

Spillover Effects in the Financial Markets among the Countries of the Central African Economic and Monetary Community (CEMAC)

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Abstract

This article examines whether and how financial contagion effects exist in the CEMAC banking sector during 1995-2024. Unlike traditional studies on stock markets, this paper uses logged banking development indicators to measure systemic risk perception in Cameroon, Central African Republic, Republic of Congo, Gabon, Chad and Equatorial Guinea. Unit root tests (ADF, PP, KPSS) and an asymmetric non-linear ECM (Ayadi et al., 2006) are used as well as a GARCH(1,1) specification to correct for heteroscedasticity bias in high and medium frequency data. The empirical results reject the linearity hypothesis of transmission mechanisms and show pure and asymmetric banking contagion in the CEMAC zone. Short-term adjustment behaviour is very different between stability and crisis periods (sharp amplification of interbank co-movements during stress). These structural vulnerabilities imply that COBAC and BEAC need non-linear macroprudential policies such as countercyclical capital requirements and a central counterparty clearing house to reduce domino effects at the regional level.

Keywords

Financial Contagion, Interdependence, Interbank Market, Non-Linear Error Correction Model (ECM), Asymmetry, CEMAC Zone, Macroprudential Regulation

1. Introduction

The term contagion first entered the international financial lexicon in July 1997 when the Thai currency crisis broke out. This local shock quickly spread (in waves) to East Asian economies, then Russia and Brazil before reaching the mature stock markets of North America and Europe. Cross-border spread of macroeconomic

shocks is not new but what kind of contagion takes place and how quickly has become key. The speed at which trade and financial flows have been globalized has reshaped mutual interdependencies automatically making economic systems more vulnerable to exogenous shocks.

The theoretical and empirical literature has always been divided on how to characterize these co-movements in stress: between the continuous interdependence thesis (Allen & Gale, 2000) and the pure contagion thesis. On the one hand, pioneers of interbank network analysis (Allen & Gale, 2000) show that shock transmission depends on completeness and structural connectivity of permanent credit and capital channels; on the other hand, Forbes and Rigobon (2002) need a strict econometric distinction: the spread of crisis is pure contagion only if there is an excess of associated movements and sudden asymmetric structural change in transmission mechanisms not just continuation of usual linkages. In the CEMAC zone (with a monetary union and deposits heavy financial systems) dynamics have to be analysed using nonlinear models able to capture such discontinuities.

In this paper, we are mainly interested in contagion effects among CEMAC countries between 1995 and 2024 by adapting the asymmetric ECM approach of Ayadi et al. (2006). That is to say: we want to empirically test whether major events (creation/restructuring/failure of a bank in one member state) have nonlinear transmission on other banking systems in the subregion via changes in the speed of market adjustment. Identifying those transmission mechanisms is managerial: it gives Central African authorities (BEAC, COBAC) leading indicators which allow macroprudential policies and preventive measures to be implemented to contain systemic crises and domino effects.

To accomplish this objective our analysis proceeds as follows. First we will present the theoretical and conceptual framework for banking contagion; second we describe the econometric methodology chosen and the specification of variables and data applied to the CEMAC sample; third we present and interpret empirical results before formulating economic policy recommendations.

2. Theoretical and Conceptual Framework for Bank Contagion

The conceptual framework of this research aims to deconstruct the phenomenon of financial crisis propagation within the interbank network by moving beyond traditional empirical approaches. Although the scientific literature does not present a single doctrinal consensus, this study segments the analysis by contrasting broad definitions of transmission with restrictive definitions based on structural breaks, while linking these concepts to the physical architecture of money markets.

Three fundamental pillars structure this theoretical framework.

2.1. The Theoretical Contrast between Interdependence and Pure Contagion

Initially inspired by epidemiological modeling, which requires a shock (a disease),

a source country (a patient), and a recipient country (a victim), contagion is broadly defined in causal terms by [Williamson \(2004\)](#) as the transmission of a crisis from point A to point B, whether it occurs through real macroeconomic channels or has a delayed effect.

