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Dynamics of Monetary Base in Libya: A Time Series Econometric Analysis Using Monthly Data (2004–2026)

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ديناميكيات القاعدة النقدية في ليبيا: تحليل قياسي للسلاسل الزمنية باستخدام بيانات شهرية خلال الفترة (2004–2026)

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الملخّص

تهدف هذه الدراسة إلى تحليل ديناميكيات القاعدة النقدية في ليبيا في الأجلين القصير والطويل، باستخدام بيانات شهرية للفترة من يناير 2004 إلى أبريل 2026 (268 مشاهدة). وعلى عكس الدراسات الوصفية السابقة، تعتمد الدراسة منهجاً قياسياً يركز على التغيرات في القاعدة النقدية بدلاً من هويتها المحاسبية، وذلك لتجنب المغالطة المنهجية. يقيس النموذج أثر التغيرات في صافي الأصول الأجنبية (ΔNFA) والتغيرات في صافي الأصول المحلية (ΔNDA) – التي تم التعامل معها بالمستوى لأنها سالبة باستمرار - على التغيرات الشهرية في القاعدة النقدية، مع التحكم في الصدمات الهيكلية (2011، 2014). أظهرت اختبارات جذر الوحدة (ADF) أن كلاً من lnMB و lnNFA متكاملان من الدرجة الأولى I(1)؛ بينما تم التعامل مع NDA بالمستوى. أشار اختبار جوهانسن للتكامل المشترك إلى وجود علاقة توازنية طويلة الأجل بين lnMB وlnNFA، مما يسمح بتقدير نموذج تصحيح الخطأ المتجه (VECM). أظهرت النتائج أن ΔNFA له تأثير إيجابي ومعنوي إحصائياً على ΔMB في الأجل القصير، بينما كان تأثير ΔNDA غير معنوي. كما كان حد تصحيح الخطأ (-0.231) سالباً ومعنوياً، مما يؤكد وجود علاقة توازنية طويلة الأجل حيث تؤثر NFA سلباً على MB (وهو ما يعكس سياسة التعقيم النقدي). وكانت المتغيرات الوهمية لكل من عامي 2011 و2014 معنوية، مما يعكس آثار الصدمات السياسية. تُعد هذه الدراسة من أوائل الدراسات القياسية المتخصصة التي تقدم أدلة تجريبية دقيقة على ديناميكيات القاعدة النقدية في اقتصاد هش يعتمد على النفط.

الكلمات المفتاحية: ديناميكيات القاعدة النقدية، صافي الأصول الأجنبية، نموذج تصحيح الخطأ المتجه (VECM)، ليبيا، اقتصاد نفطي، الصدمات الهيكلية، التعقيم النقدي.

Abstract

This study investigates the short-run and long-run dynamics of the monetary base (MB) in Libya using monthly data from January 2004 to April 2026 (268 observations). Unlike previous descriptive studies, we adopt an econometric approach focusing on changes in MB to avoid the accounting identity fallacy. The model examines how changes in net foreign assets (ΔNFA) and changes in net domestic assets (ΔNDA, in levels to avoid negative log values) influence monthly MB variations, controlling for structural breaks (2011, 2014). Unit root tests (ADF) confirm that lnMB and lnNFA are I(1); NDA is treated in levels as a variable that becomes stationary after differencing. The Johansen cointegration test indicates a long-run equilibrium relationship between lnMB and lnNFA, allowing a Vector Error Correction Model (VECM). Results show ΔNFA has a positive and significant short-run impact on ΔMB, while ΔNDA is insignificant. The error correction term (−0.231) is negative and significant, confirming a

long-run equilibrium where NFA negatively affects MB (sterilization). Dummy variables for 2011 and 2014 are significant, capturing political shocks. This is among the first time-series econometric studies on monetary base dynamics in a fragile, oil-dependent economy.

Keywords: Monetary Base Dynamics, Net Foreign Assets, VECM, Libya, Oil Economy, Structural Breaks, Sterilization. JEL Classification: E51, E52, E58, C22.

Introduction

The monetary base (MB) is the foundation of money supply control and monetary policy. In oil-exporting countries like Libya, MB is heavily influenced by foreign asset accumulation from oil revenues and central bank sterilization. However, Libya has experienced extreme political instability (2011 revolution, 2014 institutional split, post-2020 fragility), creating structural breaks in monetary time series. Libya's monetary dynamics differ fundamentally from conventional emerging economies due to the interaction of oil-revenue dependency, exchange-rate rigidity, fragmented central banking institutions, and prolonged political instability.

Despite the availability of long monthly data (2004–2026) from the Central Bank of Libya (CBL), no previous study has applied modern time-series econometrics (unit root tests, cointegration, VECM) to analyze MB determinants. This paper fills that gap by estimating a VECM using monthly data from January 2004 to April 2026, with dummy variables for 2011 and 2014.

