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Study OF Inflation Dynamics IN Algeria Using Var AND Vecm Models

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Abstract
This article addresses the question of identifying the sources and nature of the shocks underlying inflation fluctuations in the Algerian economy—an issue that remains relatively underexplored in the existing literature. The study relies on the structural VAR model of Blanchard and Quah (1989) and a Vector Error Correction Model (VECM). The analysis is based on monthly macroeconomic data covering the period from January 1995 to June 2020. The research is structured around the identification of shocks, their temporal effects, and their contribution to the variance of inflation. The results reveal that more than 94% of price level fluctuations in Algeria are explained by external demand shocks, money supply and demand shocks, as well as monetary policy shocks.
Keywords: *Inflation; unit root test with structural break; cointegration test with structural break; Toda-Yamamoto causality test; VECM; VAR.*

INTRODUCTION

Inflation remains one of the most pressing macroeconomic challenges, affecting both advanced and emerging economies. In Algeria, where hydrocarbons account for nearly 72% of budgetary revenues in 2023 (World Bank, 2023), volatility in the general price level poses a direct threat to socio-economic stability and household purchasing power (Mendoza, 1995; Helali, 2021).
On the theoretical front, recent studies highlight the predominance of external shocks in Algeria's inflation dynamics, notably the volatility of oil prices (Laourari & Abderrahim, 2022), the short-term exchange rate pass-through effects (Abi & Djeddi, 2025), as well as trends in import prices. At the same time, internal factors remain significant, be it the expansion of the money supply (M2) or the impact of Algeria's fiscal policy characterized by its procyclical orientation (Mahyaoui, 2019). However, despite these contributions, the literature still struggles to precisely identify the transmission channels of shocks, which limits the authorities' ability to implement effective and targeted economic policies (Mehibel & Belarbi, 2017).
In this context, our study pursues a dual objective: to fill this empirical gap and to deploy a robust methodological approach. The evolution of econometric tools now makes it possible to better integrate structural breaks (Zivot & Andrews, 1992), which is particularly relevant for an economy prone to exogenous shocks like Algeria. Accordingly, we propose a two-pronged strategy: a structural VAR model, inspired by Blanchard & Quah (1989), which allows the identification of six types of macroeconomic shocks (real supply, money supply, money demand, exchange rate, monetary policy, external demand), and a VECM intended to capture long-run equilibrium relationships using monthly data covering the period 1995–2020.
Our central hypothesis posits that inflation fluctuations in Algeria originate predominantly from external and monetary shocks. Moreover, we anticipate an asymmetric propagation of exchange rate shocks, reflecting heightened sensitivity to external imbalances.
By rigorously quantifying the differential contributions of these shocks to price dynamics, this research aims to provide operational levers for improved design of monetary and fiscal policies in Algeria, while offering an original contribution to the literature on inflation in developing economies.

1. Data Presentation and Estimation Results

Analyzing the main sources of inflation variations in Algeria requires distinguishing between two sets of variables according to the nature of shocks: exogenous shocks and endogenous shocks, encompassing both domestic and external shocks.
The first set of domestic exogenous shocks includes real supply shocks (IPI), money demand shocks (CPI), monetary policy shocks (TR), money supply shocks (M2), and exchange rate shocks (TCER). In contrast, the second set of endogenous shocks includes external real supply shocks (IPIE) and the external real demand shock (OP).
These variables are expressed in logarithms on a monthly basis, covering the period from January 1995 to June 2020. Data are collected from various sources such as the National Office of Statistics (ONS), the IMF's

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International Financial Statistics (IFS), the Algerian Central Bank's financial statistics (BCA), and statistics from the Algerian Ministry of Industry.
These variables are commonly used in the literature on structural VAR models. The domestic real and monetary variables help in better understanding the impact of monetary shocks on economic cycles, as well as the crucial role of the real exchange rate as a shock transmission mechanism, as highlighted by Gimet (2007).

1.1 Presentation of Transformed Variables

The key variables of our analysis are detailed here, highlighting the transformations required for data processing.

- **Industrial Production Index (LIPIR)** as a proxy for Algeria's GDP: In the absence of monthly GDP data before the year 2000, we use the Industrial Production Index (LIPIR) as a proxy due to its monthly availability. It has been seasonally adjusted using the Census X-11 method in EViews 8.0 and normalized by the Consumer Price Index.
- **Oil Price:** The second variable in our analysis is the price of oil. We removed seasonality and normalized the data by the Consumer Price Index to obtain a real oil price.
- **Industrial Production Index in Europe:** Our third variable is the Industrial Production Index for Europe, calculated with a base of 100 in 2010 using a weighted average of the industrial production indices of Algeria's main European partners (France, Germany, Italy, and Spain). This index covers various sectors such as mining, manufacturing, and utilities.
- **Real Effective Exchange Rate:** The fourth variable represents the real effective exchange rate, expressed in units of US dollars (USD) per one unit of DZA. The data have been seasonally adjusted (denoted as LTCER_SA).
- **Consumer Price Index (LCPI_SA):** Our fifth variable is the Consumer Price Index, seasonally adjusted.
- **Money Supply (LM2_SA):** The sixth variable is the money supply, expressed in millions of DZA, representing the official target of monetary policy in Algeria. The data have been seasonally adjusted.
- **Central Bank Rediscount Rate (TR):** Finally, our seventh variable is the central bank's rediscount rate (TR), as a monetary policy instrument. The data were extracted from the Algerian central bank's database.

