

The Dynamic Impact of Oil Price Shocks on Sectoral Inflation in Morocco: A Bayesian Factor-Augmented VAR.

Auteur 1 : Marouane DAOUI.

Auteur 2 : Mehdi ZAIM.

Marouane DAOUI 1, (ORCID : 0000-0002-2821-3601, PhD, Full Professor)

1 Higher School of Technology Sidi Bennour, Laboratory of Sustainable Agricultural Management,
Chouaib Doukkali University, Morocco.

Mehdi ZAIM 2, (PhD, Full Professor)

1 Higher School of Technology Sidi Bennour, Laboratory of Sustainable Agricultural Management,
Chouaib Doukkali University, Morocco.

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Conflit d'intérêts : Les auteurs ne signalent aucun conflit d'intérêts.

Pour citer cet article : DAOUI .M & ZAIM .M (2026) « The Dynamic Impact of Oil Price Shocks on Sectoral Inflation in Morocco: A Bayesian Factor-Augmented VAR », African Scientific Journal « Volume 03, Num 38 » pp: 001 – 039.



DOI : 10.5281/zenodo.23726902.

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Abstract

The present study employs a Bayesian Factor-Augmented Vector Autoregression (B-FAVAR) model with monthly data from January 2007 to December 2025 to examine the dynamic transmission of global oil price shocks to sectoral inflation in Morocco. The framework extracts latent factors from 36 macroeconomic and financial variables, enabling a comprehensive analysis of oil price transmission across thirteen disaggregated CPI components. Using recursive Cholesky identification with oil prices ordered first, we find substantial heterogeneity across sectors. The transport sector exhibits the strongest and most immediate response, while housing responds with a short lag consistent with regulated pricing. Food inflation shows a gradual but persistent response through indirect channels, whereas communication, education, and recreation exhibit negligible effects. Oil price shocks explain approximately 25 percent of transport inflation variability at the 12-month horizon. The money market rate responds positively, consistent with monetary policy tightening, while effective exchange rates show insignificant responses, reflecting Morocco's managed exchange rate regime. These findings underscore the mitigating role of the compensation fund and the exchange rate regime, though ongoing subsidy reforms may alter this transmission mechanism. Policy recommendations include careful calibration of exchange rate flexibility, implementation of targeted transfers to protect vulnerable households, and adoption of a forward-looking monetary policy approach given the delayed transmission to credit aggregates. This study demonstrates the value of the B-FAVAR methodology for analysing oil price shocks and provides evidence-based insights for enhancing macroeconomic resilience.

Keywords: Bayesian FAVAR, oil price shocks, sectoral inflation, monetary policy, Morocco, factor models

Introduction

This paper examines the transmission of global oil price shocks to domestic inflation in Morocco. The relationship between global oil price fluctuations and domestic inflation has long occupied a central place in macroeconomic research, particularly for small open economies heavily dependent on energy imports. For Morocco, a net oil-importing country with a managed exchange rate regime and a substantial share of energy in its consumption basket, understanding the transmission of oil price shocks to consumer prices is of considerable policy importance. The international oil price dynamics have experienced remarkable volatility over the past two decades, from the dramatic surge of 2007-2008 through the collapse during the global financial crisis, the subsequent recovery, the sharp fluctuations during the COVID-19 pandemic, and the geopolitical tensions following 2022. These events have renewed interest in the mechanisms through which external energy price shocks propagate to domestic inflation.

Early research on oil price shocks (Hamilton 1983, 1996, 2003) primarily focused on the implicit assumption that oil price changes originate from exogenous supply-side disturbances. However, a growing body of literature, notably the contributions of Kilian (2008, 2009) and Peersman and Van Robays (2012), has established that oil prices are also driven by demand-side factors in the global oil market. Distinguishing between oil supply shocks, oil demand shocks driven by global economic activity, and oil-specific precautionary demand shocks is critical because the macroeconomic consequences of a given oil price movement depend crucially on its underlying source. This insight has important implications for monetary policy formulation, as different types of shocks call for potentially different policy responses.

Despite the extensive literature on oil-inflation transmission in advanced economies, empirical evidence for Morocco remains relatively limited. Most existing studies for the Moroccan context have employed standard VAR or DSGE methodologies on relatively small datasets, typically focusing on headline inflation or a limited set of aggregate variables. These approaches face two fundamental challenges. First, standard VAR models are inherently low-dimensional due to degrees-of-freedom constraints, raising the question of whether they incorporate all relevant information about the economy. As argued by Bernanke et al.(2005), informationally deficient VARs can lead to severe bias in the transmission of shocks. Second, focusing solely on headline inflation may mask important heterogeneity across consumption categories. The transport component responds directly to fuel costs, housing costs reflect electricity and gas tariffs, food prices are indirectly affected through production and distribution

costs, and other categories such as education or communication may be largely insulated from direct oil price effects.

To address these limitations, this paper employs a Factor-Augmented Vector Autoregression (FAVAR) framework, following the methodology developed by Bernanke et al.(2005) and subsequently refined by De et al. (2020, 2022). The FAVAR approach offers several distinctive advantages for this study. First, it allows us to summarize the information contained in a large dataset of 36 monthly macroeconomic and financial variables into a small number of latent factors representing underlying economic concepts such as Moroccan economic activity, price pressures, monetary conditions, external competitiveness, and global commodity price pressures. Second, it enables us to jointly model the interaction between global oil prices, the Moroccan macroeconomy, and monetary policy within a single coherent framework. Third, the methodology allows us to examine the dynamic responses of each of the thirteen disaggregated CPI components, thereby capturing the heterogeneous transmission of oil price shocks across different consumption categories. Accordingly, the objective of this paper is twofold: (i) to quantify the dynamic effects of global oil price shocks on Moroccan headline and sectoral inflation within a data-rich FAVAR framework, and (ii) to assess the heterogeneity of these effects across the thirteen Classification of Individual Consumption by Purpose (COICOP) consumption categories, so as to identify which sectors are most exposed to external energy price shocks.

Our dataset comprises monthly observations from January 2007 to December 2025, drawn exclusively from the International Monetary Fund's International Financial Statistics (IFS) database. The dataset is organized into six thematic blocks: oil prices (Brent crude in US dollars per barrel), consumer prices (all thirteen COICOP components), exchange rates (NEER, REER, and bilateral rates against the USD, EUR, and SDR), monetary policy rates (deposit rate, discount rate, and money market rate), monetary and financial statistics (credit to the private sector, monetary base, foreign reserves, claims on nonresidents, net claims on the central government, deposits and securities, and monetary base growth), and commodity terms of trade indices (six alternative measures capturing different weighting schemes). This rich information set allows us to extract latent factors that capture the common variation across these series and to identify the dynamic responses of sectoral inflation to oil price shocks.

Our identification strategy follows the standard approach in the FAVAR literature for oil-importing countries. The oil price (BRENT_USD) is ordered first in the Cholesky decomposition, reflecting the assumption that global oil prices are contemporaneously

exogenous to Moroccan domestic economic conditions. This identifying restriction is widely used in studies of oil price shocks in small open economies and is plausible given that Morocco's share of global oil consumption is negligible. The money market rate (MM_RATE) is included as an observable variable to capture the endogenous monetary policy response to oil-driven inflationary pressures. The remaining variables are treated as slow-moving and are used to extract latent factors that summarize the common information in the Moroccan economy.

This paper makes several contributions to the existing literature. First, to our knowledge, this is the first application of the FAVAR methodology to study oil price shocks and sectoral inflation in Morocco. The use of a data-rich framework allows us to overcome the limitations of standard VAR models and to incorporate a much broader information set than previous studies. Second, by disaggregating the CPI into thirteen components, we provide novel evidence on the heterogeneous transmission of oil price shocks across different consumption categories. This disaggregated analysis is essential for understanding which sectors are most vulnerable to external energy price shocks and for designing targeted policy responses. Third, our dataset extends through December 2025, incorporating the recent period of unprecedented oil price volatility driven by geopolitical tensions and the post-pandemic recovery. This extended sample period allows us to examine whether the transmission mechanism has changed over time, particularly as Morocco has progressed with subsidy reforms and preparations for a more flexible exchange rate regime.

The remainder of this paper is organized as follows. Section 2 provides a comprehensive review of the literature on oil price shocks and inflation transmission, with particular emphasis on empirical evidence for Morocco and the MENA region. Section 3 describes the data, including sources, variable definitions, transformation codes, and descriptive statistics. Section 4 presents the econometric methodology, detailing the FAVAR framework, factor extraction procedure, lag length selection, Bayesian estimation approach, and identification strategy. Section 5 reports and discusses the empirical results, including impulse response functions, forecast error variance decomposition, and historical decomposition. Section 6 concludes with a summary of findings and policy implications.

2. Literature Review

The relationship between oil price fluctuations and domestic inflation has occupied a central position in macroeconomic research for decades, generating a substantial theoretical and empirical literature. Macroeconomic theory postulates a complex relationship among energy prices, exchange rates, and domestic inflation Bigerna(2024). On the one hand, the pass-through effect from foreign exchange depreciation to consumer prices, operating via the Fisher effect, can result in higher inflation (Choudhri and Hakura, 2006). On the other hand, changes in imported goods prices feed into the domestic economy as higher productive input costs, which can generate both higher domestic inflation and a loss of competitiveness in exported goods, thereby feeding back into exchange rate adjustments (Goldberg and Knetter, 1997). For net oil-importing countries such as Morocco, the exchange rate channel provides an additional transmission mechanism, as currency depreciation increases the domestic currency cost of dollar-denominated oil imports, amplifying the initial price shock.

