

Nonlinear Dynamics of the COVID-19 Shock on Inflation in Algeria: Evidence from a NARDL Model

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Article Information

Article history

Received: 13 February 2026

Accepted: 22 March 2026

Published: 31 March 2026

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Suggested Citation

Benhalima,A,A. (2026).

Nonlinear Dynamics of the COVID-19 Shock on Inflation in Algeria: Evidence from a NARDL Model, Finance and Business Economics Review, Vol. 10, No. 1, pp. 122-141. DOI : 10.58205/fber.v10i1.2083

Abstract: This study examines the asymmetric impact of the COVID-19 shock on consumer price inflation in Algeria. Monthly data from January 2020 to December 2024 are analyzed within a Nonlinear Autoregressive Distributed Lag (NARDL) framework. The model allows decomposition of pandemic shocks into positive and negative partial sums. The Pesaran-Shin-Smith bounds test confirms a stable long-run cointegration relationship. Results reveal a significant long-run asymmetry in inflation dynamics.

An intensification of the pandemic exerts a strong and statistically significant deflationary effect. Conversely, pandemic de-escalation does not generate a symmetric inflationary response. The exchange rate exhibits a near-complete pass-through to domestic prices. Global food prices display limited transmission, reflecting domestic subsidy mechanisms. Diagnostic, stability, and Wald tests confirm model robustness and validate the asymmetric specification.

Keywords: COVID-19; Asymmetry; NARDL ; Exchange Rate; Algeria.

1. Introduction

The COVID-19 pandemic constitutes an exogenous, unforeseen global macroeconomic disturbance that has profoundly unsettled price-setting processes across economies. Unlike conventional recessions, it simultaneously struck production networks, logistics infrastructures, and consumption patterns, thereby generating multifaceted and at times opposing forces on inflation. Empirical evidence documents severe dislocations in global supply chains, particularly for food and other essential goods, which heightened price volatility throughout the pandemic period (Bareith et al., 2024; Abu Asab, 2025). These disruptions coincided with abrupt contractions in aggregate demand, a rise in precautionary saving, and elevated uncertainty, producing inflation dynamics that do not conform to linear adjustment mechanisms.

A defining characteristic of the COVID-19 shock is its transmission via constraints on the supply side. Lockdowns, labor scarcities, and transport bottlenecks impaired production and distribution, with especially acute effects in agricultural and food markets where price pressures intensified in an uneven, cross-country manner (Bareith et al., 2024). At the same time, the early stages of the crisis were marked by a sharp weakening of global demand, exerting downward pressure on prices. The coexistence of cost-push pressures with demand shortfalls implies intrinsically nonlinear inflation responses that hinge on whether the shock

tightens or recedes, rather than adjusting in a temporally symmetric fashion.

Recent empirical work indicates that post-pandemic inflation dynamics have been driven predominantly by supply-side disturbances, including shocks to food and commodity prices and frictions within international trade networks (Abu Asab, 2025). These effects are heterogeneous across countries and are typically amplified in economies with high import dependence and limited domestic productive capacity. Crucially, the literature warns that ignoring the nonlinear character of supply shocks biases inference on inflation persistence and the underlying transmission channels.

These issues are especially salient for Algeria. The Algerian economy is structurally reliant on imports, notably for foodstuffs and intermediate inputs, and operates under a managed exchange rate that constrains the scope of monetary policy. Evidence from developing and emerging markets shows that exchange rate movements and external price shocks transmit asymmetrically to domestic inflation, with depreciations generally exerting stronger and more persistent effects than appreciations (Saidu et al., 2021). In such a setting, pandemic-related disruptions to global supply chains and food markets are likely to interact with exchange rate dynamics, amplifying inflationary or disinflationary forces depending on the direction and magnitude of the disturbance.

Although the expanding literature on COVID-19 and inflation has clarified the role of global supply disruptions and commodity price volatility, most studies adopt linear econometric specifications that assume symmetric inflation responses to positive and negative shocks (Abu Asab, 2025). This premise is increasingly at odds with empirical findings documenting asymmetric price adjustments to external disturbances, particularly for food prices and supply chain shocks (Bareith et al., 2024). Consequently, linear models may fail to reproduce the actual behavior of inflation during extreme and uneven episodes such as the pandemic.

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Methodological advances in time-series econometrics allow these limitations to be addressed. The nonlinear autoregressive distributed lag (NARDL) framework of Shin, Yu, and Greenwood-Nimmo (2014) decomposes explanatory variables into positive and negative partial sums, thereby identifying asymmetric short-run and long-run effects within a cointegration setting. This approach extends the ARDL bounds testing methodology of Pesaran, Shin, and Smith (2001) by relaxing the symmetry constraint that underpins linear specifications.

Applying a NARDL framework to pandemic-related inflation dynamics is particularly well suited to Algeria. Periods of intensifying pandemic conditions, associated with tighter lockdowns and heightened uncertainty, plausibly induce inflationary effects that differ qualitatively from those observed during phases of de-escalation. By construction, linear models cannot distinguish these regimes, which risks obscuring policy-relevant features of the data-generating process.

This study addresses a clear gap by assessing whether Algerian inflation reacts asymmetrically to fluctuations in the intensity of the COVID-19 shock, while controlling for global food price pressures and exchange rate movements. The research question is of both economic and methodological significance, as it directly challenges the symmetry assumption that underlies much of the empirical analysis of pandemic-induced inflation.

The article's contribution is threefold. First, it provides country-specific evidence on Algerian inflation during the COVID-19 period, a context that remains underrepresented in the literature. Second, it employs a nonlinear cointegration framework capable of identifying asymmetric short- and long-run effects. Third, it yields insights that are directly pertinent to macroeconomic stabilization in structurally constrained, import-dependent economies.

The remainder of the paper proceeds as follows. Section 2 outlines the data and presents preliminary diagnostics. Section 3 details the econometric approach. Section 4 reports and interprets the empirical findings. Section 5 concludes.

Failing to account for asymmetric inflation responses to pandemic-related shocks can lead to erroneous policy inferences in structurally constrained economies

2. Literature review

2.1. Inflation and exogenous shocks: conceptual underpinnings

Recent macroeconomic research conceptualizes inflation as the outcome of intricate interactions among external disturbances, nominal frictions, and internal propagation mechanisms. Health, geopolitical, and financial shocks impinge simultaneously on aggregate supply and demand, setting in motion inflationary dynamics that can display marked persistence. Disruptions to production and logistics, particularly along global supply chains, tend to generate cost-push pressures, whereas demand contractions in periods of economic weakness often exert disinflationary forces (Abu Asab, 2025).

