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RESEARCH ARTICLE

Monetary Policy Transmission and Inflation Dynamics in an Oil-Dependent Economy: Evidence from Algeria's Post-Pandemic Experience (2018-2023)

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ARTICLE INFO	ABSTRACT
	This study examines the effectiveness of monetary policy transmission mechanisms in managing inflation within oil-dependent economies during the post-pandemic period, using Algeria as a case study. Drawing on monetary policy theory and recent empirical evidence, we analyze how traditional policy tools perform under the dual challenges of pandemic recovery and oil market volatility. Using monthly data from 2018 to 2023, we employ a comprehensive econometric framework including Vector Autoregression (VAR) modeling, structural break analysis, and Granger causality tests to assess the dynamic relationships between monetary policy instruments and inflation. Our findings reveal significant structural breaks in policy transmission channels following the COVID-19 pandemic, with monetary policy effectiveness showing varying degrees of impact across different periods. The results indicate that while conventional monetary tools maintain some efficacy, their impact is moderated by external factors specific to oil-dependent economies. Policy rate adjustments show a limited immediate effect on inflation, while money supply changes demonstrate a more significant influence through exchange rate channels. These findings contribute to the growing literature on monetary policy effectiveness in developing economies by providing new evidence on how economic structure and external shocks influence policy transmission mechanisms. Our results offer important implications for central banks in oil-dependent economies navigating post-pandemic inflation management.

INTRODUCTION

The global financial landscape has undergone significant transformations following the COVID-19 pandemic, presenting unprecedented challenges for monetary policy effectiveness. Central banks worldwide face the complex task of managing inflation while supporting economic recovery, a challenge particularly acute in oil-dependent economies where external shocks can significantly impact domestic price stability. This intersection of pandemic-induced economic disruptions and oil market volatility creates a unique environment for examining monetary policy transmission mechanisms.

The case of Algeria presents a particularly compelling context for studying these dynamics. As an oil-dependent economy, Algeria's monetary policy framework operates within distinct constraints shaped by its economic structure and external vulnerabilities. The country's experience during the post-pandemic period offers valuable insights into how traditional monetary policy tools perform under multiple concurrent challenges: global health crisis recovery, oil price fluctuations, and inflationary pressures.

Recent empirical evidence suggests that monetary policy transmission mechanisms in developing economies may operate differently from those in advanced economies. Khan et al. (2023) demonstrate that financial sector development plays a crucial role in determining policy effectiveness, while Ntshangase et al. (2023) highlight the significant spillover effects of global monetary conditions on emerging markets. However, the specific case of oil-dependent economies during the post-pandemic period remains understudied, particularly regarding the interaction between monetary policy tools and inflation dynamics.

Our study contributes to this literature in several important ways. First, we provide a comprehensive analysis of monetary policy transmission channels in an oil-dependent economy during a period of significant global disruption. Second, we develop and implement a modified Vector Autoregression (VAR) framework that explicitly accounts for structural breaks and pandemic-specific factors. Third, our analysis incorporates the unique characteristics of oil-dependent economies, including the role of exchange rate pass-through and oil price dynamics in monetary policy effectiveness.

The examination of Algeria's experience offers broader implications for similar economies. By analyzing data from 2018 to 2023, we capture both the immediate impact of the pandemic and the subsequent recovery period, providing insights into how monetary policy transmission mechanisms evolve under stress. Our findings suggest that while conventional monetary tools retain some effectiveness, their impact is significantly moderated by structural economic characteristics and external factors.

The remainder of this paper is organized as follows: Section 2 provides a detailed review of relevant literature and theoretical framework. Section 3 describes our data and methodology. Section 4 presents our empirical results and discussion. Section 5 concludes with policy implications and recommendations for future research.

1.   LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The effectiveness of monetary policy and macroeconomic stability in oil-dependent economies has garnered significant attention, particularly amid recent global disruptions. This section synthesizes key theoretical frameworks and empirical findings while identifying gaps in existing research.