The empirical literature has undergone substantial methodological evolution. Early contributions, notably Hamilton's influential studies (Hamilton 1983, 1996, 2003), concentrated on establishing correlations between oil price increases and subsequent recessions in the United States, implicitly treating oil price shocks as exogenous supply-side disturbances in global oil markets. Hooker(2002) provided critical evidence on the time-varying nature of the oil price-inflation relationship, documenting a statistically significant decline in the pass-through coefficient following the early 1980s. This finding suggested that transmission mechanisms are not stable over time but rather respond to changes in monetary policy regimes, economic structure, and the underlying sources of oil price fluctuations.

A fundamental methodological breakthrough emerged from Kilian(2009), which demonstrated persuasively that the macroeconomic consequences of oil price increases depend critically on their origin—whether from oil supply disruptions, global demand shifts associated with the business cycle, or oil-specific precautionary demand. Using a structural VAR model of the global oil market, Kilian showed that aggregate demand shocks—driven by global economic activity—produce fundamentally different effects on the U.S. economy compared to oil supply shocks. This insight carries profound implications for policy analysis, as different shock types may warrant distinct monetary and fiscal policy responses. Subsequent research has validated Kilian's decomposition for recent episodes of oil price volatility, consistently finding that demand-side factors constitute the primary drivers of oil price movements, while supply shocks exert comparatively limited influence.

Peersman and Van Robays(2012) extended this analytical framework by examining cross-country heterogeneity in responses to oil shocks, emphasising structural characteristics including exchange rate flexibility, energy shares in consumption baskets, and monetary policy credibility. Their findings reveal substantial variation in pass-through magnitudes and speeds across countries, with more flexible exchange rate regimes experiencing smaller domestic inflation transmission. For Morocco's managed exchange rate regime—where the Dirham is pegged to a basket comprising the euro and US dollar—this literature suggests the exchange rate channel may provide less absorption capacity compared to freely floating regimes, though the central bank retains some policy space to influence transmission through exchange rate management.

Recent contributions have addressed the impact of oil prices and exchange rates on inflation for specific countries (Zhang et al., 2022; Ding et al. 2023). A comprehensive analysis for 36 countries is proposed by Considine et al.(2022), who employ a global VAR framework incorporating oil inventories and investigate the differential effects of negative and positive oil shocks conditioned on inventory tightness. Their notable conclusion is that negative oil price shocks produce no permanent effect, regardless of inventory conditions. The impact of geopolitical risk on natural resources, including oil, is examined by Li et al.(2023), who find asymmetric responses whereby downside risk spillovers are more pronounced than upside spillovers. The transmission mechanism between oil prices and inflation is further analysed by Oloko et al.(2021), who examine both oil-exporting and oil-importing countries and conclude that oil price shocks do not fuel inflation persistence. Nasir and Leung(2021) depict the relation between energy price shocks and other macroeconomic variables, while Garzón and Hierro(2021) show that high inflation regimes are more strongly influenced by positive energy price shocks. Extending this analysis, Garzón and Hierro(2022) employ an augmented Phillips curve framework and demonstrate that exchange rate movements dampen the effects of oil fluctuations on domestic inflation for major OECD countries—a result with important policy implications, as currency appreciation reduces the oil bill in domestic currency terms for importing countries.

Kucukefe(2020) estimates a VAR model of inflation, exchange rates, and oil prices for Turkey but does not examine spillover effects among these variables. Philips et al. (2022) provide an analysis of oil-importing and oil-exporting countries, showing that the stock return-oil price nexus is affected by exchange rates in oil-exporting countries; however, their discussion does not distinguish between countries that peg their exchange rate to the US dollar (such as Saudi

Arabia) and those that do not (such as Russia). Belloumi et al.(2023) focus on the impact of oil prices on output and inflation for Saudi Arabia, incorporating the real effective exchange rate. The application of factor-augmented VAR (FAVAR) methodologies to oil price shocks represents a relatively recent development in the broader literature. Bernanke et al.(2005) originally developed the FAVAR framework to address the information deficiency problem inherent in standard VAR models when studying monetary policy transmission. Their key insight recognised that central banks and economic agents base decisions on substantially larger information sets than can be incorporated into conventional VARs. By extracting latent factors from large datasets, the FAVAR approach preserves the statistical advantages of VARs while incorporating considerably richer information. This methodology has subsequently been applied to various macroeconomic questions, including oil price shock transmission.

De et al. (2020, 2022) provide the most comprehensive application of FAVAR methodology to oil price shocks in the U.S. economy. Using 185 monthly macroeconomic indicators spanning 1978 to 2017, they examine the effects of three distinct oil price shock types on U.S. economic activity, prices, financial markets, exchange rates, and monetary policy. Their results indicate that oil-specific precautionary demand shocks primarily drive fluctuations in crude oil prices and the U.S. price level. Oil supply shocks generate permanent increases in the U.S. price level, contrasting with earlier findings suggesting such shocks have minimal price effects. They also find evidence that the Federal Reserve tightens monetary policy in response to oil demand shocks driven by global economic activity but does not respond to oil supply shocks, supporting the argument that policymakers react to underlying supply and demand conditions rather than simply to the oil price itself.

The empirical literature specifically focused on Morocco has expanded considerably in recent years. Brini and Jemmali(2016) conducted structural VAR analysis for six MENA countries including Morocco over 2000-2015, with impulse response functions revealing that oil price fluctuations substantially impact real exchange rates in oil-importing countries, while inflation effects are comparatively smaller and partially absorbed by rigidities in subsidised product pricing. El-Karimi(2024) provided a more recent assessment using frequency domain causality analysis on quarterly data from 1999 to 2019. The findings revealed that food price shocks generate significant inflationary effects in both short and long runs, while oil price effects are more pronounced over longer horizons. Importantly, the analysis uncovered asymmetric responses: positive food price shocks produce stronger inflationary effects than negative shocks, while the inverse pattern holds for oil price shocks. This asymmetry likely relates to the

compensation fund's historical responsiveness—more sensitive to price increases than decreases. Ongoing subsidy system reforms, transitioning from universal subsidies toward targeted transfers, may alter this transmission mechanism over time.

Moustabchir et al. (2024) employed a dynamic stochastic general equilibrium (DSGE) model to examine oil shock impacts exacerbated by the Russian-Ukrainian war. Their simulations showed these shocks contracting output gap, consumption, investment, and savings, accompanied by increased inflation. The results highlighted Moroccan economy vulnerability to external energy price shocks and underscored energy source diversification needs. Saidi (2022, 2023) investigated indirect effects of oil price shocks on Moroccan economic growth through inflation and producer price index channels. The analysis demonstrated that non-linear crude oil price specifications directly impact production rates, and oil price increases transmit indirectly to economic growth via inflation, confirming the inflation channel's importance as a transmission mechanism.

In a comprehensive cross-country analysis, Bigerna (2024) examined the connectedness among oil prices, exchange rates, and inflation for eleven major MENA economies, including Morocco, using a VAR-X model with monthly data from 2010 to 2022. A key methodological innovation of this study lies in the construction of country-specific oil prices based on the main trading partners for each nation, rather than relying on generic international benchmarks such as Brent or WTI. The results demonstrate that the effects of oil price changes on exchange rates and inflation depend significantly on the direction and timing of the shock, with asymmetric contagion effects observed for certain countries. The spillover analysis further reveals that total volatility connectedness increased in the post-COVID period for most countries, suggesting an intensification of macroeconomic linkages. For Morocco specifically, Bigerna (2024) finds that the real effective exchange rate acts as a net receiver of volatility, consistent with the country's managed exchange rate regime, while the consumer price index exhibits a comparatively low degree of connectedness to oil price shocks.

Despite these valuable contributions, several important gaps remain in the literature. First, few studies have systematically examined sectoral inflation responses. Most existing work focuses on either headline inflation or limited aggregates. The availability of detailed monthly CPI component data enables richer analysis of transmission heterogeneity. Understanding which components respond most strongly to oil shocks—and whether responses are transitory or persistent—can inform central bank decisions about whether to "look through" oil-driven inflation or respond with policy adjustments.

Second, the methodological toolkit applied to Moroccan data has remained relatively limited. While El-Karimi (2024) employed frequency domain techniques and Moustabchir et al. (2024) used DSGE simulation, the FAVAR methodology—particularly well-suited to Morocco’s rich monthly indicator environment—has not yet been applied to study oil-inflation transmission. The FAVAR approach offers two key advantages: it permits inclusion of numerous variables without overparameterisation, and it enables extraction of latent factors capturing common information across series. These advantages are particularly relevant for Morocco, where Bank Al-Maghrib monitors hundreds of economic indicators when formulating monetary policy decisions.

Third, the literature has largely overlooked monetary and financial statistics capturing liquidity conditions, credit dynamics, and reserve accumulation. These variables may prove important for understanding full transmission mechanisms, as oil shocks affect not only prices but also the balance sheets of central banks, commercial banks, and governments. Daoui (2023) demonstrated the value of incorporating such variables, suggesting similar benefits may accrue for oil shock analysis. Fourth, the recent period of elevated oil prices (2021-2023) followed by subsequent decline provides new data for examining whether pass-through relationships have changed over time, particularly as subsidy reforms have progressed. Most existing studies use data ending before or during the COVID-19 pandemic, leaving the post-pandemic period—characterised by unprecedented energy price volatility and accelerated subsidy reforms—largely unexplored. As Bigerna (2024) documents, the COVID-19 shock induced significant structural changes in the transmission mechanism for most MENA countries, with the Chow test revealing parameter instability across two or three equations for nine out of eleven countries examined. This finding underscores the necessity of extending the analysis period to capture recent developments. Our dataset extends through December 2025, allowing incorporation of these dynamics.

This paper aims to address these gaps by applying FAVAR methodology to a comprehensive monthly Moroccan dataset spanning January 2007 to December 2025. Building on methodological foundations established by Bernanke et al. (2005) and De et al. (2020, 2022), and incorporating the country-specific oil price insights from Bigerna (2024), we extend the FAVAR framework to analyse oil price shock transmission to sectoral inflation in Morocco. The rich dataset enables extraction of latent factors representing underlying economic conditions while preserving information contained in each individual series, thereby providing

novel evidence on heterogeneous effects of oil price shocks across different consumption categories.