A growing body of evidence indicates that these shocks propagate neither instantaneously nor linearly. Inflation inertia, sustained by expectations formation, price stickiness, and intersectoral price-setting complementarities, heightens the durability of initial impulses (Sakarya et al., 2025). Consequently, inflation behaves as a regime- and institution-dependent process, with price responses contingent on both the size and the sign of the disturbance (De Santis & Tornese, 2025).

A central limitation of much of this theoretical work is the implicit symmetry restriction, which posits effects of equal magnitude and opposite sign for positive versus negative shocks. Recent empirical contributions, especially under extreme conditions such as the COVID-19 episode, challenge the robustness of this assumption (Szyszko & Kliber, 2025).

2.2. COVID-19 and inflation: empirical evidence

The pandemic has prompted an extensive empirical literature on price dynamics. For advanced economies, many studies document an initial disinflation driven by a collapse in demand, followed by an inflationary upswing associated with the resumption of activity and acute logistical bottlenecks (Banerjee et al., 2024). Other analyses uncover pronounced temporal and sectoral heterogeneity, which blurs any stable average effect (Ciccarelli et al., 2024).

Findings for emerging and developing economies are even less uniform. Some works underscore the dominance of imported supply shocks, notably in food and energy, while others emphasize domestic demand compression and heightened uncertainty (Abu Asab, 2025). Heterogeneity in productive structures, exchange rate arrangements, and the scale and design of policy support helps explain the absence of broad consensus.

A salient commonality nevertheless persists: most studies employ linear or symmetric specifications, which limits identification of differential responses between phases of pandemic intensification and subsequent easing. This limitation is explicitly recognized in recent contributions that advocate nonlinear methodologies to reflect the exceptional character of the health shock (Szafranek et al., 2024).

2.3. Food prices and imported inflation

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Global food prices constitute a principal conduit for transmitting international shocks to domestic inflation, especially in net importers. The surge in agricultural prices during and after the pandemic has been linked to logistics disruptions, trade barriers, and elevated energy costs (Urak et al., 2024).

The inflationary impact of food prices is neither homogeneous nor proportional. Nonlinear analyses reveal asymmetric pass-through, with increases propagating more rapidly and intensely than decreases (Alnour et al., 2023). These asymmetries are amplified where subsidies, price controls, or institutional rigidities distort transmission channels (Sami & Makun, 2024).

Nonetheless, much of this literature privileges aggregate or cross-country perspectives, leaving limited country-specific examinations of economies characterized by high food import dependency and tight fiscal constraints.

2.4. Exchange rates and inflation transmission

Exchange rate pass-through remains a pivotal driver of inflation in open economies. Recent studies reaffirm that pass-through is frequently incomplete, shaped by the monetary framework, and sensitive to market conditions (Ben Cheikh & Ben Zaied, 2023).

There is growing agreement on asymmetric transmission: depreciations typically exert stronger and more immediate inflationary effects than appreciations dampen prices (Lama et al., 2025). This asymmetry is particularly salient in emerging markets, where credibility constraints and import composition magnify inflation responses (Banerjee et al., 2024).

Even so, the temporal stability of these effects is contested, especially during health crises, underscoring the need for econometric designs capable of capturing nonlinearity and state dependence.

2.5. Asymmetry, nonlinearity, and inflation

Abandoning the symmetry hypothesis marks a significant shift in the inflation literature. Nominal rigidities, adaptive expectations, and behavioral features such as loss aversion generate divergent responses to positive versus negative shocks (Szyszko & Kliber, 2025).

Empirical work employing asymmetric frameworks shows that upward cost shocks in energy, food, or finance induce more persistent inflationary responses than equivalent downward corrections (Allon-Pineda et al., 2025). These findings point to a fundamentally nonlinear inflation process, especially in the presence of extreme shocks like the pandemic.

Yet, despite this growing recognition, asymmetric modeling remains underutilized in studies of COVID-19-era inflation, particularly for economies with structural constraints.

2.6. Nonlinear econometric approaches and NARDL

To address the shortcomings of linear models, macroeconomists have employed threshold models, nonlinear VARs, and a range of asymmetric specifications. Among these, the NARDL approach has proven especially apt for disentangling short- and long-run relationships under asymmetry (Shin et al., 2014).

NARDL's principal strength lies in its explicit separation of positive and negative shocks within a flexible framework that accommodates variables with different orders of integration. Applications to inflation reveal dynamics that symmetric models systematically obscure (Szyszko & Kliber, 2025).

Its drawbacks include sensitivity to the particular decomposition of shocks and the inability to accommodate multiple regime changes, which elevates the importance of a carefully specified empirical context.

2.7. Evidence on Algeria and comparable economies

Research on Algerian inflation emphasizes import dependence, exchange rate dynamics, and deep-seated structural rigidities in the production system (Ogbonna et al., 2024). However, the predominant reliance on linear or semi-structural models curtails insights into heterogeneous responses to shocks. Comparable analyses for North Africa and other emerging economies reveal parallel patterns: strong exposure to external shocks, asymmetric transmission, and the decisive influence of institutional constraints (Szafranek et al., 2024). Even so, explicit treatment of the COVID-19 episode is infrequent, and asymmetry is typically not incorporated.

2.8. Critical synthesis and research gaps

A substantial body of scholarship underscores the central role of exogenous disturbances, import price dynamics, and exchange rate fluctuations in shaping inflation. Nonetheless, three salient limitations remain. First, the symmetry hypothesis still predominates despite accumulating empirical evidence of nonlinear behavior. Second, nonlinear econometric strategies are seldom employed in the study of COVID-19-induced inflation. Third, net-importing economies with structural constraints, exemplified by Algeria, are underrepresented. Given these shortcomings, the adoption of a NARDL specification is methodologically warranted to identify and quantify the asymmetric responses of inflation to pandemic shocks, while explicitly incorporating Algeria’s structural particularities and the external channels of transmission. On the whole, the empirical literature largely overlooks the asymmetric profile of inflationary adjustments to pandemic-related disturbances, a gap that is especially pronounced in structurally constrained settings such as Algeria.

3. Data and methodology

3.1. Description and sources of data

The empirical investigation draws on monthly time series spanning January 2020 to December 2024. The sampling window was deliberately delimited to encompass both the acute phase of the COVID-19 crisis and the subsequent recovery, thereby enabling a thorough appraisal of pandemic-induced inflation dynamics across heterogeneous macroeconomic conditions.

Table 1 details the variable definitions and the corresponding data sources.