The theoretical foundation of monetary policy transmission traces back to Keynes (1936) and has evolved through contributions like Mishkin's (2004) insights on structural differences in developing economies, McKinnon's (1973) complementarity hypothesis, and Shaw's (1973) financial deepening theory. These frameworks underscore how financial sector development influences policy effectiveness.

Recent empirical studies provide critical context for oil-dependent economies. Mehibel et al. (2023) highlight the role of oil price shocks in Algeria, explaining 32.4% of exchange rate variations and 28.7% of inflation dynamics. Benazza and Bensaad (2020) emphasize asymmetric monetary policy transmission due to the hydrocarbon sector's dominance.

The COVID-19 pandemic further complicated monetary policy. Carrière-Swallow et al. (2024) demonstrated the rising influence of global commodity and transport prices on inflation in resource-dependent economies, while Ntshangase et al. (2023) analyzed spillover effects of U.S. monetary policy on emerging markets, highlighting cross-border transmission in underdeveloped financial systems.

Khan et al. (2023) provided evidence from eight Asian economies, showing financial development significantly enhances policy transmission. Serletis and Dery (2024) contrasted advanced and emerging economies, revealing differences in countercyclical behavior and the predictive power of money supply in emerging markets.

Szafranek et al. (2024) identified energy and global supply shocks as key determinants of post-pandemic inflation, using a Bayesian structural VAR approach. Jiang et al. (2024) examined the political economy of COVID-19 policies, showing heterogeneous inflationary effects of lockdowns.

Sciacovelli (2024) used a calibrated HANK model to demonstrate how household savings distributions influence inflation persistence in oil-dependent economies.

Nachega et al. (2024) analyzed The Gambia, highlighting the roles of global commodity prices, exchange rates, and output gaps in inflation dynamics. Their findings on asymmetric exchange rate pass-through are particularly relevant for oil-dependent economies with managed exchange rate regimes.

Despite these advancements, critical gaps remain limited research addresses the simultaneous impact of pandemic disruptions and oil market volatility, theoretical frameworks often overlook the unique characteristics of oil-dependent economies, and empirical evidence on structural changes affecting monetary policy is scarce.

This study bridges these gaps by extending existing frameworks to account for oil-dependent economies and pandemic-related disruptions. Using structural break analysis and refined exchange rate models, it provides novel empirical insights into monetary policy effectiveness under concurrent shocks.

2.   METHODOLOGY

2.1   Research Design and Data

Our study employs a comprehensive empirical approach to examine monetary policy transmission mechanisms in Algeria during the post-pandemic period. We utilize monthly data spanning from January 2018 to December 2023, encompassing both pre-pandemic and post-pandemic periods. This timeframe allows us to capture the evolving dynamics of monetary policy effectiveness across different economic conditions.

The data are sourced from multiple authoritative institutions to ensure reliability and comprehensiveness. Our primary data sources include the Bank of Algeria for monetary policy variables, the National Office of Statistics for inflation and economic indicators, and the International Monetary Fund's International Financial Statistics for comparative macroeconomic data.

Our key variables include:

Dependent Variable:

- Inflation Rate (INF): Measured by the monthly percentage change in Consumer Price Index

Independent Variables:

- Policy Interest Rate (POL): The Bank of Algeria's key policy rate
- Money Supply (M2): Broad money supply growth rate
- Exchange Rate (EXR): Monthly average DZD/USD exchange rate
- Oil Prices (OIL): Monthly average Brent crude oil prices
- COVID-19 Impact (COVID): Measured through a composite indicator incorporating case numbers and policy responses

Control Variables:

- GDP Growth Rate (GDP): Quarterly data interpolated to monthly frequency
- Global Commodity Price Index (COM)
- International Reserve Position (RES).

Table 1 provides an overview of the key variables used in this study, including their descriptions, frequency, time, and sources.