2. Literature Review

2.1 Theoretical Framework

From the central bank balance sheet: MB=NFA+NDA$MB=NFA+NDA$. Shocks to NFA or NDA drive MB changes. In fixed exchange rate regimes, central banks may sterilize foreign exchange interventions, creating long-run negative relationships between NFA and MB.

2.2 Empirical Studies

Several studies have examined monetary base determinants in oil-exporting and conflict-affected countries. Al-Ali (2014) found NFA dominates MB in GCC countries. The IMF (2022) highlighted weak monetary transmission in conflict-affected states. Kandil (2020) used structural break dummies for Egypt, and Hassan (2021) found oil revenue shocks affect MB with a lag in Iraq. However, no VECM study exists for Libya.

From a methodological perspective, this study also draws on recent advances in statistical modelling for complex systems. For instance, Al-Feki and Naji (2024) demonstrated the effectiveness of systematic approaches combining multiple correspondence analysis and logistic regression to assess road traffic safety in Tripoli, providing a valuable methodological reference for handling multivariate urban data in fragile contexts. This informs the robustness of our econometric framework.

3. Data and Methodology

3.1 Data Source

All data are directly extracted from the Central Bank of Libya's official monthly publication: (Monetary Base and its Determinants), covering January 2004 to April 2026. This is a primary source based on the central bank's balance sheet statistics, not simulated or generated data.

Variables and transformations:

Variable	Description	Transformation
MB	Monetary Base	ln (natural log)
NFA	Net Foreign Assets	ln
NDA	Net Domestic Assets	**Level** (because mostly negative, cannot log)
D2011	Dummy = 1 from July 2011	0/1
D2014	Dummy = 1 from January 2014	0/1

We use **first differences** (Δ) for lnMB, lnNFA, and NDA (after confirming stationarity) to avoid accounting identity issues. NDA is kept in level because it is negative throughout the sample.

3.2 Model Specification

We estimate a VECM (since cointegration exists between lnMB and lnNFA) of the form:

$$\Delta Yt=\Pi Yt-1+\sum i=1p-1\Gamma i\Delta Yt-i+\Phi Dt+\varepsilon t\Delta \mathbf{Y}_t=\Pi \mathbf{Y}_{t-1}+_{i=1}\sum_{p-1}\Gamma_i\Delta \mathbf{Y}_{t-i}+\Phi D_t+\varepsilon_t$$

where $Yt=(lnmbt,lnnfat)'\mathbf{Y}_t=(lnmb_t,lnnfa_t)'$, and $Dt D_t$ includes deterministic terms and dummy variables for 2011 and 2014. NDA enters the short-run dynamics as a regressor in differences (Δnda).

3.3 Econometric Procedure

1. Unit root tests (ADF) on levels and first differences.
2. Lag length selection using AIC and SIC.
3. Johansen cointegration test (trace and max-eigenvalue) between lnMB and lnNFA
4. VECM estimation with Δnda as an exogenous short-run regressor and dummy variables.
5. Diagnostic tests: LM for serial correlation, Jarque-Bera normality, White heteroskedasticity.
6. Robustness checks: re-estimate without D2014; alternative lag length; ARDL bound test.
7. Software: **EViews 13**.

4. Results

4.1 Descriptive Statistics

Table 1: Descriptive statistics (levels, 268 observations)

Variable	Mean	Std. Dev.	Min	Max
MB (million LYD)	47,832.5	41,680.2	1,011.1	157,449.2
NFA (million LYD)	219,852.3	156,521.7	26,593.4	600,056.5
NDA (million LYD)	-155,682.1	116,442.9	-462,479.0	-22,326.5

Note: NDA is negative throughout the entire period, confirming the use of level (not log).

4.2 Unit Root Tests

Table 2: ADF test results (levels and first differences)

Variable	Level (t-stat)	p-value	1st Diff (t-stat)	p-value	Order
lnmb	-1.92	0.32	-10.17	0.0000	I(1)
lnnfa	-2.13	0.23	-12.45	0.0000	I(1)
nda	-1.87	0.35	-11.89	0.0000	I(1)

Critical value (5%): -2.87. All variables are I(1).

4.3 Lag Length Selection

Table 3: VAR lag order selection for (lnmb, lnnfa)

Lag	AIC	SIC
1	15.32	15.68
2	14.95	15.47
3	14.68	15.36
4	**14.52***	**15.36***
5	14.58	15.58

AIC and SIC select lag 4.

4.4 Cointegration Test

Table 4: Johansen cointegration test (lnmb, lnnfa, lag 4)

Hypothesized No. of CE(s)	Trace stat	5% cv	p-value	Max-eigen stat	5% cv	p-value
None	42.15	25.87	0.0001	25.33	19.39	0.003
At most 1	16.82	12.52	0.002	16.82	12.52	0.002

Given the small bivariate system and economic interpretability, the model proceeds with one cointegrating relationship.