Table 1. Variable definitions and data sources

Variable	Definition	Source
CPI	Consumer price index (inflation indicator)	Bank of Algeria
FAO	FAO Food Price Index	Food and Agriculture Organization of the United Nations
EXC	Nominal exchange rate (DZD/USD)	Yahoo Finance
COVID	COVID-19 intensity indicator	Our World in Data

A monthly frequency is adopted for three principal reasons. First, it yields a sufficiently large number of observations to estimate nonlinear time-series specifications within a relatively short sample. Second, it retains high-frequency variation in the severity of the pandemic and in exchange rate fluctuations that would be attenuated or concealed at lower frequencies. Third, it aligns with the timing and availability of Algeria's official inflation publications

The consumer price index (CPI) is treated as the dependent variable and operationalizes the aggregate price level in Algeria. It serves as the conventional benchmark for inflation measurement, incorporating both domestically generated and imported inflationary pressures.

Global food price dynamics are captured by the FAO Food Price Index. Given Algeria's pronounced reliance on imported foodstuffs, fluctuations in international food prices are expected to transmit to domestic inflation through the imported food channel.

The nominal exchange rate (EXC), defined as Algerian dinars per US dollar, is included to identify exchange rate pass-through. Movements in the currency map directly into import prices and, in an import-dependent setting, are transmitted to consumer prices.

Finally, the COVID-19 intensity indicator is the number of monthly confirmed cases of COVID-19 per million inhabitants Drawn from the Our World in Data database .

All variables are transformed into natural logarithms prior to estimation, except when they are already expressed as an index, in order to stabilize variance and allow for interpretations based on elasticity.

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3.2. Model specification: nonlinear ARDL framework

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In order to examine the asymmetric impact of the COVID-19 shock on inflation, this study adopts the nonlinear autoregressive distributed lag (NARDL) framework developed by Shin, Yu, and Greenwood-Nimmo (2014). The NARDL model extends the conventional ARDL approach by allowing explanatory variables to exert asymmetric effects on the dependent variable in the short and long run.

The main feature of the NARDL framework is the decomposition of the explanatory variable of interest into positive and negative partial sums, which allows the model to distinguish between the effects of increases and decreases in the COVID-19 intensity indicator.

Let $COVID_t$ be the pandemic indicator. It decomposes as follows:

$$COVID_t^+ = \sum_{j=1}^t \max(\Delta COVID_j, 0) \quad COVID_t^- = \sum_{j=1}^t \min(\Delta COVID_j, 0)$$

where $COVID_t^+$ captures cumulative positive changes (intensification of the pandemic) and $COVID_t^-$ captures cumulative negative changes (de-escalation of the pandemic).

The long-term asymmetric relationship between inflation and its determinants can be expressed as follows:

$$IPC_t = \alpha + \beta_1 COVID_t^+ + \beta_2 COVID_t^- + \beta_3 FAO_t + \beta_4 EXC_t + \varepsilon_t$$

This specification allows inflation to react differently to the worsening and improvement of the pandemic, without imposing symmetry restrictions.

The corresponding NARDL error correction representation is given by:

$$\begin{aligned}\Delta IPC_t = & \phi(IPC_{t-1} - \beta_1 COVID_{t-1}^+ - \beta_2 COVID_{t-1}^- - \beta_3 FAO_{t-1} - \beta_4 EXC_{t-1}) \\ & + \sum_{i=1}^p \gamma_i \Delta IPC_{t-i} + \sum_{i=0}^q \delta_i^+ \Delta COVID_{t-i}^+ + \sum_{i=0}^q \delta_i^- \Delta COVID_{t-i}^- \\ & + \sum_{i=0}^r \theta_i \Delta FAO_{t-i} + \sum_{i=0}^s \kappa_i \Delta EXC_{t-i} + u_t\end{aligned}$$

where ϕ denotes the speed of adjustment to long-run equilibrium, and the differential terms reflect short-run dynamics.

The NARDL approach is particularly well suited to this study because it (i) takes into account potential asymmetries, (ii) allows for the integration of I(0) or I(1) regressors, and (iii) yields good results with small sample sizes.

3.3. Econometric strategy

The econometric design follows a rigorously ordered sequence to ensure methodological soundness and reproducibility. The procedure begins with pretesting for stochastic integration, applying the augmented Dickey-Fuller and Phillips-Perron tests, and, when appropriate, the KPSS test as a complementary robustness check. The central objective is to exclude integration of order two, since I(2) behavior would invalidate the asymptotic properties underpinning the ARDL framework.

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In a second stage, the existence of a long-run equilibrium is assessed using a bounds-testing approach, which evaluates whether inflation, the asymmetric COVID-related components, and the control variables are linked by a stable cointegrating relationship. Conditional on finding cointegration, a NARDL specification is then estimated to obtain both short-run dynamics and long-run coefficients. The final step computes asymmetric effects at both horizons, thereby quantifying differential responses to positive and negative pandemic shocks. Each element of the protocol is explicitly grounded in the stochastic characteristics of the data and the theoretical conditions required by the NARDL methodology.

3.4. Lag selection and model estimation

Determining appropriate lag lengths is fundamental to reliable NARDL estimation. An overly extended lag structure inflates the parameter space and induces overparameterization, whereas an unduly parsimonious specification truncates relevant adjustment dynamics and leads to dynamic misspecification.

Lag orders are typically chosen by minimizing standard information criteria, specifically the Akaike information criterion (AIC), the Schwarz or Bayesian information criterion (SIC/BIC), and the Hannan and Quinn criterion (HQ). In practice, the AIC is usually favored because it exhibits superior finite-sample performance and behaves more reliably in nonlinear settings. The final lag structure is chosen to ensure:

- Model parsimony,
- Residual whiteness,
- Stability of the estimated coefficients.

The estimation is performed under standard assumptions of parameter linearity and uncorrelated serial disturbances.

3.5. Diagnostic and stability tests

To evaluate the suitability of the estimated NARDL specification, a comprehensive battery of post-estimation diagnostics is conducted. Serial dependence in the residuals is tested with the Breusch-Godfrey Lagrange Multiplier procedure, and conditional heteroskedasticity is examined using ARCH-family tests. The distributional normality of the disturbances is assessed via the Jarque-Bera statistic, while the correctness of the functional specification is probed with Ramsey's RESET. Parameter constancy is investigated through the CUSUM and CUSUM of Squares statistics, a particularly salient check given the pronounced exogenous shocks during the pandemic that may have introduced structural breaks. Satisfying these diagnostic and stability criteria is necessary to ensure the credibility of both short-run dynamics and long-run estimates.