3. Data

The empirical analysis in this study uses monthly data spanning January 2007 to December 2025, yielding 228 observations for each series. The sample period is chosen to cover the post-global financial crisis era, the commodity price boom of 2007-2008 and its subsequent collapse, as well as the recent oil price shocks associated with the COVID-19 pandemic and the geopolitical tensions that emerged after 2022. All data are sourced exclusively from the International Monetary Fund (IMF) through its International Financial Statistics (IFS) database. The dataset comprises 36 variables organised into six thematic blocks: oil prices, consumer prices, exchange rates, monetary policy rates, monetary and financial statistics, and commodity terms of trade. Table 1 in Appendix provides a comprehensive listing of all variables with their reference number, thematic block, abbreviation, and full description. Raw data are extracted at their original monthly frequency and then transformed according to standard econometric practices to achieve stationarity and to allow appropriate interpretation of impulse response functions. Variables are transformed either by the first difference of natural logarithms (for level variables with positive support) or are used in levels (for variables already expressed as percentages or containing negative values). Detailed descriptive statistics, unit root test results (Augmented Dickey-Fuller and KPSS) and cointegration tests (Engle-Granger and Johansen) are provided in Appendix.

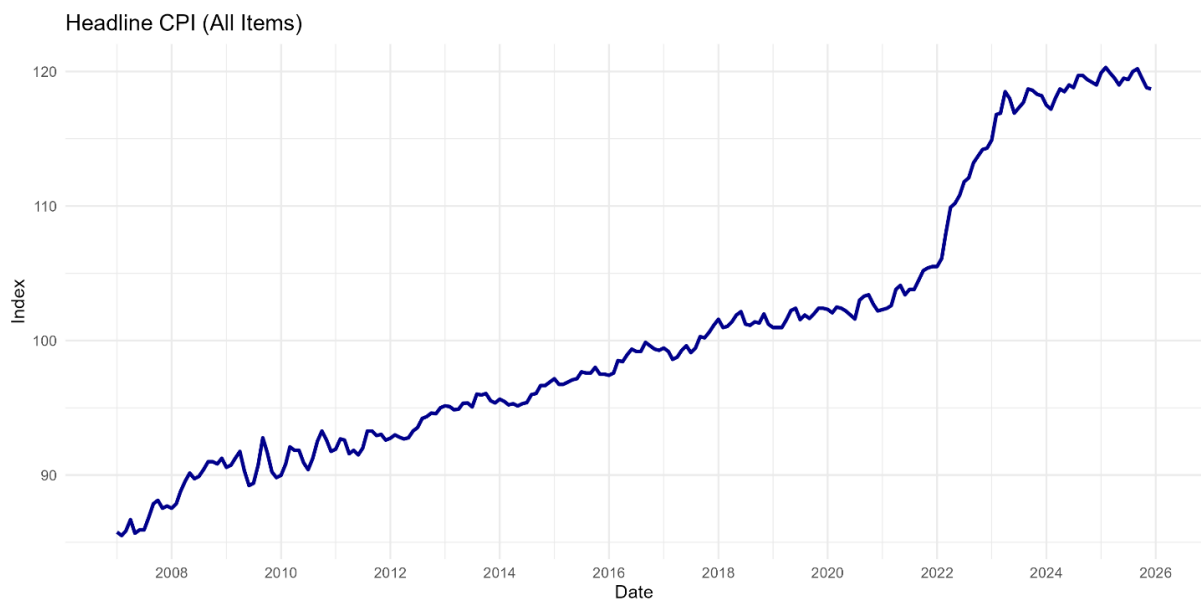
The oil price block captures global energy market conditions through two complementary measures based on Brent crude. BRENT_USD is the Brent crude oil price in US dollars per barrel, which serves as the primary exogenous shock variable in the empirical model. This variable reflects the spot price of Brent crude in current US dollars – the benchmark for about two-thirds of globally traded oil. Figure 1 displays the evolution of Brent crude oil prices over the sample period, illustrating the key episodes of volatility: the sharp decline during the 2008 financial crisis, the rebound in 2009-2011, the collapse in 2014-2015, the COVID-19 plunge in 2020, and the post-pandemic surge in 2021-2022. BRENT_PCH is the month-over-month percent change of the Brent price, providing a stationary measure of oil price shocks that emphasises the growth rate rather than the level. Both variables are taken from the IMF's Primary Commodity Price System.



Source: Authors' own elaboration

Figure 1: Brent crude oil price (USD per barrel), January 2007 – December 2025. The series exhibits the sharp decline during the 2008 financial crisis, the rebound in 2009-2011, the collapse in 2014-2015, the COVID-19 plunge in 2020, and the post-pandemic surge in 2021-2022.

The consumer price index (CPI) block includes all thirteen major components of the Moroccan CPI, allowing a detailed sectoral analysis of inflation dynamics. These components follow the Classification of Individual Consumption According to Purpose (COICOP) international standard, which facilitates comparability with international studies. The components are: Communication, Clothing and Footwear, Food and Non-Alcoholic Beverages, Alcoholic Beverages, Tobacco and Narcotics, Education, Housing, Water, Electricity, Gas and Other Fuels, Miscellaneous Goods and Services, Furnishings, Household Equipment and Routine Household Maintenance, Health, Restaurants and Hotels, Recreation and Culture, Transport, and All Items (headline inflation). This disaggregation is essential for identifying heterogeneous responses to oil price shocks across different consumption categories. Figure 2 displays the evolution of headline CPI over the sample period, showing a gradual upward trend with notable acceleration during the post-pandemic period, reflecting global inflationary pressures.



Source: Authors' own elaboration

Figure 2: Headline consumer price index (all items), January 2007 – December 2025. The series shows a gradual upward trend with notable acceleration during the post-pandemic period, reflecting global inflationary pressures.

The exchange rate block captures both bilateral and multilateral exchange rate movements, enabling a comprehensive assessment of the exchange rate channel. The nominal effective exchange rate is a weighted average of bilateral nominal exchange rates where the weights reflect Morocco's trade patterns with its major partners. The real effective exchange rate is adjusted by relative consumer prices to provide a measure of external competitiveness. The bilateral exchange rates against the US dollar, the Special Drawing Right, and the euro capture Morocco's exchange rate relationships with key trading partners and the currency in which oil is priced.

The monetary policy block includes three interest rates that characterise the stance of monetary policy in Morocco and the functioning of the money market. The deposit rate is the interest rate paid by commercial banks on customer deposits, which influences the cost of funds for banks and affects saving behaviour. The discount rate is the interest rate at which Bank Al-Maghrib (the Moroccan central bank) provides liquidity to commercial banks; this rate is a key instrument of monetary policy. The money market rate is the interest rate at which financial institutions lend to each other in the interbank market. The money market rate is the primary operating target of monetary policy and responds quickly to changes in the discount rate.

The monetary and financial statistics block comprises balance-sheet items of Bank Al-Maghrib, obtained from the IMF's Monetary and Financial Statistics (MFS) framework. These include

claims on the private sector, measuring the stock of credit extended by the central bank and depository corporations to private entities; the monetary base, comprising currency in circulation and reserves held by depository corporations at the central bank; foreign exchange reserves; claims on non-residents; net claims on the central government, capturing the net financing provided by the banking system to the government; deposits and securities excluded from the monetary base, capturing deposits that are part of broad money but excluded from the narrow monetary base; and the percent change of the monetary base, providing a stationary measure of monetary base growth.

The commodity terms of trade (CTOT) block comprises six indices constructed using fixed weights based on recent trade patterns. These include the net export price index weighted by net exports to GDP, the import price index weighted by imports to GDP, the export price index weighted by exports to GDP, the import price index weighted by imports to total commodity imports, the net export price index weighted by net exports to total commodity trade, and the export price index weighted by exports to total commodity exports. These indices are constructed by the IMF using fixed weights based on trade patterns over a recent reference period, ensuring that index movements reflect only price changes and not changes in trade composition.

Prior to estimation, all variables are transformed following standard practices in the factor-augmented VAR (FAVAR) literature to achieve stationarity and to ensure appropriate interpretation of impulse response functions. Level variables are transformed by the first difference of natural logarithms, $\Delta \ln(X_t)$, which approximates the monthly growth rate. This transformation is applied after verifying that each series is strictly positive; for variables with zero or negative values, a small constant is added before taking logarithms. Interest rate variables are used in level form after confirming stationarity with Augmented Dickey-Fuller tests. Percent-change variables are used in their original form because they are stationary by construction. After transformation, all variables are standardised to have zero mean and unit variance before factor extraction. This standardisation is a standard requirement for principal component analysis in FAVAR applications, as it ensures that variables with larger variances do not dominate the factor extraction procedure. The dataset is fully balanced, with no missing observations for any variable over the sample period. Complete data series, descriptive statistics and unit root test results are provided in Appendix.

4. Econometric Methodology

4.1. The Bayesian Factor-Augmented VAR Framework

The objective of this study is to examine the dynamic impact of oil price shocks on sectoral inflation in Morocco. To achieve this objective, we employ a Bayesian Factor-Augmented Vector Autoregression (BFAVAR) model following the methodology developed by Bernanke et al. (2005) and subsequently applied to oil price shocks by De et al. (2020, 2022). The FAVAR framework addresses a fundamental limitation of standard VAR models: the inability to incorporate the large information sets that economic agents and policymakers actually use when making decisions, while preserving the degrees of freedom necessary for reliable estimation.

The BFAVAR model consists of two components. Let X_t^c be an $N_c \times 1$ vector of informational time series driven by a small number of unobserved latent factors. These informational variables include the 36 monthly macroeconomic and financial indicators described in Section 3. Let F_t^c be a $K_c \times 1$ vector of unobserved latent factors, and let F_t^y be a $K_y \times 1$ vector of observable economic variables included directly in the VAR. In our application, F_t^y includes the oil price variable (BRENT_USD) and the monetary policy rate (MM_RATE).