Conversely, the study adopts a restrictive approach based on the dichotomy proposed by [Calvo and Reinhart \(1996\)](#) and [Fratzscher \(2002\)](#):

- Fundamental interdependence: Corresponds to the normal and continuous transmission of shocks through permanent macroeconomic and financial channels (trade links, balance of payments). According to [Moser \(2003\)](#), financial markets here merely rationally anticipate and accelerate convergence toward an inevitable new equilibrium.
- Pure (or irrational) contagion: Defined as an abrupt structural change in transmission mechanisms, disconnected from economic fundamentals. It is a market imperfection characterized, according to [Karolyi \(2003\)](#), by “excessive associated movements” at high frequency, fueled by financial panic, herding behavior, and a sudden increase in risk aversion.

2.2. Transmission Channels and Imperfections in the Banking Sector

The conceptual model revolves around the two major channels that govern banking interactions:

- The credit (or lending) channel: Based on information asymmetries and illiquidity. A negative exogenous shock to deposits cannot be offset by issuing unsecured debt (bonds), which has become too costly due to a high risk premium. This channel is amplified in less developed systems (such as the CEMAC), where heavy reliance on short-term deposits exposes banks to a critical transformation risk (maturity mismatch), forcing them to ration credit or raise lending rates in a procyclical manner.
- The bank capital channel: Based on the failure of the Modigliani-Miller theorem in the presence of market frictions and regulatory capital requirements. When losses or nonperforming loans erode a bank’s capital below the regulatory adequacy ratio, the institution is forced to contract its credit supply to restore its net margin and rebuild its target capital levels, spreading the credit crunch to the rest of the network.

2.3. Network Architecture and Systemic Propagation

Drawing on the theories of interbank networks developed by [Allen and Gale \(2000\)](#) and [Freixas et al. \(2000\)](#), the conceptual framework demonstrates that systemic risk depends on market topology:

- Complete (diversified) structures: These distribute risks symmetrically. The failure of a single bank is spread out and absorbed by all counterparties, reducing the probability of a chain reaction of failures. However, as [Gai and Kapadia \(2010\)](#) point out, these networks are “robust but fragile”: if an extreme shock

exceeds the capital's absorption capacity, the completeness of the network facilitates a widespread and severe propagation of the crisis.

- Incomplete or fragmented structures: These concentrate shocks on a small number of direct counterparties (long credit chains). In a "monetary center" (star) structure, the default of a peripheral bank is absorbed by the center, but the failure of the pivotal central bank triggers an immediate and devastating domino effect across the entire periphery.

A comparison of theoretical approaches reveals a fundamental divide regarding the nature of financial shock transmission. On the one hand, the network architecture models of Allen and Gale (2000) and Freixas et al. (2000) demonstrate that the adjustment of banking structures depends on the completeness of permanent credit and capital channels. On the other hand, the empirical literature pioneered by Forbes and Rigobon (2002) and Moser (2003) posits that the manifestation of pure contagion cannot be separated from a sudden, nonlinear, and asymmetric change in agent behavior, occurring specifically during the transition to a crisis regime. Consequently, the analysis of the CEMAC region characterized by less developed money markets, high vulnerability to transformation risk, and structural dependence on deposits requires a statistical tool capable of reconciling these two dimensions. The study of long-term interdependence (permanent physical channels) must therefore be integrated with an examination of short-term dynamic disruptions (panic or the domino effect).

It is precisely to operationalize this theoretical framework that we turn to the econometric approach inspired by Ayadi et al. (2006). By adapting a nonlinear and asymmetric Error Correction Model (ECM), our methodology allows us to empirically test these concepts. First, the search for linear cointegration relationships enables us to isolate and quantify the long-run interdependence vectors (β), which represent the regular banking channels within the subregion. Second, decomposing the lag term (z_{t-1}) into positive (z_{t-1}^+) and negative (z_{t-1}^-) components provides the appropriate framework for capturing the nonlinearity of the adjustment speeds (δ_1 and δ_2). This approach makes it possible to verify whether the CEMAC banking sector reacts symmetrically to routine fluctuations (stable regime) or whether it experiences a sharp acceleration in its co-movements during periods of extreme stress, thereby providing formal econometric evidence of the existence of a pure contagion process.

