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UNEMPLOYMENT, INFORMAL ECONOMY, AND POVERTY PRESSURE IN ALGERIA

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A B S T R A C T

This study examines the dynamic relationship between unemployment, informality, and a poverty-pressure proxy in Algeria over 1990-2018. Because direct annual poverty observations are discontinuous, the dependent variable is not a poverty headcount; it is a consumption-based welfare proxy inversely transformed into poverty pressure using the World Bank WDI series Households and NPISHs final consumption expenditure per capita (constant 2015 US$). The estimation relies on World Bank WDI data on unemployment, growth, and inflation, together with the World Bank Informal Economy Database for informality. With only 29 annual observations, the full five-variable VECM is parameter-sensitive because retaining UNR and INEPG together consumes degrees of freedom and the variables overlap empirically. ADF/PP tests and Johansen trace tests support a cointegration framework, although Johansen critical values are asymptotic and the short sample requires cautious interpretation. The full model remains the theoretical baseline but has weak adjusted fit and an insignificant error-correction term; the restricted model is preferred for parsimony and valid adjustment because it provides a negative and statistically significant ECT. Informality is significant mainly in short-run VECM dynamics, while the frequency-domain results show predictive content from past informality for poverty-pressure movements across short, medium, and long horizons. The findings concern a poverty-pressure proxy, not direct poverty measurement or structural causal identification.

1 INTRODUCTION

Poverty, unemployment, and the informal economy are often studied as separate policy problems. In Algeria, such a separation may be analytically misleading. A person may be officially unemployed, informally employed, or moving between short spells of both. A household may

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escape open joblessness without escaping vulnerability. For this reason, the question is not only whether unemployment raises poverty pressure, but whether informal activity changes how poverty pressure is transmitted and sustained over time.

The theoretical starting point is the dual structure of labor markets in developing economies. Lewis (1954) described how surplus labor can persist beside a modern sector, while Harris and Todaro (1970) showed how migration, expected income, and urban unemployment may coexist in a two-sector setting. Fields (1975) refined this view by distinguishing unemployment, underemployment, and job search in economies where formal-sector jobs cannot absorb the available labor force. These arguments remain useful for Algeria because labor-market adjustment does not occur through formal employment alone.

Informality adds a second layer. It can provide income when formal jobs are scarce, but it can also lock workers into low-productivity activities, weak legal protection, and unstable earnings. Schneider and Enste (2000) frame the shadow economy as a response to taxation, regulation, and institutional weakness. Maloney (2004) warns against treating all informal work as pure exclusion. La Porta and Shleifer (2014), however, stress the development cost of informality through low productivity and weak firm growth. The Algerian case sits between these readings: informal activity is partly a survival margin, but not necessarily a path out of poverty.

Poverty itself also requires caution. A narrow income view can miss household vulnerability, access to services, and the capability losses that follow insecure work. Sen (1999) treats poverty as capability deprivation, and Ravallion (2016) shows why poverty measurement depends on both data availability and the welfare concept used. In Algeria, direct annual poverty series are limited and discontinuous. The empirical analysis therefore uses a consumption-based welfare proxy inversely transformed into a poverty pressure proxy, a choice consistent with the individual-consumption-index approach used by Ayad and Belmokaddem (2018). This proxy is not a direct poverty headcount and must be interpreted as a poverty-pressure indicator rather than a full measure of poverty.

Recent evidence on informality in the Middle East and North Africa suggests that the problem is regional, not only national. Informal employment in the region reflects firm size, weak enforcement, tax and regulatory burdens, and limited access to better jobs (Gatti et al., 2014; Lopez-Acevedo et al., 2023). Algeria shares these features, but its hydrocarbon-based macroeconomic structure makes the transmission more specific. Public spending, import dependence, inflationary pressure, and formal job creation are closely linked to the country's broader growth model.

For Algeria, the literature is still thinner than the policy debate. Bennihi et al. (2021) provide recent measurement evidence on the informal economy and its interaction with formal activity. Cherfi-Feroukhi and Souam (2020) examine the links between informality, government intervention, and the labor market. Adair and Souag (2023) describe informal employment before the COVID-19 pandemic as a cheap substitute for formal jobs, a phrase that captures both its buffering role and its social cost. These studies give the present article its institutional ground.

The empirical gap is more precise than saying that informality and poverty have not been studied. Earlier Algerian work has examined poverty with growth and financial development, including frequency-domain causality in Ayad et al. (2019), and recent work has revisited Okun-type unemployment dynamics in Algeria (Chenini et al., 2023). What is still missing is an integrated time-series treatment of unemployment, informality, and a poverty-pressure proxy that separates long-run equilibrium from short-run adjustment and then tests whether predictive content differs across frequencies.

This article addresses that gap by estimating a dynamic model for Algeria. Although some raw series extend to 2019 or later, the final estimation sample is 1990-2018, the balanced common period retained after aligning the poverty pressure proxy, the informal-economy indicator, unemployment, growth, and inflation without additional interpolation. This gives 29 annual

observations, so the empirical design is deliberately parsimonious. The study first checks the integration properties of the series, then tests for Johansen cointegration, estimates a vector error-correction model, and finally applies the Breitung and Candelon (2006) frequency-domain causality test. The frequency-domain step matters because a predictive relation that appears weak in the aggregate may be concentrated in short, medium, or long horizons.

The research question is direct: how do unemployment and the informal economy relate to poverty-pressure movements in Algeria, and does the direction of frequency-domain predictive causality differ across time horizons? The contribution is threefold. First, the article treats informality not as a residual category but as a labor-market channel that may transmit vulnerability. Second, it uses a cointegration-based framework suitable for non-stationary annual series. Third, it combines VECM evidence with frequency-domain predictive-causality analysis, allowing the study to distinguish persistence from transitory patterns without claiming structural causality beyond what the data can support.

The analysis is guided by three hypotheses. H1: The poverty-pressure proxy, unemployment, informality, growth, and inflation share a long-run equilibrium relationship in Algeria. H2: Unemployment and informality are associated with poverty-pressure movements, with the clearest evidence expected in short-run adjustment. H3: Frequency-domain predictive causality between informality and the poverty-pressure proxy differs across horizons and is expected to run mainly from past informality toward poverty-pressure movements, without implying structural causality.

