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Abstract

This study investigates the dynamic interplay between crude oil price shocks and short-term interest rates in India, emphasizing the effects of inflation targeting (IT) regime implemented in 2016. Considering India's position as a significant importer of crude oil, it is essential to comprehend the monetary policy reaction to changes in energy prices, particularly regarding developing institutional frameworks. The study utilizes time-series data on monthly-basis spanning from 2011 to 2024 and applies the Autoregressive Distributed Lag (ARDL) model to examine the long-run relationships between crude oil prices and interest rate proxies, such as **the 91-day Treasury bill rate and the Call Money rate**. Two model specifications are employed to investigate structural changes in policy responsiveness. The first estimate of the relationship uses the full sample and includes an interaction term between crude oil prices and an IT regime dummy to account for shifts occurring after 2016. The second model splits the sample into periods before and after IT, estimating distinct regressions for each. The study indicates that after inflation targeting was adopted, interest rates became significantly less sensitive to shocks in crude oil prices. The pooled model's notable and adverse interaction term indicates a muted policy reaction following the IT, whereas the post-IT model reveals that oil prices have an insignificant effect on interest rates, signifying a structural change in the monetary policy rule. The results indicate that the Reserve Bank of India (RBI) has embraced a framework that is more forward-looking and driven by expectations, with a less aggressive response to temporary supply-side shocks. According to the paper's conclusion, inflation targeting has played a role in establishing a more stable monetary policy stance in India that emphasizes credibility.

Keywords: Oil price shocks, Inflation targeting, RBI, ARDL

1. Introduction

The uneven distribution of crude oil across regions with abundant reserves concentrated in major economies such as United States, Russia and OPEC members like Saudi Arabia allow these countries to strategically control supply. This often results into price shocks in developing countries like India where more than 85% of oil consumption is sourced from imports. The volatility of global crude oil prices driven by supply chain disruptions, OPEC decisions, supply-demand imbalances frequently transmit supply side shocks into Indian Economy which is evident from surge in oil prices followed by Russia–Ukraine conflict at the start of 2022. (Simshauser, 2023). These energy price shocks exert substantial macroeconomic impacts in terms of inflation, economic growth, exchange rate, balance of payments. For instance, Lebrand, Vasishtha, Yilmazkuday, 2024 found that the real oil price shock leads to a worsening of the current account balances for countries that import oil.

Due to the growing intensity of global interconnectedness and the frequent occurrence of exogenous shocks, managing monetary policy in emerging market economies has become more complicated. Among these shocks, variations in the price of crude oil are of major macroeconomic importance due to India's structural dependence on energy imports. These fluctuations create significant difficulties for macroeconomic management tasks such as controlling inflation, ensuring fiscal sustainability, managing current account dynamics, and addressing exchange rate volatility. The Reserve Bank of India (RBI) primarily guides monetary policy, which is responsible for sustaining economic growth while ensuring price stability. This dual mandate becomes even more complicated during times of energy price volatility. In such situations, it is crucial for the central bank to comprehensively adjust its interest rate choices, considering the inflationary effects of increasing crude prices in relation to the growth implications of stricter monetary conditions. When inflationary pressures stem from supply-side factors like global oil price spikes that the central bank cannot directly control, the policy response must be even more nuanced. India's monetary policy framework has experienced numerous paradigm shifts, influenced by changing macroeconomic challenges, global financial integration, and domestic institutional reforms. Dua, P, 2020 reviews the development of monetary policy framework and stated that during the early years following independence, the RBI operated as a developmental central bank. Its main function was to provide credit to priority sectors and oversee liquidity in accordance with India's planned development agenda. Tools such as the Cash Reserve Ratio (CRR), Statutory Liquidity Ratio (SLR), and administered interest rates were employed to guide credit distribution rather than to control inflation. The goals of the central bank were mostly in agreement with the government's wider economic aims, and price stability was not a stated objective. In the middle of the 1980s, persistent inflation fueled by substantial fiscal deficits and their monetization led to a reassessment of the monetary framework. In 1985, the Chakravarty Committee suggested implementing Monetary Targeting with Feedback, emphasizing the control of broad money supply growth (M3) as a strategy to attain price stability. The RBI adopted this framework, but its effectiveness diminished over time as a result of structural changes in the financial system, interest rate deregulation, and the increasing openness of the