3. Methodology

To detect and analyze possible contagion among CEMAC banks, we employ a three-step methodological strategy: 1) specify the model to measure banking contagion; 2) present variables and data; 3) report and interpret results.

3.1. Specification of the Contagion Process Measurement Model

Based on an adaptation of the framework developed by Ayadi et al. (2006), our model tests the nonlinearity and asymmetry of short-term propagation mecha-

nisms relative to stable long-term relationships.

Step 1: Modeling Interdependence (Long Term)

The long-run equilibrium relationship between the banking system of a recipient country (y_t) and a sending country (x_t) is estimated by the following cointegration function:

$$y_t = \alpha + \beta x_t + z_t$$

where β represents the long-run elasticity (permanent channels) and z_t is the stochastic error term.

Step 2: Specification of the Asymmetric Error Correction Model (ECM) (Short Term)

To capture true contagion over short time periods, the lagged equilibrium error (z_{t-1}) is split nonlinearly based on the sign of its change (Δz_{t-1}):

$$z_{t-1}^+ = \max(z_{t-1}, 0) \text{ (regime of crisis)}$$

$$z_{t-1}^- = \min(z_{t-1}, 0) \text{ (regime of stability)}$$

The contagion test model then takes the form of the following equation:

$$\Delta y_t = \mu + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \sum_{j=1}^q \gamma_j \Delta y_{t-j} + \delta_1 z_{t-1}^+ + \delta_2 z_{t-1}^- + \varepsilon_t$$

where δ_1 and δ_2 represent the respective adjustment speeds of the crisis and stability regimes.

Decision rule: If the Wald test rejects the null hypothesis $H_0: \delta_1 = \delta_2$ the existence of significant asymmetry supports the pure contagion hypothesis. Handling Heteroscedasticity: The error term ε_t is modeled as a GARCH(1,1) process to neutralize volatility biases.

3.2. Data, Variables, and Institutional Controls

To proxy the systemic risk perception and financial soundness within the Central African Economic and Monetary Community, this study deviates from standard stock market indices and utilizes three macro-banking indicators. The dataset spans an annual baseline period from 1995 to 2024 ($N = 30$) across the six CEMAC member states: Cameroon (CAM), Central African Republic (CAF), Republic of the Congo (COG), Gabon (GAB), Chad (TCD), and Equatorial Guinea (GNQ). All variables are transformed into natural logarithms to allow an elasticity-based interpretation of the parameters. The indicators are defined as follows:

- **Interbank Assets-to-GDP Ratio:** Sourced from the Bank of Central African States (BEAC) monetary surveys, this variable measures the depth, liquidity, and level of mutual trust within the regional money market, serving as a proxy for the liquidity coinsurance mechanism.
- **Domestic Credit to the Private Sector as a Percentage of GDP:** Sourced from the World Bank's Global Financial Development Database (GFDD), this variable measures the operational capacity for financial intermediation and acts as the baseline proxy to test the bank credit channel.

- **Bank Capital-to-Assets Ratio:** Sourced from the Central African Banking Commission (COBAC) annual reports, this ratio captures the structural solvency and loss-absorption capacity of commercial banks, proxying the bank capital channel under regulatory constraints.

Filtering Common CEMAC-wide Shocks:

To isolate true cross-border banking contagion from simultaneous national reactions to common regional innovations (such as oil price fluctuations, structural adjustments, or regional policy shifts), the short-run dynamics of the empirical model include two explicit macroeconomic controls: the BEAC prime lending rate (*TIAO*) and a regional commodity export price index. Furthermore, a common regional factor was extracted using Principal Component Analysis (PCA) to filter out systemic co-movements before running the country-specific regressions.

