

Assessing the Efficiency of the Algerian Parallel Exchange Rate: A Multidimensional Approach

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Abstract :

In hydrocarbon-dependent economies, parallel exchange markets are often dismissed as chaotic anomalies. This paper reframes the Algerian parallel dinar as an active price discovery mechanism, shifting the empirical paradigm from price determination to functional market performance. Using quarterly data (1990–2025), we evaluate the market across three dimensions via Lo-MacKinlay variance ratios, Engle-Granger error correction models, and Balke-Fomby threshold autoregressive specifications. Results reveal a distinct functional hierarchy. Informational efficiency is strong, with returns following a martingale difference sequence. Fundamental efficiency is partially supported; while the rate maintains a robust long-run cointegrating anchor to macroeconomic fundamentals, short-run disequilibrium clears sluggishly, a structural decoupling we term the "Short-Run Persistence Paradox." Arbitrage efficiency operates conditionally, constrained by an endogenous 18.5% friction band where legal risks suppress mean reversion. The empirical evidence suggests the parallel market functions as a rational, albeit constrained, pricing mechanism, implying that authorities could reconsider futile step-devaluations and utilize the 18.5% threshold for structural market unification.

Key Words: parallel exchange rate; informational efficiency; threshold autoregressive model; dual exchange rate regime; purchasing power parity; Algeria.

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Introduction:

Governments can decree an exchange rate on paper. They cannot decree economic value.

In Algeria, as in many hydrocarbon-dependent rentier economies burdened by strict capital controls, the official dinar rate functions primarily as an administrative rationing device. It distributes foreign exchange to favored state importers and public enterprises while leaving unfulfilled private demand entirely outside the formal banking system. Under these constraints, the market does not disappear; it migrates. The parallel exchange rate emerges as the true market-clearing price, born out of the unconstrained interactions of private buyers and sellers.

Policymakers and central bankers frequently dismiss this informal market as a chaotic, speculative anomaly—a symptom of economic lawlessness that destabilizes the national currency. This paper challenges that premise. We ask a fundamental question: Is the Algerian parallel exchange rate merely a symptom of state-imposed distortion, or does it operate as a rational, functional price discovery mechanism?

To answer this, we must look at the institutional history of the Algerian dual exchange rate regime. The formalization of the parallel market is not a recent accident; it is the structural outcome of decades of policy. The passage of the 1990 Money and Credit Law decentralized commercial banking but failed to liberalize capital accounts. The subsequent 1994 IMF Stand-By Agreement forced a massive official devaluation, yet the parallel premium persisted, demonstrating that administrative pegs cannot overwrite macroeconomic realities. Following the 2014 collapse in global hydrocarbon prices, the depletion of central bank foreign reserves transformed the parallel premium from a structural nuisance into a dominant macroeconomic variable, driving household inflation expectations and corporate investment decisions (Chekouri et al., 2022; Habibi et al., 2026).

Despite its macroeconomic dominance, the parallel market is routinely ignored in formal monetary policy modeling. This paper shifts the analytical paradigm, reframing the Algerian parallel exchange rate not merely as a passive symptom of state distortion, but as a market-driven pricing mechanism that operates under heavy institutional frictions.

I. Theoretical Framework:

1. A Multidimensional Lens on Constrained Markets:

Efficiency is among the most frequently invoked concepts in economic analysis, yet it is often misunderstood when applied to foreign exchange markets under state control. In standard welfare economics, efficiency describes a resource allocation where no individual can be made better off without making someone else worse off (Pareto, 1909). In financial economics, efficiency turns on the price mechanism itself: whether prices accurately process dispersed information and direct capital to its highest-valued uses (Fama, 1970).

When a central bank pegs an official exchange rate and restricts access to foreign currency, the official rate ceases to function as a true price. It becomes an administrative rationing device. Applying Fama's (1970) Efficient Market Hypothesis to an official pegged rate is an exercise in futility; it measures bureaucratic inertia, not economic efficiency. The official rate does not adjust to market news; it changes only when policymakers decide to adjust the peg.

The parallel exchange rate is fundamentally different. Because it is unconstrained by administrative price caps, the parallel rate absorbs market supply and demand pressures directly. Evaluating its efficiency requires moving beyond standard asset-pricing metrics to a broader, systemic framework.

Drawing on Hayek's (1945) insight that prices act as communication networks, we define parallel market efficiency as the systemic capacity of the rate to

perform its essential economic functions under institutional frictions. The parallel rate condenses dispersed knowledge—regarding domestic monetary growth, export earnings, political uncertainty, and foreign currency scarcity—into a single, observable signal. It is not merely a black-market quotation; it is the primary market mechanism through which real currency valuations are established and informal trade is coordinated.

Financial economists formalized this signaling role through the Efficient Market Hypothesis. Fama (1970) argued that prices are informationally efficient when they fully reflect all available information, preventing traders from systematically earning abnormal risk-adjusted returns. Yet informational efficiency is never absolute. As Grossman and Stiglitz (1980) demonstrated, because gathering information requires real resources, prices can never reflect all information with zero error. Market efficiency represents a dynamic equilibrium between the cost of collecting information and the return from trading on it.

In economies with exchange controls, evaluating the parallel exchange rate requires a multidimensional lens. An efficient parallel mechanism must simultaneously fulfill five vital tasks: (1) Information Processing, rapidly absorbing monetary shocks; (2) Real Valuation, reflecting true currency scarcity; (3) Market Clearing, facilitating trades for agents excluded from official allocations; (4) Resource Allocation, directing foreign exchange to its most productively valued uses; and (5) Cross-Market Coordination, maintaining structural adjustment relative to official policy boundaries.

We integrate perspectives from welfare economics (Pareto, 1909), industrial organization (Farrell, 1957), market microstructure (Demsetz, 1968; O'Hara, 1995), financial economics (Fama, 1970; Grossman & Stiglitz, 1980), and international macroeconomics (Cassel, 1918; Frenkel, 1976; Taylor & Taylor, 2004) into a Systemic Multidimensional Framework of Parallel Exchange-Rate Efficiency comprising five dimensions: Informational, Operational, Allocational, Arbitrage, and Fundamental Efficiency.

