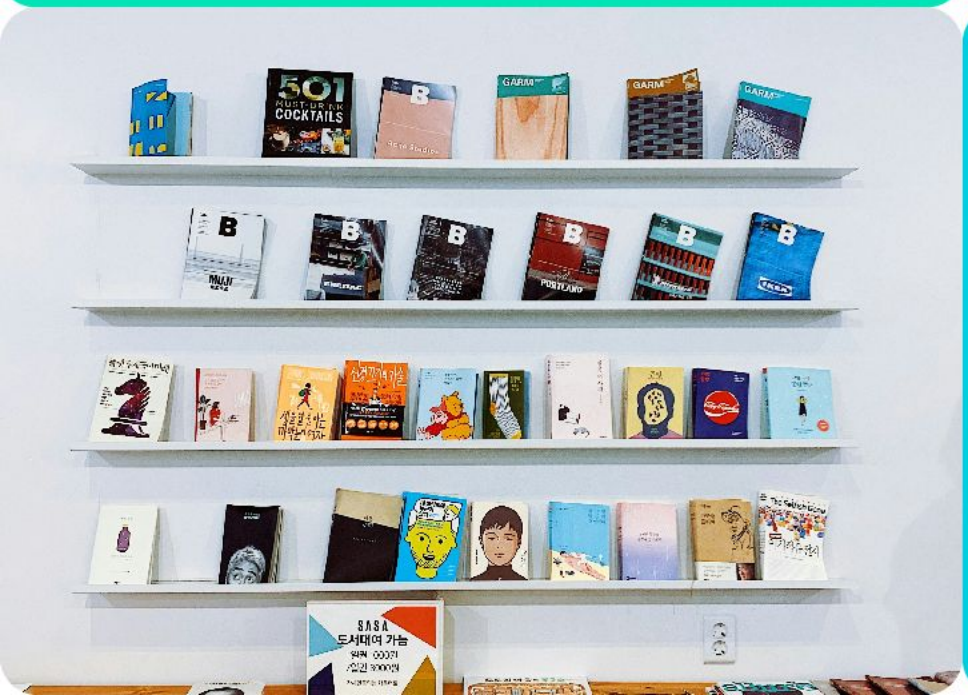
- Possible data gaps and structural breaks.
- ML prioritizes fit, which may diverge from theory.

Future Work

- Integrate Bayesian methods for uncertainty modeling.
- Incorporate higher-frequency data and governance indicators.
- Develop hybrid Python-STATA pipelines for advanced ML.
- Focus on network spillover analysis and real-time dashboards.

Study Conclusions

The study confirms long-run convergence but incomplete harmonization across WAMZ countries, highlighting the central role of fiscal and external variables in ensuring macroeconomic stability.



Conclusion & Next Steps

Policy Recommendations

Sustained coordination, technological integration, and phased reforms are essential for successful Eco launch and durable West African monetary union. Future research should focus on real-time monitoring and institutional indicators.

Conclusion & Next Steps

WAMZ shows long-run convergence but incomplete harmonisation. Fiscal and external variables are central to stability.

AI-guided econometrics offers scalable, data-driven policy tools.

Sustained coordination, institutional reforms, and phased integration are key to a successful Eco launch.

THANK YOU

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