3.3. Procedure Estimation

Before modeling, we assess the stochastic properties of the series to verify stationarity (constant mean, variance, autocovariance over time). Three complementary tests are applied to levels and first differences, with three deterministic options (Trend and Intercept, Intercept, None):

Econometric Reconciliation of Unit-Root Tests

Before applying the Johansen co-integration framework, the properties of the time series were rigorously cross-examined. Standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests initially yielded conflicting classifications, notably identifying Cameroon's banking development indicators as integrated of order two, $I(2)$, while showing contradictions with the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test statistics.

To resolve these inconsistencies, a two-fold econometric reconciliation was performed:

1) **Structural Break Correction:** Because standard unit-root tests lose power and suffer from specification bias when a series undergoes structural shifts—such as the banking overhauls and post-devaluation adjustments in the CEMAC locomotive—we applied the [Zivot and Andrews \(1992\)](#) unit-root test. This test endogenously accounts for a structural break in the intercept and trend. The Zivot-Andrews statistics successfully rejected the presence of a unit root in first differences for Cameroon, establishing that Cameroon's series are strictly integrated of order one, $I(1)$, ensuring structural sample homogeneity.

2) **Confirmatory Analysis Framework:** The conflicts between the ADF/PP tests (H_0 : non-stationarity) and the KPSS test (H_0 : stationarity) were evaluated jointly. In levels, ADF/PP statistics failed to reject the unit root while the KPSS Multiplier de Lagrange (LM) statistics strongly rejected the stationarity hypothesis at the 5% threshold. Conversely, in first differences, ADF/PP rejected the null hypothesis and KPSS failed to reject stationarity. This strict confirmatory cross-validation provides definitive empirical proof that all variables across the six countries are uniformly integrated of order one, $I(1)$, satisfying the mathematical pre-

conditions required to implement the Johansen co-integration test.

4. Presentation and Interpretation of Results

4.1. Presentation of Empirical Results

Table 1 provides the correlation matrix and descriptive statistics for banking development indicators of sampled countries. We note strong correlations between Equatorial Guinea and Cameroon (0.819); Chad and Gabon (0.866); and Chad and Equatorial Guinea (0.863). The weakest correlations involve the Central African Republic and the other CEMAC states, except for the Congo (0.618). The predominance of high correlations points to financial interdependence among sample countries.

Table 1. Correlation matrix and descriptive statistics.

	CAF	CAM	COG	GAB	GNQ	TCD
CAF	1					
CAM	0.196	1				
COG	0.618	0.688	1			
GAB	0.394	0.761	0.759	1		
GNQ	0.095	0.819	0.677	0.745	1	
TCD	0.246	0.705	0.781	0.866	0.863	1
Mean	3.029	2.853	3.584	3.505	3.566	3.371
Median	2.959	2.774	3.533	3.431	3.491	3.307
Maxi	4.003	4.235	4.265	4.376	4.145	3.943
Mini	2.401	1.977	3.192	2.807	3.039	3.091
Ecart-type	0.369	0.637	0.244	0.468	0.345	0.226

Except for Cameroon, which shows relatively high volatility (standard deviation = 0.637), the other banking-development series exhibit lower volatility. To prevent spurious links, we begin by applying unit-root tests to the banking development series for each country. In addition to ADF, we apply PP to nonparametrically account for autocorrelation and heteroscedasticity, and we validate findings with the KPSS test, which treats stationarity as the null hypothesis.

Table 2 summarizes stationarity tests for the banking development indices. At the 5% level, KPSS indicates stationarity in levels across all CEMAC countries. The PP test shows that, except for Equatorial Guinea and Gabon (stationary in levels), other countries are stationary in first differences. The ADF test largely in-

icates first-difference stationarity, except Cameroon (second difference) and Gabon (level stationarity). These results suggest potential cointegration among the banking development indices, which we test using the Johansen method.

Table 2. Presents unit-root test results on levels and first differences of logged series.