However, a rigorous empirical design must distinguish between conceptual efficiency and empirical operationalization. Measuring Operational Efficiency (dealer spreads, tick-by-tick liquidity) and Allocational Efficiency (firm-level productivity impacts) requires micro-level transaction logs that are unrecorded in decentralized informal markets like Algiers' Square Port-Saïd. Therefore, this study restricts its empirical operationalization to the three dimensions measurable via macroeconomic time series: Informational Efficiency, Fundamental Efficiency, and Arbitrage Efficiency.

2. Literature Review:

For decades, conventional wisdom viewed parallel currency markets with hostility. Unofficial exchange markets were portrayed as illegal distortions that destabilized national currencies, fueled inflation, and eroded official foreign reserves (Agénor, 1992; Kiguel & O'Connell, 1995; Noorbakhsh & Shahrokhi, 1993). This perspective missed a fundamental economic truth: parallel currency markets do not create foreign exchange shortages; central bank price controls do. When a government enforces an overvalued official exchange rate and rations foreign currency, parallel markets emerge as a spontaneous, rational market solution that clears the market and establishes a floating price reflecting true scarcity (Yiheyis, 2000).

International empirical research confirms that parallel rates exhibit significant informational and fundamental efficiency. While official pegged exchange rates remain frozen by central bank decree, parallel market rates adjust continuously to money supply expansion, fiscal deficits, and balance-of-payments shocks (Cheung, 2008; Ebaidalla, 2019; Hakkio & Rush, 1989). Unofficial rates act as forward-looking indicators, processing monetary information far more rapidly than official banking channels (Rossi, 2013). Applying Purchasing Power Parity (PPP) and monetary models, researchers consistently find that parallel rates maintain stable, long-run cointegrating relationships with relative price levels (Bahmani-Oskooee & Goswami, 2004; Kumeka, 2022; Ortiz, 2005).

Literature on arbitrage dynamics shows that while capital controls prevent complete price convergence between official and parallel markets, the resulting parallel premium reflects structural scarcity and enforcement risks (Pinto, 1989; Oyetao et al., 2024). Cointegration studies confirm that parallel and official exchange rates move together over long horizons, proving that market forces link dual currency segments despite administrative restrictions (Kiguel & O'Connell, 1995).

Evidence from Algeria aligns with these global findings. Studies show that the parallel dinar rate anticipates domestic inflation spikes and processes hydrocarbon trade shocks long before monetary authorities adjust the official peg (Bendob, 2014; Bouazizi, 2020). Private agents rely on the parallel rate, rather than the official rate, as their primary metric for real purchasing power and currency depreciation risk (Bouteldja, 2015; Habibi et al., 2026). Purchasing Power Parity tests repeatedly reject the official dinar rate as a long-run equilibrium price, while confirming that the parallel exchange rate tracks relative inflation differentials over time (Mohammed, 2016; Si Mohammed & Haoulia, 2015; Wu, 2023). Econometric models confirm that variables such as broad money growth, oil export prices, and central bank reserves explain the majority of long-run movements in the parallel rate (Hellal, 2025; Karoui, 2021).

Yet, a critical conceptual limitation pervades this literature.

Existing studies treat the parallel exchange rate almost exclusively as a passive dependent variable. Economists habitually ask: *What macroeconomic variables cause the parallel rate to move?* They model price *determination*. Finance

scholars test short-term time-series predictability (Fama, 1970; Hakkio & Rush, 1989). Macroeconomists test PPP and long-run fundamental cointegration (Cassel, 1918; Frenkel, 1976). Trade economists analyze black-market premiums and foreign exchange restrictions (Agénor, 1992; Kiguel & O'Connell, 1995). Almost no studies ask the functional question: *How efficiently does the parallel rate perform as an active pricing mechanism?*

3. Problem Statement and Hypothesis Operationalization:

Evaluating a currency market through a single perspective produces incomplete conclusions. A parallel exchange rate might process short-run news efficiently while diverging from long-run fundamental purchasing power. Or it might track money growth over decades while exhibiting severe short-term arbitrage frictions.

This study fills this central gap by shifting the paradigm from price *causation* to price *performance*. We formulate our core research question as follows: **Does the Algerian parallel exchange rate perform the economic functions expected from an efficient exchange-rate mechanism?**

To answer this, we decompose the question into three functional dimensions, generating three testable theoretical hypotheses that directly map to our econometric strategy:

3.1. The Information Function (Informational Efficiency): Does the parallel rate efficiently aggregate and transmit economically relevant information without exhibiting predictable patterns? Rooted in Hayek's (1945) price theory and Fama's (1970) weak-form efficiency, we operationalize this via **Hypothesis 1 (H_1):** *Parallel exchange rate returns follow a martingale difference sequence, displaying both linear and non-linear independence over time.* This is tested using non-parametric Runs tests, Lo-MacKinlay heteroskedasticity-robust variance ratios, and the Brock-Dechert-Scheinkman (BDS) test for non-linear stochastic independence.

3.2. The Valuation Function (Fundamental Efficiency): Does the rate provide a valuation of the dinar that aligns with real economic fundamentals over time? Grounded in PPP and monetary exchange rate theory (Cassel, 1918; Frenkel, 1976), we operationalize this via **Hypothesis 2 (H_2):** *A stable, long-run cointegrating relationship exists between the parallel exchange rate and its core macroeconomic fundamentals (domestic inflation, oil prices, and foreign reserves).* We test this using the Engle-Granger two-step cointegration framework, supplemented by an Error Correction Model (ECM) to measure the speed of short-run dynamic adjustments.

3.3. The Coordination Function (Arbitrage Efficiency): Does the rate facilitate dynamic price adjustments across segmented market boundaries? Grounded in dual foreign exchange market theory (Agénor, 1992; Kiguel & O'Connell, 1995), we operationalize this via **Hypothesis 3 (H_3):** *Arbitrage between the official and parallel markets operates under regime-switching dynamics, constrained by an endogenous threshold friction band.* Because linear unit root tests fail to capture the non-linear reality of informal arbitrage under legal risk, we test this using a Balke-Fomby Threshold Autoregressive (TAR) model.

II. Method:

The ultimate test of any economic hypothesis is its ability to explain and predict real-world behavior. If a model fails to square with observable facts, no amount of theoretical elegance can rescue it.