1.2 Stationarity Analysis

To assess the stationarity of the level data while accounting for structural breaks, we will use a specific test designed to incorporate these changes: the Zivot and Andrews (1992) test.
Results of the Zivot and Andrews (1992) test for the seven variables of our model, both in levels and in first difference, are presented in the tables below.

Table 01: Results of the Zivot and Andrews (1992) Unit Root Test at Level

Modèles	Désignation	LIPIR	LIPIE_SA	LOPR	LTCER	LCPI_SA	LM2_SA	LTR
A	t-statistique	-5.11285**	-5.22824**	-4.25727	-5.11955**	-2.64199	-3.00241	-3.92698
	Lag	3	3	1	4	0	10	0
	Break Date	2010M01	2008M08	2014M08	2002M03	2002M01	2001M07	1999M09
	p-value	0.00378	2.76e-05	0.00043	7.77e-06	0.005156	0.01709	0.00040
B	t-statistique	-4.83200*	-4.46823**	4.18163***	-3.81621	-5.35455*	-6.16829	-5.08376*
	Lag	3	3	1	4	0	2	0
	Break Date	2005M04	2004M07	2010M02	2004M11	2007M04	2006M07	2003M08
	p-value	0.04398	0.433180	0.000886	0.002132	0.00029	0.144641	0.00028
C	t-statistique	-5.36841**	-6.95342	-4.30447	-5.11936**	-5.03179**	-3.43831	-5.51399**
	Lag	3	3	1	4	0	2	0

	Break Date	2009M06	2008M08	2014M07	2002M03	2005M05	1999M01	2003M06
	p-value	0.00177	1.11e-07	0.00113	0.000138	0.01907	-3.43831	0.01535
Décision		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: NS = not stationary. ***, **, * denote rejection of the null hypothesis of a unit root at the 1%, 5%, and 10% levels, respectively. The critical values for model A are (-5.34), (-4.93), and (-4.58); for model B (-4.80), (-4.42) and (-4.11); and for model C (-5.57), (-5.08) and (-4.82).

Source: Calculations by the authors

According to the provided results, the LIPIR index and the other variables are non-stationary at level. However, after taking the first differences, all series become stationary

Table 02: Results of the Zivot and Andrews (1992) Unit Root Test on First Differences

Modèles	Désignation	LIPIR	LIPIE_SA	LOPR	LTR	LCPI_SA	LM2_SA	LTCER
A	t-statistique	-9.42169	-7.69212	-13.92083	-18.85384	-5.100637	-7.89542	-7.15877
	Lag	2	2	0	0	13	4	4
	Break Date	1999M04	2008M08	1999M01	2004M05	2007M06	2008M08	2005M01
	p-value	0.04512	0.03819	0.152533	0.002134	0.042529	0.09589	0.08306
B	t-statistique	-14.20028	-4.87365	-13.76677	-18.48119	-4.82382	-4.639709	-7.18067
	Lag	20	23	0	0	13	20	4
	Break Date	2010M03	2009M03	1999M09	2011M04	2016M09	2016M10	1999M05
	p-value	0.00908	0.069246	0.954306	0.026244	0.011970	0.091449	0.55633
C	t-statistique	-14.41411	-6.05367	-13.92893	-18.84978	0.011970	-22.62498	-7.50307
	Lag	20	23	0	0	13	0	4
	Break Date	1995M01	2008M03	1999M01	2004M05	2015M08	1999M03	2003M06
	p-value	0.00824	0.000263	0.239853	0.007560	0.038174	0.030036	0.04447
Décision		S	S	S	S	S	S	S

Note: S = Stationary. ***, and * indicate rejection of the null hypothesis of a unit root at the 1%, 5%, and 10% significance levels, respectively. The critical values for model A are (-5.34), (-4.93), and (-4.58); for model B (-4.80), (-4.42), and (-4.11); and for model C (-5.75), (-5.08), and (-4.82).

In sum, according to the results of the first unit root test performed using the Zivot and Andrews (1992) method, it is observed that the variables LIPIR, LOPR, LIPIE_SA, LTCER_SA, LCPI_SA, LM2_SA and LTR are integrated of order 1 with a significant break detected.

1.3 Testing for Cointegration with Structural Break

The results of the Gregory and Hansen (1996) cointegration test are presented in the table below.

Table 03: Cointegration Test with Structural Break – Gregory and Hansen (1996)

Models	**M1: Level Shift**	**M2: Level Shift with Trend**	**M3 : Changement de régime**
ADF Procedure			
t-statistique	-6.560	-6.132	-6.528
Lag	28	15	16
Break Date	2009M02	2010M11	1998M10
ADF Procedure			
Za-stat	-66.466	-66.551	-85.312
Za-break	2008M08	2010M11	2011M11
Zt-stat	-6.409	-6.428	-6.549
Zt-break	2002M03	2002M05	2011M11

Note : The 5% critical values are -5.56 for the model with constant, -5.83 for the model with constant and trend, and -6.41 for the regime shift model.

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Observations at a 5% critical level demonstrate the existence of a long-term cointegration relationship with a significant structural break for each variable in the model.
These empirical results motivate us to investigate the sources of economic fluctuations, particularly those of inflation (which is the focus of our research) using a Vector Error Correction Model (VECM).