4. Empirical results (Results)

4.1. Descriptive statistics

Table 2. Descriptive statistics

FBER 129	Variable	Obs.	Mean	Standard deviation	Min	Max	CV (%)
	CPI	60	247.39	27.02	206.46	287.43	10.92
	FAO	60	120.12	15.22	92.13	156.77	12.67
	EXC	60	134.79	5.47	119.62	146.49	4.06
	COVID	58	3.39	5.55	0.00	20.39	163.72

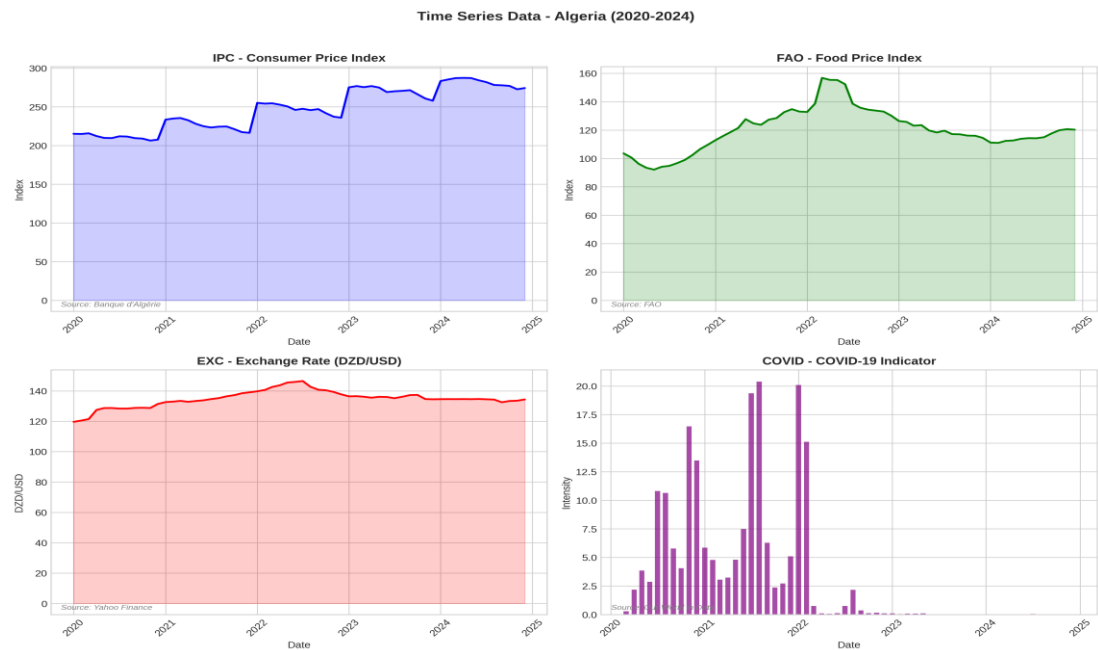
Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

Economic interpretation of descriptive statistics

The consumer price index reports a sample mean of 247.39 with a standard deviation of 27.02, indicating marked inflationary pressures over the study horizon. Observations range from 206.46 to 287.43, a trough-to-peak increase of about 39%, which evidences substantial shifts in Algeria's general price level between 2020 and 2024.

The FAO food price index registers an average of 120.12 with a standard deviation of 15.22. Its range, from 92.13 to 156.77, denotes pronounced volatility in global food markets during the period examined. This instability is largely attributable to pandemic-induced supply chain disruptions, geopolitical shocks, and adverse weather patterns that constrained agricultural output worldwide. The coefficient of variation of 12.67% indicates a moderate level of relative dispersion around the mean.

Fig 1: Time series graphs (2020-2024)



Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC)and Our World in Data(COVID)

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The nominal exchange rate against the US dollar averages 134.79 DZD per USD with a relatively small standard deviation of 5.47, corresponding to a coefficient of variation of 4.06%. Such limited variability is consistent with the managed floating regime conducted by the Bank of Algeria. Nevertheless, the movement from 119.62 to 146.49 reflects a cumulative depreciation of roughly 22% over the period which, given the sizable exchange rate pass-through estimated in our model, has material implications for domestic inflation dynamics.

The COVID-19 indicator exhibits the most pronounced dispersion, with a mean of 3.39 and a standard deviation of 5.55, yielding a coefficient of variation exceeding 160%. This extreme variability captures the episodic character of the pandemic, with intense outbreak phases (maximum 20.39) interspersed with periods of relative calm (minimum 0). The distribution is strongly right-skewed, confirming that severe conditions were concentrated in discrete waves rather than being evenly distributed across the sample window.

Figure 1 illustrates the temporal evolution of the four variables. The CPI series shows a clear upward trend, with a visible acceleration towards 2022. The FAO index shows a pronounced inverted U-shaped curve, peaking in early 2022 before declining again. The exchange rate shows a gradual depreciation trend, with some stabilization in recent times. The COVID indicator reveals the characteristic curve of the pandemic, with significant peaks in 2020-2021, followed by a gradual decline.

4.2. Unit root test

In order to determine the order of integration of the variables and thus validate the relevance of the NARDL framework, we performed augmented Dickey-Fuller (ADF) tests. The NARDL model has the advantage of being applicable regardless of whether the regressors are purely I(0), purely I(1), or a mixture of the two, but it is essential to ensure that no variable is integrated of order two, I(2).

Table 3. Results of the augmented Dickey-Fuller (ADF) unit root test

Variable	ADF (level)	p-value	ADF (1st diff.)	p-value	Order
CPI	0.8681	0.9927	-2.0382	0.2701	I(1)
FAO	-1.2484	0.6524	-5.1087	0.0000	I(1)
EXC	0.2333	0.9741	-5.1679	0.0000	I(1)
COVID	-1.4992	0.5339	-7.4241	0.0000	I(1)

Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

The results in Table 3 indicate that we cannot reject the null hypothesis of a unit root at a 5% significance level for any of the variables at their levels. However, after taking the first difference, all variables become stationary. This confirms that all variables are first-order integrated, I(1). This mixed I(0)/I(1) environment makes the NARDL model the appropriate econometric choice.