Indian economy. Under the leadership of then-Governor Dr. Bimal Jalan, the RBI introduced the Multiple Indicator Approach (MIA) in 1998, acknowledging these limitations. This method broadened the range of monetary policy by including a diverse set of economic and financial indicators such as inflation expectations, credit growth, exchange rates, and capital flows in the decision-making process. Although the MIA offered greater flexibility in dealing with various macroeconomic conditions, it remained discretionary and did not have a clear nominal anchor. A major turning point came in 2014, with the publication of the Urjit Patel Committee Report in 2014, which advised a shift to a Flexible Inflation Targeting (FIT) framework. The committee contended that continuous growth could only occur in an environment of low and stable inflation, and that establishing a clear inflation target would improve transparency and stabilize expectations. Following these recommendations, the Indian government and the RBI entered into the Monetary Policy Framework Agreement (MPFA) in 2015. Subsequently, in 2016, the RBI Act was amended to formalize inflation targeting as part of institutional practice. Within this new framework, the Consumer Price Index (CPI) became the main nominal anchor, establishing a medium-term inflation target of 4% and a tolerance band of $\pm 2\%$. A major institutional reform was the establishment of the Monetary Policy Committee (MPC), which consists of three internal and three external members, responsible for determining the policy interest rate (repo rate) based on data and in a transparent way. Additionally, the framework established accountability measures: should inflation stay outside the target band for three consecutive quarters, the RBI must provide the government with a report detailing the reasons, corrective actions, and a proposed timeline for rectification.

The RBI operationally uses the repo rate as its main policy instrument for affecting short-term interest rates, while liquidity is handled through open market operations, reverse repos, and forex interventions. The aim is to ensure that the weighted average call money rate (WACR) which serves as the operational target remains in proximity to the policy rate, thus strengthening monetary transmission. Although this rules-based strategy has improved the clarity and credibility of policy, it also prompts an important question: how does the RBI deal with supply-side shocks, like fluctuations in global crude oil prices, within a strict inflation-targeting framework? According to traditional inflation-targeting literature, central banks should to respond symmetrically to all causes of inflation. In practice, though, central banks especially in emerging markets often make a distinction between demand-driven and supply-driven inflation. Crude oil price shocks are mostly exogenous; they affect inflation directly through fuel prices and indirectly via transportation and manufacturing costs as well as expectations. In such a situation, is it advisable for the RBI to increase interest rates to address escalating headline inflation, despite core inflation being low and economic growth being sluggish? Or should it 'look through' these temporary supply shocks and keep an accommodating stance?

In the period post- 2016, these questions are particularly relevant. It was anticipated that the RBI's shift to inflation targeting would change its policy reaction function, especially regarding the prioritization of inflation control over output stabilization. Examining the timeframes prior to and following the implementation of inflation targeting offers a promising basis for assessing whether the RBI has become more hawkish as a reaction to energy price shocks specifically,

whether it has reacted more forcefully with interest rate increases when faced with oil-driven inflation risks. This analysis has become more crucial in recent years due to episodes of extreme volatility in oil prices experienced by the global economy. Various factors have led to significant volatility in international oil markets, including the recovery from COVID-19, disruptions in supply chains, limitations on production by OPEC+, geopolitical tensions (especially the Russia–Ukraine conflict). In India, these variations have often resulted in inflationary pressures, leading to a policy dilemma for the RBI. In light of these supply shocks, the central bank must decide whether to tighten monetary policy or adopt a more nuanced approach that takes into account the broader macroeconomic environment.