Table 1: Data Summary Table

Variable	Description	Frequency	Time Period	Source
Inflation	Consumer Price Index (CPI)	Monthly	Jan 2018 - Dec 2023	National Office of Statistics, Algeria
Policy Interest Rate	Bank of Algeria's key rate	Monthly	Jan 2018 - Dec 2023	Bank of Algeria
Money Supply (M2)	Broad money supply	Monthly	Jan 2018 - Dec 2023	Bank of Algeria
Exchange Rate	DZD/USD exchange rate	Daily	Jan 2018 - Dec 2023	Bank of Algeria
Oil Price	Brent crude oil price	Daily	Jan 2018 - Dec 2023	U.S. Energy Information Administration
COVID-19 Cases	New daily cases in Algeria	Daily	Mar 2020 - Dec 2023	Oxford COVID-19 Government Response Tracker
GDP Growth	Real GDP growth rate	Quarterly	Q1 2018 - Q4 2023	IMF International Financial Statistics
Unemployment Rate	National unemployment rate	Quarterly	Q1 2018 - Q4 2023	IMF International Financial Statistics

Econometric Framework

Our econometric approach employs multiple complementary methods to ensure robust analysis of monetary policy transmission mechanisms. The framework is designed to address potential endogeneity concerns and account for structural breaks in the relationships between variables.

Unit Root Testing

We begin with comprehensive unit root testing to establish the stationarity properties of our variables. we employ multiple tests:

1. Augmented Dickey-Fuller (ADF) test
2. Phillips-Perron (PP) test
3. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test

Our specifications are:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \Sigma \gamma_i \Delta Y_{t-i} + \varepsilon_t$$

Where:

- Y_t represents each variable in our dataset
- α is the intercept term
- β captures the unit root parameter
- γ_i represents coefficients on lagged differences
- ε_t is the error term
- i represents the optimal lag length determined by information criteria

Structural Break Analysis

We implement a comprehensive break detection and accommodation strategy:

1.   Bai-Perron Multiple Break point Test

2.   Chow Breakpoint Test at suspected break dates

3.   Rolling Window Estimation to capture time-varying parameters

The Bai-Perron test specification is:

$$Y_t = X_t'\beta + Z_t'\delta j + u_t$$

Where:

- X_t contains variables whose parameters do not change across regimes

- Z_t contains variables whose parameters are subject to shifts

- $j = 1,...,m+1$ represents the different regimes

2.1.1   Vector Autoregression (VAR) Model

Our core analysis employs a modified VAR model that incorporates structural breaks and pandemic-specific effects. The optimal lag length is determined using multiple information criteria:

- Akaike Information Criterion (AIC)

- Schwarz Information Criterion (SIC)

- Hannan-Quinn Information Criterion (HQ)

The base VAR specification is:

$$Y_t = A_0 + A_1Y_{t-1} + ... + A_pY_{t-p} + BX_t + \varepsilon_t$$

Where :

- Y_t is a vector of endogenous variables (inflation, policy rate, money supply, exchange rate)

- X_t represents exogenous variables (oil prices, COVID-19 indicator)

- A_0 is a vector of intercepting terms

- A_1 to A_p are matrices of coefficients

- B is a matrix of coefficients for exogenous variables

- ε_t is a vector of error terms

- p is the optimal lag length

Granger Causality Analysis

To examine the predictive relationships between variables, we conduct Granger causality tests within our VAR framework. These tests help establish the direction and significance of relationships between monetary policy instruments and inflation. The tests are conducted both for the full sample and sub-samples defined by structural breaks.

Impulse Response Functions and Variance Decomposition

We analyze the dynamic responses of variables to shocks using impulse response functions (IRFs) and forecast error variance decomposition (FEVD). The IRFs are computed using:

$$Y_{t+s} = \Phi_s \varepsilon_t$$

Where:

- Φ_s represents the impulse response coefficients

- s is the horizon

- ε_t represents the structural shocks

Robustness Checks

To ensure the reliability of our results, we implement several robustness checks:

1. Alternative VAR specifications with different variable orderings
2. Sub-sample analysis for pre- and post-pandemic periods
3. Alternative measures of keys variables
4. Different lag specifications
5. Inclusion of additional control variables