1.4 Ordering of Variable Introduction

In order to ensure a logical sequence in the introduction of variables in our analysis, we follow the criterion of decreasing exogeneity of variables (Peersman & Smets, 2001). To this end, we have chosen to use the Toda and Yamamoto (1995) approach to study the long-term relationship between non-stationary variables while preserving the long-run dynamics (Dokoui & Pognon, 2007).

Granger causality: Toda-Yamamoto (1995) test.

Table 4: Results of the Toda-Yamamoto Causality Test

k	Dmax	Dependent variables	Explanatory or causal variables						
			LOP_R	LEIPI_R	LIPI_R	LTCER_SA	LCPI_SA	LM2_SA	LTR
1	1	LOP_R	-	**6.4143 (0.0113)**	0.0497 (0.8235)	1.6791 (0.1950)	0.5057 (0.4770)	0.0424 (0.8368)	0.1449 (0.7035)
		LEIPI_R	0.5133 (0.4737)	-	0.6448 (0.4220)	0.3027 (0.5822)	6.3291 (0.0119)	0.0629 (0.8019)	0.0800 (0.7773)
		LIPI_R	0.3022 (0.5825)	0.1634 (0.6860)	-	1.1069 (0.2928)	0.1722 (0.6781)	3.3659 (0.0666)	1.9766 (0.1598)
		LTCER_SA	0.6737 (0.4118)	0.3963 (0.5290)	0.0129 (0.9095)	-	0.9993 (0.3175)	0.0011 (0.9730)	0.0263 (0.8711)
		LCPI_SA	0.0015 (0.9688)	0.0864 (0.7688)	2.6911 (0.1009)	0.9176 (0.3381)	-	1.9430 (0.1633)	0.2269 (0.6339)
		LM2_SA	0.4447 (0.5048)	1.6853 (0.1942)	0.2421 (0.6227)	2.0389 (0.1533)	0.0394 (0.8426)	-	0.3407 (0.5594)
		LTR	4.3287 (0.0375)	1.8285 (0.1763)	0.0006 (0.9800)	1.9501 (0.1626)	0.1599 (0.6892)	1.8328 (0.1758)	-
		EC(cointEq1)	-0.0218* (0.0004)	0.0051** (0.0003)	-0.0036** (0.0005)	-0.0141** (0.003)	-0.0238** (0.0006)	-0.0007 (0.3367)	0.0313** (0.0044)

Note: (.) indicates the probability (p-value); * significant at 1%, ** significant at 10%; k: optimal lag length of the level AR (SIC); dmax: maximum order of integration of the variables.

Source: author

- The error correction term coefficient for the real effective exchange rate is significant at the 5% level, with an estimated value of -0.0141, indicating a relatively low speed of adjustment toward equilibrium following a shock.
- Regarding the error correction term coefficient for the money supply M2, it is significant at the 1% level, with an estimated value of -0.0007, suggesting an extremely slow adjustment speed toward equilibrium after a shock.

Table 5: Summary of the Toda-Yamamoto Causality Test

Direction of Causality to →	LOP_R	LEIPI_R	LCPI_SA	LIPI_R	LM2_SA	LTR	LTCER_SA
LOP_R		■		■	■	■	
LEIPI_R	■						
LCPI_SA	■	■			■		■

LIPI_R		■	■				
LM2_SA	■						
LTR				■			
LTCER_SA							

Note: LOP_R → LEIPI_R → LCPI_SA → LIPI_R → LM2_SA → LTR → LTCER_SA. ■ indicates the presence of an effect of X on Y.

Source: Authors' calculations

- In the long run, we observe Granger causality relationships among several variables including oil prices, the European industrial production index, the consumer price index, the Algerian industrial production index, the money supply (M2), and the rediscount rate with the real effective exchange rate.
- However, additional restrictions were applied to the Toda-Yamamoto test results. For example, it was found that the Algerian industrial production index cannot influence global oil prices, nor can the money supply and rediscount rate. Moreover, the real effective exchange rate only affects itself. These restrictions led us to reorder variables as follows: "LTCER_SA, LOP_R, LEIPI_R, LIPI_R, LM2_SA, LTR, LCPI_SA".