The rest of the paper proceeds as follows. Section 2 reviews the theoretical and empirical literature on unemployment, informality, and welfare vulnerability, with attention to Algeria and comparable economies. Section 3 describes the data and the econometric methodology. Later sections report the empirical results, discuss their interpretation, and draw policy implications.

2 THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Poverty Pressure, Unemployment, and Labor-Market Duality

The link between unemployment and poverty pressure is not mechanical. In a standard labor-income channel, unemployment reduces household resources and raises the risk of deprivation. Yet this channel is filtered through household composition, social transfers, informal earning opportunities, and the duration of joblessness. Okun's (1962) law gives a macroeconomic entry point by connecting output fluctuations and unemployment, while Agénor (2004) shows that unemployment and poverty can respond differently to growth and stabilization policies. For Algeria, this distinction matters because welfare vulnerability may persist even when open unemployment is partly absorbed outside formal employment.

Dual-sector theory remains a useful lens for economies where formal job creation is slow. Lewis (1954) and Harris and Todaro (1970) show that labor can be abundant while modern-sector jobs remain rationed. In such settings, unemployment statistics alone may understate hardship because workers may avoid open unemployment by accepting informal, unstable, or low-productivity work. Fields (1975) sharpened this point by distinguishing unemployment, underemployment, and job search in developing labor markets. Fields (2012) later made the same argument in welfare terms: working hard is not the same as escaping poverty. This is central for Algeria, where unemployment and informal activity can coexist as connected forms of labor-market adjustment.

Poverty pressure also depends on the type of growth and the behavior of prices. Ravallion and Chen (2003) define pro-poor growth by its effect on poor households, while Dollar and Kraay (2002) show that average income growth can matter for the poor over long periods. These insights do not imply that growth automatically reduces welfare stress. When labor markets are segmented, growth may fail to reach informal workers or the unemployed. Inflation can also

weaken purchasing power and raise pressure on household consumption, especially in an import-dependent economy. This justifies treating growth and inflation as controls in a model where unemployment and informality are the main labor-market channels.

2.2 Informality as Exit, Exclusion, and Vulnerability

The informal economy is not a single behavioral category. Perry et al. (2007) distinguish informality as exit from burdensome formality and informality as exclusion from formal opportunities. This distinction prevents a simplistic reading. Some informal workers may choose flexibility or avoid costly regulation. Others enter informality because formal jobs, legal protection, credit, and social insurance are unavailable. Loayza (1996) links informality to tax and regulatory burdens, while OECD and ILO (2019) emphasize vulnerability and the absence of protection.

These two faces of informality explain why its relationship with poverty pressure can differ by horizon. In the short run, informal activity may operate as a survival buffer. It can provide income when formal employment is scarce or when households face sudden shocks. In the longer run, however, the same channel can reproduce vulnerability through low productivity, unstable earnings, weak legal protection, limited pension coverage, and restricted access to finance. Schneider and Enste (2000) and La Porta and Shleifer (2014) therefore point to different but compatible mechanisms: informality is both a response to institutional constraints and a constraint on development. The direction and time profile of the relationship must therefore be treated as empirical questions rather than assumed in advance.

International labor evidence supports this cautious view. The ILO (2018) treats informal employment as a large and persistent part of global labor markets, while ILO Recommendation No. 204 frames formalization as a transition that should protect rights and livelihoods rather than simply suppress informal activity (International Labour Organization, 2015). For the poverty-pressure study, this point is important. Policies that reduce informality without expanding formal employment, social protection, and productivity may remove a short-run income margin without reducing underlying vulnerability.

2.3 Algerian and MENA Evidence and the Remaining Gap

Algerian evidence gives strong reasons to model unemployment and informality together. Bennihi et al. (2021) estimate the informal economy in Algeria and examine its interaction with formal activity. Cherfi-Feroukhi and Souam (2020) analyze informality, government intervention, and the labor market through structural models. Bellache et al. (2021) provide micro evidence from Kabylia showing how informal employment is linked to segmentation, mobility, and earnings. Taken together, these studies show that the informal sector is embedded in the labor-market structure, not simply outside it.

The broader MENA literature points in the same direction. Informality in the region reflects firm size, weak enforcement, tax and regulatory burdens, and limited access to better jobs (Gatti et al., 2014; Lopez-Acevedo et al., 2023). Algeria shares these features, but its hydrocarbon-based growth model gives them a specific macroeconomic form. Formal job creation is closely tied to public spending, while purchasing-power pressure can intensify when inflation rises or when growth does not translate into stable work. This makes the unemployment-informality-poverty-pressure nexus a labor-market and macroeconomic issue at the same time.

The poverty side of Algerian research is more fragmented. Ayad (2018) studies poverty reduction, financial development, and growth in Algeria with a regime-shift cointegration approach. Ayad et al. (2019) apply frequency-domain causality to poverty, growth, and financial development. These works are close to the present article in methodology, but their core mechanism is different. They do not place unemployment and informality inside the same system centered on poverty-pressure movements, nor do they separate long-run equilibrium, short-run adjustment, and frequency-specific predictive causality within one Algerian time-series design.

This is the narrower contribution of the present study. It does not ask whether informality is generally good or bad. It asks whether unemployment and informality help explain movements in the poverty-pressure proxy once growth and inflation are controlled for. It also asks whether the predictive content of past informality for poverty-pressure movements is concentrated in short-run fluctuations or remains visible across longer horizons. This positioning is deliberately cautious because the dependent variable is a consumption-based welfare proxy that is inversely transformed into poverty pressure, not a direct poverty headcount.

3 DATA AND METHODOLOGY

3.1 Data, Variables, and Sample Construction

The empirical analysis uses annual Algerian data for the final estimation sample, 1990-2018. The starting point is dictated by the availability of comparable post-1990 macro-labor indicators, while the endpoint is dictated by the need to retain a balanced common sample across all variables. Some source series provide observations beyond 2018, including 2019 for selected labor-market information, but those observations are not used in the VECM because the full variable set is not consistently available on the same basis. Keeping the common sample avoids mixing observed values with interpolated or externally modeled data. The resulting sample contains 29 annual observations. This short time dimension is a binding econometric constraint, particularly for a five-variable VECM with lags and adjustment terms. The definitions below correspond to the dataset used for the correlation matrix, unit-root tests, Johansen cointegration, VECM, impulse-response analysis, and frequency-domain predictive-causality results carried forward in the article.