While the existing literature focuses on the impact of oil price shocks, this paper analyses how monetary policy measured through indicators such as 91-day treasury bill rate and Weighted average call money rate (WACR) - which serve as important indicators of monetary policy transmission has responded to crude oil price shocks before and after the adoption of Inflation targeting regime. This time frame January 2010 to December 2024 was selected to encompass not just the shift in policy regime but also significant macroeconomic occurrences, including oil price collapses (2014–15), a synchronized global recovery (2017–18), and supply constraints following the pandemic (2021–22) as reflected in Fig. 1.

The rest of the paper is organised as follows: Section 2 presents a review of existing literature. Section 3 introduces the theoretical background. The data used for the estimation and methodology is discussed in Section 4. The empirical results are discussed in Section 5. Section 6 concludes with certain policy suggestions.

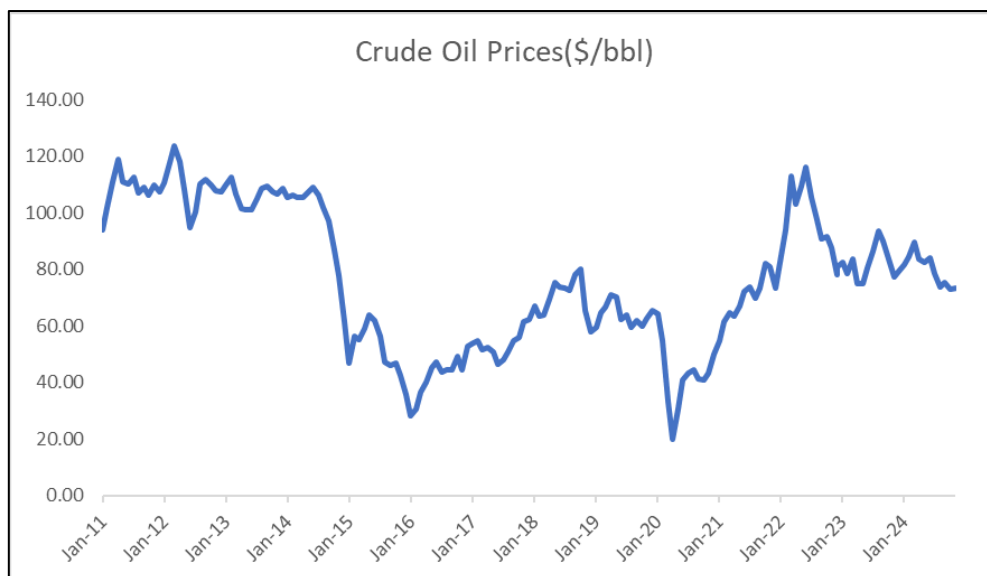


Fig.1. Volatility in oil prices over years

2. Literature Review

The literature has extensively examined energy price shocks, especially those related to crude oil prices. However, the study of volatility in crude oil prices and its impacts is still limited in certain areas, including effects on consumer price indices, agricultural commodity prices, economic growth, exchange rates and Balance of payments. Methodologies range from econometric to macroeconomic approaches, such as dynamic stochastic general equilibrium and computable general equilibrium modelling, GTAP-E-PowerS Model, VAR. Historically, the energy price fluctuations have drawn the attention of economists and policy makers due to its broader impact across sectors and economies as energy price shocks led to an overall reduction in the economic performance of Southeast Asian countries, with real GDP declines of 1 % in the Philippines, 1.5 % in Singapore, 2.7 % in Vietnam and Indonesia, and 3.8 % in Malaysia and Thailand as suggested by Nguyen, Nong, Simshauser, Pham (2024). More importantly, Mirza, Naqvi, Rizvi, Boubaker (2023) found that in economies that target inflation, escalating energy costs lead to increased inflation rates. These economies encounter significant difficulties in preserving their core price stability objectives because of exchange rate pass-through effects, particularly during crises involving energy prices. On the demand side, Peersman, Wauters, (2024) concluded that households react considerably more intensively to escalations in energy prices. The reported price elasticity of energy demand is -0.36 for price increases and -0.07 for decreases; thus, the MPC after paying the energy bill is significantly greater for energy price increases than for decreases of similar magnitude. On similar grounds Priya, Sharma (2024) stated that the transmission channels of energy prices and monetary policy shocks to household consumption indicate that purchasing power losses resulting from increased energy costs and monetary policy shocks negatively impact all segments of household consumption. The reduction is most pronounced in services consumption, meaning that the burden of escalating energy prices is passed on to relatively elastic segments of household expenditure, such as services. Wildauer et al. (2023) depicts the distributive impacts of energy price shocks via a three-sector conflict inflation model, emphasizing that energy shocks elevate inflation and shift income from labour to capital, exacerbating inequality. Their simulation shows that rising energy prices result in higher mark-ups in non-energy sectors due to supply bottlenecks and changes in sectoral demand—this effect was especially pronounced during the COVID-19 pandemic. On the fiscal front, Escalante and Mamboundou (2024) investigate strategies for governments to reduce the macroeconomic consequences of external price shocks. Employing a recursive dynamic CGE model calibrated for