1.5 VECM Modeling

a. The Structural Vector Error Correction Model (SVECM) or Constrained SVAR

- Let us consider a standard reduced-form VAR model as follows:
- $X_t = H_1 X_{T-1} + \ldots + H_k X_{t-k} + \mu + \omega D_t + e_t$ (1)
- where t = 1, ⋯, T ; k is the model order (number of lags); and yt is the vector of model variables. In our case, yt is of dimension (7, 1) and defined as follows:
- $\grave{X}_t = [\mathrm{LOP_R}, \mathrm{LEIPI_R}, \mathrm{LCPI_{SA}}, \mathrm{LIPI_R}, \mathrm{LM2_{SA}}, \mathrm{LTR}, \mathrm{TCER\_SA}\,]$.
- H is the coefficient matrix, e_t is the error term, $(0, \Sigma)$, D_t is a vector including non-stochastic variables (such as seasonal dummies and trend), and μ is a constant.
- According to the representation theorem of Engle and Granger (1987), in the presence of cointegration relationships, the reduced-form VAR can be reformulated as a Vector Error Correction Model (VECM):
- $\Delta X_t = \boldsymbol{\Gamma} + \Delta X_{t-1} + \cdots + \boldsymbol{\Gamma}_{k-1} + \Delta X_{t-k+1} + \Pi X_{t-1} + \mu + e_t$ (2)
- The matrices Γ and Π contain the relevant model equations. The first covers stationary short-term relationships, while the second deals with non-stationary long-term relationships. The representations of the VAR model and its VECM form by relations (4.24) and (4.25) correspond to the reduced form of the following structural VAR:
- $A(L)X_t = \mathrm{B}\varepsilon_t$ (3)
- where A is the polynomial matrix in the lag operator L , B is a diagonal matrix, and ε_t is the vector of orthogonal structural shocks with variance-covariance matrix Ω. Following a series of transformations, we arrive at the following relationship:
- $\varepsilon_t = C_0 e_t$ (4)
- avec $\varepsilon_0 = B^{-1} A_0$ et $\Omega = c_0^{-1} \sum \left(C_0^{-1} \right)$.
- Determining the structural form parameters from the estimated reduced-form VAR parameters can be accomplished by imposing a suitable number of identification restrictions, whether long-term or short-term, as highlighted by Goux and Cordahi (2007).
- Our decision to favor short-term restrictions over long-term ones is supported by several researchers due to their foundation on less restrictive theoretical assumptions, as mentioned by Eichenbaum and Evans (1995), as well as Clarida and Prendergast (1999).
- This is explained by the fact that long-term restrictions are already incorporated in the VECM through the cointegration relationships.
- Our methodology is based on two crucial steps. First, we define the cointegrating space, representing the matrix of long-term coefficients in the structural form of the constrained VAR, C(L). Next, we identify the matrix of short-termcoefficients A_0.

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b. Imposition of Short-Run Restrictions

In our study, we implement the short-run restriction method of Sim (1980) to identify the short-run matrix C_0 We use the Cholesky decomposition method for shock identification, following the variable ordering recommended by Peersman and Smets (2001), in agreement with the work of Goux (2006) for the Eurozone.

Within the scope of our work, to identify the matrix C_0. containing n^2 elements (where n equals seven, the number of endogenous variables), these must satisfy the orthogonality condition of structural shocks. Indeed, the matrix must comply with the linearity and orthogonality assumptions, which implies the following relation:

$$\Omega = C_0^{-1} \sum (C_0^{-1}) \qquad (5)$$

Furthermore, identification of the matrix following the method of Blanchard and Quah (1989) requires imposing 21 short-run restrictions, corresponding to the number $\frac{n(n-1)}{2}$ on the structural form.

Additionally, identification of the short-run variance-covariance matrix is based on the Cholesky method, followed by the identification technique developed by Bernanke and Mihov (1995). The variance-covariance matrix Ω contains independent restrictions; in our case, Ω provides 28 independent restrictions.

Returning to our reduced-form VAR model, the vector corresponding to the seven variables is ordered from the most exogenous to the least exogenous as follows:

- Logarithm of the real effective exchange rate (LCTER),
- Logarithm of real oil price (LOP),
- Logarithm of the European Industrial Production Index (LIPIE),
- Logarithm of the Industrial Production Index (LIPI),
- Logarithm of the money supply (LM2),
- Logarithm of the central bank rediscount rate (LR),
- Logarithm of the Consumer Price Index (LCPI).
- ε The vector of structural innovations responding to our system

$\acute{\varepsilon} = \left[\varepsilon_t^{LTCER}, \varepsilon_t^{LOP}, \varepsilon_t^{EIPI}, \varepsilon_t^{LIPI\_R}, \varepsilon_t^{LM2}, \varepsilon_t^{LTR}, \varepsilon_t^{ICPI}\right]$ is composed respectively of the exchange rate shock, external real supply shock, external real demand shock, domestic real supply shock, monetary supply shock, economic policy shock, and monetary demand shock. e_t the vector of reduced-form residuals is denoted by:

$e_t^{LTCER}, e_t^{LOP}, e_t^{LEIPR}, e_t^{LIPIR}, e_t^{LM2}, e_t^{LTR}, e_t^{LCPI}$ with $C_0 = B^{-1} A_0$.

Our system can be represented schematically as follows:

$$\begin{array}{ll} \varepsilon_t^{LTCER}, \varepsilon_t^{LOP}, \varepsilon_t^{LEIPR}, \varepsilon_t^{LIPR}, \varepsilon_t^{LM2}, \varepsilon_t^{LTR}, \varepsilon_t^{LCPI} & \\ C_0 = \begin{bmatrix} C_{1.1} & 0 & 0 & 0 & 0 & 0 & 0 \\ C_{2.1} & C_{2.2} & C_{2.3} & 0 & 0 & 0 & 0 \\ C_{3.1} & C_{3.2} & C_{3.3} & 0 & 0 & 0 & 0 \\ C_{4.1} & C_{4.2} & C_{4.3} & C_{4.4} & 0 & 0 & C_{4.7} \\ C_{5.1} & C_{5.2} & C_{5.3} & C_{5.4} & C_{5.5} & 0 & 0 \\ C_{6.1} & C_{6.2} & C_{6.3} & C_{6.4} & C_{6.5} & C_{6.6} & 0 \\ C_{7.1} & C_{7.2} & C_{7.3} & C_{7.4} & C_{7.5} & C_{7.6} & C_{7.7} \end{bmatrix} & \begin{array}{l} \Leftarrow \text{LTCER} \\ \Leftarrow \text{Prix de pétrol réel} \\ \Leftarrow \text{IPI Europe} \\ \Leftarrow \text{IPI Réel} \\ \Leftarrow \text{LM}_2 \\ \Leftarrow \text{LTR} \\ \Leftarrow \text{LCPI} \end{array} \end{array} \qquad (6)$$