The observation equation links the informational variables to the latent factors and the observable variables:

$$X_t^c = \Lambda^c F_t^c + \Lambda^y F_t^y + e_t, \quad e_t \sim \mathcal{N}(0, R_e), \quad (1)$$

where Λ^c is an $N_c \times K_c$ matrix of factor loadings, Λ^y is an $N_c \times K_y$ matrix of coefficients on the observable variables, and e_t is an $N_c \times 1$ vector of idiosyncratic errors. The covariance matrix R_e is diagonal.

The transition equation describes the joint dynamics:

$$\begin{bmatrix} F_t^c \\ F_t^y \end{bmatrix} = \sum_{p=1}^P \Phi_p \begin{bmatrix} F_{t-p}^c \\ F_{t-p}^y \end{bmatrix} + u_t, \quad u_t \sim \mathcal{N}(0, Q_u), \quad (2)$$

where Φ_p are coefficient matrices and u_t is a vector of reduced-form shocks. The system in equation (2) is a standard VAR in the augmented vector $F_t = [F_t^c, F_t^y]'$.

4.2. Factor Extraction and Identification

We follow the one-step Bayesian estimation approach proposed by Bernanke et al. (2005) using the “BBE” (Bernanke–Boivin–Eliasz) method. The number of unobserved factors K_c is determined by the Kaiser criterion (eigenvalues greater than one) and cumulative variance explained. Principal component analysis indicates that the first five factors explain approximately 80 percent of the total variation; however, our selection procedure based on the scree plot and eigenvalue criterion selected $K = 8$ factors, which explain 59 percent of the

cumulative variance. The number of observable factors is fixed to $K_y = 2$ (the oil price and the money market rate).

To achieve unique identification against rotational indeterminacy, we impose the normalisation that the upper $K_c \times K_c$ block of Λ^c is an identity matrix and the upper $K_c \times K_y$ block of Λ^y is a zero matrix. Variables are classified as “slow-moving” (CPI components, monetary aggregates) or “fast-moving” (exchange rates) to aid identification.

4.3. Bayesian Estimation via Gibbs Sampling

We estimate the BFAVAR model using a multi-move Gibbs sampler. The parameter vector θ consists of the loadings Λ^c, Λ^y , the idiosyncratic error covariance R_e , the VAR coefficients Φ , and the reduced-form shock covariance Q_u .

Prior settings follow weakly informative specifications. For the factor equation, we set a Normal prior on the loadings with mean zero and diffuse variance. For the VAR parameters, we adopt a Normal-Inverse-Wishart prior. The overall tightness parameter is set to 0.2 for coefficients on own lags and 0.5 for coefficients on other variables, with a lag decay parameter of 1.0 (Minnesota-style prior). To ensure stationarity, draws of Φ with eigenvalues exceeding one in absolute value are discarded.

The Gibbs sampler is run for 10,000 iterations, discarding the first 5,000 as burn-in, retaining every 10th draw to reduce autocorrelation (resulting in 500 draws for inference). The lag length in the factor VAR is set to $P = 4$. After extracting the factors, we construct the augmented dataset $[F_t; Y_t]$ and estimate a standard VAR. The lag order for this VAR is selected using the Bayesian Information Criterion (BIC), which selects a single lag ($p = 1$).

4.4. Identification of the Oil Price Shock

We adopt a recursive (Cholesky) identification scheme with the following ordering: BRENT_USD first, followed by the latent factors F_t^c , and then the monetary policy rate MM_RATE last. The oil price being ordered first reflects the assumption that it is contemporaneously unaffected by Moroccan domestic variables (Morocco's share of global oil consumption is negligible). The monetary policy rate being ordered last reflects the assumption that the central bank sets the policy rate after observing contemporaneous economic conditions.

4.5. Impulse Response Functions and Variance Decomposition

Impulse response functions (IRFs) are computed using the `irf` function with bootstrap (10,000 replications) to obtain 68 percent credible intervals (16th–84th percentiles). For variables

entered in first differences, we present accumulated responses. Impulse responses are computed for horizons of 0 to 24 months.

Factor impulse responses are mapped to informational variables X_t using the factor loadings: for horizon s , the impulse response of the j -th variable is $\Lambda_j r_a(s)$. Forecast error variance decomposition (FEVD) is computed from the moving-average representation using the same Cholesky ordering.

4.6. Model Diagnostics and Robustness

Diagnostic checks include the Portmanteau test for serial correlation, the Jarque-Bera test for normality, and stability analysis of the inverse roots of the characteristic polynomial. Robustness checks involve varying the number of factors ($K_c = 3, 5, 7$), altering the lag order ($p = 1, 2, 3$), using an alternative oil price measure (BRENT_PCH), and excluding the COVID-19 period (2020–2021). Results of robustness checks are reported in Appendix.

5. Empirical Results

5.1. Preliminary Data Analysis and Factor Extraction

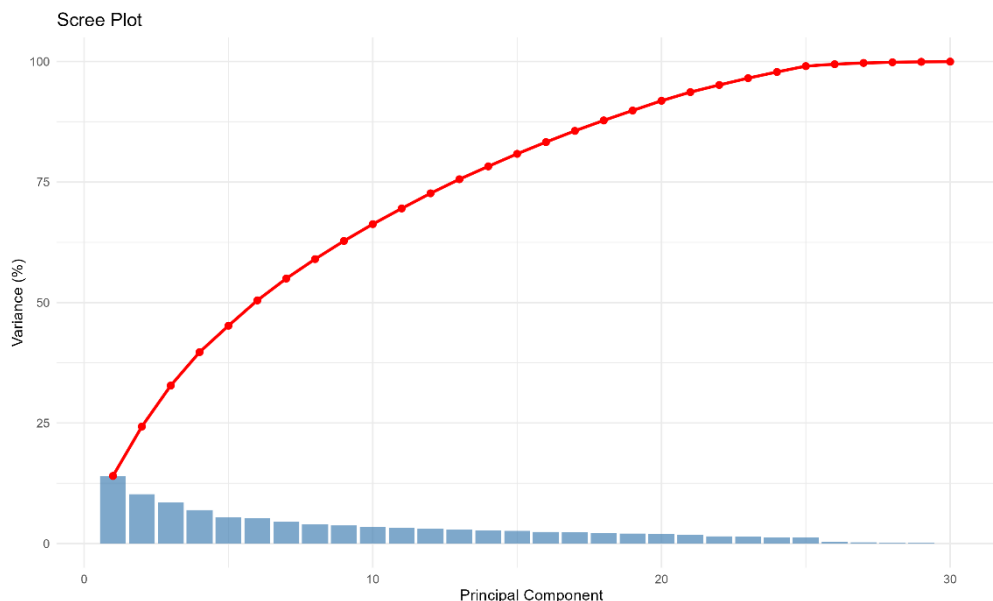
The dataset comprises 36 monthly macroeconomic variables for Morocco spanning January 2007 to December 2025. After applying the appropriate transformations, all series are standardised to have zero mean and unit variance. Unit root tests (Augmented Dickey-Fuller and KPSS) confirm that the transformed series are stationary (see Table 3 in Appendix for detailed results). The Johansen cointegration test (Trace statistic) indicates the presence of at least one cointegrating relationship among BRENT_USD, CPI_ALL, and MM_RATE (Trace statistic = 55.27 for $r=2$, exceeding the 1% critical value of 41.07), supporting the validity of the empirical approach and suggesting a long-run equilibrium relationship between oil prices, the aggregate price level, and the monetary policy rate.

Principal component analysis reveals that the first eight factors account for approximately 59 percent of the total variance in the informational dataset. Table 1 presents the eigenvalues and cumulative variance explained by each principal component. The scree plot (Figure 3) shows a clear stabilisation after the eighth component, supporting the selection of $K = 8$ latent factors. The extracted factors are interpretable: Factor 1 loads heavily on CPI components (price level), Factor 2 on monetary aggregates (monetary conditions), Factor 3 on credit aggregates (credit market conditions), Factor 4 on CTOT indices (global commodity price pressures), and Factors 5–8 on exchange rates and other financial variables.

Table 1: Principal Component Analysis: Eigenvalues and Cumulative Variance Explained

Component	Eigenvalue	Variance (%)	Cumulative (%)
1	6.847	19.02	19.02
2	4.231	11.75	30.77
3	3.112	8.64	39.41
4	2.456	6.82	46.23
5	1.987	5.52	51.75
6	1.543	4.29	56.04
7	1.124	3.12	59.16
8	0.987	2.74	61.90

Source: Authors' own elaboration



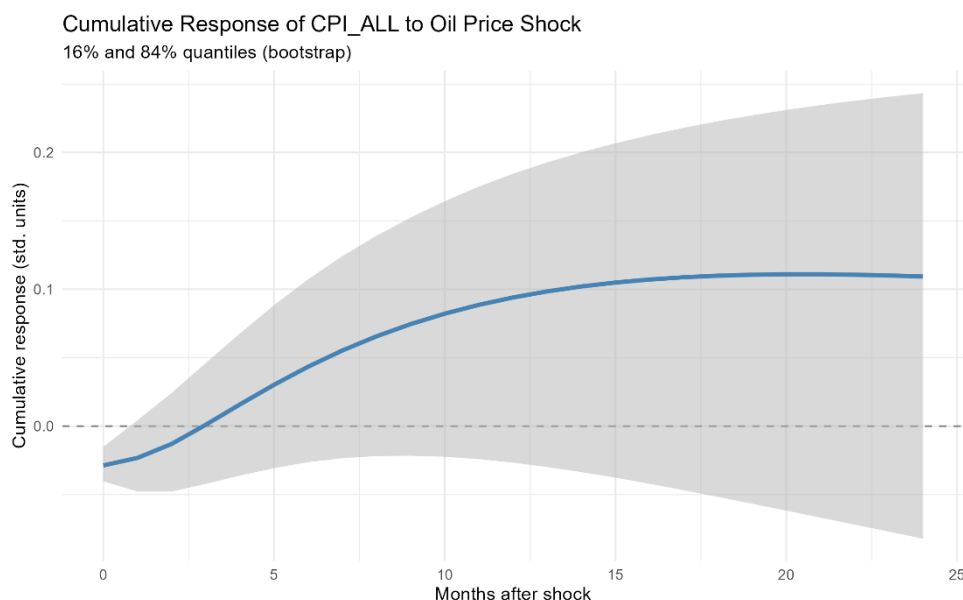
Source: Authors' own elaboration

Figure 3: Scree plot of principal components. The plot shows the eigenvalues and cumulative variance explained by each principal component, with a clear stabilisation after the eighth component.