The dependent variable, denoted PPG, is a consumption-based welfare proxy inversely transformed into poverty pressure. This choice is imposed by the discontinuity of direct annual poverty observations in Algeria. The raw consumption input is the World Bank WDI series Households and NPISHs final consumption expenditure per capita (constant 2015 US$; indicator code NE.CON.PRVT.PC.KD), which is used to construct an individual-consumption-based welfare proxy. The procedure follows the individual-consumption-index logic used by Ayad and Belmokaddem (2018), while Ravallion (2016) is retained as a general poverty-measurement reference. Because the underlying consumption measure rises with welfare, the series is direction-adjusted so that higher PPG indicates stronger poverty pressure rather than higher welfare. The World Bank Poverty and Inequality Platform is used only to verify the limited availability of direct annual poverty observations (World Bank, n.d.-b). This variable should not be read as a direct poverty headcount or multidimensional poverty measure.

The two labor-market variables are unemployment and informality. Unemployment, denoted UNR, is measured by the World Bank WDI series Unemployment, total (% of total labor force) (modeled ILO estimate; indicator code SL.UEM.TOTL.ZS). The informal-economy variable, denoted INEPG, is measured by the World Bank Informal Economy Database as model-based informal output relative to official GDP. These World Bank sources are retained consistently for the descriptive statistics, correlation matrix, unit-root tests, Johansen test, VECM, impulse responses, and frequency-domain predictive-causality results reported in the article (World Bank, n.d.-a, n.d.-c).

Two control variables are included. Economic growth, denoted GDPG, captures the macroeconomic income channel through which aggregate activity may reduce or intensify poverty pressure. Inflation, denoted INF, captures pressure on purchasing power, which is relevant for welfare in an import-dependent economy. Both controls are obtained from the World Development Indicators and are used to avoid attributing to unemployment or informality what may instead be due to aggregate growth or price dynamics (Ravallion & Chen, 2003; Dollar & Kraay, 2002; World Bank, n.d.-a). Table 1 summarizes the variables, definitions, transformations, roles, sources, and common period.

Table 1. *Variables, Definitions, and Data Sources*

Variable	Symbol	Measurement/definition	Role in the model	Source	Period
Poverty pressure proxy	PPG	Direction-adjusted welfare proxy from WDI household final consumption per capita (constant 2015 US$; NE.CON.PRVT.PC.KD). Higher values indicate poverty pressure, not a poverty headcount.	Dependent variable	Author calculation from WDI; method aligned with Ayad and Belmokaddem (2018); PIP used only to verify gaps in direct poverty observations.	1990-2018
Unemployment rate	UNR	Unemployment, total (% of total labor force), modeled ILO estimate (SL.UEM.TOTL.ZS). Tested in levels and first differences; entered according to integration results.	Theoretical labor-market variable in full model	World Bank, WDI	1990-2018
Informal economy	INEPG	World Bank model-based informal output indicator (% of official GDP). Tested in levels and first differences.	Main informality variable in full and restricted models	World Bank Informal Economy Database	1990-2018
Economic growth	GDPG	Annual GDP growth rate (%). Tested in levels and first differences.	Macroeconomic control	World Bank, WDI	1990-2018
Inflation	INF	Consumer price inflation, annual (%). Tested in levels and first differences.	Purchasing-power control	World Bank, WDI	1990-2018

Note: PPG denotes a consumption-based welfare proxy inversely transformed into a poverty-pressure indicator rather than a direct poverty measure.

Source: Prepared by the authors based on the data sources described in the study.

The model is estimated in two versions. The full system includes unemployment, the informal economy, growth, and inflation because unemployment belongs to the theoretical poverty-pressure mechanism, and it is retained as the theoretical baseline. However, the common annual sample contains only 29 observations, and estimating UNR and INEPG jointly with two lags and an error-correction term consumes substantial degrees of freedom. The two labor-market variables also overlap empirically, with an absolute correlation of about 0.65. In this small sample, the full five-variable VECM is therefore parameter-sensitive, has a weak adjusted fit, and yields an insignificant ECT in the PPG equation. The restricted model omits UNR only for parsimony and degrees-of-freedom preservation; it provides a negative and statistically significant ECT and better diagnostic behavior. This preference is econometric, not a theoretical claim that unemployment is irrelevant to poverty pressure.

3.2 Model Specification

The baseline long-run relationship is written as:

$$PPG_t = f(UNR_t, INEPG_t, GDPG_t, INF_t)$$

$$PPG_t = \beta_0 + \beta_1 UNR_t + \beta_2 INEPG_t + \beta_3 GDPG_t + \beta_4 INF_t + \varepsilon_t$$

where PPG_t denotes the poverty pressure proxy, UNR_t unemployment, INEPG_t the informal economy, GDPG_t economic growth, INF_t inflation, and ε_t the disturbance term. In the restricted version, UNR_t is omitted while the remaining variables are retained. The purpose of the specification is not to impose a structural poverty model, nor to treat consumption as a direct poverty measure, but to organize the long-run and short-run associations implied by the annual data.

Before estimating the VECM, the analysis applies Augmented Dickey-Fuller and Phillips-Perron unit-root tests. These tests are standard diagnostics for identifying whether the series are stationary in levels or become stationary after first differencing (Dickey & Fuller, 1979; Phillips & Perron, 1988). The VECM route is appropriate only when the variables are integrated in a compatible way and when a cointegrating relationship exists.

3.3 Johansen Cointegration and VECM

The Johansen cointegration test is then used to determine whether the variables share one or more long-run equilibrium relations. Johansen's (1988) maximum-likelihood framework is appropriate for multivariate systems because it allows more than one cointegrating vector and treats all variables as potentially endogenous. This is useful here because poverty pressure, unemployment, informality, growth, and inflation may adjust jointly rather than through a single dependent-variable equation.