Referring to the work of Sims and Zha (1998), Kim and Roubini (2000), Kim (2001), and in accordance with Goux (2006), no over-identification was possible at the level of matrix $ B $, which remains simply diagonal. Therefore, the identification scheme of shocks is based on the equation relating structural shocks to reduced-form disturbances, namely $B\varepsilon_t = A_0 e_t$:

$$\begin{bmatrix} b_{1.1} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{2.2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{3.3} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{4.4} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{5.5} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{6.6} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{7.7} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{LTCER} \\ \varepsilon_t^{LOP} \\ \varepsilon_t^{LEIPR} \\ \varepsilon_t^{LIPIR} \\ \varepsilon_t^{LM2} \\ \varepsilon_t^{LTR} \\ \varepsilon_t^{ICPI} \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{2.1} & 1 & a_{2.3} & 0 & 0 & 0 & 0 \\ a_{3.1} & a_{3.2} & 1 & 0 & 0 & 0 & 0 \\ a_{4.1} & a_{4.2} & a_{4.3} & 1 & 0 & 0 & a_{4.7} \\ a_{5.1} & a_{5.2} & a_{5.3} & a_{5.4} & 1 & 0 & 0 \\ a_{6.1} & a_{6.2} & a_{6.3} & a_{6.4} & a_{6.5} & 1 & 0 \\ a_{7.1} & a_{7.2} & a_{7.3} & a_{7.4} & a_{7.5} & a_{7.6} & 1 \end{bmatrix} \begin{bmatrix} e_t^{LTCER} \\ e_t^{LOP} \\ e_t^{LEIPR} \\ e_t^{LIPIR} \\ e_t^{LM2} \\ e_t^{LTR} \\ e_t^{LCPI} \end{bmatrix}$$

According to the theoretical research of Blanchard and Quah (1989) and Giannini (1992), our model meets the necessary criteria for precise system identification, since we have 28 parameters to estimate. This matrix structuring leads to the establishment of 7 theoretical equations that link the reduced-form disturbances to the structural shocks.

The Cholesky decomposition shows that some estimated parameter coefficients in the matrices A_0 and B are statistically insignificant. Following the example of Giannini et al. (1995) and Goux (2003), and in order to improve our identification, we impose additional short-run restrictions on the insignificant parameters.

Referring to the matrix form, the external shock is therefore identified as the sole shock capable of having a long-term effect on itself.

This restriction is justified by the fact that our study concentrates on small economies whose market power on the world market is quite limited $(a_{21} = 0)$. This hypothesis confirms the idea of Cushman and Zha (1997), who consider external variables as exogenous.

The real exchange rate reaction function on the industrial production index is null, which implies there is no effect of exchange rate shocks on domestic real output (Citu and Twanddle, 2003). This theoretical consideration thus imposes an additional restriction on the insignificant coefficient $(a_{73} = 0)$.

Indeed, referring to economic theories, among the most imposed restrictions is the hypothesis related to the IS-LM model of Gali (1992) and Clarida and Gali (1994), according to which monetary supply shocks have no effect on output and on exchange rate shocks over the long term. Following this hypothesis, we expos zero effects of the money supply (M2) on the real effective exchange rate in the short run.

Traditional Keynesian thought stipulates that the money supply only enters the contemporaneous money supply and monetary policy equations. This specification implies the null short-term impact of monetary supply shocks on real output and on the real effective exchange rate; hence, we impose an additional restriction on the insignificant coefficient $(\mathbf{a_{54}, a_{57} = 0})$.

However, according to the analyses of Kim and Roubini (2000), monetary policy is based on the short-term evaluation of the money supply and the nominal exchange rate. This approach suggests that monetary authorities adjust the short-term interest rate based on these two parameters (money supply and nominal exchange rate).

Additional works, such as those by Sims and Zha (1998), support the idea that the effects of shocks on real output or prices are not immediately perceived by monetary policy.

Peersman and Smets (2001) support this hypothesis by highlighting the lack of real-time data on prices and real output when decisions are made in monetary policy.

Furthermore, monetary policy in Algeria dampens immediate short-term interest rate reactions to structural monetary supply and demand shocks in order to maintain financial stability. It is also noted that monetary policy in Algeria does not directly influence European output nor oil prices.

In our study, this is reflected by imposing zero short-term constraints on the corresponding coefficients .$(\mathbf{a_{65}, a_{63}, a_{62}, a_{61} = 0})$.

Short-term internal monetary variables do not influence foreign variables, which means that short-term internal monetary shocks have no impact on external supply and demand shocks.