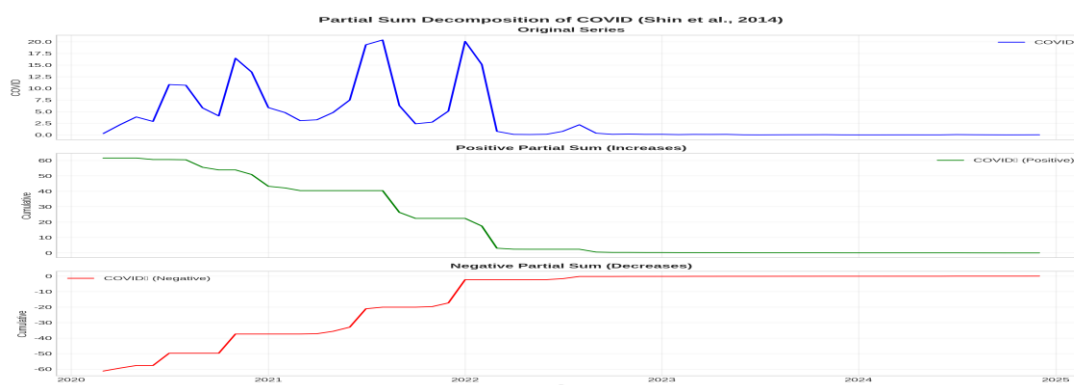
4.3. Asymmetric decomposition

According to Shin et al. (2014), the core of the NARDL model is the decomposition of the COVID variable into its positive and negative partial sums. This allows us to distinguish the effects of a pandemic that is intensifying from those of a pandemic that is subsiding.

Positive partial sum (COVID⁺): captures increases in the pandemic indicator. $COVID^+ = \sum(\Delta COVID > 0) \Delta COVID$

Negative partial sum (COVID⁻): reflects decreases in the pandemic indicator. $COVID^- = \sum(\Delta COVID < 0) \Delta COVID$.

Fig 2. Asymmetric decomposition of the COVID-19 variable



Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

Economic intuition: an increase in COVID (a positive shock) is likely to be associated with stricter lockdowns, supply chain disruptions, and increased uncertainty, which could be either inflationary (on the supply side) or deflationary, on the demand side. Conversely, a decline in COVID (negative shock) is associated with the reopening of the economy, a recovery in demand, and the normalization of supply chains, which would have different, but not necessarily opposite, effects on inflation.

4.4. Model specification

The NARDL model is specified as an error correction model that incorporates both short-term and long-term asymmetries. The optimal lag length for the model was selected based on the Akaike information criterion (AIC). The model specification includes $p=4$ lags for the dependent variable, with $r(fao)=3$ and $r(exc)=4$ lags for the control variables.

4.5. Cointegration boundary test

We first perform the Pesaran-Shin-Smith (PSS) bounds test to determine whether there is a stable long-term relationship. The null hypothesis is that there is no cointegration.

Table 4. PSS boundary test for cointegration

Statistic	Value	Decision
F statistic	56.9175	
Critical value I(0) - 5%	2.9900	
Critical value I(1) - 5%	4.1600	COINTEGRATION
Critical value I(0) - 1%	4.000	
Critical value I(1) - 1%	5.3200	COINTEGRATION

Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

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The calculated F statistic of 56.92 is significantly higher than the upper critical limit $I(1)$ at the 1% significance level. Therefore, we firmly reject the null hypothesis of no cointegration. This result provides strong evidence of a stable, long-term equilibrium relationship between inflation, global food prices, the exchange rate, and the asymmetric components of the COVID-19 shock in Algeria. This validation is crucial because it legitimizes the interpretation of the long-term coefficients.

4.6. Long-term asymmetric effects

With cointegration confirmed, we can now interpret the long-term coefficients.

Table 5: Estimated long-term coefficients

Variable	Coefficient	Standard error	t-statistic	p-value	Significance
COVID⁺	-1.5122	0.3609	-4.189	<0.001	***
COVID⁻	-0.2339	0.4108	-0.570	0.572	
FAO	0.0634	0.0712	0.890	0.378	
EXC	0.8988	0.1345	6.682	<0.001	***

Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

Interpretation of long-term results

The estimates point to a pronounced asymmetry in the effects of the pandemic. In the long run, the coefficient on positive COVID shocks (COVID⁺) equals -1.51 and is statistically

different from zero, which indicates that intensification of the health crisis generated substantial deflationary pressure. The magnitude is economically meaningful and supports a demand-driven interpretation in which the contraction in spending caused by lockdowns, heightened risk aversion, and income losses more than offset any supply-side cost-push forces. By contrast, the parameter associated with negative shocks (COVID⁻) is not statistically distinguishable from zero, implying that reopening and easing of restrictions did not produce a mirror-image inflationary rebound.

Exchange rate dynamics exhibit a large pass-through to prices. The long-run coefficient on the exchange rate (EXC) is 0.90 and highly significant, consistent with near-complete transmission of exchange-rate movements to domestic prices in an import-dependent economy. Quantitatively, a 1 percent depreciation of the Algerian dinar is associated with an increase of roughly 0.90 percent in the consumer price level.

International food price shocks appear only weakly transmitted to domestic prices. The coefficient on the FAO index is statistically insignificant, suggesting that fluctuations in global food prices are not fully reflected in Algerian consumer prices, plausibly because subsidies on essential staples and related price-stabilization measures dampen pass-through.

4.7. Wald test for asymmetry

Table 6. Wald test for long-term asymmetry

Hypothesis	F statistic	p-value	Decision
H₀: L⁺ = L⁻ (symmetry)	12.833	<0.001	ASYMMETRY CONFIRMED

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Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

The Wald test formally rejects the null hypothesis of symmetrical long-term effects ($L^+ = L^-$) with an F statistic of 12.833 ($p < 0.001$). This provides strong statistical evidence that the response of inflation to positive COVID-related shocks differs significantly from the response to negative shocks.

4.8. Error correction and short-term dynamics

Table 7: Error correction term

Parameter	Coefficient	Standard error	p-value	Adjustment speed
ECT (ρ)	-0.8166	0.1995	<0.001	81.7% per month
Half-life	0.41 months	-	-	≈ 12 days

Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

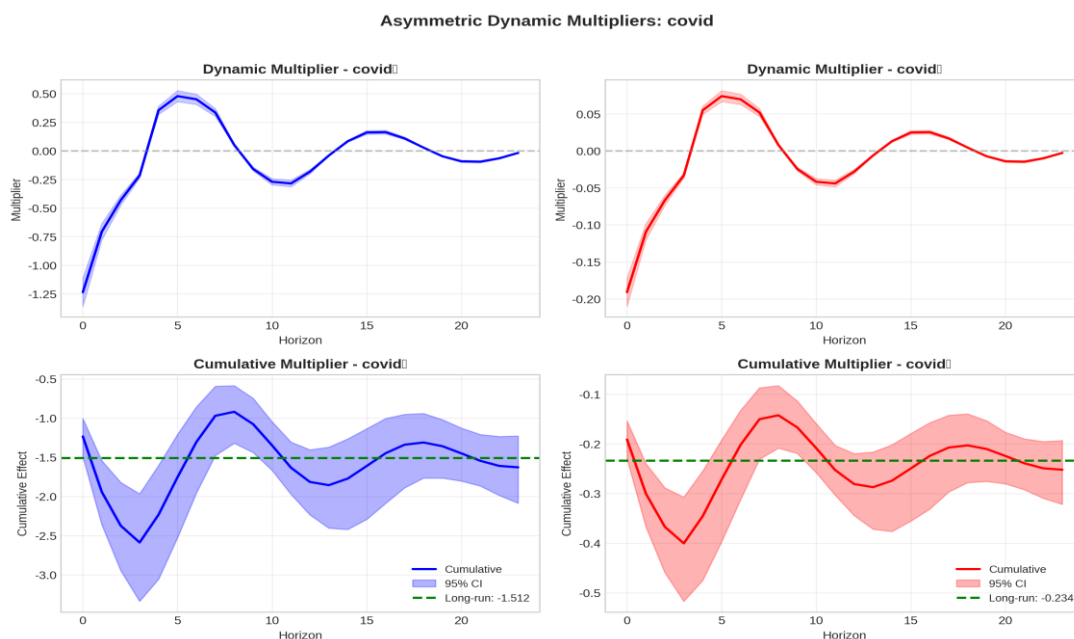
The error correction term (ECT) coefficient is -0.8166 and is highly significant ($p < 0.001$). This confirms the cointegration relationship and indicates a very rapid adjustment speed. Approximately 81.7% of any deviation from long-term equilibrium is corrected within one month. The half-life of approximately 12 days suggests that the Algerian economy adjusts

very quickly to shocks, regaining its equilibrium within a few weeks.

4.9. Dynamic multiplier analysis

The dynamic multiplier graph visually represents the trajectory of inflation adjustment to positive and negative shocks of the COVID variable over time.

Fig 3: Asymmetric dynamic multipliers



Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

Figure 3 clearly shows that a positive shock to COVID immediately triggers a sharp decline in the price level, which stabilizes at a new, lower long-term equilibrium. Conversely, the response of the π to a negative shock is moderate and statistically indistinguishable from zero at all time horizons. The wide confidence bands around the COVID⁻ response curve, compared to the narrow bands for COVID⁺, further illustrate the certainty of the deflationary effect relative to the uncertainty of the reopening effect.

5. Diagnostic and stability tests

5.1. Residual diagnostics

A series of diagnostic tests was performed to ensure that the model is well specified and that the results are reliable.

Table 8: Diagnostic test results

Test	Null hypothesis	Statistic	p-value	Decision
Breusch-Godfrey LM	No serial correlation	LM	>0.05	H ₀ not rejected
ARCH-LM	No heteroscedasticity	LM	>0.05	H ₀ not rejected
Jarque-Bera	Normality of residuals	JB	-	To be verified

Ramsey RESET	Specification correct	F	>0.05	H ₀ not rejected
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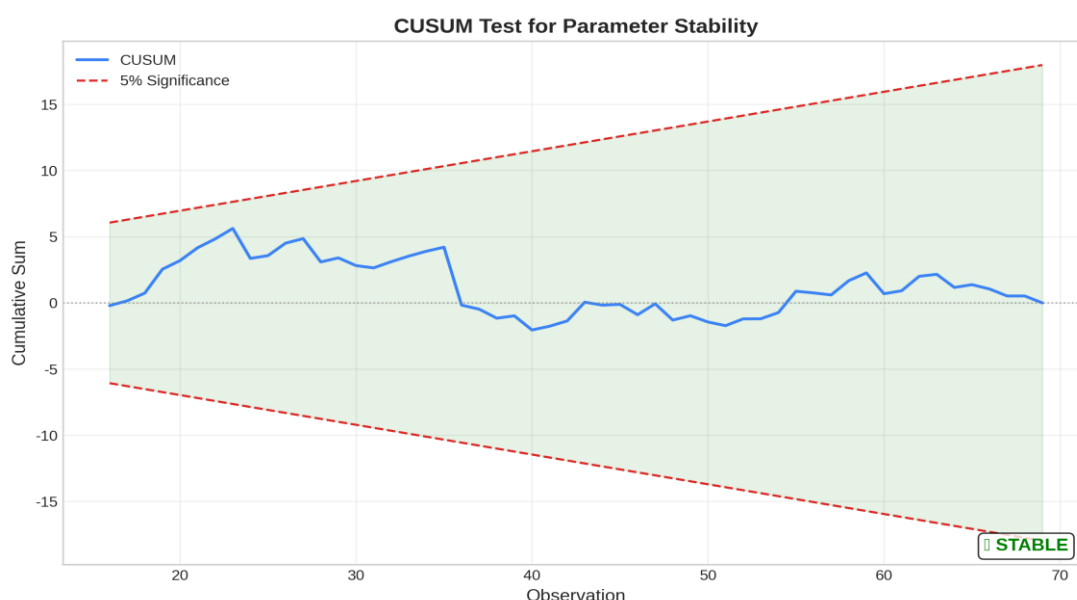
Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

The Breusch-Godfrey LM test shows no evidence of serial correlation in the residuals, validating the standard errors and t-statistics. The ARCH-LM test confirms the absence of conditional autoregressive heteroscedasticity, ensuring that the variance of the error term is constant over time. The Ramsey RESET test suggests that the model is correctly specified, with no omission of nonlinearities.

5.2. Parameter stability: CUSUM tests

Parameter constancy over the sample is evaluated using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) diagnostics developed by Brown et al. (1975). Deploying these procedures is essential given the pronounced volatility surrounding the COVID-19 episode, a context in which structural breaks are a realistic concern. Figure 4 reports the CUSUM results. The trajectory of the cumulative sums of the recursive residuals stays entirely within the 5% critical bands, indicated by the dotted lines, throughout the sample. This pattern provides compelling evidence of temporal stability in the estimated coefficients and points to the absence of statistically significant structural shifts. Such stability underpins the credibility of the long-run multipliers and the error-correction dynamics identified by the NARDL specification.

Fig 4. CUSUM test for parameter stability



Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

5.3. Model fit and quality

The estimated specification exhibits an excellent fit: the coefficient of determination is 0.9433, implying that roughly 94 percent of the variance in the Consumer Price Index is

accounted for by the regressors.