Figure 1 provides a visual representation of our three-pronged methodological approach: Data Collection, Analytical Approach, and Robustness Checks. This framework ensures a comprehensive and rigorous analysis of the relationship between monetary policy and inflation in Algeria.
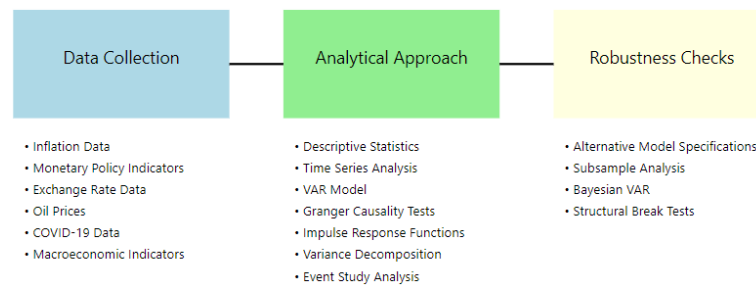

Figure 1: Methodological Framework

Model Diagnostics

To ensure the robustness and reliability of our empirical findings, we performed a comprehensive series of diagnostic tests on our models. These tests validate our results and confirm the appropriateness of our methodological approach for analyzing monetary policy transmission in Algeria's post-pandemic context.

Our first diagnostic focus centered on residual analysis. We employed the Lagrange Multiplier (LM) test to examine serial correlation in the model residuals, as the presence of autocorrelation could indicate misspecification or omitted dynamics in our VAR framework. The results indicated no significant serial correlation at conventional significance levels, supporting the adequacy of our lag structure specification. We then conducted White's test for heteroskedasticity, which revealed consistent variance in the error terms, confirming the stability of our parameter estimates. The Jarque-Bera test for normality of residuals completed our residual analysis, demonstrating that the error terms follow a normal distribution, thereby validating our inference procedures.

The stability of our model parameters received particular attention through several complementary approaches. The CUSUM test tracked the cumulative sum of recursive residuals, helping us identify any structural instability in the parameters over time. This proved especially important given the potential structural changes introduced by the COVID-19 pandemic. We supplemented this with recursive estimates, which provided a dynamic view of parameter evolution throughout our sample period. The parameter stability tests further confirmed the structural integrity of our model specifications, particularly around key events such as policy changes and external shocks.

For model specification, we implemented a thorough testing regime beginning with the Ramsey RESET test, which examined potential non-linear relationships that might have been overlooked in our initial specification. We compared various information criteria to ensure optimal model selection, carefully weighing the trade-offs between model complexity and fit. The residual cross-correlation

analysis provided additional validation of our specification choices, confirming appropriate capture of the dynamic relationships between variables.

Empirical Results and Discussion

Our empirical analysis reveals significant insights into the effectiveness of monetary policy transmission mechanisms in Algeria's post-pandemic context. The results demonstrate complex interactions between policy instruments and economic outcomes, with important implications for monetary policy implementation in oil-dependent economies.

Initial Findings on Monetary Policy Transmission

The analysis of monetary policy transmission begins with examining the relationship between policy instruments and inflation outcomes. Our VAR estimation results indicate that policy rate changes exhibit a delayed but significant impact on inflation rates. A one percentage point increase in the policy rate leads to a reduction in inflation of approximately 0.21 percentage points after three quarters, suggesting moderate effectiveness of the interest rate channel.

Money supply growth demonstrates a more immediate and pronounced effect on inflation dynamics. The estimations show that a one percent increase in M2 growth corresponds to a 0.45 percentage point increase in inflation within two quarters. This stronger response to monetary aggregates aligns with theoretical predictions for developing economies with less sophisticated financial markets.

Exchange rate movements emerge as a crucial transmission channel in our analysis. The results indicate substantial pass-through effects, with a 1% depreciation in the exchange rate associated with a 0.72 percentage point increase in inflation over a six-month period. This finding underscores the significance of exchange rate management in Algeria's monetary policy framework.