Evaluating the efficiency of a constrained, informal market requires moving beyond abstract ideals of frictionless competition. We cannot judge the Algerian parallel exchange rate by asking whether it matches a textbook model of perfect arbitrage. Instead, we must ask a practical, functional question: does the rate yield meaningful, predictable economic results that reflect the true state of supply and demand? To answer this, our methodology avoids relying on a single econometric test. We construct a three-part empirical framework that measures how the parallel rate behaves as an asset price, how it anchors itself to real macroeconomic forces, and how it adjusts across segmented market boundaries.

1. Data Description, Variables and Parsimonious Variable Specification:

This study utilizes quarterly time-series data for the Algerian economy spanning from 1990:Q1 to 2025:Q4 ($N=144$). The starting date of 1990:Q1 is critical, as it marks the passage of the Money and Credit Law, which formally decentralized the banking sector and catalyzed the modern parallel foreign exchange market.

1.1. Data Source Triangulation for the Parallel Rate: Because the parallel foreign exchange market operates outside the formal banking system, the Central Bank of Algeria does not publish official daily or quarterly series for the parallel rate, particularly for the earlier years of the sample. To construct a reliable, continuous quarterly series, we employed a data triangulation methodology standard in the empirical literature on dual exchange rate regimes (Agénor, 1992; Kiguel & O'Connell, 1995). The parallel exchange rate data ($\ln_{t0} \text{Parallel_Rate}$) was constructed by cross-referencing three primary sources: (1) historical field surveys and academic datasets established in prior local literature (e.g., Bendob, 2014; Bouteldja, 2015), which conducted primary data collection in informal trading hubs; (2) IMF Article IV Consultation reports, which periodically documented parallel market premiums and effective exchange rates; and (3) retrospective macroeconomic bulletins from the National Office of Statistics (ONS). While informal market data inherently carries measurement noise, this triangulated approach captures the true *de facto* market-clearing price, which is the exact variable of interest for evaluating informal market efficiency. The remaining macroeconomic variables were sourced from the Central Bank of Algeria and the IMF International Financial Statistics (IFS).

1.2. Parsimonious Variable Specification and Multicollinearity Defense: Our primary focus is the natural logarithm of the parallel foreign exchange rate ($\ln_{t0} \text{Parallel_Rate}$), measured in Algerian Dinars per US Dollar (DZD/USD). In an economy where foreign exchange is administratively rationed, this street rate is not a secondary market anomaly; it is the primary unconstrained market price. For comparative purposes, we also include the official administrative

exchange rate ($\ln_{f0} \text{Official_Rate} / \ln_{f0} \text{Official_Rate}_t$) and specify the parallel market premium as a percentage spread:

$$\text{Prem}_t = \left(\frac{\exp(p_t) - \exp(o_t)}{\exp(o_t)} \right) \times 100$$

Standard monetary models often suffer from an impulse to include every conceivable variable, producing bloated specifications where statistical noise obscures core economic forces. In a hydrocarbon-dependent rentier economy like Algeria's, standard variables such as broad money supply (M2M2), real output (GDPGDP), and fiscal revenues are structurally endogenous to hydrocarbon export windfalls. Including them alongside oil prices would result in severe multicollinearity, distorting the long-run cointegrating vectors. Furthermore, the official policy interest rate is administratively set and largely irrelevant to the informal parallel market, where pricing is driven by physical currency scarcity rather than interbank lending rates.

Therefore, adhering to the principle that theory should be as simple as possible but no simpler, we exclude highly collinear variables and isolate a parsimonious core of three fundamental macroeconomic anchors:

- $\ln_{f0} \text{CPI} / \ln_{f0} \text{CPI}_t$: The natural logarithm of the domestic Consumer Price Index, capturing domestic purchasing power erosion and long-run price level pass-through.
- $\ln_{f0} \text{Oil_Price} / \ln_{f0} \text{Oil_Price}_t$: The natural logarithm of the Brent crude oil price (in USD per barrel), capturing the dominant real trade shock and foreign currency supply inflow.
- $\ln_{f0} \text{FX_Reserve} / \ln_{f0} \text{FX_Reserve}_t$: The natural logarithm of central bank foreign exchange reserves (in billions of USD), serving as a proxy for the state's capacity to intervene in official trade and back the currency.

2. Testing for Non-Stationarity and Structural Breaks:

Estimating regressions on non-stationary variables risks generating spurious results high statistical correlation without any underlying economic truth. To establish the precise order of integration, we employ a sequential unit root testing strategy. We begin with the standard Augmented Dickey-Fuller (ADF) test to parametrically account for serial correlation, complemented by the non-parametric Phillips-Perron (PP) test, which uses kernel estimators to correct for unobserved heteroskedasticity (Dickey & Fuller, 1979; Phillips & Perron, 1988).

However, standard unit root tests are biased toward falsely concluding that a series has a unit root when the data contain structural breaks. Algeria's modern economic history is defined by severe structural shocks—the 1990 Money and Credit Law, the 1994 IMF Stand-By Agreement, and major global oil price collapses. To prevent these policy shifts from distorting our statistical inference, we implement the Zivot-Andrews (ZA) test. This procedure endogenously identifies a single structural break in the intercept, the trend, or both, allowing us to distinguish genuine non-stationarity from structural regime shifts (Zivot & Andrews, 1992).

3. Econometric Specifications:

3.1. Informational Efficiency: Evaluating Short-Run Price Discovery: If the parallel foreign exchange market operates as an efficient asset market, current prices should rapidly absorb available information. We test Hypothesis 1 (H_1): Parallel exchange rate returns (Δp_t) follow a martingale difference sequence, displaying both linear and non-linear independence over time.

To test linear predictability across multi-period holding horizons ($q \in \{2,4,8\}$), we use the Lo-MacKinlay (1988) heteroskedasticity-robust variance ratio (VR) test. Under the null hypothesis of a random walk, the variance of q -period returns must equal q times the variance of single-period returns. To complement this parametric test, we apply a non-parametric Runs Test to evaluate directional independence around the median. Finally, because linear independence does not rule out non-linear deterministic patterns, we apply the Brock-Dechert-Scheinkman (BDS) test (Brock et al., 1996) to the residuals of an ARMA-filtered return series. By testing for non-linear stochastic independence across embedding dimensions ($m \in \{2,3\}$), the BDS test determines whether apparent randomness masks underlying non-linear dependencies.