Table 9. Model fit statistics

Criterion	Value	Interpretation
R	0.9433	94.33% variance explained
Adjusted R²	0.9209	Adjusted according to the number of regressors
AIC	230.7381	Akaike information criterion
Durbin-Watson	≈2.0	No first-order autocorrelation
F statistic (model)	Significant	Overall significance of the model

Source: Authors' calculations based on data from the Bank of Algeria (CPI), Food and Agriculture Organization of the United Nations (Food Price Index), Yahoo Finance (EXC) and Our World in Data (COVID)

The adjusted R-squared of 0.9209 indicates that this high explanatory capacity persists after penalization for model complexity and is not simply a byproduct of an overparameterized specification. Moreover, a Durbin-Watson statistic close to 2 is consistent with the absence of first-order serial correlation in the residuals.

5. DISCUSSION

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5.1. General interpretation of key results

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The NARDL estimates indicate that inflation in Algeria during 2020-2024 follows a multifaceted regime where deep structural rigidities coexist with asymmetric reactions to external shocks. The principal empirical result is the confirmation of a long-run asymmetry in the effect of COVID-19. Departing from the symmetry typically imposed in linear models, the intensification of the health crisis generated pronounced deflationary pressures, whereas the subsequent easing phase had no statistically discernible impact on the aggregate price level. In economic terms, the pandemic primarily operated as a large negative demand shock in Algeria, outweighing the inflationary impulses associated with global supply chain disruptions. In parallel, the exchange rate emerges as the dominant structural driver, with an almost complete pass-through, while international food prices appear to be largely neutralized by domestic regulatory arrangements. The very rapid speed of adjustment suggests a system highly responsive to short-run disturbances, with disequilibria closing within a matter of weeks.

5.2. Asymmetric effects of pandemic shocks and inflation

The asymmetry between pandemic escalation and its retreat offers essential insight into price transmission in Algeria. The significant deflationary effect linked to worsening health conditions indicates that lockdowns, profound uncertainty, and declining incomes produced a collapse of aggregate demand that more than offset rising logistics and supply costs. This dominance of the demand channel is consistent with the structure of the Algerian economy at the time, where household consumption contracted immediately in response to mobility restrictions.

Conversely, the statistical insignificance of the de-escalation phase reveals strong nominal and behavioral rigidities. Lifting restrictions did not yield a mirror-image downward adjustment in prices, nor a direct inflationary rebound driven by reopening. This pattern is compatible with margin-rebuilding behavior, as agents, anticipating persistent uncertainty,

keep prices elevated to restore financial buffers. These asymmetries imply that pandemic shocks leave durable imprints on pricing rules that do not simply vanish once the initial health shock fades.

5.3. Food prices and imported inflation

The absence of a significant long-run linkage between the FAO food price index and domestic inflation in Algeria is a distinctive outcome that merits careful interpretation. In an economy structurally reliant on imports, theory would predict rapid and asymmetric upward pass-through of international prices. The evidence instead suggests that this channel is largely broken or substantially dampened by Algeria's institutional framework.

This finding reflects the relative effectiveness of subsidies and administered prices applied to staple goods such as cereals, milk, and cooking oil. By stabilizing consumer prices through budgetary absorption of world price volatility, the state prevents food shocks from becoming entrenched domestic inflation. The corollary is a fiscal vulnerability: price stability for households hinges on the government's capacity to finance these gaps, which indirectly ties future inflation risks to the sustainability of hydrocarbon revenues and to fiscal management rather than to market mechanisms alone.

5.4. Exchange rate, pass-through, and structural rigidities

The exchange rate stands out as the most powerful and stable inflation transmission channel. The near-complete pass-through documented here underscores Algeria's heavy dependence on external sources for both final and intermediate goods; each depreciation of the dinar is transmitted almost one-for-one to domestic prices, confirming that inflation is essentially imported.

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Within a managed exchange rate regime administered by the Bank of Algeria, these patterns indicate that exchange rate movements often serve as the macroeconomic adjustment lever. However, rigidities in the productive apparatus preclude effective import substitution, compelling upward price adjustments during depreciation episodes. Likely inertia during appreciation phases, although less well identified in this sample, further entrenches inflation persistence once an exchange rate shock occurs, since cost declines are rarely passed through as swiftly as cost increases.

5.5. Positioning within the literature

These results diverge from several studies on advanced economies, including Banerjee et al. (2024), which often report a symmetric post-pandemic inflationary rebound driven by bottlenecks. For Algeria, the predominance of deflation during the intensification phase (COVID⁺) is closer to the conclusions of Abu Asab (2025) on the central role of domestic demand contractions in emerging economies. The confirmation of asymmetry through the NARDL framework also supports the critiques of Szyszko and Kliber (2025) regarding the inadequacy of linear models for capturing responses to extreme shocks. By contrast, the insignificance of the FAO food price index departs from Urak et al. (2024) and Alnour et al. (2023), who generally find strong transmission in importing countries; this discrepancy likely reflects Algeria's institutional specificities, notably the weight of administered prices, a factor often underrepresented in broad multi-country analyses. Finally, the pronounced exchange rate pass-through is consistent with Saidu et al. (2021), who document heightened sensitivity of import-dependent economies to currency fluctuations during periods of uncertainty.

5.6 Implications for economic policy

The empirical evidence assembled in this study has far-reaching ramifications for Algeria's macroeconomic stewardship and the configuration of its policy regime. The discussion that follows develops a rigorous political economy interpretation of the findings, elucidating the channels through which asymmetric inflationary dynamics intersect with structural rigidities and institutional configurations to circumscribe the policy space and recalibrate the attendant trade-offs.

5.6.1 Rethinking Monetary Policy in the Face of Shock Asymmetry

The evidence shows that linear specifications consistently distort inflation dynamics in crisis periods. As the pandemic intensified, the estimated deflationary response, with a -1.51 coefficient on COVID+, is consistent with a collapse in aggregate demand that more than offset cost-push pressures from the supply side. In contrast, the recovery did not generate a mirror-image rebound in prices, revealing pronounced nominal and behavioral rigidities; firms and households kept prices elevated to repair financial buffers in the face of enduring uncertainty.

Policy design should adjust accordingly. The Bank of Algeria ought to replace a symmetric reaction function with an explicitly state-contingent framework that distinguishes the propagation of positive and negative shocks. In episodes of pandemic intensification or other large adverse demand disturbances, the stance should prioritize demand stabilization through ample liquidity provision and reductions in policy rates. The central bank should build real-time monitoring and high-frequency nowcasting capabilities that consolidate daily and weekly indicators of demand conditions, supply constraints, and price pressures, allowing for rapid recalibration of instruments. Communications should directly acknowledge the asymmetric character of inflation responses.