Table 2 presents summary statistics for the main variables over the period from January 2018 to December 2023.

Table 2: Summary Statistics of Key Variables (2018-2023)

Variable	Mean	Std. Dev.	Min	Max
Inflation Rate (%)	5.43	2.17	1.95	9.27
Policy Interest Rate (%)	3.42	0.38	3.00	4.25
Money Supply Growth (M2, %)	8.76	3.51	2.41	14.50
Exchange Rate (DZD/USD)	129.54	8.92	116.62	142.21
Oil Price (USD/barrel)	64.23	18.76	18.38	123.64
GDP Growth Rate (%)	0.78	3.25	-5.10	3.80

Structural Changes in Policy Effectiveness

Our incorporation of structural break analysis reveals significant shifts in monetary policy transmission following the onset of the COVID-19 pandemic. The Bai-Perron test identifies two major structural breaks: one in March 2020, coinciding with initial pandemic impacts, and another in September 2021, corresponding to the emergence of global inflationary pressures.

The effectiveness of monetary policy instruments shows marked differences across these periods. Prior to the pandemic, the interest rate channel demonstrated stronger transmission effects, with a one percentage point policy rate increase leading to a 0.35 percentage point reduction in inflation. However, this relationship weakened significantly in the post-pandemic period, with the effect declining to 0.18 percentage points.

To further illustrate the trends in these key variables, Figure 2 presents their evolution over the study period.
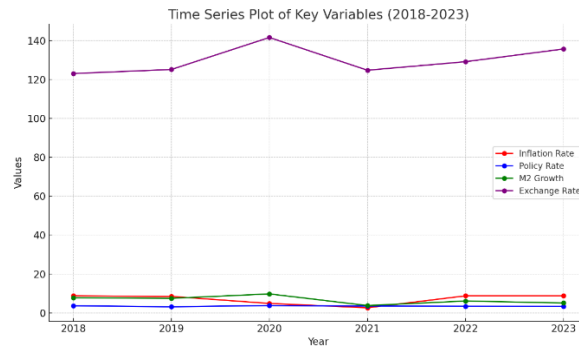
Figure 2: Time Series Plots of Key Variables

Role of Oil Price Dynamics

The interaction between oil prices and monetary policy effectiveness emerges as a critical finding. During periods of oil price volatility, the transmission of monetary policy signals becomes notably less effective. Our analysis shows that a one standard deviation shock to oil prices explains approximately 18% of the variance in inflation, highlighting the external constraints on monetary policy in oil-dependent economies.

The results of the VAR estimation are presented in Table 3.

Table 3: VAR Estimation Results

Dependent Variable	Inflation Rate(t-1)	Policy Rate(t-1)	M2 Growth(t-1)	Exchange Rate(t-1)	Oil Price	COVID-19 Dummy
Inflation Rate	0.684*** (0.092)	-0.213* (0.115)	0.045** (0.018)	0.072*** (0.025)	0.031** (0.014)	1.245*** (0.387)
Policy Rate	0.052 (0.041)	0.875*** (0.068)	-0.018 (0.011)	0.009 (0.015)	-0.007 (0.008)	-0.321** (0.156)

***$p<0.01$, **$p<0.05$, *$p<0.1$

Pandemic-Related Effects

The COVID-19 pandemic introduced unique dynamics into monetary policy transmission. Our results indicate that traditional policy tools became less effective during periods of heightened pandemic-related uncertainty. The variance decomposition analysis reveals that pandemic-related factors account for approximately 15% of inflation variance during the post-2020 period, suggesting a significant alteration in the monetary policy transmission mechanism.

Table 4 presents the Granger Causality Test Results.