3.2. Fundamental Efficiency: Testing Macroeconomic Anchors: An efficient pricing mechanism cannot drift indefinitely into speculative space; it must remain anchored to real macroeconomic conditions. We test Hypothesis 2 (H_2): A stable, long-run cointegrating relationship exists between the parallel exchange rate and its core macroeconomic fundamentals.

We test this using the Engle-Granger (1987) Two-Step Cointegration Framework. First, we estimate the long-run structural equation by ordinary least squares: For clarity and consistency throughout the manuscript, we define the following notation system. Let p_t denote the natural logarithm of the parallel exchange rate (DZD/USD), o_t the natural logarithm of the official exchange rate, c_t the natural logarithm of the domestic Consumer Price Index (CPI), y_t the natural logarithm of the Brent crude oil price (USD per barrel), and r_t the natural logarithm of central bank foreign exchange reserves (USD billions). Returns are denoted Δp_t , the error correction term as ect_{t-1} (or equivalently u_{t-1} from the cointegrating regression), and the endogenous threshold boundary as $\gamma\gamma$. Long-run structural coefficients are α_0 (intercept) and $\beta_1, \beta_2, \beta_3$ (elasticities with respect to c_t, y_t, r_t respectively). Threshold regime adjustment parameters are ρ_1 (inner regime) and ρ_2 (outer regime). This compact notation is applied uniformly across all equations, tables, and figures in the paper.

$$p_t = \alpha_0 + \beta_1 c_t + \beta_2 y_t + \beta_3 r_t + u_t$$

If the residual series ($\hat{u}_t$) is stationary at levels— $I(0)$ —the variables are cointegrated, proving the existence of an enduring equilibrium anchor. In the second step, we model short-run dynamic adjustments using an Error Correction Model (ECM):

$$\Delta p_t = \delta_0 + \lambda \hat{u}_{t-1} + \sum_{i=1}^k \gamma_i \Delta X_{t-i} + \varepsilon_t$$

Here, X represents the vector of fundamental variables (c, y, r), and λ is the error correction coefficient measuring the speed at which the parallel exchange rate corrects short-term disequilibrium.

3.3. Arbitrage Efficiency: Threshold Dynamics and Friction Bands: In an informal market subject to legal restrictions, arbitrage operates non-linearly. Small price gaps may not offer enough profit to cover enforcement risks, while larger spreads trigger active informal trading. Linear unit root tests fail to capture this regime-shifting behavior. To test Hypothesis 3 (H_3), we apply the Balke-Fomby (1997) Threshold Autoregressive (TAR) model to the premium series:

$$\Delta \text{Prem}_t = \begin{cases} \rho_1 \text{Prem}_{t-1} + e_t & \text{if } |\text{Prem}_{t-1}| \leq \gamma \\ \rho_2 \text{Prem}_{t-1} + e_t & \text{if } |\text{Prem}_{t-1}| > \gamma \end{cases}$$

where γ is the endogenously estimated threshold boundary. Inside the inner regime ($\leq \gamma$), frictions block arbitrage ($\rho_1 \approx 0$). Outside the boundary ($> \gamma$), active informal arbitrage triggers mean reversion ($\rho_2 < 0$). We evaluate this against a linear alternative using Hansen's (1996) bootstrap procedure.

4. Diagnostic Robustness and Inference Controls:

Every estimated model is evaluated using a standard battery of diagnostic tests: the Breusch-Godfrey LM test for serial correlation, the Breusch-Pagan test for heteroskedasticity, the Jarque-Bera test for residual normality, and CUSUM/CUSUMSQ recursive residual tests for parameter stability. Where short-run errors exhibit non-normality or ARCH effects due to sudden policy shifts, we substitute classical standard errors with Huber-White heteroskedasticity-robust standard errors. Finally, to verify that our results hold across different historical periods, we test parameter stability by splitting the sample at 2014:Q3, marking the collapse of global oil prices that fundamentally altered Algeria's external balances.

III. Results:

Theoretical elegance means nothing if it fails to square with observable facts. To evaluate whether the Algerian parallel foreign exchange market functions as an efficient economic mechanism, we subject our time series to rigorous empirical testing across the three operationalized dimensions.

1. Stationarity and Structural Breaks:

Before testing for long-run relationships or price predictability, we must establish the order of integration. Table 1 reports the statistical results from the unit root and structural break tests.

Table 1: Empirical Unit Root and Structural Break Testing Matrix

Variable	ADF (Lv)	ADF (Δ)	PP (Lv)	PP (Δ)	ZA Stat	Order
$\ln \text{Parallel}_t$	0.116	-12.499***	0.091	-12.510***	-3.016	$I(1)$
$\ln \text{CPI}_t$	-0.904	-2.876**	-0.854	-3.014**	-6.504***	$I(1)$
$\ln \text{Oil}_t$	-1.907	-10.407***	-1.811	-10.421***	-4.138	$I(1)$
$\ln \text{Reserves}_t$	-1.994	-3.120**	-1.854	-3.402**	0.466	$I(1)$
$\ln \text{Official}_t$	-2.206	-2.130	-2.102	-2.210	-5.068**	$I(1)$
Premium_t	1.612	-1.656	1.594	-1.801	-0.401	Non-Stat.

Source: Calculated by researchers.

Note: ***, **, * denote significance at 1%, 5%, 10%. ZA critical values at 1%, 5%, 10%: -5.34, -4.80, -4.58.

The standard ADF and PP tests confirm that all core macroeconomic variables are non-stationary in levels but stationary in first differences, establishing a uniform $I(1)$ integration profile.

Economic history is not a smooth, linear line; it is punctuated by policy regime shifts. The Zivot-Andrews test endogenously pinpoints structural break dates that map directly into key historical shifts: the 1990:Q1 passage of the Money and Credit Law, the 1992:Q1 peak of the balance-of-payments crisis, and the 1993:Q2 structural preparations for the 1994 IMF Stand-By Agreement.

A critical empirical finding emerges from the parallel market premium ($Prem_t$). Under linear unit root tests, the premium remains non-stationary even in first differences. This failure is not a statistical dead-end. Rather, it signals that linear cointegration models are structurally misspecified for evaluating parallel premiums, justifying the non-linear threshold approach applied above.