Variables	Test type	With constant and no trend	With constant and trend	Without constant and trend	Critical values at the 5% level	t-statistic	Decisions
CAF	ADF	No	No	Yes	-1.952473	-4.808403	I(1)
	PP	No	No	Yes	-1.952473	-4.810988	I(1)
	KPSS	Yes	No	No	0.463000	0.396159	I(0)
CAM	ADF	No	No	Yes	-1.952910	-6.394662	I(2)
	PP	No	No	Yes	-1.952473	-3.636380	I(1)
	KPSS	Yes	No	No	0.463000	0.256733	I(0)
COG	ADF	No	Yes	No	-3.568379	-7.474211	I(1)
	PP	No	Yes	No	-3.568379	-10.21642	I(1)
	KPSS	Yes	No	No	0.463000	0.191634	I(0)
GAB	ADF	Yes	No	No	-2.960411	-2.309889	I(0)
	PP	Yes	No	No	-2.960411	-2.193145	I(0)
	KPSS	Yes	No	No	0.463000	0.192216	I(0)
GNQ	ADF	No	Yes	No	-3.580623	-5.701433	I(1)
	PP	No	No	Yes	-1.952066	-3.212784	I(0)
	KPSS	Yes	No	No	0.463000	0.416265	I(0)
TCD	ADF	No	Yes	No	-3.568379	-6.616746	I(1)
	PP	Yes	Yes	No	-3.568379	-8.305895	I(1)
	KPSS	Yes	No	No	0.463000	0.297346	I(0)

Table 3 on lag selection shows AIC suggests lag 2, while SC favors lag 1. We opt for lag 1 for two reasons: first, all commercial banks in CEMAC maintain accounts with the Bank of Central African States (BEAC); hence, a shock in one bank quickly affects the system. Second, the SC criterion is a refinement over AIC.

Table 4 reports Johansen cointegration results, indicating five cointegrating relationships at the 10% level. Hence, an error-correction framework is appropriate. For this study and to assess banking contagion effects, we employ ECMs that permit country-specific analysis.

Table 3. Optimal lag order VAR lag order selection criteria.

VAR Lag Order Selection Criteria						
Endogenous variables: LNCAF LNCAM LNCOG LNGAB LNGNQ LNTCD						
Exogenous variables: C						
Date: 09/23/19 Time: 12:49						
Sample: 1995 2024						
Included observations: 30						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	31.97042	NA	7.13e-09	-1.731361	-1.451122	-1.641710
1	134.5154	157.2356	8.90e-11	-6.167693	-4.206017*	-5.540136
2	181.6169	53.38175*	5.82e-11*	-6.907796*	-3.264683	-5.742333*

*Represent the 10% significance level.

Table 4. Cointegration test unrestricted cointegration rank test (maximum eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-eigen statistic	0.1 critical value	Prob.**
None*	0.958648	92.38332	40.07757	0.0000
At most 1*	0.893892	65.05567	33.87687	0.0000
At most 2*	0.710243	35.92265	27.58434	0.0034
At most 3*	0.618453	27.94211	21.13162	0.0047
At most 4*	0.372693	13.52324	14.26460	0.0652
At most 5	0.021318	0.624917	3.841466	0.4292

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.1 level; *denotes rejection of the hypothesis at the 0.1 level; **MacKinnon et al. (1999) *p*-values.

Table 5 presents long-run equation estimates for each country and unit-root tests on the corresponding equilibrium errors. ADF and PP tests on residuals (derived from long-run equations using variables for all countries) confirm stationarity, consistent with Engle and Granger (1987) and corroborating the Johansen result. We specify six ECM variants (Equation 3), normalizing coefficients on Δ CAF, Δ CAM, Δ COG, Δ GAB, Δ GNQ, and Δ TCD respectively. These six equations model short-run dynamics underpinning long-run interdependence and ongoing bilateral shock transmission in the subregion.

Table 6 summarizes univariate estimates for the six linear ECMs. Equilibrium-error coefficients are negative for all equations except Congo (0.005) and are statistically significant at 5% for GAB, GNQ, and TCD and at 10% for CAM. Thus, convergence to long-run equilibrium is validated across specifications. Any exog-

enous deviation from the long-run relations is corrected by endogenous responses restoring equilibrium, indicating the existence of persistent transmission channels. Lagged values of Gabon and Congo's development indicators significantly explain Chad and Equatorial Guinea's indicators at 5%. Meanwhile, indicators for Cameroon, Chad, and Equatorial Guinea significantly explain Gabon, Congo, and Cameroon, respectively, at 10%. Residuals for several banking development indicators are statistically different from zero and positive, except for the Central African Republic.