The VECM can be written in compact form as:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta Y_{t-i} + u_t$$

The same error-correction logic can also be written in a single-equation form:

$$\Delta Y_t = \beta_0 + \sum_{j=1}^{q} \beta_{1j} \, \Delta Y_{t-j} + \sum_{i=0}^{p} \beta_{2i} \, \Delta X_{t-i}$$

$$+\delta ECT_{t-1} + \varepsilon_t$$

For the poverty-pressure equation estimated in this study, the corresponding VECM representation is:

$$\Delta PPG_t = \beta_0 + \sum_{j=1}^{p} \alpha_{1j} \, \Delta PPG_{t-j} + \sum_{j=1}^{p} \alpha_{2j} \, \Delta UNR_{t-j}$$

$$+ \sum_{j=1}^{p} \alpha_{3j} \, \Delta INEPG_{t-j} + \sum_{j=1}^{p} \alpha_{4j} \, \Delta GDPG_{t-j}$$

$$+ \sum_{j=1}^{p} \alpha_{5j} \, \Delta INF_{t-j} + \gamma ECT_{t-1} + \varepsilon_t$$

The lagged error-correction term is derived from the long-run relation as:

$$ECT_{t-1} = PPG_{t-1} - \beta_0 - \beta_1 UNR_{t-1} - \beta_2 INEPG_{t-1}$$

$$-\beta_3 GDPG_{t-1} - \beta_4 INF_{t-1}$$

where Y_t is the vector of variables, Δ is the first-difference operator, p is the selected lag length, β contains the cointegrating coefficients, and α contains the adjustment parameters. A negative and statistically significant adjustment coefficient in the PPG equation indicates that deviations from long-run equilibrium are corrected over time. The interpretation is deliberately separated across two objects: β describes the cointegrating vector, while α shows which equation actually adjusts toward equilibrium. Thus, a significant coefficient on UNR in the cointegrating vector should not be read as a stand-alone long-run effect on the poverty-pressure proxy unless the relevant adjustment equation is valid, statistically meaningful, and diagnostically well behaved. The VECM links long-run equilibrium with short-run movements, but substantive claims depend on the adjustment path and residual diagnostics (Engle & Granger, 1987; Lütkepohl, 2005).

The annual frequency and the short sample require strict parsimony. With only 29 observations, adding many lags or retaining a heavily parameterized five-variable VECM can quickly consume degrees of freedom and make the adjustment equation unstable. Lag selection is therefore guided by information criteria, residual diagnostics, and economic interpretability. Serial-correlation and heteroskedasticity tests are used to check whether residual behavior undermines the estimated dynamics. Impulse-response analysis is retained later as a diagnostic tool for tracing the response of the poverty-pressure proxy and informality to innovations, not as proof of structural causality.

3.4 Frequency-Domain Causality

Standard Granger causality asks whether lagged values of one variable improve the prediction of another variable (Granger, 1969). That time-domain test can be informative, but it compresses all horizons into one decision. The frequency-domain approach separates the predictive-causality question by horizon. This is especially relevant for informality and poverty-pressure movements because a household buffer may operate quickly, while the development cost of informal work may appear more slowly.

The frequency-domain test used in the article follows Breitung and Candelon (2006), building on the spectral causality work of Geweke (1982) and Hosoya (1991). For a selected frequency ω in the

interval (0, π), the null hypothesis is that X has no Granger-predictive content for Y at that frequency. In the bivariate VAR representation, the relevant frequency-domain objects and linear restrictions are as follows:

The bivariate moving-average representation is:

$$Y_t = \Psi(L)\varepsilon_t$$

$$\Psi(L) = \begin{bmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{22}(L) \end{bmatrix}$$

The frequency-domain causality measure proposed by Geweke and Hosoya is:

$$M_{y\Rightarrow x}(\omega) = \log\left[\frac{2\pi f_x(\omega)}{|\Psi_{11}(e^{-i\omega})|^2}\right]$$

$$M_{y\Rightarrow x}(\omega) = \log\left[1 + \frac{|\Psi_{12}(e^{-i\omega})|^2}{|\Psi_{11}(e^{-i\omega})|^2}\right]$$

Non-causality at frequency ω requires:

$$|\Psi_{12}(e^{-i\omega})|^2 = 0$$

$$H_0: M_{y\Rightarrow x}(\omega) = 0$$

Breitung and Candelon (2006) express the test through the following linear restrictions:

$$\sum_{k=1}^{p} \theta_{11,k}\cos(k\omega) = 0, \qquad \sum_{k=1}^{p} \theta_{12,k}\sin(k\omega) = 0$$

Equivalently, the bivariate autoregressive equation and restriction matrix can be written as:

$$x_t = \alpha_1 x_{t-1} + \cdots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p} + \varepsilon_{1t}$$

$$H_0: R(\omega)\beta = 0$$

$$R(\omega) = \begin{bmatrix} \cos(\omega) & \cos(2\omega) & \cdots & \cos(p\omega) \\ \sin(\omega) & \sin(2\omega) & \cdots & \sin(p\omega) \end{bmatrix}$$

The empirical interpretation groups frequencies into long-, medium-, and short-run ranges following the original Stata output. Frequencies from 0 to 1 are read as long-run movements, frequencies from 1 to 2 as medium-run movements, and frequencies from 2 to π (approximately 3.14) as short-run fluctuations. The article applies the test in both directions between informality and the poverty-pressure proxy. This permits a sharper question than aggregate Granger causality: whether past informality predicts poverty-pressure movements only temporarily, or whether its predictive content remains visible across the whole frequency band.

4 EMPIRICAL RESULTS

4.1 Preliminary Correlation Evidence

The preliminary correlation matrix is used as a diagnostic step rather than as evidence of causality. It is useful here because unemployment and informality are theoretically related and may overlap empirically in a short annual sample. Table 2 reports the pairwise correlations used to motivate the later full and restricted specifications.

The absolute correlation between UNR and INEPG is about 0.65. This is high enough to justify caution, but not high enough to erase unemployment from the theoretical framework. The negative sign reflects the coding and movement of the retained informality series. The restricted model is therefore treated as an econometric robustness and stability device, not as evidence that unemployment is irrelevant to welfare or poverty pressure.