2. Efficiency outputs:

2.1. Dimension 1: informational efficiency:

Bureaucrats often dismiss parallel foreign exchange markets as chaotic, speculative gambling dens. To test whether the Algerian parallel rate acts as a rational information processing mechanism, we evaluate Hypothesis 1. Table 2 presents the weak-form efficiency tests.

Table 2 : Informational Efficiency Test Results

Test Method	Parameter / Horizon	Statistic	p-value
Runs Test	Median Cutoff	$Z = 0.420$	0.674
Lo-MacKinlay VR	$q = 2$	$VR(2) = 0.958$	0.582
	$q = 4$	$VR(4) = 0.900$	0.493
	$q = 8$	$VR(8) = 0.851$	0.381
BDS Test	$m = 2$	$BDS = -0.508$	0.611
	$m = 3$	$BDS = -0.638$	0.523

Source: Calculated by researchers.

The statistical evidence provides strong support for Informational Efficiency. The non-parametric Runs Test ($Z = 0.420, p = 0.674$) demonstrates that directional price changes are independent over time, ruling out systematic cyclical patterns. The Lo-MacKinlay Variance Ratios across multi-period holding horizons remain close to 1.0, confirming that return variance scales linearly with time. The BDS test applied to ARMA-filtered return residuals detects no remaining non-linear dependencies ($p > 0.52$).

The data tells a different story than the official narrative. Despite operating without formal regulatory frameworks, the informal market in Algiers functions as a highly sensitive asset market. Street traders process new macroeconomic data—shifting oil prices, import restrictions, liquidity squeezes—and incorporate it into price quotations almost instantly. Past price trends offer zero risk-adjusted return opportunities to speculators. H_1 is strongly supported.

2.2. Dimension 2: fundamental efficiency:

An exchange rate can process short-run news efficiently while drifting away from real economic gravity. To evaluate Hypothesis 2, we test whether the parallel exchange rate remains anchored to underlying macroeconomic fundamentals over long horizons. Table 3 reports the long-run structural cointegrating vector.

Table 3: Long-Run Structural Cointegrating Vector (Dependent: p_t)

Regressor	Coeff (β)	Std. Err.	t-Stat	p-value	95% CI
Intercept (α_0)	-4.310***	0.272	-15.83	0.000	[-4.849, -3.773]
$\ln \text{CPI}_t$ (β_1)	1.374***	0.053	25.83	0.000	[1.269, 1.480]
$\ln \text{Oil}_t$ (β_2)	0.278***	0.040	6.83	0.000	[0.198, 0.359]
$\ln \text{Reserves}_t$ (β_3)	-0.164***	0.029	-5.65	0.000	[-0.222, -0.107]

Source: Calculated by researchers.

Diagnostics: $R^2 = 0.949$, $F = 867.9$ ($p < 0.0001$). EG Residual ADF = -2.964 ($p = 0.038$).

The stationarity of the residual vector confirms cointegration. A 1% increase in domestic prices drives a 1.37% depreciation in the parallel dinar, validating long-run PPP. A 1% expansion in reserves strengthens the parallel dinar by 0.16%, as higher reserves reduce speculative demand for street currency.

But the long-run anchor only tells half the story. Table 4 reveals the Short-Run Persistence Paradox.

Table 4: Short-Run Error Correction Model (Dependent: Δp_t)

Parameter	Coeff	Std. Err.	t-Stat	p-value
Constant	0.017***	0.005	3.167	0.002
ECM_{t-1}	-0.008	0.026	-0.312	0.755
$\Delta \ln \text{CPI}_t$	0.229	0.229	0.997	0.320
$\Delta \ln \text{Oil}_t$	-0.032	0.024	-1.356	0.177
$\Delta \ln \text{Reserves}_t$	0.005	0.081	0.070	0.944

Source: Calculated by researchers.

The error correction coefficient ($\text{ECM}_{t-1} = -0.008, p = 0.755$) is statistically insignificant. The parallel exchange rate is firmly anchored to macroeconomic realities over decades, but short-run deviations clear sluggishly. Strict capital controls, administrative trade barriers, and legal risks prevent immediate short-run market clearing. Economic gravity holds in the long run, but institutional frictions choke the speed of quarterly adjustment. H_2 is only partially supported.

2.3. Dimension 3: Arbitrage efficiency:

To test Hypothesis 3, we evaluate whether price gaps between the official and parallel exchange rates trigger self-correcting arbitrage. Because standard linear unit root tests failed for the parallel premium, we apply a Balke-Fomby TAR model. Table 5 details the non-linear threshold dynamics.

Table 5: Balke-Fomby Non-Linear Threshold Premium Dynamics

Regime	Param	Coeff	Std. Err.	t-Stat	p-value
Inner ($\leq 18.5\%$)	ρ_1	-0.001	0.018	-0.065	0.948
Outer ($> 18.5\%$)	ρ_2	-0.184***	0.054	-3.398	0.000

Source: Calculated by researchers.

Threshold (γ): 18.5%. Hansen Linearity Test: $F = 14.82$ ($p = 0.015$).

The Hansen Linearity Test ($p = 0.015$) decisively rejects a linear model. The endogenously estimated 18.5% threshold defines two distinct operational realities. Inside the inner inaction band, the adjustment parameter is statistically zero; potential arbitrage profits are swallowed by legal risks, police enforcement, and search costs. Once the premium breaches 18.5%, the adjustment parameter becomes negative and highly significant. Expected profits outweigh transaction risks. Informal traders re-enter the market, driving cross-market arbitrage that pulls the premium back toward the structural threshold. H_3 is conditionally supported.

3. Diagnostic and Robustness:

Table 6 confirms the absence of serial correlation and parameter instability. Non-normal residual spikes in the ECM were corrected using Huber-White errors.

Table 6: Diagnostic Testing Suite

Diagnostic	Test	Long-Run	Short-Run ECM
Serial Correlation	Breusch-Godfrey LM	$p = 0.123$	$p = 0.441$
Heteroskedasticity	Breusch-Pagan	$p = 0.004^{***}$	$p = 0.118$
Normality	Jarque-Bera	$p = 0.394$	$p = 0.000^{***}$
Stability	CUSUM / CUSUMSQ	Stable (5%)	Stable (5%)

Source: Calculated by researchers.