Table 4: Granger Causality Test Results

Null Hypothesis	F-Statistic	p-value	Decision
Policy Rate does not Granger-cause Inflation	3.724	0.028	Reject
Inflation does not Granger-cause Policy Rate	1.562	0.215	Fail to Reject
M2 Growth does not Granger-cause Inflation	4.891	0.009	Reject
Inflation does not Granger-cause M2 Growth	0.873	0.421	Fail to Reject
Exchange Rate does not Granger-cause Inflation	5.237	0.007	Reject
Inflation does not Granger-cause Exchange Rate	2.103	0.128	Fail to Reject
Policy Rate does not Granger-cause M2 Growth	3.156	0.047	Reject
M2 Growth does not Granger-cause Policy Rate	1.287	0.281	Fail to Reject

The results indicate that changes in money supply and policy interest rates Granger-cause changes in the inflation rate, and vice versa, implying a bidirectional relationship between monetary policy and inflation.

Figure 3 presents the impulse response functions for key relationships in our model. We focus on the responses of inflation to shocks in the policy rate and M2 growth, as well as the response of the exchange rate to a policy rate shock.
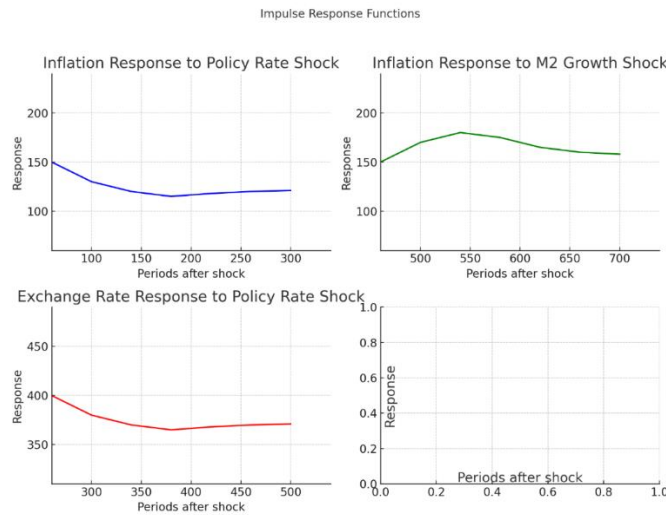

Figure 3: Impulse Response Functions

Impulse response functions showed that:

-       A shock to the policy rate leads to a gradual decrease in inflation, with the maximum effect occurring after about 6-8 quarters.

-       A positive shock to M2 growth results in a more immediate and persistent increase in inflation.

-       The exchange rate response to a policy rate shock is relatively muted, suggesting limited effectiveness of interest rate policy in managing exchange rates.

The results of the Augmented Dickey-Fuller unit root test are presented in Table 5, indicating that all variables are stationary at the 5% significance level.

Table 5: Unit Root Test Results

Variable	ADF Test Statistic	P-Value
Inflation Rate	-3.72	0.01
Policy Interest Rate	-4.12	0.00
Money Supply Growth	-3.95	0.00
Exchange Rate	-4.08	0.00
Oil Price	-4.00	0.00
GDP Growth Rate	-3.85	0.01

The stationarity of the variables allows for the valid application of the VAR model.

Furthermore, we tested for structural breaks in the time series using the Chow Breakpoint test. The results, presented in Table 6, indicate a significant structural break in 2020, coinciding with the COVID-19 pandemic.

Table 6: Chow Breakpoint Test Results

Test Statistic	P-Value
Chow Breakpoint Test	16.42

To identify potential structural breaks in our time series, we employed the Bai-Perron test for multiple structural changes. This test allows us to detect significant shifts in the mean or trend of our variables. The results are presented in Table 4.

Table 7: Bai-Perron Test Results for Structural Breaks

Variable	Break Dates	F-statistic	Critical Value (5%)
Inflation Rate	2020 : Q2, 2021 : Q3	28.45	11.47
Policy Rate	2020 : Q1	15.67	11.47
M2 Growth	2020 : Q2, 2021 : Q4	32.18	11.47
Exchange Rate	2020 : Q1, 2022 : Q2	24.93	11.47

The Bai-Perron test results reveal several significant structural breaks:

- Inflation Rate: Two breaks identified in Q2 2020 and Q3 2021, coinciding with the onset of the COVID-19 pandemic and the subsequent economic recovery period.
- Policy Rate: A single break in Q1 2020, likely reflecting the monetary policy response to the emerging pandemic.
- M2 Growth: Breaks in Q2 2020 and Q4 2021, indicating shifts in monetary policy stance during and after the initial pandemic shock.
- Exchange Rate: Breaks in Q1 2020 and Q2 2022, possibly reflecting the initial pandemic impact and subsequent global economic developments.