Table 2. *Correlation Matrix*

Variable	PPG	UNR	INEPG	GDPG	INF
PPG	1.000				
UNR	0.651	1.000			
INEPG	-0.423	-0.650	1.000		
GDPG	-0.359	0.012	0.222	1.000	
INF	0.644	0.447	-0.554	-0.516	1.000

Source: Author calculations using EViews 13.

4.2 Unit-Root and Cointegration Tests

The Augmented Dickey-Fuller and Phillips-Perron tests are used to determine the integration order of the variables before applying the Johansen procedure. This step is necessary because VECM estimation is appropriate when the variables are non-stationary in levels, integrated of the same order, and cointegrated. The unit-root evidence in Table 3 points mainly to I(1) behavior. The few level-stationarity signals for INEPG and GDPG under one specification are not stable across test forms, so the first-difference results guide the cointegration strategy.

Table 3. ADF and PP Unit-Root Test Results

Variable	ADF level I / I+T	ADF first diff. I / I+T	PP level I / I+T	PP first diff. I / I+T	Order
PPG	-1.74 (0.39) / -1.33 (0.85)	-5.37*** (0.00) / -4.36*** (0.00)	-1.77 (0.38) / -1.42 (0.83)	-5.35*** (0.00) / -5.21*** (0.00)	I(1)
UNR	-0.37 (0.90) / -2.40 (0.36)	-3.64** (0.01) / -3.63** (0.04)	-0.68 (0.83) / -2.43 (0.35)	-3.63** (0.01) / -3.63** (0.04)	I(1)
INEPG	-1.29 (0.61) / -3.65** (0.04)	-5.42*** (0.00) / -5.39*** (0.00)	-0.92 (0.76) / -2.41 (0.36)	-7.05*** (0.00) / -6.72*** (0.00)	I(1)
GDPG	-3.25** (0.02) / -3.18 (0.10)	-8.47*** (0.00) / -8.67*** (0.00)	-3.17** (0.03) / -3.12 (0.12)	-9.81*** (0.00) / -21.87*** (0.00)	I(1), mixed level evidence
INF	-1.49 (0.52) / -1.82 (0.66)	-5.39*** (0.00) / -5.40*** (0.00)	-1.45 (0.54) / -1.97 (0.58)	-5.49*** (0.00) / -5.89*** (0.00)	I(1)

*Note: I = intercept; I+T = intercept and trend. Values are test statistics with p-values in parentheses. ** and *** indicate significance at the 5% and 1% levels, respectively.*

Source: Author calculations using EViews 13.

The Johansen trace test is then applied to the full system and to the restricted system without unemployment. Table 4 shows cointegration in both cases. With unemployment included, the trace test rejects the null hypothesis up to the third cointegrating vector. Without unemployment, it rejects the null of no cointegration and supports one cointegrating vector. This confirms that the restricted model does not discard the long-run structure; it simply produces a more parsimonious adjustment equation.

Table 4. Johansen Cointegration Trace Test

Specification	Hypothesized CE(s)	Eigenvalue	Trace statistic	5% critical value	p-value
Including UNR	None*	0.754	96.80	69.81	0.0001***
Including UNR	At most 1*	0.609	60.33	47.85	0.022**
Including UNR	At most 2*	0.587	35.90	29.79	0.0087***
Including UNR	At most 3	0.387	12.87	15.49	0.1193
Including UNR	At most 4	0.004	0.125	3.84	0.7236
Excluding UNR	None*	0.608	51.12	47.85	0.023**
Excluding UNR	At most 1	0.522	26.72	29.79	0.1086
Excluding UNR	At most 2	0.232	7.524	15.49	0.5175
Excluding UNR	At most 3	0.024	0.632	3.841	0.4264

*Note: ** and *** indicate rejection at the 5% and 1% levels, respectively. Johansen's critical values are asymptotic; given the 29-observation annual sample, the cointegration evidence should be interpreted cautiously.*

Source: Author calculations using EViews 13.

4.3 VECM Estimates and Diagnostics

The VECM results are reported in two steps in Table 5, with diagnostics summarized in Table 6. The full specification retains unemployment because it belongs to the theoretical system and is kept as the baseline. Yet the full model is empirically weak in the 29-observation sample: jointly estimating UNR and INEPG consumes degrees of freedom, their absolute correlation is about 0.65, adjusted R^2 is only 0.06, the ECT is statistically insignificant, and most short-run coefficients are not significant. The restricted specification omits UNR for parsimony rather than theoretical exclusion. Its poverty-pressure adjustment equation provides a negative and significant ECT, stronger adjusted fit, and no decisive residual diagnostic problem. This distinction is important: a significant coefficient in a cointegrating vector is not the same as a valid error-correction adjustment in the poverty-pressure equation.

Table 5. VECM Estimates:[1]