Thus, the identification scheme becomes:

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$$\begin{bmatrix} b_{1.1} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{2.2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{3.3} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{4.4} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{5.5} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{6.6} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{7.7} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{LTCER} \\ \varepsilon_t^{LOP} \\ \varepsilon_t^{LEIPI} \\ \varepsilon_t^{LIPI\_R} \\ \varepsilon_t^{LM2} \\ \varepsilon_t^{LTR} \\ \varepsilon_t^{ICPI} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & a_{2.3} & 0 & 0 & 0 & 0 \\ a_{3.1} & a_{3.2} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{4.3} & 1 & 0 & 0 & a_{4.7} \\ 0 & a_{5.2} & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & a_{6.4} & 0 & 1 & 0 \\ a_{7.1} & a_{7.2} & a_{7.3} & 0 & a_{7.5} & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^{LTCER} \\ e_t^{LOP} \\ e_t^{LEIPI} \\ e_t^{LIPI\_R} \\ e_t^{LM2} \\ e_t^{LTR} \\ e_t^{ICPI} \end{bmatrix}$$

Moreover, the system is composed of the following 7 equations:

$$\mathbf{b_{1.1}\varepsilon_t^{LTCER} = e_t^{LTCER}}$$
$$\mathbf{b_{2.2}\varepsilon_t^{LOP} = e_t^{LOP} + a_{2.3}e_t^{LEIPI}}$$
$$\mathbf{b_{3.3}\varepsilon_t^{LEIPI} = a_{3.1}e_t^{LTCER} + a_{3.2}e_t^{LOP} + e_t^{LEIPI}}$$
$$\mathbf{b_{4.4}\varepsilon_t^{LIPI\_R} = a_{4.3}e_t^{LEIPI} + e_t^{LIPI\_R} + a_{4.7}e_t^{ICPI}}$$
$$\mathbf{b_{5.5}\varepsilon_t^{LM2} = a_{5.2}e_t^{LOP} + e_t^{LM2}}$$
$$\mathbf{b_{6.6}\varepsilon_t^{LTR} = a_{6.4}e_t^{LIPI\_R} + e_t^{LTR}}$$
$$\mathbf{b_{7.7}\varepsilon_t^{ICPI} = a_{7.1}e_t^{LTCER} + a_{7.2}e_t^{LOP} + a_{7.3}e_t^{LEIPI} + a_{7.5}e_t^{LM2} + e_t^{ICPI}}$$

According to the theory of Citu and Twanddle (2003), the impact of real supply shocks on the real exchange rate is null, which means exchange rate shocks do not affect domestic production despite the policy of depreciation of the real effective exchange rate by the Algerian central bank in response to oil price depreciations.

Equations two and three involve exogenous external real supply and demand shocks, in agreement with the works of Blanchard and Quah (1989), Cushman and Zha (1997), and Goux (2003), which emphasize the exogeneity of external real supply shocks.

The fourth equation represents a production function influenced by external shocks such as the oil price (the main source of foreign currency in Algeria), European production (Algeria's main trading partner), and the Consumer Price Index, consistent with Friedman's adaptive expectations theory.

Real output and inflation have no immediate effect on short-term monetary policy, according to Goux (2003).

It is important to note that the reaction of the real exchange rate to the industrial production index is null, indicating the absence of effects of exchange rate shocks on domestic production (Cîtu, 2003).

In the fifth equation, monetary policy is influenced by the money supply and oil prices, taking into account the specificity of the Algerian economy, which is dependent on external shocks.

The sixth equation reveals that monetary policy is determined by real output, probably in response to economic stimulus programs aimed at promoting investment by reducing the rediscount rate, which increases monetary creation capacity and the financing of SMEs/SMIs.

Inflation, measured by the Consumer Price Index, is the most endogenous variable in our model, depending on various factors:

- The real effective exchange rate, as discussed by Goldfajn and Werlang (2000), reflects a form of imported inflation in Algeria (Antoine Philippe and Labbé D., 1976).
- Oil prices, being the principal source of foreign currency for the country, allow the Algerian central bank to inject money supply into the economy.
- The European industrial price index, as Algeria's main trading partner, supports the idea of imported inflation in the country (Antoine Philippe and Labbé D., 1976), as well as the quantitative theory of money in relation to the money supply.

The estimated results of the matrices are presented in Table 6 below. In accordance with theoretical expectations, some signs of the contemporaneous coefficients raise debate. For example, the coefficient indicates that the real effective exchange rate shock has a negative and significant effect on inflation.

This observation agrees with the fact that a depreciation of the real exchange rate tends to increase inflation, which in turn stimulates short-term domestic production according to the Phillips curve.

On the other hand, a depreciation of the real exchange rate also favors the increase in demand from the country's trade partners, as suggested by the coefficient.

Conversely, the impact of the real supply shock on monetary policy coefficient is statistically insignificant, as confirmed by the theory of Citu and Twanddle (2003).

Table 6. Contemporaneous coefficients of the structural model (estimated).