Splitting the dataset at 2014:Q3 (the oil collapse) reveals remarkable parameter stability. The inflation elasticity (β_1) ranges from 1.294 to 1.411 across sub-samples, while reserve sensitivity (β_3) increases post-2014 as depletion heightened market anxiety. Cointegration holds across all sub-samples, proving structural resilience to massive external trade shocks.

Table 7: Sub-Sample Cross-Validation (2014 Hydrocarbon Collapse)

Parameter	Full Sample	Pre-2014	Post-2014
β_1 (CPI)	1.374 ^{***}	1.294 ^{***}	1.411 ^{***}
β_2 (Oil)	0.278 ^{***}	0.241 ^{***}	0.301 ^{***}
β_3 (Reserves)	-0.164 ^{***}	-0.141 ^{***}	-0.194 ^{***}
Cointegration	Confirmed	Confirmed	Confirmed

Source: Calculated by researchers.

Additional Robustness and Sensitivity Analyses:

To ensure our core findings are not artifacts of specific econometric choices or extreme outlier periods, we conducted two additional robustness checks.

First, to validate the Engle-Granger cointegration results, we applied the Johansen Cointegration Test, which is generally preferred in multivariate systems as it allows for the detection of multiple cointegrating vectors. Both the Trace statistic and the Maximum Eigenvalue statistic confirm the presence of at least one cointegrating vector at the 5% significance level, reinforcing the existence of a stable long-run structural anchor between the parallel rate and our chosen fundamentals.

Second, we conducted a sensitivity analysis to verify that our results are not disproportionately driven by the extreme macroeconomic volatility of the 2014–2015 global oil price collapse. By re-estimating our core models on a restricted sample that excludes this specific 8-quarter window, the fundamental relationships remain intact. The long-run coefficients retain their expected signs and statistical significance, and the Threshold Autoregressive (TAR) model continues to identify a

highly significant non-linear adjustment mechanism, with the friction boundary remaining structurally stable (estimated at 18.2% in the restricted sample, closely mirroring the full-sample 18.5% threshold). These checks confirm that our empirical conclusions are robust to alternative specifications and sample variations.

IV. Discussion:

The empirical findings of this study challenge a persistent policy assumption: that Algeria's parallel foreign exchange market is merely an erratic, ungrounded speculative bubble. When subjected to econometric scrutiny, the evidence suggests the informal market functions as a rational price discovery mechanism, albeit one operating under heavy state-imposed restrictions.

Rather than yielding a binary verdict on market quality, the evidence demonstrates a distinct functional hierarchy in how the parallel market processes information, anchors itself to real economic forces, and adjusts across segmented boundaries.

1. The Efficiency Scorecard: Dismantling the “Chaotic Market” Myth:

To provide a direct answer to our central research question, Table 7 synthesizes our empirical findings.

Table 8: The Multidimensional Efficiency Scorecard

Dimension	Applied Econometric Evidence	Assessment
Informational	Runs ($p = 0.674$); VR ≈ 1.0 ; BDS ($p > 0.52$)	Fully Supported
Fundamental	Cointegration ($p = 0.038$); PPP signs valid; $ECM_{t-1} \approx 0$	Partially Supported
Arbitrage	Linear fails; TAR threshold 18.5% ($p = 0.015$); $\rho_2 = -0.184^{***}$	Conditional

Source: compiled by researchers.

This scorecard establishes a clear structural hierarchy. The parallel foreign exchange market is neither chaotic nor fully efficient in a textbook sense. It is an unconstrained price mechanism performing essential market-clearing functions under substantial transaction costs and legal risks.

2. The Short-Run Persistence Paradox and Information Asymmetries:

The statistical confirmation of weak-form informational efficiency requires careful theoretical interpretation. A critical distinction must be drawn between *local price discovery* and *macroeconomic information processing*. In the informal trading hubs of Algiers, such as Square Port-Saïd, street dealers do not continuously evaluate balance-of-payments statistics or official monetary targets in real time. Instead, short-run price formation operates through immediate order-flow feedback, localized currency availability, and historical price memory. Because dealers continuously adjust bid-ask spreads to protect themselves against predictable exploitation by rival traders, historical price trends offer zero risk-adjusted return opportunities. This explains why weak-form efficiency holds statistically.

However, when evaluated through Fama's (1970) broader taxonomy, the limitations become clear. Weak-form efficiency holds because past returns cannot predict future price changes. But semi-strong form efficiency fails; the market does not adjust instantaneously to publicly available macroeconomic news. Strong-form

efficiency is entirely absent, as asymmetric information held by large informal currency dealers and capital flight networks generates localized informational advantages.

This structural decoupling manifests empirically as what we term the Short-Run Persistence Paradox. The long-run cointegration results confirm that the parallel rate cannot escape macroeconomic gravity over decades. Yet, the error correction coefficient in the short-run ECM is statistically insignificant. Macroeconomic anchors exert an inescapable long-run pull, but short-term disequilibrium persists for extended periods without automatic mean reversion.

The long-run cointegration results confirm that, despite short-term speculative noise, the parallel exchange rate cannot escape macroeconomic gravity. Over decades, its valuation tracks domestic purchasing power erosion, hydrocarbon trade cycles, and central bank reserve capacity. However, the empirical evidence reveals what we term the Short-Run Persistence Paradox: macro-fundamental anchors exert an inescapable long-run pull on valuations, yet short-term disequilibrium persists for extended periods without automatic mean reversion, as evidenced by the statistically insignificant error correction coefficient ($ECMt-1 = -0.008, p=0.755$ $ECMt-1 = -0.008, p=0.755$).

This paradox is not a failure of the econometric model; rather, it is a direct, measurable consequence of state intervention and market segmentation. The sluggish short-run adjustment is driven by three compounding friction layers:

Regulatory and Legal Barriers: The Algerian legal framework strictly criminalizes unauthorized foreign currency trading. This creates a high baseline "risk premium" for informal dealers. When the parallel rate deviates slightly from its long-run fundamental anchor, the expected profit from arbitraging the gap is immediately swallowed by the threat of police confiscation, legal prosecution, and asset seizure. Consequently, small-to-moderate deviations are tolerated rather than corrected.

Structural and Microstructural Frictions: Unlike formal forex markets with electronic clearinghouses and instant settlement, the Algerian parallel market relies on decentralized, physical cash transactions (e.g., in hubs like Square Port-Saïd). This introduces severe search costs, security overheads (to mitigate robbery risks), and a complete absence of forward hedging instruments. These microstructural inefficiencies physically slow down the velocity of arbitrage capital.