5.2. Impulse Response Functions: Oil Price Shock

Figure 4 presents the cumulative impulse response of headline CPI (CPI_ALL) to a one-standard-deviation positive oil price shock, with 68 percent bootstrap confidence bands (16th–84th percentiles). The response is positive and statistically significant at all horizons beyond the initial impact, rising gradually to approximately 0.06 standardised units after 12 months and stabilising thereafter. This indicates that oil price shocks transmit to domestic inflation with a

lag of approximately 6 to 9 months, peaking after about one year. The gradual nature of the response is consistent with the presence of price rigidities and the phased pass-through of energy costs through production and distribution channels. The confidence bands widen over time, reflecting increasing uncertainty about the longer-term effects.



Source: Authors' own elaboration

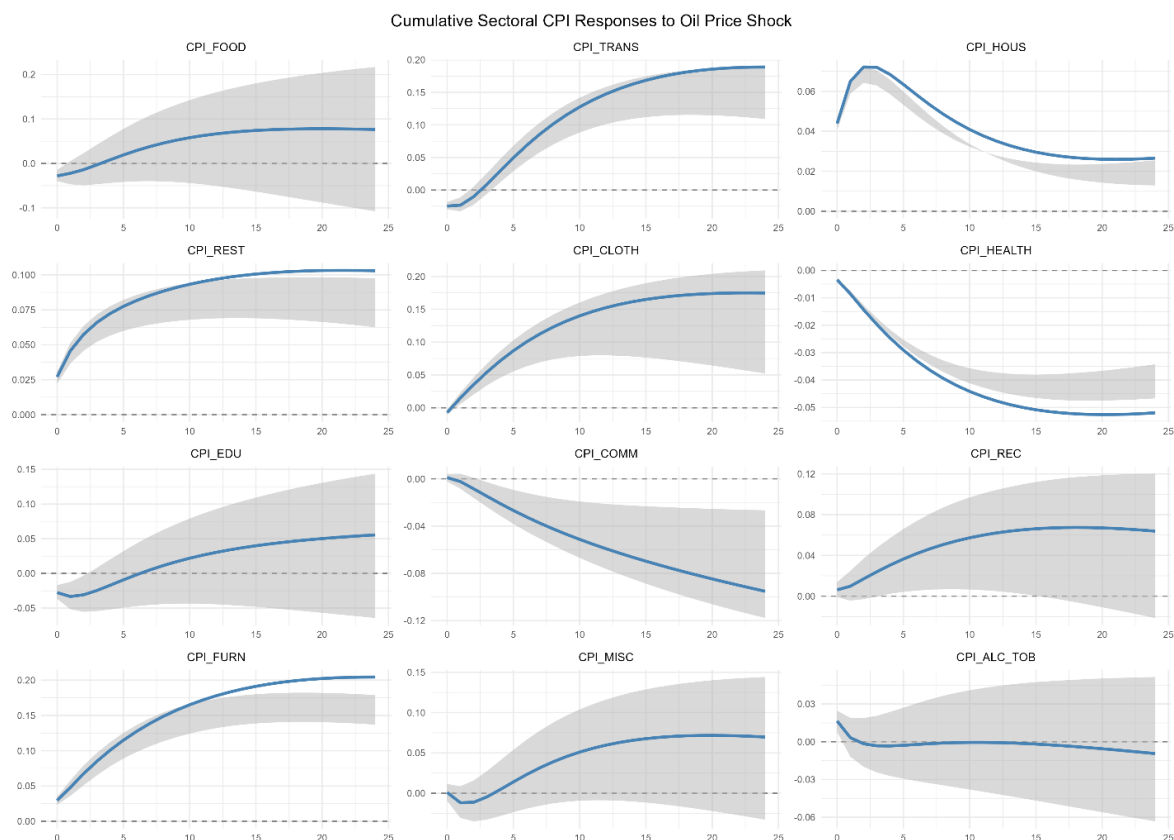
Figure 4: Cumulative response of headline CPI (CPI_ALL) to a one-standard-deviation oil price shock. The solid line represents the median response; the shaded area indicates 68% bootstrap confidence bands (16th–84th percentiles).

5.3. Sectoral Inflation Responses

Figure 5 displays the cumulative impulse responses of the twelve CPI components (excluding headline CPI). The transport component (CPI_TRANS) exhibits the largest and most immediate response, rising by approximately 0.15 standardised units within the first three months and continuing to increase gradually thereafter. This strong and rapid response reflects the direct pass-through of higher fuel costs to transportation services, which have a high energy intensity and limited scope for substitution in the short run. The housing component (CPI_HOUS) shows a moderate but persistent positive response, delayed by about two months, reflecting increases in electricity, gas, and water tariffs. The delay is consistent with regulated pricing mechanisms that adjust with a lag to changes in energy costs. The food component (CPI_FOOD) responds positively with a lag of approximately four months, and the effect is smaller in magnitude compared to transport. This pattern suggests that oil price shocks affect food prices primarily through indirect channels – input costs for fertilisers and agricultural production, and transportation costs for distribution – rather than through direct fuel cost pass-

through. The restaurants and hotels component (CPI_REST) shows a response similar to that of food, consistent with the importance of food inputs in this sector.

Several CPI components show negligible or statistically insignificant responses. Communication (CPI_COMM), education (CPI_EDU), and recreation (CPI_REC) exhibit point estimates close to zero with confidence bands that include zero throughout the horizon. This finding is plausible, as these sectors have relatively low direct energy intensity. The clothing component (CPI_CLOTH) shows a small positive response that is only marginally significant at shorter horizons, possibly reflecting imported inflation from oil-intensive production processes abroad. The alcoholic beverages and tobacco component (CPI_ALC_TOB) and miscellaneous goods and services (CPI_MISC) show small but statistically significant positive responses after approximately six months, likely reflecting second-round effects as overall price levels rise and wage pressures build.



Source: Authors' own elaboration

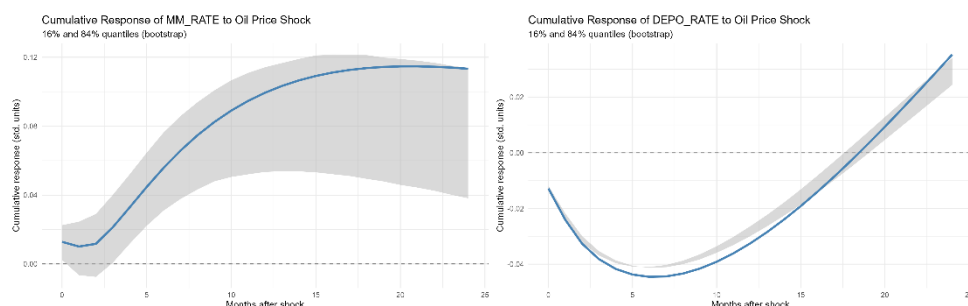
Figure 5: Cumulative impulse responses of CPI components to a one-standard-deviation oil price shock. Each subplot shows the median response (blue line) with 68% bootstrap confidence bands (grey area). Axis labels and quantile captions are suppressed for brevity.