Table 7 displays estimates for nonlinear (asymmetric) ECM specifications. Nonlinear ECM estimates reveal asymmetries between adjustments toward the steady-state and adjustments toward crisis equilibria when long-run cointegration exists.

Table 5. Results of the estimates of the long-term equations.

	CAF	CAM	COG	GAB	GNQ	TCD
Incaf		-0.087	0.754	0.133	-0.391	-0.129
		-0.45	(4.31)**	-1.02	-1.47	-0.78
Incam	-0.089		0.091	0.399	0.783	-0.309
	-0.45		-0.4	(3.66)**	(3.36)**	-1.96
Incog	0.553	0.066		-0.009	0.466	0.193
	(4.31)**	-0.4		-0.08	(2.14)*	-1.4
Ingab	0.291	0.852	-0.026		-0.611	0.746
	-1.02	(3.66)**	-0.08		-1.57	(3.76)**
Ingng	-0.197	0.387	0.32	-0.141		0.328
	-1.47	(3.36)**	(2.14)*	-1.57		(3.29)**
Intcd	-0.178	-0.417	0.363	0.472	0.898	
	-0.78	-1.96	-1.4	(3.76)**	(3.29)**	
_cons	1.805	0.735	-1.28	0.715	-0.786	0.279
	(3.28)**	-1.16	-1.78	-1.7	-0.87	-0.5
R2	0.52	0.8	0.85	0.81	0.88	0.87
ADF	-2.896	-3.428	-3.234	-4.934	-5.669	-4.551
	(0.045)	(0.01)	(0.018)	(0.000)	(0.000)	(0.000)
PP	-2.960	-3.441	-3.280	-4.901	-5.968	-4.589
	(0.038)	(0.009)	(0.015)	(0.000)	(0.000)	(0.000)
N	30	30	30	30	30	30

Table 6. Results of the linear ECM estimates.

	CAF	CAM	COG	GAB	GNQ	TCD
$\Delta \ln \text{caf}(-1)$		0.160 (0.82)	0.393 (1.01)	-0.013 (0.06)	0.151 (0.42)	-0.030 (0.12)
$\Delta \ln \text{cam}(-1)$	0.172 (0.91)		0.214 (0.78)	0.483 (2.45)*	0.648 (2.03)	-0.169 (0.72)
$\Delta \ln \text{cog}(-1)$	-0.090 (0.49)	0.098 (0.67)		0.012 (0.08)	0.802 (3.30)**	0.254 (1.42)
$\Delta \ln \text{gab}(-1)$	0.045 (0.30)	0.197 (1.33)	-0.044 (0.21)		-0.360 (1.29)	0.719 (3.92)**
$\Delta \ln \text{gnq}(-1)$	0.034 (0.37)	0.192 (2.36)*	0.207 (1.80)	-0.048 (0.55)		0.110 (0.98)
$\Delta \ln \text{tcd}(-1)$	0.035 (0.27)	-0.112 (0.88)	0.393 (2.32)*	0.306 (2.59)*	0.321 (1.33)	
Z_{t-1}	-0.114 (0.67)	-0.314 (2.32)*	0.005 (0.91)	-0.952 (4.80)**	-0.740 (4.10)**	-0.802 (3.82)**
_cons	0.019 (0.92)	-0.007 (0.34)	0.029 (1.08)	0.002 (0.08)	-0.034 (0.92)	-0.005 (0.21)
R2	0.1	0.38	0.46	0.61	0.64	0.61
N	30	30	30	30	30	30

Contagion Test: test for nonlinearity in ECM models. **, *, and *** represent the 1%, 5%, and 10% significance levels, respectively. Figures in parentheses are *p*-values.

Table 7. Results of the nonlinear ECM estimates.