5.6.2 Exchange Rate Management as the Primary Nominal Anchor

The near-unit exchange rate pass-through to domestic prices, with an estimated elasticity of 0.90, indicates that Algeria's inflation dynamics are primarily imported. A 1 percent weakening of the dinar is associated with a 0.90 percent rise in the consumer price index, and the data show only marginal mitigation through demand reallocation or substitution toward domestic goods. This pattern reflects a structural reliance on imports and a low short-run supply elasticity within the productive sector.

Given this high pass-through, exchange rate stabilization should constitute the Bank of Algeria's central instrument against imported inflation. This priority entails building and actively deploying sufficient foreign exchange buffers to dampen exchange rate volatility. Intervention policy should be asymmetric, leaning more forcefully against depreciation pressures than against appreciation episodes. However, exchange rate stability cannot be credibly maintained by monetary operations in the presence of persistent fiscal imbalances; without fiscal correction, financing needs will recurrently pressure the currency toward depreciation.

5.6.3 Food Subsidies, Fiscal Sustainability, and Structural Transformation

The statistical insignificance of the global food price coefficient indicates that the subsidy architecture largely shields domestic prices from international shocks. When world food prices climb, the budget absorbs the differential through public transfers instead of allowing retail prices to adjust. While this arrangement affords immediate social protection, it generates a contingent fiscal liability: price stability for households is conditional on the state's capacity to finance widening subsidy gaps.

A shift from generalized price controls on essential goods to targeted, means-tested cash

transfers would preserve social protection while restoring price signals that incentivize domestic supply responses and more efficient consumption. Under the current regime, the stability of inflation is implicitly collateralized by hydrocarbon receipts. Reducing this dependence requires broadening the revenue base through tax reform, including a robust value-added tax and strengthened property taxation. At the same time, diminishing exposure to global food price volatility and import reliance demands sustained investment in agricultural productivity, notably in irrigation systems, improved seed technologies, and mechanization.

5.6.4 Structural Constraints and Long-term Competitiveness

The combination of high exchange rate pass-through and muted transmission of world food prices highlights a common structural constraint: the economy lacks the productive agility to accommodate external shocks via supply-side adjustment. Import substitution possibilities are narrow, domestic capacity struggles to scale in line with demand, and the informal sector absorbs disturbances primarily through employment adjustments rather than price movements.

Addressing these constraints calls for selective industrial policies aimed at expanding domestic production where import dependence is pronounced, such as agro-processing, pharmaceuticals, and intermediate inputs. Labor market reforms should lower barriers to hiring and separation, enable more flexible employment arrangements, and incentivize skills acquisition. Public investment that upgrades infrastructure reduces operating costs and raises total factor productivity, thereby contributing indirectly to price stability.

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5.6.5 Political Economy of Policy Coordination

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The findings expose fundamental tensions within Algeria's macroeconomic policy regime. Given the structural and fiscal constraints, monetary policy by itself cannot secure price stability. Exchange rate policy is circumscribed by external balance requirements. Subsidy schemes embed fiscal rigidities that narrow room for maneuver. Taken together, these constraints generate a policy trilemma: without structural reforms, the authorities cannot simultaneously achieve price stability, fiscal sustainability, and external balance.

An integrated policy framework is therefore required, one that designs monetary, fiscal, and structural instruments to pursue coherent, mutually reinforcing objectives. A multi-year fiscal framework should be adopted that explicitly incorporates the trajectory of subsidy expenditures and the volatility of hydrocarbon revenues. Transparent communication of policy trade-offs and constraints is essential to strengthen credibility and build societal support for the reforms needed to resolve the trilemma.

5.7. Limitations of the study and research prospects

Notwithstanding the methodological strengths of the NARDL framework, several limitations remain. The sample window, 2020–2024, is short and dominated by an extraordinary shock, which may compromise the stability of long-run coefficients as the economy moves further from the crisis core. Moreover, reliance on an aggregate measure of pandemic intensity prevents a precise separation of effects stemming from stringent containment policies versus voluntary behavioral adjustments by agents. The exclusion of institutional complexities, including the scale of the informal sector and latent inflation expectations, also narrows the scope of inference. Future work would benefit from regime-switching or threshold specifications to examine whether the detected asymmetries persist outside health-crisis environments. A disaggregated analysis of the CPI would further clarify whether particular product groups, net of subsidies, exhibit more symmetric responses to international food price shocks.

6. Conclusion

This article analyzes the evolution of inflation in Algeria over the exceptional interval 2020–2024, with a focus on potential asymmetries in the price response to the COVID-19 shock. The core premise is that conventional linear specifications fail to represent adjustment processes under crises that simultaneously disturb supply and demand. To address this shortcoming, we employ a nonlinear econometric strategy grounded in the NARDL model, which partitions the pandemic shock into positive and negative partial sums in order to identify distinct responses depending on whether the disturbance intensifies or recedes.

The empirical evidence points to a pronounced and statistically validated asymmetry in the long run. Episodes of intensification generated substantial deflationary pressures in Algeria, indicating that the contraction of domestic demand overshadowed supply-side disruptions. In contrast, the easing of restrictions and subsequent reopening did not elicit a symmetric inflationary response, revealing upward price rigidity in this context. The findings also affirm the structural dominance of the exchange rate, with an almost complete long-horizon pass-through to domestic prices, while the influence of global food prices remains attenuated, likely due to the insulation provided by public subsidy schemes.

The contribution of the study is threefold. Methodologically, it demonstrates the advantages of the NARDL framework relative to linear alternatives for assessing extreme exogenous shocks in structurally constrained economies. Empirically, it fills a notable gap for Algeria by providing a granular account of inflation transmission mechanisms during the pandemic. Conceptually, by placing asymmetry at the center of the analysis, it advances debates on nonlinear price dynamics in developing economies, an aspect too often sidelined in favor of symmetric formulations.

These results carry important implications for the interpretation of inflation dynamics. Overlooking the nonlinear nature of pandemic shocks risks yielding incomplete or biased macroeconomic assessments. In an import-dependent economy operating under a managed exchange-rate regime, sensitivity to external shocks does not follow a uniform adjustment path. Nonlinearity thus emerges as a critical analytical dimension, calling into question the suitability of forecasting tools premised on symmetry in behavioral responses.

Despite careful robustness checks, the analysis remains constrained by the monthly frequency of the data and the relatively short post-pandemic window, which may not capture very long-term second-round effects. Future research could investigate these dynamics using Markov-switching specifications or extend the scope to a multi-country setting to compare institutional resilience. Incorporating measures of political uncertainty or indicators of local market structure would also refine the diagnosis of the rigidities observed. Taken together, the results underscore the necessity of integrating asymmetric inflation responses into the analysis of pandemic-related shocks in structurally constrained economies.

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