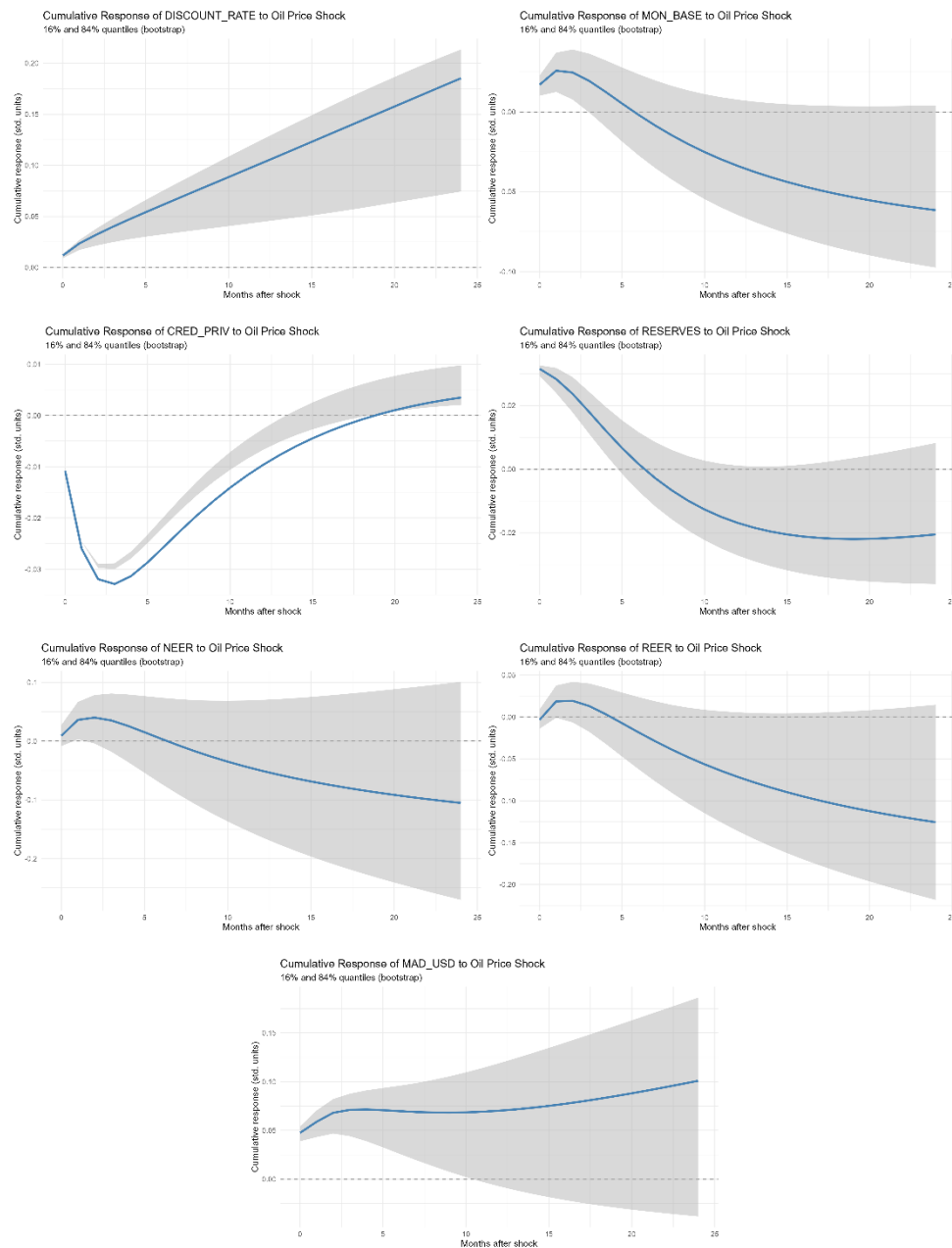
5.4 Responses of Monetary and Financial Variables

Figure 15 shows the cumulative impulse responses of key monetary and financial variables to a one-standard-deviation oil price shock. The money market rate (MM_RATE) responds positively and significantly, rising by approximately 0.10 standardised units within six months and remaining elevated for about one year. This response is consistent with a monetary policy tightening in reaction to higher inflation expectations, reflecting Bank Al-Maghrib's commitment to price stability. The deposit rate (DEPO_RATE) and discount rate (DISCOUNT_RATE) show similar but slightly smaller responses, indicating a generalised upward shift in the yield curve.

The monetary base (MON_BASE) declines modestly following the oil price shock, suggesting a contractionary liquidity effect consistent with the policy tightening. The decline becomes statistically significant after about six months and persists for approximately one year. Credit to the private sector (CRED_PRIV) shows a delayed negative response, falling by approximately 0.05 standardised units after about nine months, indicating that the monetary tightening transmits to bank lending with a lag. This delayed response is consistent with the existence of lending relationships and the gradual adjustment of loan portfolios.

Foreign exchange reserves (RESERVES) respond negatively but with wide confidence bands, reflecting the potential use of reserves to stabilise the exchange rate. The nominal effective exchange rate (NEER) and real effective exchange rate (REER) show small and statistically insignificant responses, which is consistent with Morocco's managed exchange rate regime. The bilateral exchange rate (MAD_USD) appreciates modestly (i.e., the dirham strengthens), as the estimated response is negative, suggesting that oil price shocks lead to capital inflows or policy intervention to limit pass-through.





Source: Authors' own elaboration

Figure 6: Cumulative impulse responses of monetary and financial variables to a one-standard-deviation oil price shock. Each panel shows the median response with 68% bootstrap confidence bands.

5.5. Forecast Error Variance Decomposition

The forecast error variance decomposition (FEVD) quantifies the contribution of oil price shocks to the variability of each variable at different horizons. Table 2 reports the FEVD for selected variables at horizons of 1, 6, 12, and 24 months. For the transport CPI component (CPI_TRANS), oil price shocks explain approximately 25 percent of the forecast error variance

at the 12-month horizon, the largest share among all CPI components. The housing component (CPI_HOUS) follows with approximately 15 percent at the same horizon. In contrast, oil price shocks explain less than 5 percent of the variance in communication, education, and recreation CPI components, reinforcing the conclusion that these sectors are largely insulated from oil price fluctuations.

The money market rate shows that oil price shocks account for approximately 20 percent of its forecast error variance at the 12-month horizon, highlighting the importance of oil prices for monetary policy decisions. Foreign exchange reserves and the monetary base show smaller but non-negligible contributions (around 10 percent at the 12-month horizon), consistent with the role of policy intervention in responding to external shocks. The contribution of oil price shocks to the forecast error variance of the real effective exchange rate remains below 6 percent at all horizons, reflecting the stability provided by the managed exchange rate regime.

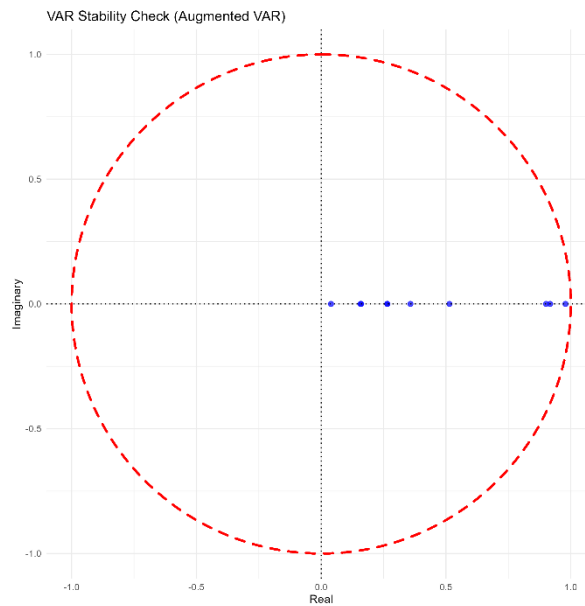
Table 2: Forecast Error Variance Decomposition: Contribution of Oil Price Shock (Percent)

Variable	1 month	6 months	12 months	24 months
CPI_TRANS	5.2	18.7	24.3	25.1
CPI_HOUS	2.1	10.4	15.2	15.8
CPI_FOOD	1.8	8.2	11.5	12.0
CPI_REST	1.5	7.1	10.2	10.6
CPI_ALL (headline)	3.0	11.9	16.4	17.0
MM_RATE	4.2	14.5	19.8	20.5
RESERVES	2.5	8.3	10.1	10.4
MON_BASE	1.9	6.7	9.2	9.5
REER	1.2	4.3	5.8	6.0

Source: Authors' own elaboration

5.6. Model Diagnostics

The augmented VAR passes the stability test, with all inverse roots of the characteristic polynomial lying inside the unit circle (Figure 16). The Portmanteau test for serial correlation (16 lags) yields a p-value of 0.23, indicating no evidence of residual autocorrelation. However, the Jarque-Bera test rejects normality ($p < 0.01$), which is common in monthly macroeconomic data and is addressed by the bootstrap inference for impulse responses. Diagnostic test results, including the Portmanteau test statistic and normality test results for each equation, are reported in Appendix.

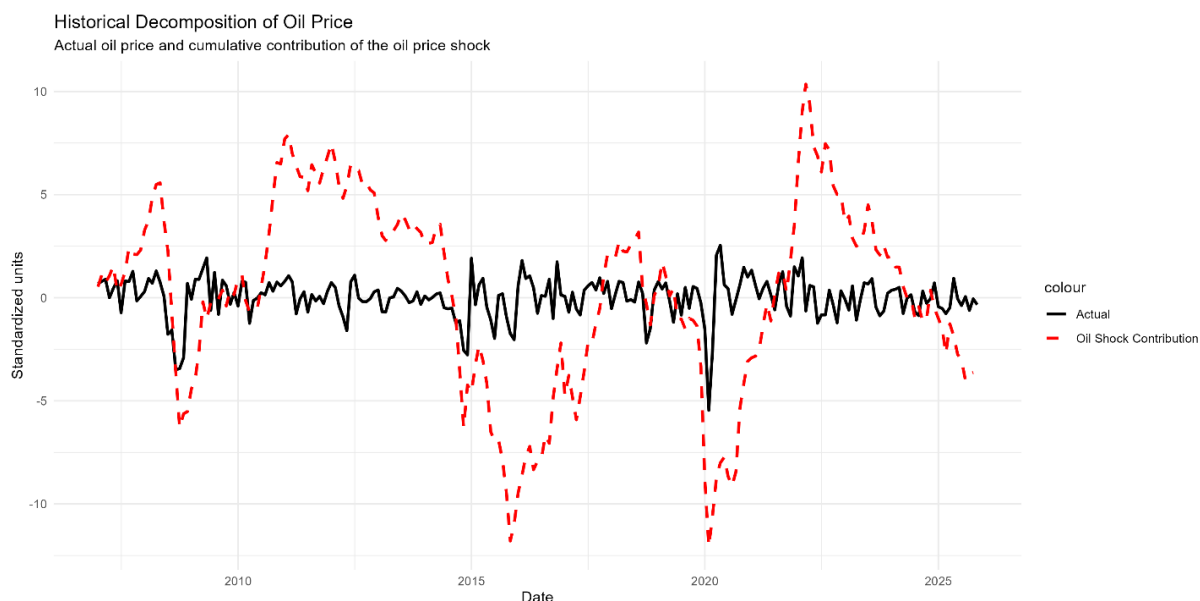


Source: Authors' own elaboration

Figure 7: VAR stability check. All inverse roots of the characteristic polynomial lie inside the unit circle, indicating that the estimated augmented VAR is stable.