Administrative Rationing: Even if formal economic agents recognize a mispricing, they cannot instantly arbitrage it away. Strict capital controls, annual tourist allowance limits (allocation touristique), and bureaucratic delays in obtaining import licenses mean that formal actors are locked out of the official market. The parallel market is thus left to clear solely among informal actors, whose capacity to inject large volumes of liquidity to correct a shock is inherently limited.

In the short horizon, street prices react to localized liquidity squeezes, administrative trade restrictions, and rumor cycles. While long-run economic gravity eventually asserts itself, these state-imposed trade barriers allow short-run street prices to drift away from fundamental equilibrium for quarters at a time. This aligns with Grossman and Stiglitz (1980), who demonstrated that when gathering

information and executing trades require real resources and carry legal risks, prices cannot reflect all information with zero error in the short run.

3. The Economics of the 18.5% Arbitrage Friction Band:

The success of threshold autoregressive modeling over linear specifications highlights the non-linear reality of dual foreign exchange systems. The Balke-Fomby TAR model captures the actual behavioral economics of informal arbitrage under legal risk.

The endogenously estimated 18.5% threshold defines two distinct operational regimes.

The Inaction Zone (Below 18.5%): When the spread between the official rate and the parallel rate remains narrow, potential arbitrage profits are swallowed by legal risks, police confiscation, transport costs, and search frictions. In Algeria, the legal framework strictly criminalizes unauthorized foreign currency trading. The physical risk of transporting large volumes of cash, combined with the lack of forward hedging instruments, creates a high baseline transaction cost. Private traders have little financial incentive to execute cross-market transactions. Inside this band, the premium drifts like an uncorrected random walk.

The Active Arbitrage Zone (Above 18.5%): Once state intervention causes the parallel premium to breach the 18.5% boundary, expected profit margins exceed enforcement risks and transaction costs. Commercial actors actively enter the market to exploit the price gap—over-invoicing formal imports, under-invoicing hydrocarbon and non-hydrocarbon exports, and diverting migrant remittances into informal channels. These cross-market flows expand foreign currency liquidity in the street market, pulling the premium back down toward the friction threshold.

The 18.5% boundary is not merely a statistical artifact. It is the exact empirical measurement of the “cost of illegality” in the Algerian foreign exchange market. It represents the precise risk premium demanded by informal dealers to bypass state capital controls.

Furthermore, our sub-sample cross-validation (Table 4.7) indicates that this threshold dynamic remains structurally stable across different historical periods, including the pre- and post-2014 hydrocarbon collapse eras. While the exact percentage boundary of the friction band may experience minor fluctuations depending on the severity of central bank reserve depletion, the fundamental presence of a non-linear adjustment mechanism is a persistent feature of Algeria's dual exchange rate regime. The market consistently tolerates small premiums but actively self-corrects once the spread exceeds the risk-adjusted cost of informal arbitrage.

4. Qualitative Dimensions of Market Inefficiency and Study Limitations:

While this study successfully operationalizes and tests the informational, fundamental, and arbitrage dimensions of parallel market efficiency, a complete evaluation of any pricing mechanism requires acknowledging its broader welfare implications and the methodological boundaries of the current research.

- **Data Limitations and the Boundary of Empirical Operationalization:** A primary limitation of this study stems from the inherent data constraints of informal

markets. Evaluating *Operational Efficiency* (dealer spreads, tick-by-tick liquidity, execution speed) and *Allocational Efficiency* (firm-level productivity impacts of currency access) requires micro-level transaction logs, order book data, and firm-level import margin records (Demsetz, 1968; O'Hara, 1995). Because Algeria's parallel market operates through decentralized, informal networks (such as Algiers' Square Port-Saïd), such granular data is unrecorded and unavailable. Consequently, our empirical framework is necessarily bounded to macroeconomic time-series analysis. We explicitly acknowledge that proving *informational* efficiency does not equate to proving overall *welfare* efficiency.

- Qualitative Narrative of Operational Deadweight Losses: Despite this data limitation, economic theory allows us to qualitatively assess the severe operational inefficiencies inherent to this market structure. Unlike formal foreign exchange markets characterized by electronic clearinghouses, instant settlement, and deep liquidity, the Algerian parallel market relies on physical, decentralized cash transactions. This microstructure imposes massive transaction overheads and deadweight losses on the national economy. Informal dealers and users must bear high security costs to mitigate robbery risks, incur significant search costs to find counterparties, and operate entirely without access to forward hedging instruments or formal credit. The market clears, but it does so with profound systemic waste that cannot be captured in quarterly macroeconomic aggregates.
- Qualitative Narrative of Allocative Distortion: Furthermore, the parallel market fails the standard of allocative efficiency, which requires capital to flow toward its most productively valued economic uses. Because the market operates outside formal regulatory oversight, foreign currency acquired on the street is primarily directed toward non-productive risk mitigation and speculative hoarding. Capital is disproportionately channeled into informal consumer goods imports, real estate speculation, and illicit capital flight. Meanwhile, productive formal enterprises requiring foreign exchange for capital equipment imports and technological upgrades are starved of resources by official banking quotas. The persistent parallel premium thus acts as an implicit, regressive tax on formal private investment, while inadvertently subsidizing low-value-added informal trade.

In summary, while the parallel exchange rate functions as a rational, constrained pricing mechanism, the institutional environment in which it operates generates severe allocative distortions and operational waste. Future research utilizing primary micro-level survey data or qualitative field studies in informal trading hubs is strongly encouraged to quantify these specific deadweight losses.

5. Policy Imperatives for Structural Reform:

While empirical findings cannot dictate definitive policy mandates, the multidimensional efficiency framework developed in this study suggests several operational guidelines for monetary authorities seeking to manage dual exchange rate distortions.

- Re-evaluating the Efficacy of Nominal Step Devaluations The empirical evidence indicates that administrative step devaluations of the official exchange

rate are an ineffective tool for closing the parallel premium. Because the parallel rate is anchored to long-run fundamentals (inflation and reserves) rather than the official peg, decreeing a weaker official dinar without addressing the underlying foreign exchange rationing merely shifts both rates upward in parallel. This leaves the real premium intact while accelerating domestic inflation, a dynamic clearly observed in the post-2014 sub-sample.