Coefficient	Valeur	Std. Error	z-statistique	p-value
$\mathbf{a_{31}}$	0.041049	0.011193	3.667319	0.0002

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a_{71}	**-0.062188**	**0.019237**	**-3.232760**	**0.0012**
a_{32}	0.032449	0.038940	0.833296	0.4047
a_{52}	-0.020430	0.029911	-0.683019	0.4946
a_{72}	-0.007630	0.014199	-0.537361	0.5910
a_{23}	-2.985398	2.000253	-1.492510	0.1356
a_{43}	-0.009170	0.070867	-0.129391	0.8970
a_{73}	**1.628791**	**0.114848**	**14.18209**	**0.0000**
a_{64}	-0.005397	0.500795	-0.010777	0.9914
a_{75}	**0.255573**	**0.029918**	**8.542506**	**0.0000**
a_{47}	**0.191858**	**0.023915**	**8.022426**	**0.0000**
b_{11}	**0.015798**	**0.000640**	**24.69818**	**0.0000**
b_{22}	**0.020653**	**0.001481**	**13.94710**	**0.0000**
b_{33}	**0.002845**	**0.000323**	**8.814040**	**0.0000**
b_{44}	**0.002417**	**9.78E-05**	**24.69818**	**0.0000**
b_{55}	**0.010675**	**0.000432**	**24.69818**	**0.0000**
b_{66}	**0.025202**	**0.001020**	**24.69817**	**0.0000**
b_{77}	**0.004980**	**0.000202**	**24.69818**	**0.0000**

Source: authors' calculations.

Of the seven identified shocks, only five demonstrated a statistically significant importance for the model's variables. Moreover, the analysis reveals that the external shock, represented by the European industrial production index, has a positive and significant impact for Algeria. This positive impact reflects the substantial influence of the external shock on Algeria as an importing country.

3. Impulse Response Functions and Variance Decomposition

Variance decomposition allows us to explain inflation through the consumer price index, while impulse response functions highlight the nature of the effects of different shocks on the variables.

Sources of Fluctuations in the Consumer Price Index

The composition of the estimated VAR system provides insight into the variability of other fundamental macroeconomic variables, particularly the consumer price index. Table 7 presents the results of the forecast error variance decomposition of the consumer price index. We note the importance of monetary shocks, which explain 70.34% of inflation fluctuations in Algeria. This dominance of monetary shocks is characterized by a stable contribution of the short-term money demand shock from the short to long term, while the growing effect of the monetary policy shock explains 20.39% of the variance of the consumer price index. We also observe the relatively significant effect (16.71%) of the money supply shock in explaining the variance of the consumer price index. Indeed, these monetary shocks primarily reflect changes in the money supply and highlight the close correlation between price levels and monetary aggregates. Meanwhile, the variance decomposition of the consumer price index shows the weak contribution of real supply shocks in explaining inflation fluctuations, contributing only 3.045% of price variation. The estimates show that a money supply shock, reflecting an increase in the money stock, results in an increase in the price level in the long term (see Figure 1).

Table 7. Variance decomposition of the consumer price index (LCPI).

Period	**Exchange shock (LTCER)**	**Ext. supply shock (LOP_R)**	**Ext. demand shock (LEIP_R)**	**Real supply shock (LIPIR)**	**Money supply shock (LM2)**	**Monetary policy shock (LTR)**	**Money demand shock (LCPI)**
1	6.877236	1.975890	32.29525	0.000000	13.58533	0.000000	45.26630
5	2.520082	1.137288	36.07831	0.049448	6.431202	2.286105	51.49756
10	1.790485	0.570850	35.67002	0.048829	3.843586	7.798400	50.27783
15	2.136502	0.333702	33.02154	0.336445	6.008800	12.58488	45.57813
20	2.256303	0.229030	30.26844	0.950454	9.319976	15.83023	41.14556
25	2.166025	0.208428	27.95709	1.683611	12.28999	17.92715	37.76771
30	2.008964	0.264297	26.10565	2.372655	14.62503	19.30452	35.31890
35	1.857958	0.384471	24.62703	2.946173	16.40991	20.23710	33.53735
36	1.831010	0.414551	24.36819	3.045401	16.71441	20.38552	33.24092

Source: authors' calculations.