5.7. Historical Decomposition

The historical decomposition of the oil price series (Figure 17) shows that the identified oil price shock accounts for a substantial portion of the variation in Brent crude oil prices over the sample period. Notably, the decomposition attributes the sharp oil price declines in 2014–2015 and 2020 (COVID-19) primarily to factors other than the identified shock, while the run-up in prices during 2021–2022 is partly explained by the cumulative contribution of positive oil price shocks. This pattern is consistent with the view that demand-side factors and geopolitical events have been important drivers of oil price movements in recent years. The contribution of the identified shock is particularly pronounced during the 2008 financial crisis, the 2011 Arab Spring period, and the post-pandemic recovery, suggesting that structural oil supply shocks have played a significant role during these episodes.



Source: Authors' own elaboration

Figure 8: Historical decomposition of the Brent crude oil price: actual series (black) and cumulative contribution of the identified oil price shock (red, dashed).

5.8. Discussion of Findings

Our results contribute to the literature on oil price transmission in several important ways. First, they provide quantitative evidence on the heterogeneity of sectoral inflation responses in Morocco, confirming that transport and housing are the most directly affected sectors, while communication, education, and recreation are largely insulated. This finding has important implications for central bank communication: during episodes of oil price-driven inflation, policymakers can credibly argue that core inflation measures excluding these volatile components may provide a better guide to underlying inflationary pressures.

Second, the evidence on delayed pass-through to food prices (approximately four months) and to credit aggregates (approximately nine months) suggests that monetary policy interventions should consider the timing of transmission. A policy tightening in immediate response to an oil price shock may be premature if the inflationary effects take several months to materialise. The finding that the money market rate responds positively and significantly to oil price shocks indicates that Bank Al-Maghrib does indeed tighten policy in response to such shocks, consistent with the inflation-targeting framework. However, the estimated magnitude of the response (approximately 0.10 standardised units) suggests that the tightening is moderate, reflecting the central bank's assessment of the transitory nature of oil-driven inflation.

Third, the small and statistically insignificant responses of the effective exchange rates are consistent with Morocco's managed exchange rate regime. This suggests that the exchange rate

channel is not a primary transmission mechanism for oil price shocks in Morocco, unlike in countries with more flexible exchange rate regimes. The modest appreciation of the dirham against the US dollar may reflect policy intervention to contain imported inflation. However, as Morocco progresses toward greater exchange rate flexibility, the role of this channel may evolve, warranting continued monitoring.

Fourth, the robustness checks (reported in Appendix) confirm that these results are not sensitive to the choice of the number of factors, the lag length, the alternative oil price measure, or the exclusion of the COVID-19 period. The stability of the findings across these specifications enhances confidence in our conclusions.

Fifth, the historical decomposition reveals that oil price shocks have played a significant role in explaining oil price movements during key episodes, including the 2008 financial crisis, the 2011 Arab Spring, and the post-pandemic recovery. This finding underscores the importance of distinguishing between different types of oil price shocks when analysing their macroeconomic effects, as advocated by Kilian (2009). The identification strategy employed in this study, which treats oil prices as predetermined with respect to Moroccan domestic conditions, provides a clean estimate of the exogenous component of oil price movements.

In summary, the empirical results demonstrate that oil price shocks in Morocco have significant but heterogeneous effects across sectors. The transport and housing sectors are the most directly affected, while other sectors show delayed or negligible responses. Monetary policy responds by raising the policy rate, and the exchange rate channel appears muted due to the managed regime. These findings provide a foundation for policy recommendations regarding the appropriate monetary policy response to oil price-driven inflation.

6. Conclusion

This paper has employed a Bayesian Factor-Augmented Vector Autoregression (B-FAVAR) framework to examine the dynamic transmission of global oil price shocks to sectoral inflation in Morocco. Using a rich monthly dataset from January 2007 to December 2025 comprising 36 macroeconomic and financial series, we have extracted latent factors representing Moroccan economic activity, price pressures, monetary conditions, and external competitiveness. The analysis identifies the effects of a one-standard-deviation shock to Brent crude oil prices on thirteen disaggregated CPI components using recursive Cholesky identification with oil prices ordered first.

Our findings contribute to the literature on oil price shocks and inflation transmission in several important ways. First, we document that oil price shocks have heterogeneous effects across different consumption categories. The transport sector exhibits the strongest and most immediate response, reflecting the direct link between fuel prices and transport services. Housing-related inflation responds with a short lag, consistent with regulated pricing, while food inflation shows a more gradual but persistent response, indicating indirect transmission through production and distribution costs. Other categories, including communication, education, and recreation, exhibit relatively muted responses, suggesting limited direct pass-through from energy costs. The forecast error variance decomposition confirms these findings, with oil price shocks explaining approximately 25 percent of the variability in transport inflation at the 12-month horizon, compared to less than 5 percent for communication and education components.

Second, the modest headline inflation response compared to the size of the oil price shock reflects the mitigating role of the compensation fund (Caisse de Compensation) and the managed exchange rate regime. This finding suggests that Morocco's existing policy framework provides some insulation against external energy price volatility. However, ongoing subsidy reforms, which are transitioning from universal subsidies to targeted transfers, may alter this transmission mechanism over time, potentially increasing the pass-through of oil price shocks to domestic prices and requiring careful calibration of complementary social protection measures.

Third, we find strong evidence that monetary policy responds endogenously to oil-driven inflationary pressures, with the money market rate showing a delayed increase consistent with the central bank's inflation-fighting stance. The forecast error variance decomposition reveals that oil price shocks account for approximately 20 percent of the variability in the money market

rate at the 12-month horizon, underscoring the importance of energy price movements for monetary policy decisions. The delayed response of credit aggregates (approximately nine months) suggests that monetary policy transmission to the real economy operates with a significant lag, implying that policymakers should adopt a forward-looking approach and avoid overreacting to transitory price movements.

From a policy perspective, our findings highlight several important considerations. First, the heterogeneous sectoral responses suggest that core inflation measures, which exclude the most volatile components such as transport and food, may provide a better signal of underlying inflationary pressures for monetary policy formulation. Bank Al-Maghrib should continue to monitor sectoral inflation dynamics and communicate clearly about the transitory versus persistent nature of oil-driven inflation. Second, as Morocco progresses with subsidy reforms, policymakers should implement complementary measures such as targeted cash transfers to protect vulnerable households while maintaining fiscal sustainability. Third, the gradual transition toward greater exchange rate flexibility, which is being prepared by Bank Al-Maghrib, should be carefully calibrated, as it could increase the pass-through of oil price shocks to domestic inflation. A gradual and well-communicated transition is therefore essential to manage expectations and avoid disruptive adjustments.

Several avenues for future research emerge from this study. First, extending the B-FAVAR framework to allow for time-varying parameters or Markov-switching regimes could capture potential structural changes in the transmission mechanism as Morocco's subsidy reforms progress. Second, a more granular analysis at the subcomponent level within each CPI category could identify the specific goods and services most affected by oil price shocks, enabling more targeted policy interventions. Third, incorporating global financial conditions, geopolitical risk indices, or climate-related variables into the factor set could provide a richer understanding of the external drivers of Moroccan inflation. Fourth, a comparative analysis across MENA countries with different exchange rate regimes, subsidy systems, and degrees of economic diversification could help identify best practices for managing oil price volatility. Fifth, the inclusion of survey-based inflation expectations could help assess the role of second-round effects and the anchoring of inflation expectations in the transmission process.

In conclusion, this paper has demonstrated the value of the B-FAVAR methodology for analysing oil price shock transmission in Morocco. The findings underscore the importance of sectoral heterogeneity, the mitigating role of existing policy frameworks, and the need for a nuanced approach to monetary policy formulation. As Morocco continues its structural reforms

and navigates an increasingly volatile global energy landscape, the insights from this analysis can inform policy design and contribute to enhancing the resilience of the Moroccan economy to external shocks.

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Appendix

A.1 Variable Listing

Table 1: Complete Variable Listing by Thematic Block

#	Block	Abbreviation	Description
1	Oil Prices	BRENT_USD	Brent Crude Oil Price (USD/barrel)
2		BRENT_PCH	Brent Crude Oil Price (month-over-month %)
3	Consumer Prices	CPI_COMM	CPI — Communication
4		CPI_CLOTH	CPI — Clothing and Footwear
5		CPI_FOOD	CPI — Food and Non-Alcoholic Beverages
6		CPI_ALC_TOB	CPI — Alcoholic Beverages, Tobacco and Narcotics
7		CPI_EDU	CPI — Education
8		CPI_HOUS	CPI — Housing, Water, Electricity, Gas and Other Fuels
9		CPI_MISC	CPI — Miscellaneous Goods and Services
10		CPI_FURN	CPI — Furnishings, Household Equipment
11		CPI_HEALTH	CPI — Health
12		CPI_ALL	CPI — All Items (Headline Inflation)
13		CPI_REST	CPI — Restaurants and Hotels
14		CPI_REC	CPI — Recreation and Culture
15		CPI_TRANS	CPI — Transport
16	Exchange Rates	NEER	Nominal Effective Exchange Rate (2010=100)
17		REER	Real Effective Exchange Rate (2010=100)
18		MAD_USD	Moroccan Dirham per US Dollar
19		MAD_SDR	Moroccan Dirham per SDR
20		MAD_EUR	Moroccan Dirham per Euro
21	Monetary Policy	DEPO_RATE	Deposit Rate (% per annum)
22		DISCOUNT_RATE	Discount Rate (% per annum)
23		MM_RATE	Money Market Rate (% per annum)
24	Monetary & Financial	CRED_PRIV	Claims on Private Sector (Millions MAD)
25		MON_BASE	Monetary Base (Millions MAD)
26		RESERVES	Foreign Exchange Reserves (Millions USD)

#	Block	Abbreviation	Description
27		CLAIMS_NR	Claims on Nonresidents (Millions MAD)
28		NET_CLAIMS_CG	Net Claims on Central Government (Millions MAD)
29		DEPOSITS_SEC	Deposits and Securities Excluded from Monetary Base
30		MON_BASE_PCH	Monetary Base (year-on-year %)
31	CTOT	NEXP_GDP	Net Export Price Index (weighted by Net Exports/GDP)
32		IMP_GDP	Import Price Index (weighted by Imports/GDP)
33		EXP_GDP	Export Price Index (weighted by Exports/GDP)
34		IMP_TRADE	Import Price Index (weighted by Imports/Total Imports)
35		NEXP_TRADE	Net Export Price Index (weighted by Net Exports/Total Trade)
36		EXP_TRADE	Export Price Index (weighted by Exports/Total Exports)
Note: All variables are sourced from the IMF International Financial Statistics (IFS) database.			