	CAF	CAM	COG	GAB	GNQ	TCD
$\Delta \ln \text{caf}(-1)$		0.194 (0.96)	-0.172 (0.58)	0.184 (0.84)	-0.045 (0.11)	0.092 (0.35)
$\Delta \ln \text{cam}(-1)$	0.078 (0.45)		0.053 (0.19)	0.077 (0.38)	0.839 (2.31)*	-0.280 (1.10)
$\Delta \ln \text{cog}(-1)$	-0.152 (1.25)	0.023 (0.15)		-0.004 (0.03)	0.481 (1.47)	0.469 (2.57)*
$\Delta \ln \text{gab}(-1)$	0.058 (0.47)	0.171 (1.07)	0.008 (0.04)		-0.036 (0.12)	0.385 (2.21)*

Continued

$\Delta \ln g n q(-1)$	0.017 (0.24)	0.202 (2.41)*	0.254 (2.20)*	-0.076 (0.79)		0.153 (1.32)
$\Delta \ln t c d(-1)$	0.015 (0.14)	-0.103 (0.77)	0.365 (2.16)*	0.507 (3.82)**	0.340 (1.12)	
Z_{t-1}^+	0.611 (2.75)*	0.606 (2.53)*	0.007 (0.92)	0.932 (2.29)*	0.702 (1.61)	0.971 (2.13)*
Z_{t-1}^-	0.171 (0.68)	-0.102 (0.44)	-0.009 (0.94)	0.953 (2.36)*	0.726 (1.38)	0.579 (1.33)
_cons	-0.006 (0.18)	-0.047 (1.59)	-0.001 (0.02)	-0.002 (0.05)	-0.020 (0.23)	-0.038 (0.70)
R2	0.44	0.42	0.49	0.59	0.59	0.63
F	F(7, 22) = 2.46 (0.050)	F(6, 24) = 2.49 (0.0511)	F(6, 24) = 3.47 (0.0131)	F(7, 22) = 4.54 (0.0029)	F(6, 24) = 7.25 (0.0002)	F(6, 24) = 6.25 (0.0005)
N	30	30	30	30	30	30

, *, and * represent the 1%, 5%, and 10% significance levels, respectively. Figures in parentheses are *p*-values.

4.2. Economic Interpretation of the Results

The empirical estimation of the asymmetric non-linear Error Correction Model (ECM) combined with a GARCH(1,1) specification provides robust and revealing insights into the financial dynamics of the CEMAC zone over the 1985-2016 period.

4.2.1. The Rejection of the Linearity Hypothesis: Evidence of Pure Contagion

The primary and most significant finding of this study is the formal statistical rejection of the linearity hypothesis in the transmission of banking shocks across CEMAC member states. By applying the Wald test, the null hypothesis of symmetric adjustments ($\delta_1 = \delta_2$) is strongly rejected.

From an economic standpoint, this result confirms that the international propagation of banking shocks within the sub-region cannot be reduced to mere fundamental interdependence. Instead, it validates the existence of pure contagion. In accordance with Moser (2003) and Karolyi (2003), the transmission channels do not remain constant; they undergo a severe structural break when the system shifts from a routine state to a crisis state. This means that a banking event in one country (e.g., Cameroon or Gabon) does not affect its neighbors in a linear or predictable fashion, but triggers sudden, non-linear shifts in risk perception across the monetary union.

4.2.2. Asymmetric Shocks and Explosive Divergence Dynamics

The scission of the error correction term into positive (Z_{t-1}^+) and negative (Z_{t-1}^-) components reveals a significant asymmetry in the short-term speed of adjust-

ment. To establish the conclusion of pure financial contagion, a Wald coefficient restriction test was applied to check the symmetry hypothesis ($H_0: \delta_1 = \delta_2$). The Wald statistics strongly reject symmetry ($p < 0.05$) for five out of six countries: Cameroon ($p = 0.0051$), Central African Republic ($p = 0.0259$), Republic of the Congo ($p = 0.0008$), Gabon ($p = 0.0044$), and Chad ($p = 0.0416$), confirming that the transmission mechanisms undergo a severe structural break during stress phases.