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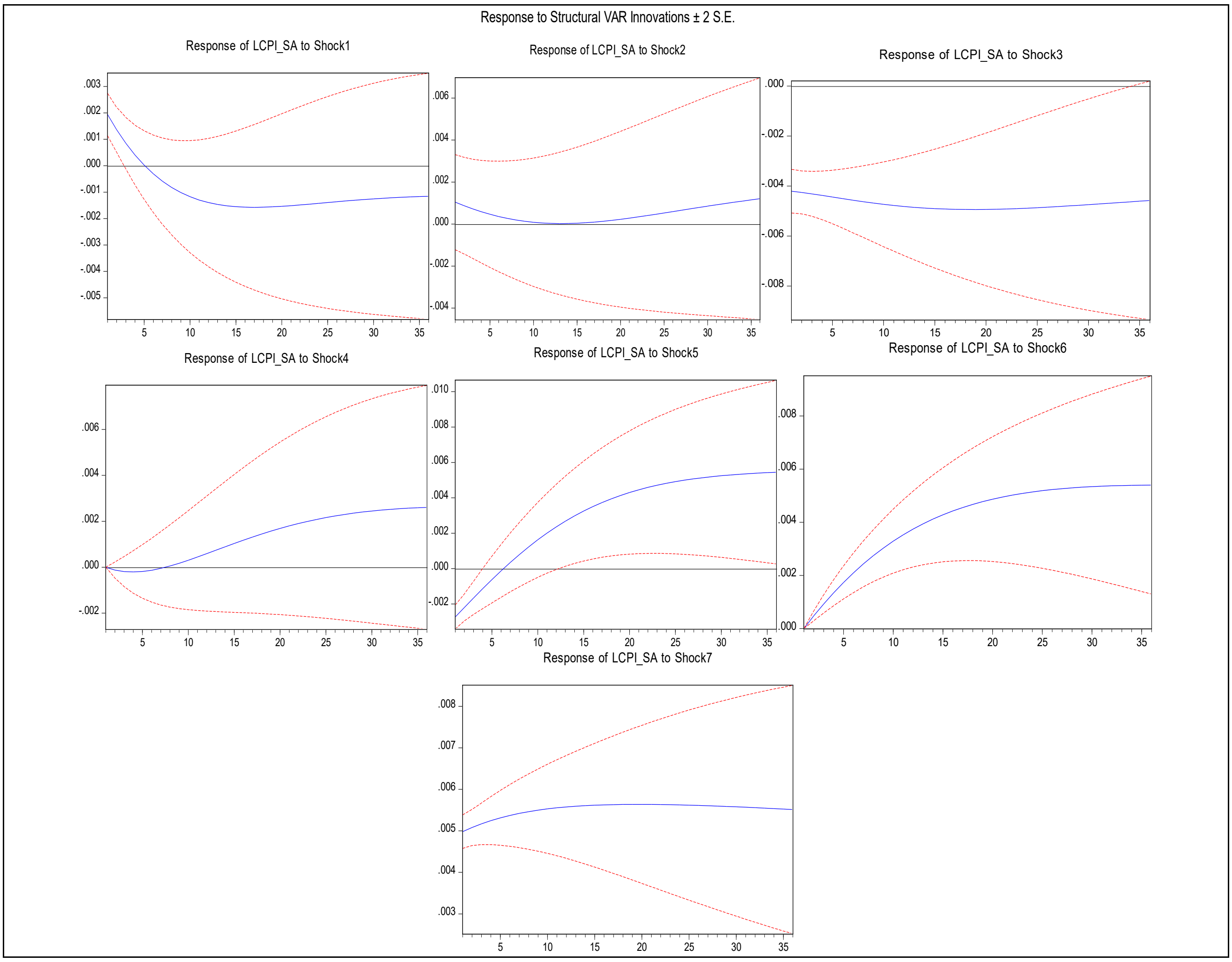
We find here a result consistent with economic theory: an increase in money supply results in inflationary pressures, especially if it is not accompanied by an improvement in the level of economic activity. A depreciation of the real exchange rate leads to a rise in prices. In effect, in the long term the response of the real exchange rate to prices is not significant.

Figure 1. Impulse responses of the different shocks on CPI.



Source: authors' calculations.

The variance decomposition of the consumer price index highlights a significantly high contribution (24.37%) of the external demand shock, whereas the impact of the external supply shock is minimal (0.41%). These findings are supported by the observed impulse responses. Indeed, the analysis of CPI impulse responses shows a relatively weak effect of the exchange rate shock on prices. In the long term, the effect of the external demand shock on prices turns out to be not significant. In summary, our findings, based on variance decomposition and impulse responses, indicate a predominance of external demand, money demand, money supply, and monetary policy shocks in explaining price fluctuations, contributing to more than 94% of price changes.

Conclusion

Our research undertook an in-depth examination of the main sources of inflation fluctuations in Algeria, using an advanced econometric methodology based on a structural VECM model. This approach allowed us to simultaneously integrate the impact of internal and external shocks in explaining short-term inflation variations. Given the specific characteristics of the Algerian economy, marked by different reforms and successive crises, we favored the use of adapted unit root tests in order to detect structural breaks that could affect the series under study. In this respect, the Zivot and Andrews (1992) test proved particularly pertinent in ensuring the robustness of the results obtained. The results show that most series become stationary after differencing, despite the

presence of significant breaks, and that cointegration relationships persist, as confirmed by the Gregory and Hansen (1998) test.
The application of the Blanchard and Quah decomposition method made it possible to identify seven major types of shocks, covering all relevant economic dimensions: real supply, money demand, monetary policy, money supply, exchange rate, as well as external real supply and demand. This classification provided a deep insight into the mechanisms underpinning price dynamics in Algeria. Our results underscore the dominant weight of external demand shocks, money demand and supply shocks, as well as monetary policy shocks, which together account for over 94% of changes in the general price level. The external demand shock, in particular, stands out for its central role, whereas the impact of external supply shocks remains marginal.
From a theoretical and methodological standpoint, our work is distinguished by the combined use of robust econometric techniques—integrating structural breaks and long-term relationships—and by the originality of our macroeconomic shock classification. These contributions enrich the existing literature by providing a solid empirical basis for understanding inflationary mechanisms in an emerging hydrocarbon-dependent economy.
Our conclusions call for rigorous monetary management: it is essential to control money supply growth and strengthen the credibility of stabilization policies. Furthermore, particular attention should be paid to exchange rate management, even if its inflationary effect remains transient. On the fiscal front, the adoption of counter-cyclical policies and the buildup of stabilization reserves are recommended to limit the transmission of external shocks. Finally, the coordination between monetary and fiscal policies, as well as the diversification of the economy, emerge as indispensable levers for strengthening the country's resilience to inflationary shocks.
It should be noted that this study has certain limitations, notably the lack of explicit integration of fiscal policy and certain internal structural factors, as well as the assumption of model linearity. Exploring non-linear models, incorporating data beyond 2020, and conducting an international comparison could represent relevant extensions for future research, allowing for a more refined understanding of price dynamics and informing economic decision-making (Blanchard & Quah, 1989; Zivot & Andrews, 1992; Gregory & Hansen, 1998).

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