Panel / Variable	Coefficient	T-Statistic	Comment
Full specification with unemployment			
Long-run: C	0.69	-	Intercept in cointegrating relation
Long-run: UNR	0.85	-6.08	Cointegrating coefficient only; not a stand-alone effect on the poverty-pressure proxy
Long-run: INEPG	0.66	-3.91	Cointegrating coefficient
Long-run: GDPG	4.70	-4.13	Cointegrating coefficient
Long-run: INF	0.59	-4.13	Cointegrating coefficient
ECT in PPG equation	-0.13	-0.59	Negative but statistically insignificant
ΔPPG(-1)	0.45	1.17	Short-run term
ΔUNR(-1)	-0.14	-0.19	Short-run term
ΔINEPG(-1)	0.38	1.64	Short-run term
ΔGDPG(-1)	-0.67	-0.70	Short-run term
ΔINF(-1)	-0.14	-0.52	Short-run term
ΔPPG(-2)	-0.11	-0.58	Short-run term
ΔUNR(-2)	0.92	1.46	Short-run term
ΔINEPG(-2)	-0.23	-0.93	Short-run term
ΔGDPG(-2)	-0.79	-1.17	Short-run term
ΔINF(-2)	-0.003	-0.01	Short-run term
R^2 / adjusted R^2	0.47 / 0.06	-	Low adjusted fit in the full system
LM serial correlation	lag 1 = 0.82; lag 2 = 0.67	p = 0.44; p = 0.97	No residual serial correlation detected
Heteroskedasticity test	335.76	p = 0.40	No strong evidence of heteroskedasticity
Restricted Specification Without Unemployment			
Long-run: C	-55.23	-	Intercept in cointegrating relation
Long-run: GDPG	-5.51	3.10	Cointegrating coefficient
Long-run: INEPG	0.50	-1.56	Cointegrating coefficient
Long-run: INF	0.24	-0.80	Cointegrating coefficient
ECT in PPG equation	-0.38***	-4.63	Negative and significant; preferred adjustment equation
Constant	-1.34**	-2.26	Short-run intercept
ΔPPG(-1)	0.06	0.46	Short-run term
ΔGDPG(-1)	1.80***	3.38	Short-run term
ΔINEPG(-1)	0.30**	2.28	Short-run informality coefficient
ΔINF(-1)	-0.33**	-2.22	Short-run inflation coefficient
ΔPPG(-2)	-0.31**	-2.59	Short-run term
ΔGDPG(-2)	0.96**	2.47	Short-run term
ΔINEPG(-2)	-0.03	-0.20	Short-run term
ΔINF(-2)	-0.20	-1.55	Short-run term
R^2 / adjusted R^2	0.73 / 0.59	-	Stronger explanatory performance
LM serial correlation	lag 1 = 1.83; lag 2 = 0.71	p = 0.07; p = 0.75	No decisive serial correlation problem
Heteroskedasticity test	176.54	p = 0.55	No strong evidence of heteroskedasticity

Source: Author calculations using EViews 13.

[1] Signs and t-statistics in EViews cointegrating equations may appear with opposite signs because of normalization conventions; coefficients should be interpreted consistently with the normalized cointegrating relation. Stars are attached only to short-run coefficients and the ECT; cointegrating-vector t-statistics are not treated as conventional stand-alone tests.

The full model is retained for theoretical completeness, but its error-correction term is not statistically meaningful.

The restricted model is preferred because it provides a negative and significant ECT in the poverty-pressure equation.

The results support the cautious modeling decision made in the methodology section. Retaining UNR and INEPG jointly preserves the theoretical unemployment channel, but in a 29-observation annual sample, it also consumes degrees of freedom, reflects substantial empirical overlap, and fails to yield a statistically meaningful poverty-pressure adjustment equation. Once UNR is omitted, the ECT is negative and significant, and the adjusted fit improves, so the restricted model is preferred for parsimony and valid adjustment, rather than as evidence that unemployment has no role. In the restricted model, INEPG is significant in the short run at the first lag, but its long-run coefficient is not statistically significant. The article therefore does not claim a strong long-run VECM effect of informality; the longer-horizon evidence is limited to frequency-domain predictive content.

Table 6. *Residual Diagnostics and Model-Selection Evidence*

Criterion	Full model with UNR	Restricted model without UNR	Interpretation
R^2	0.47	0.73	Restricted model has stronger explanatory performance.
Adjusted R^2	0.06	0.59	Full model is weak after parameter adjustment; restricted model is preferred.
ECT in PPG equation	-0.13 (t = -0.59)	-0.38*** (t = -4.63)	Only the restricted model provides a negative and significant adjustment term.
LM serial correlation	Lag 1 p = 0.44; Lag 2 p = 0.97	Lag 1 p = 0.07; Lag 2 p = 0.75	No decisive serial correlation problem.
Heteroskedasticity	χ^2 = 335.76; p = 0.40	χ^2 = 176.54; p = 0.55	No strong evidence of heteroskedasticity.
Preferred for interpretation?	No	Yes	Preference is econometric and diagnostic, not a theoretical exclusion of unemployment.

*Note: *** indicates significance at the 1% level. Diagnostic p-values are reported as retained from the EViews 13 output.*
Source: Author calculations using EViews 13.

4.4 Stability and Impulse Responses

Stability is checked through the inverse roots of the estimated characteristic polynomial. As shown in Figure 1, all inverse roots lie inside the unit circle. The selected restricted VECM can therefore be used for dynamic simulation. The impulse-response functions are read as descriptive model-based dynamics, not as structural policy shocks.

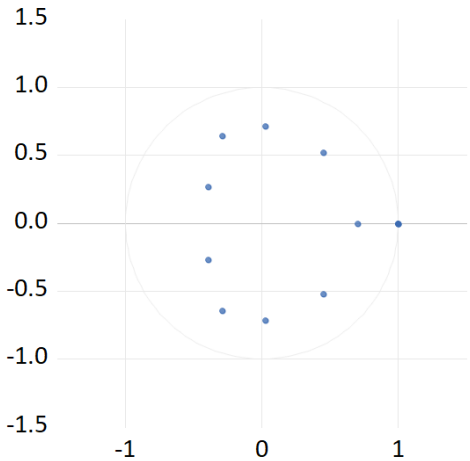

Figure 1. *Inverse Roots of the Selected VECM*
Source: Author calculations using EViews 13.