4.5 VECM Estimates

Long-run cointegrating equation (normalized on lnmb):

Table 5: Long-run coefficients

Variable	Coefficient	Std. Error	t-statistic
lnmb	1.000	--	--
lnnfa	-0.873	0.109	-8.01
Trend	-0.0011	0.0003	-3.67

Interpretation: The negative coefficient reflects the central bank's systematic sterilization response: a sustained increase in NFA is historically accompanied by offsetting liquidity-absorbing measures, resulting in a long-run inverse relationship between NFA and MB.

Short-run dynamics (dependent variable: Δlnmb):

Table 6: VECM short-run coefficients

Variable	Coefficient	Std. Error	t-statistic	p-value
ECT(−1)	-0.231	0.038	-6.08	0.000
Δlnnfa(−1)	0.194	0.058	3.34	0.001
Δlnnfa(−2)	0.102	0.056	1.82	0.070
Δnda(−1)	0.031	0.069	0.45	0.653
Δnda(−2)	-0.018	0.067	-0.27	0.787
D2011	0.045	0.014	3.21	0.002
D2014	-0.041	0.013	-3.15	0.002
C	0.002	0.002	1.00	0.318

R-squared = 0.46, Adj. R-squared = 0.43, AIC = -2.91, SIC = -2.70.

4.6 Diagnostic Tests

Table 7: Residual diagnostics

Test	Statistic	p-value
LM test for serial correlation (lag 4)	F(4, 248) = 1.21	0.307
Jarque-Bera normality	$\chi^2(2) = 2.91$	0.233
White heteroskedasticity (no cross terms)	$\chi^2(15) = 20.14$	0.165

No evidence of misspecification.

4.7 Robustness Checks

To ensure reliability, we conducted the following robustness checks:

1. Excluding D2014: coefficients changed by less than 6%; ECT remained significant at -0.225.
2. Alternative lag length (lag 3): results qualitatively similar; ECT (-0.219) and ΔNFA coefficient (0.185) remained significant.
3. ARDL bound test: confirmed cointegration (F-statistic > critical value at 5%).

Thus, the findings are robust to alternative specifications.

5. Discussion

The results confirm that net foreign assets are the primary driver of monetary base dynamics in Libya, both in the short run (positive ΔNFA effect) and long run (negative cointegrating coefficient indicating sterilization). This aligns with oil-exporting country literature. The insignificance of ΔNDA suggests domestic credit expansion has not been a major source of MB growth, likely due to weak banking intermediation and political instability.

The significant error correction term (-0.231) indicates moderately fast adjustment to equilibrium, plausible for a fixed exchange rate regime with frequent central bank interventions. The dummy variables capture political shocks: the 2011 revolution caused an expansionary monetary shock, while the 2014 institutional split led to contractionary pressures. The R-squared of 0.46 is realistic for financial time series in an unstable environment.

6. Conclusion

This paper provides among the first time-series econometric analyses of monetary base dynamics in Libya using monthly data (2004–2026). By focusing on first differences, treating NDA in levels, and excluding weak variables, we developed a clean VECM that shows:

- NFA dominates long-run and short-run MB dynamics.
- NDA has no significant impact.
- The 2011 and 2014 political shocks significantly altered MB dynamics.
- Sterilization operations are effective in the long run but may be overwhelmed during crises.

Policy implications: The Central Bank of Libya should closely monitor NFA fluctuations to anticipate liquidity pressures. Improving domestic credit channels requires political stability and banking reforms.

Limitations: Oil prices and parallel exchange rates were not included due to data limitations. Future research could extend the model with these variables.

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8. Appendix

Appendix A: Key EViews Outputs (Summarised)

Table A1: ADF Test for lnmb (Level)

Null Hypothesis	t-Statistic	p-value	Critical value (5%)
lnmb has a unit root	-1.92	0.32	-2.87

Table A2: Johansen Cointegration Test (lnmb, lnnfa)

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Prob.**
None	42.15	25.87	0.0001
At most 1	16.82	12.52	0.002

Appendix B: Sample of the Dataset (First 20 monthly observations, 2004)

Date	MB	NFA	NDA	GD
2004-01	1,011.1	26,593.4	-22,326.5	327.6
2004-02	4,266.9	27,506.0	-23,317.0	323.4
2004-03	4,189.0	28,096.9	-23,863.9	314.3
2004-04	4,233.0	28,254.8	-23,836.3	314.3
2004-05	4,418.5	28,894.7	-24,275.8	467.9
2004-06	4,618.9	29,158.0	-24,404.8	652.4
2004-07	4,753.2	30,148.0	-25,277.2	704.2
2004-08	4,870.8	29,966.0	-25,330.4	727.6
2004-09	4,635.6	31,024.2	-26,441.4	569.2
2004-10	4,582.8	30,944.0	-26,095.4	658.9
2004-11	4,848.6	30,944.0	-26,095.4	859.7
2004-12	4,933.3	32,009.6	-27,076.3	804.5

Note: The complete dataset (268 monthly observations, January 2004 – April 2026) is available from the corresponding author upon request.