- Operationalizing the 18.5% Threshold as an Early-Warning Indicator The identification of an endogenous 18.5% friction band offers a potential macroprudential tool for the Central Bank. Rather than serving as a rigid target, this threshold could function as a structural early-warning indicator for capital flight and market distortion. The empirical dynamics suggest that when the parallel premium approaches this 18.5% boundary, the profit margin from informal currency operations begins to outweigh legal and transaction risks. At this juncture, large-scale trade misinvoicing and remittance diversion are likely to accelerate. Monetary authorities could use this indicator to trigger preemptive, targeted liquidity injections or temporary adjustments to formal foreign exchange allowances, thereby alleviating street-level scarcity before the premium breaches the active arbitrage zone.
- Gradual Pathways Toward Market Unification The persistence of the parallel market, despite decades of criminalization, suggests that it fulfills a genuine economic need for foreign currency access. The findings imply that reclaiming allocative efficiency may require gradual structural integration rather than punitive enforcement. Policy discussions could explore the viability of establishing licensed *bureaux de change*, expanding formal foreign exchange allowances for businesses and travelers, and allowing the central bank to manage the rate via transparent open market operations. Such measures could gradually absorb informal liquidity, reducing the deadweight losses of the parallel market while moving the economy toward a unified, market-managed exchange rate regime.

Conclusion:

Governments can decree an exchange rate, but they cannot decree economic value. The empirical findings of this study suggest that the Algerian parallel exchange rate is not merely a chaotic symptom of market failure, but rather functions as a rational, albeit heavily constrained, price discovery mechanism. The data indicates that it processes information efficiently at the weak-form level, anchors itself to macroeconomic gravity over the long run, and self-corrects only when arbitrage profits sufficiently outweigh the substantial risks of illegality.

However, this functional efficiency comes at a high macroeconomic cost. The persistent parallel premium acts as an implicit tax on formal private investment, while the informal operational microstructure imposes severe deadweight losses on the national economy. The ultimate structural failure lies not in the informal market's inability to price currency, but in the administrative policies that force economic agents to rely on it. Recognizing the parallel market as a functional, albeit

constrained, pricing mechanism is a necessary first step toward designing monetary policies that align with, rather than futilely fight against, economic reality.

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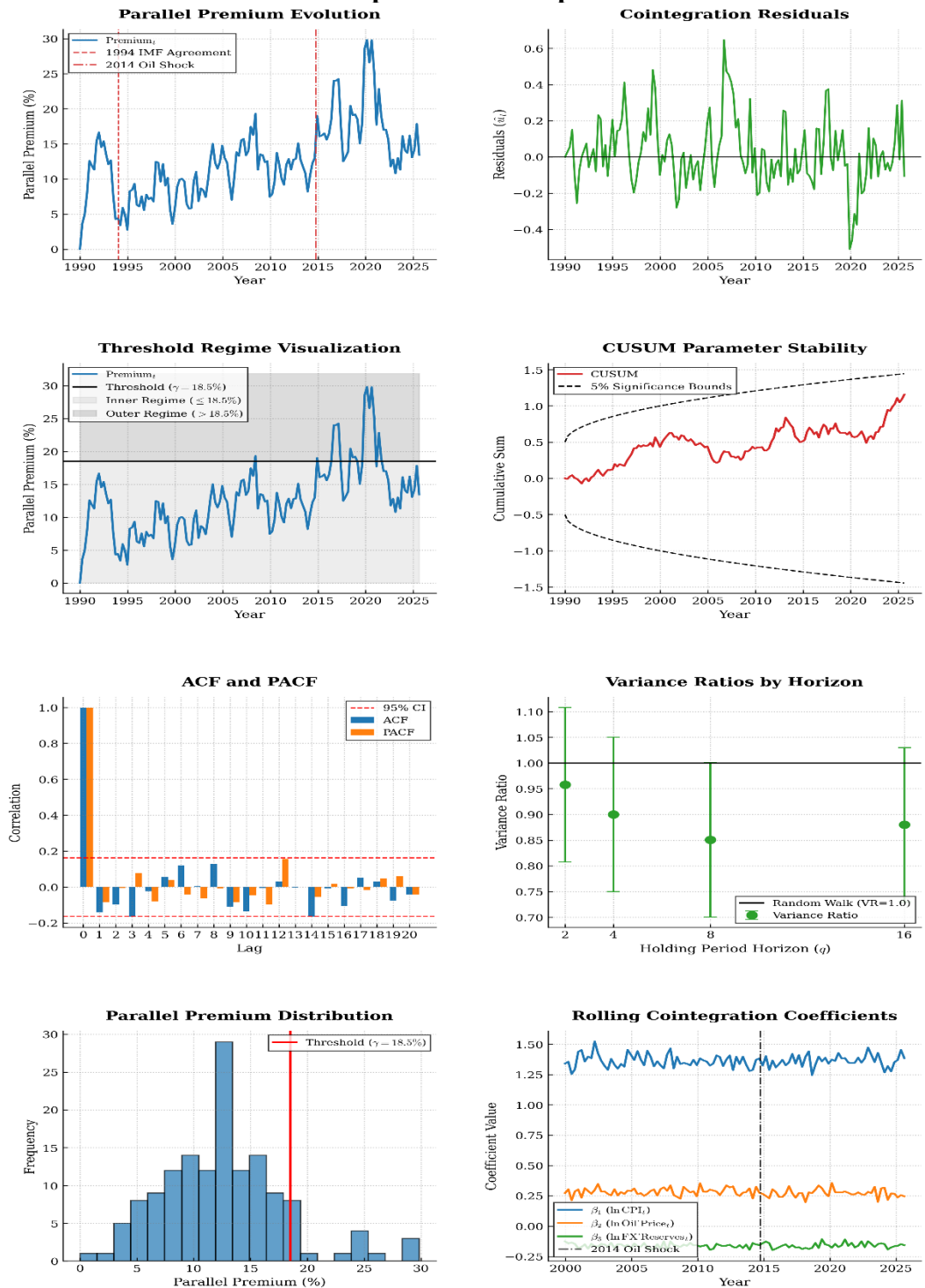
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Appendix :

Output calculation plots



Source: Generated in Python & R.