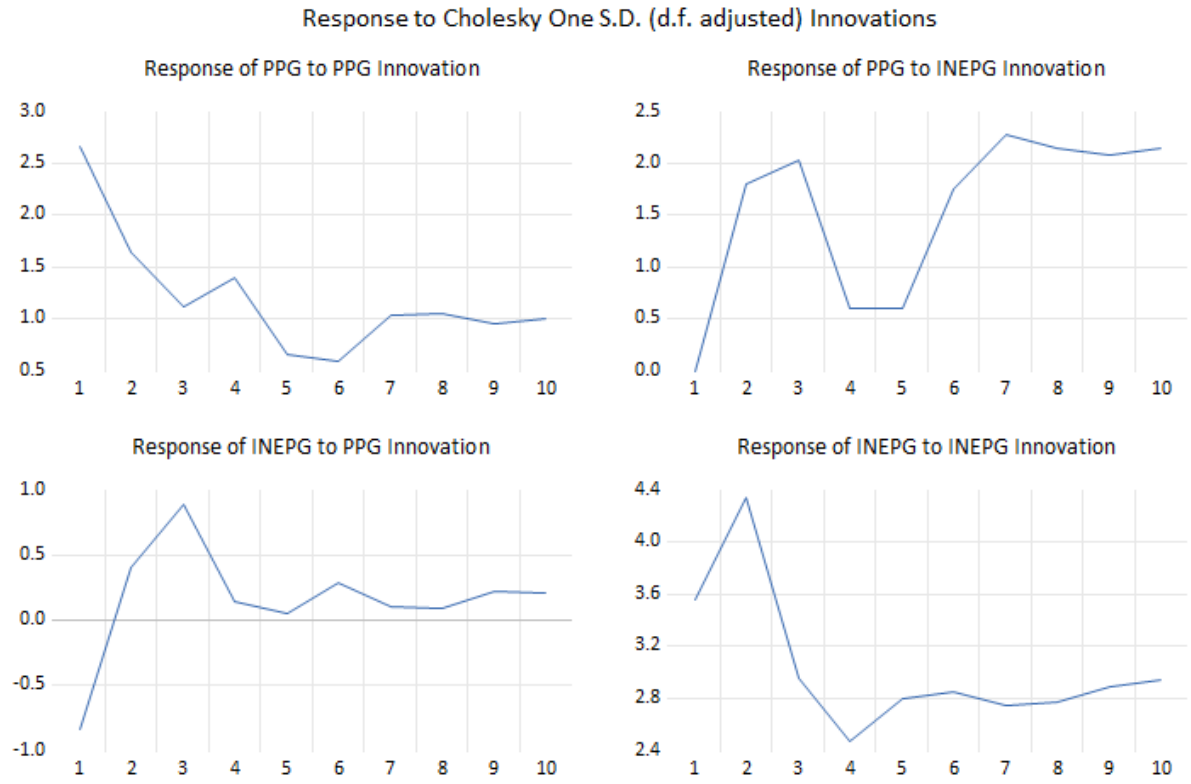

Figure 2. *Impulse responses between poverty pressure and informality*
Source: Author calculations using EViews 13.

The impulse responses suggest that the poverty-pressure proxy responds positively to an informality innovation over most of the ten-year horizon, although the path is not monotonic. The response of informality to PPG innovation is weaker and fades after the first few years. This descriptive pattern is consistent with the view that informality can act as a short-run income margin while also transmitting vulnerability when employment is unstable, low-productivity, and outside social protection; it is not a structurally identified effect.

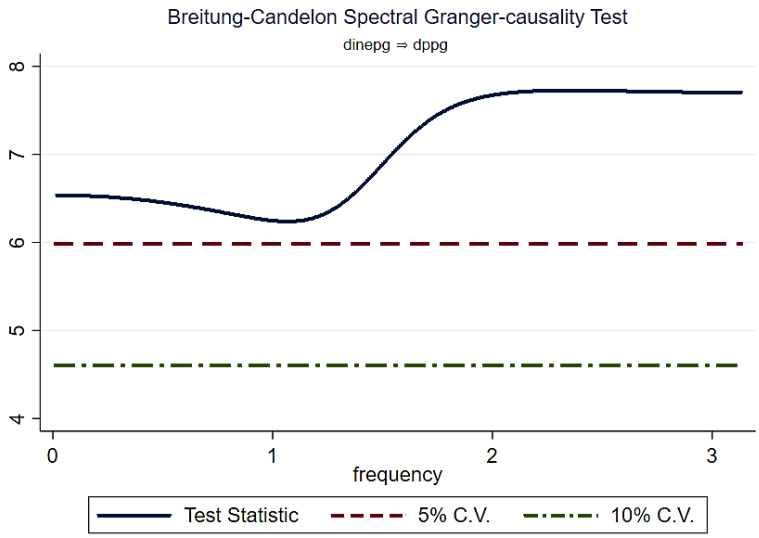

Figure 3*. Frequency-Domain Causality from Informality to Poverty Pressure*
Source: Author calculations using Stata 17.

4.5 Frequency-Domain Causality

The Breitung-Candelon test is used to ask whether predictability differs across horizons. Low frequencies correspond to long-run movements, while higher frequencies correspond to short-run fluctuations. Figures 3 and 4 show the two directions of frequency-domain predictive causality between INEPG and PPG. The test statistics in the INEPG-to-PPG direction remains above the 5% critical value across the reported frequency range, while the reverse direction remains below the critical value

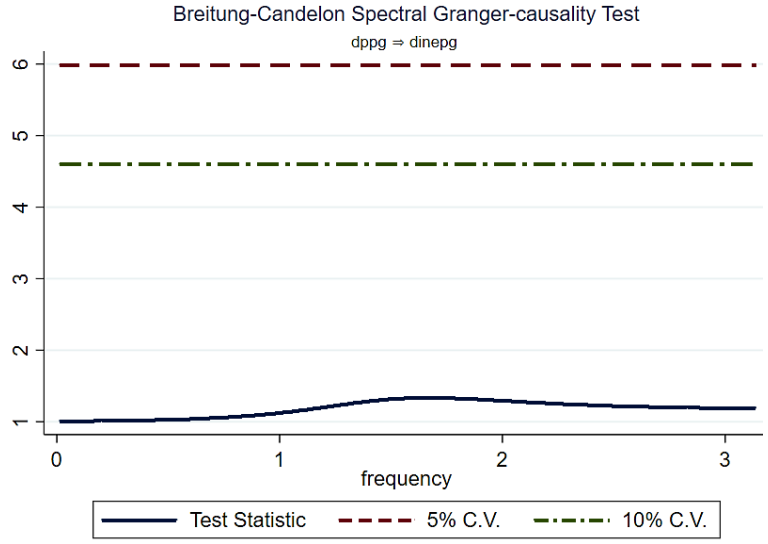

Figure 4. *Frequency-Domain Causality from Poverty Pressure to Informality*
Source: Author calculations using Stata 17.