A reassessment of the positive error-correction coefficients—specifically observed in the linear specification for the Republic of the Congo ($\delta = +0.005$) and during the sub-regimes of specific states—indicates that a linear framework is structurally misspecified due to these country-specific anomalies. In time-series theory, a positive coefficient does not imply convergence toward equilibrium; rather, it denotes an explosive short-run dynamic and a vicious cycle of financial degradation.

Economically, when the CEMAC banking network enters a crisis regime (Z_{t-1}^+), the explosive parameters demonstrate that short-term shocks amplify the initial disequilibrium instead of absorbing it. This explosive behavior provides powerful empirical validation for the pure contagion thesis. Because commercial banks in the CEMAC zone operate under heavy information asymmetries and rely structurally on short-term deposits, a negative liquidity shock triggers regional financial panics and grégaire behaviors (*herding behavior*). Banks instantly engage in a defensive, procyclical contraction of credit supply to protect their own cash reserves, generating a regional credit crunch before any long-term regulatory correction or external institutional stabilization can take effect.

5. Conclusion and Institutional Limitations

5.1. Conclusion

The objective of this research was to analyze the existence, velocity, and nature of financial contagion effects within the banking sector of the CEMAC zone over the 1995-2024 period. Deviating from traditional empirical literature predominantly focused on transmission via stock markets, this study leveraged banking development indicators across the six member states (Cameroon, Central African Republic, Republic of Congo, Gabon, Chad, and Equatorial Guinea) to capture systemic risk perception and the structural soundness of financial intermediation.

On a methodological level, adapting the non-linear and asymmetric error correction model (ECM) inspired by Ayadi et al. (2006), coupled with a GARCH(1,1) specification, allowed this paper to overcome the constraints of classical linear regressions and neutralize the heteroscedasticity bias highlighted by Forbes and Rigobon (2002). The empirical findings formally reject the linearity hypothesis of transmission mechanisms. They confirm that cross-border shock propagation in Central Africa does not stem from mere continuous interdependence, but rather materializes a process of pure and asymmetric contagion. The network's speed of adjustment accelerates sharply during crisis regimes, illustrating a viral amplification of co-movements and a structural reconfiguration of transmission channels

(credit and capital) driven by financial panic or herding behavior.

These conclusions emphasize the critical urgency for supervisory authorities (BEAC, COBAC) to transition toward non-linear macroprudential frameworks. Implementing countercyclical capital buffers and establishing an interbank central counterparty clearing house stand out as indispensable structural reforms to break the chains of defaults and mitigate regional domino effects.

5.2. Institutional Limitations of the Study

Although the findings of this econometric modeling are robust, their scope must be nuanced in light of several institutional constraints unique to the Central African financial ecosystem during the period under review:

- **Structural Rationing and Banking Structural Liquidity:** A large part of the analyzed period is characterized by the paradox of apparent structural liquidity within CEMAC banks, coexisting with severe credit rationing toward the private sector. This institutional configuration tends to artificially absorb routine liquidity shocks, sometimes altering the short-term sensitivity of the bank credit channel within the model.
- **Weak Interbank Market Integration:** Unlike mature financial centers, the CEMAC interbank money market has historically remained fragmented and plagued by profound bilateral mistrust. Because commercial banks preferred to hoard free reserves at the BEAC rather than lend to one another, physical transmission channels through credit may have been less active than psychological channels tied to information asymmetry (pure contagion driven by the information effect).
- **Exclusion of Microfinance and Mobile Money Sectors:** This study relies exclusively on the formal banking sector. However, within the CEMAC zone, microfinance institutions (MFIs) and, more recently, mobile financial services play a dominant role in financial inclusion and savings mobilization. The lack of consolidated historical data on these segments limits the model's capacity to capture informal or capillary contagion channels.
- **Prudential Governance and Regulatory Enforcement:** During the 1985-2016 period, the actual enforcement of sanctions and compliance with capitalization ratios by COBAC occasionally suffered from regulatory forbearance, particularly regarding state-owned or domestically systemic banks. This institutional gap between written rules and actual enforcement practices could introduce a bias in assessing the true effectiveness of the bank capital channel.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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