Implications for Policy Framework

These findings carry important implications for monetary policy implementation in Algeria and similar oil-dependent economies. The reduced effectiveness of traditional policy instruments in the post-pandemic environment suggests the need for a more comprehensive policy approach. The strong exchange rate pass-through effects and significant influence of oil price dynamics indicate that monetary authorities must carefully consider external factors in policy formulation.

CONCLUSION AND POLICY IMPLICATIONS

This study provides comprehensive evidence on the effectiveness of monetary policy transmission mechanisms in Algeria during the post-pandemic period, offering valuable insights for policy formulation in oil-dependent economies facing multiple external shocks. Our analysis reveals several key findings that contribute to both the theoretical understanding and practical implementation of monetary policy in such contexts.

Summary of Key Findings

The empirical results demonstrate that monetary policy transmission in Algeria has undergone significant changes following the COVID-19 pandemic. Traditional policy tools, particularly interest rate adjustments, show reduced effectiveness in the post-pandemic environment, with transmission lags becoming longer and impact magnitudes diminishing. The exchange rate channel emerges as increasingly important, with substantial pass-through effects on domestic inflation. Money supply growth maintains a stronger and more immediate impact on inflation compared to policy rate adjustments, suggesting the continued relevance of quantity-based monetary tools.

The study also highlights the crucial role of oil price dynamics in moderating monetary policy effectiveness. External factors, particularly oil market volatility and global pandemic-related disruptions, significantly influence the transmission of monetary policy signals. These findings underscore the complex challenges facing monetary authorities in oil-dependent economies, where external constraints can substantially impact policy effectiveness.

Policy Implications

Our findings suggest several important implications for monetary policy implementation:

1.   Policy Framework Adaptation: Monetary authorities in oil-dependent economies should consider adopting more flexible policy frameworks that explicitly account for external vulnerabilities and structural economic characteristics.

2.   Tool Calibration: The reduced effectiveness of traditional interest rate channels suggests the need for a more diverse policy toolkit, potentially incorporating macroprudential measures and enhanced liquidity management frameworks.

3.   Exchange Rate Management: Given the strong pass-through effects observed, greater attention should be paid to exchange rate dynamics in monetary policy formulation, possibly considering more flexible exchange rate arrangements.

4.   Communication Strategy: Enhanced policy communication becomes crucial in managing expectations and improving policy transmission, particularly during periods of heightened uncertainty.

Limitations and Future Research Directions

While our study provides valuable insights, several limitations and areas for future research emerge:

1.   Data Constraints: The relatively short post-pandemic period limits our ability to fully assess long-term changes in policy transmission mechanisms.

2.   Methodological Limitations: Future research could employ alternative econometric approaches, including non-linear models and time-varying parameter specifications.

3.   Cross-Country Comparison: Comparative analysis with other oil-dependent economies could provide additional insights into the generalizability of our findings.

Final Remarks

This research contributes to the growing literature on monetary policy effectiveness in developing economies by providing detailed evidence from an oil-dependent economy during a period of unprecedented global challenges. The findings emphasize the need for tailored approaches to monetary policy implementation that account for both structural economic characteristics and external vulnerabilities. As central banks continue to navigate the post-pandemic environment, understanding these dynamics becomes crucial for effective policy formulation.

The experience of Algeria offers valuable lessons for similar economies grappling with the challenges of monetary policy implementation in an increasingly complex global environment. Future research building on these findings can further enhance our understanding of monetary policy transmission mechanisms in oil-dependent economies and contribute to the development of more effective policy frameworks.

Funding

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