Table 7. *Breitung-Candelon Frequency-Domain Causality Results*

Direction	Frequency band	Frequency range (ω)	Decision basis	5% critical value	10% critical value	Decision
INEPG -> PPG	Long run	0 < ω ≤ 1	Available plot: test-statistic curve above the 5% critical-value line	≈5.99	≈4.61	Reject H0; predictive causality
INEPG -> PPG	Medium run	1 < ω ≤ 2	Available plot: test-statistic curve above the 5% critical-value line	≈5.99	≈4.61	Reject H0; predictive causality
INEPG -> PPG	Short run	2 < ω ≤ π	Available plot: test-statistic curve above the 5% critical-value line	≈5.99	≈4.61	Reject H0; predictive causality
PPG -> INEPG	Long run	0 < ω ≤ 1	Available plot: curve below the 10% critical-value line	≈5.99	≈4.61	Do not reject H0
PPG -> INEPG	Medium run	1 < ω ≤ 2	Available plot: curve below the 10% critical-value line	≈5.99	≈4.61	Do not reject H0
PPG -> INEPG	Short run	2 < ω ≤ π	Available plot: curve below the 10% critical-value line	≈5.99	≈4.61	Do not reject H0

Note: Decisions use the plotted test-statistic curve relative to the 5% and 10% critical-value lines; point-by-point numerical output should be archived in future replication.
Source: Author summary based on Stata 17 frequency-domain plots.

Table 7 summarizes the plot-based frequency-domain decisions. Because the available output for this study was retained as plots rather than frequency-by-frequency numerical tables, the decisions are based on the position of the plotted test-statistic curve relative to the 5% and 10% critical-value lines. Future replication should archive the numerical frequency-by-frequency output.

5 DISCUSSION

The evidence should be read in layers. First, the Johansen tests indicate that the poverty pressure proxy, informality, unemployment, growth, and inflation are not drifting independently. They share a long-run equilibrium structure in Algeria, so H1 is supported at the level of cointegration. This result is not evidence for a directly observed poverty headcount.

Second, the VECM results show why the distinction between cointegration and adjustment matters. The full model with unemployment confirms that UNR belongs to the conceptual system, but the 29-observation sample makes the five-variable specification costly in degrees of freedom and parameter-sensitive, especially given the approximately 0.65 absolute correlation between UNR and INEPG. Its adjusted fit is weak, and the ECT in the PPG equation is insignificant. The restricted model is preferred for parsimony and valid adjustment because it preserves degrees of freedom, produces a negative and significant ECT, and has better diagnostic performance. This is not evidence that unemployment is theoretically irrelevant. H2 is therefore supported mainly through the short-run informality coefficient in the preferred model, not through a broad long-run VECM effect of unemployment or informality.

Third, the positive short-run coefficient on informality in the poverty-pressure equation challenges a purely protective reading of the informal economy. Informal work may provide income, but it often does so without stable contracts, insurance, pensions, credit access, or enforceable rights. In this sense, informality can absorb some open unemployment while still reproducing vulnerability. This association is consistent with Algerian evidence on informal work as a cheap substitute for formal employment and with the broader development literature that treats informality as both exit and exclusion.

Finally, the frequency-domain tests add an important temporal dimension. H3 is supported only as frequency-domain predictive causality: past informality contains information useful for predicting movements in the poverty-pressure proxy across the plotted short-, medium-, and long-run frequency bands, while the reverse direction is not supported. The result should not be interpreted as structural causal identification; it refers only to predictive content within the estimated bivariate system.

6 CONCLUSION AND POLICY IMPLICATIONS

This article examined the relationship between unemployment, the informal economy, and a poverty-pressure proxy in Algeria over 1990-2018. Because direct annual poverty observations are discontinuous, the dependent variable is a consumption-based welfare proxy inversely transformed into poverty pressure, not a direct poverty measure. Using World Bank WDI unemployment, growth, and inflation data and the World Bank Informal Economy Database for informality, the analysis combined unit-root testing, Johansen cointegration, VECM estimation, impulse-response diagnostics, and Breitung-Candelon frequency-domain predictive-causality testing.

The results support three main conclusions. First, the variables share a long-run equilibrium relationship at the Johansen level, indicating that the poverty-pressure proxy is linked to labor-market duality and macroeconomic conditions. Second, the restricted VECM is preferred because it preserves degrees of freedom and provides a negative and significant ECT; the full model remains the theoretically complete baseline, but its adjusted fit is weak, and its PPG adjustment term is insignificant. Third, informality is significant mainly in short-run VECM dynamics, while past informality contains frequency-domain predictive information for poverty-pressure movements across short, medium, and long horizons.

The policy relevance is not that informality should be suppressed mechanically. Informality is partly a survival margin, especially when formal job creation is weak. The findings are consistent with

a transition strategy that simplifies formalization procedures, reduces the cost of compliance for micro and small activities, expands social protection to vulnerable workers, supports productivity and access to finance, and coordinates labor-market policy with inflation control. Such measures are relevant to reducing poverty pressure by turning informal work into more secure and productive livelihoods, but the present estimates do not identify their structural causal effects.

7 LIMITATIONS

The analysis has four limitations. First, the sample is short and annual: 1990-2018 provides only 29 observations, which restricts lag length, reduces degrees of freedom, and makes the full five-variable VECM parameter-sensitive. This is the main reason why the parsimonious restricted model is preferred for interpretation. Second, PPG is a consumption-based welfare proxy inversely transformed into poverty pressure, not a direct annual poverty headcount or multidimensional poverty measure. This practical response to data discontinuity cannot capture all dimensions of poverty. Third, the informality series is model-based and taken from the World Bank Informal Economy Database; alternative informality measures could produce different estimates and would require full re-estimation. Fourth, the frequency-domain tests provide predictive causality in the Granger sense, not structural causal identification.

The present manuscript partly addresses robustness by comparing the full and restricted specifications, reporting residual diagnostics, checking inverse-root stability, interpreting the Johansen and VECM evidence cautiously, and explicitly recognizing the short sample. Future work should test sensitivity to lag length, compare alternative VECM specifications, examine alternative welfare or poverty-pressure proxies, compare alternative informality measures, archive point-by-point numerical Breitung-Candelon frequency statistics, and provide a replication dataset and code.

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