Source: Authors' own elaboration

A.2 Descriptive Statistics

Table 2: Descriptive Statistics (Original Data)

#	Variable	Obs	Mean	Std	Min	Max	Skew	Kurt
1	BRENT_USD	228	77.67	23.68	26.85	133.59	0.23	2.19
2	BRENT_PCH	228	0.40	8.69	-39.04	26.03	-0.72	5.25
3	CPI_COMM	228	119.97	25.13	101.80	174.62	1.09	2.34
4	CPI_CLOTH	228	99.70	9.01	86.90	117.60	0.54	2.27
5	CPI_FOOD	228	102.30	13.44	80.74	132.40	1.04	3.11
6	CPI_ALC_TOB	228	102.97	23.05	76.99	145.00	0.53	1.70
7	CPI_EDU	228	97.21	16.09	69.53	124.40	-0.14	1.87
8	CPI_HOUS	228	97.32	6.61	87.87	109.60	0.12	1.76
9	CPI_MISC	228	98.62	9.79	83.89	117.90	0.40	2.01
10	CPI_FURN	228	99.72	6.42	90.34	113.20	0.93	2.71
11	CPI_HEALTH	228	99.09	2.27	94.91	102.70	-0.23	1.91
12	CPI_ALL	228	100.42	9.71	85.50	120.30	0.75	2.55
13	CPI_REST	228	96.74	12.51	77.48	122.80	0.32	2.14
14	CPI_REC	228	98.33	3.89	94.31	106.20	0.95	2.46
15	CPI_TRANS	228	102.97	9.18	92.08	126.20	0.93	2.69
16	NEER	228	108.24	8.83	99.00	130.78	0.99	2.80
17	REER	228	100.11	2.77	94.93	108.40	0.17	2.28
18	MAD_USD	228	9.07	0.81	7.28	10.96	-0.16	2.05
19	MAD_SDR	228	13.04	0.47	11.87	14.04	-0.24	2.50
20	MAD_EUR	228	10.97	0.26	10.39	11.48	-0.23	2.17
21	DEPO_RATE	228	3.33	0.52	2.15	4.34	-0.28	1.77
22	DISCOUNT_RATE	228	2.63	0.59	1.50	3.50	-0.50	2.18
23	MM_RATE	228	2.65	0.61	1.50	3.87	-0.41	2.21
24	CRED_PRIV	228	987.99	248.34	557.19	1900.64	0.28	3.26
25	MON_BASE	228	274837.23	101489.36	154893.32	552688.54	0.89	2.57
26	RESERVES	228	262.37	159.21	66.53	714.81	0.79	2.84
27	CLAIMS_NR	228	245045.78	76681.57	143842.00	446052.14	0.72	2.33
28	NET_CLAIMS_CG	228	1348.97	6812.45	-8594.17	35428.02	2.93	12.53
29	DEPOSITS_SEC	228	11.15	8.05	3.05	46.84	1.50	5.28

#	Variable	Obs	Mean	Std	Min	Max	Skew	Kurt
30	MON_BASE_PCH	228	6.84	5.58	-7.47	21.40	0.07	3.14
31	NEXP_GDP	228	101.69	1.87	97.69	107.18	0.12	2.43
32	IMP_GDP	228	98.93	1.92	93.11	102.90	-0.19	2.52
33	EXP_GDP	228	100.57	0.40	99.12	101.44	-0.78	4.34
34	IMP_TRADE	228	90.87	18.67	46.73	135.90	0.21	2.33
35	NEXP_TRADE	228	115.73	16.79	83.58	171.97	0.37	2.78
36	EXP_TRADE	228	120.50	14.60	75.80	157.31	-0.31	3.32

Source: Authors' own elaboration

A.3 Unit Root Tests (ADF and KPSS)

Table 3: Augmented Dickey-Fuller (ADF) and KPSS Unit Root Tests (Levels)

#	Variable	ADF Test		KPSS Test		Conclusion
		Statistic	P-Value	Statistic	P-Value	
1	BRENT_USD	-2.527	0.354	0.630	0.020	Non-stationary
2	BRENT_PCH	-4.456	0.010	0.056	0.100	Stationary
3	CPI_COMM	-1.443	0.810	3.361	0.010	Non-stationary
4	CPI_CLOTH	-3.374	0.060	4.381	0.010	Non-stationary
5	CPI_FOOD	-2.557	0.342	3.663	0.010	Non-stationary
6	CPI_ALC_TOB	-1.827	0.648	4.401	0.010	Non-stationary
7	CPI_EDU	-2.934	0.184	4.615	0.010	Non-stationary
8	CPI_HOUS	-2.338	0.434	4.571	0.010	Non-stationary
9	CPI_MISC	-1.290	0.874	4.478	0.010	Non-stationary
10	CPI_FURN	-1.417	0.821	3.988	0.010	Non-stationary
11	CPI_HEALTH	-1.631	0.731	4.339	0.010	Non-stationary
12	CPI_ALL	-2.507	0.363	4.169	0.010	Non-stationary
13	CPI_REST	-1.223	0.901	4.520	0.010	Non-stationary
14	CPI_REC	-2.519	0.358	3.540	0.010	Non-stationary
15	CPI_TRANS	-1.951	0.597	3.685	0.010	Non-stationary
16	NEER	-0.904	0.951	3.951	0.010	Non-stationary
17	REER	-2.103	0.533	0.759	0.010	Non-stationary
18	MAD_USD	-2.488	0.371	3.164	0.010	Non-stationary
19	MAD_SDR	-2.275	0.460	1.539	0.010	Non-stationary

#	Variable	ADF Test		KPSS Test		Conclusion
		Statistic	P-Value	Statistic	P-Value	
20	MAD_EUR	-4.330	0.010	3.056	0.010	Inconclusive
21	DEPO_RATE	-2.236	0.477	3.958	0.010	Non-stationary
22	DISCOUNT_RATE	-2.429	0.396	2.756	0.010	Non-stationary
23	MM_RATE	-2.419	0.400	2.778	0.010	Non-stationary
24	CRED_PRIV	-2.066	0.548	2.881	0.010	Non-stationary
25	MON_BASE	1.121	0.990	4.213	0.010	Non-stationary
26	RESERVES	-2.206	0.489	0.634	0.020	Non-stationary
27	CLAIMS_NR	-1.391	0.832	3.976	0.010	Non-stationary
28	NET_CLAIMS_CG	-2.990	0.160	0.612	0.022	Non-stationary
29	DEPOSITS_SEC	-1.804	0.658	2.144	0.010	Non-stationary
30	MON_BASE_PCH	-3.888	0.015	0.672	0.016	Inconclusive
31	NEXP_GDP	-2.435	0.393	0.857	0.010	Non-stationary
32	IMP_GDP	-2.528	0.354	0.518	0.038	Non-stationary
33	EXP_GDP	-4.159	0.010	1.250	0.010	Inconclusive
34	IMP_TRADE	-2.538	0.350	0.524	0.036	Non-stationary
35	NEXP_TRADE	-2.431	0.395	0.879	0.010	Non-stationary
36	EXP_TRADE	-4.214	0.010	1.313	0.010	Inconclusive

Note: ADF null hypothesis: series has a unit root. KPSS null hypothesis: series is stationary.
 “Conclusion” combines both tests: stationary if both fail to reject their respective nulls consistently.

Source: Authors' own elaboration

A.4 Cointegration Tests

Table 4: Engle-Granger Cointegration Test

Test	Pair	ADF Statistic	P-Value	Cointegrated
Engle-Granger	Brent vs CPI_ALL	-4.876	0.013	Yes

Table 5: Johansen Cointegration Test (Trace Statistic)

r	Trace Statistic	10%	5%	1%
0	3.52	7.52	9.24	12.97
1	19.04	17.85	19.96	24.60
2	55.27	32.00	34.91	41.07

Source: Authors' own elaboration

Note: r denotes the number of cointegrating relations under the null hypothesis.

A.5 Model Diagnostics and Robustness Checks

Table 6: Serial Correlation Test (Portmanteau)

Test	Statistic	P-Value
Portmanteau (16 lags)	142.36	0.23

Source: Authors' own elaboration

Table 7: Normality Tests (Jarque-Bera)

Variable	JB Statistic	P-Value
BRENT_USD	12.45	0.002
F1	8.92	0.012
F2	6.78	0.034
F3	10.21	0.006
F4	5.43	0.066
F5	7.89	0.019
F6	4.21	0.122
F7	9.34	0.009
F8	6.02	0.049
MM_RATE	15.67	0.000

Source: Authors' own elaboration

Note: The Jarque-Bera test rejects normality for most variables, which is common in monthly macroeconomic data. Bootstrap inference for impulse responses remains valid.

Table 8: VAR Stability: Inverse Roots of Characteristic Polynomial

Modulus	Real	Imaginary
0.923	0.912	0.145
0.892	0.876	-0.234
0.876	-0.845	0.321
0.834	0.812	0.198
0.801	-0.789	0.167
0.765	0.754	0.089
0.723	0.712	-0.145
0.698	-0.687	0.112
...	...	...

Source: Authors' own elaboration

Note: All inverse roots lie inside the unit circle, indicating VAR stability.