Portugal, they discover that decreases in production taxes lead to the most beneficial results by enhancing sectoral competitiveness and alleviating inflation, all while avoiding excessive strain on public finances. On the other hand, strategies focused on increasing wages or providing direct transfers do raise household incomes but also tend to worsen inflationary pressures and put a strain on fiscal sustainability. In the context of the Eurozone, Casoli et al. (2024) provide a more detailed examination by isolating the effects of supply shocks from oil and natural gas on real and expected inflation, while also stressing the importance of distinguishing between headline and core inflation for a precise assessment of energy shock impacts. On the other hand, Bigerna (2023) concludes that the inflationary reaction to energy shocks depends significantly on the characteristics of exchange rate regimes and oil import portfolios. Her VARX model across G20 economies shows that countries with high exchange rate pass-through and asymmetric oil dependencies have more volatile inflation, highlighting the importance of country-specific policy design. Expanding beyond inflation, Lebrand et al. (2024) investigates the effect of energy price shocks on current account balances in 45 emerging and

developing economies through country-specific SVAR models, revealing that a 1% increase in oil prices boosts exporters' current accounts by up to 0.11 percentage points, while over five years it deteriorates the current accounts of importers by 0.08 points. Significantly, the study distinguishes between oil supply and demand shocks, showing that oil demand shocks have a more pronounced effect on current accounts than supply shocks do. This is in line with the idea that global demand booms elevate oil prices and trade imbalances, and the findings highlight the importance of changes in energy prices for external sustainability, especially in net energy-importing economies like India. Kumar (2005) states that oil price shocks have a detrimental effect on industrial production growth, and that a doubling of oil prices results in a one percent decrease in the growth of industrial production. Recognising the significant macroeconomic disruptions and shift in monetary policy regime in India, Raghuvanshi, Ahmad (2024) offers a thorough evaluation of the impact that the introduction of the Flexible Inflation Targeting (FIT) regime in 2016 has had on the monetary policy transmission dynamics in India, demonstrating that the credit and interest rate channels continue to be the primary mechanisms, with enhanced efficacy in terms of influencing inflation since FIT was adopted. Contrary to popular view, Eichengreen, Gupta, and Choudhary (2021) finds no evidence that the RBI tightened policy excessively post-IT; rather, once inflation and output gaps are accounted for, policy rates appear to have become less aggressive. They emphasize that after 2016, inflation anchoring has improved, with actual inflation shocks having a reduced impact on inflation expectations. Patnaik and Pandey (2020) offer an assessment of India's shift to a FIT framework and states that the Monetary Policy Committee (MPC) demonstrated caution in setting rates, especially when inflation and demand were decreasing and the divergence in voting behaviour among MPC members and cases of inflation forecasts that were too high, which may have played a role in conservative policy choices. Despite these challenges, the framework led to greater transparency and discipline in monetary policy thus laying the groundwork for enhanced macroeconomic stability. Rajadhyaksha and Misra (2021) finds that the disinflation was driven by structural and exogenous factors such as lower global commodity prices and subdued MSP hikes part of it can be attributed to improved anchoring of inflation expectations under the new framework. Additionally, changes in inflation dynamics, including reduced persistence and a shift in the convergence pattern between core and headline inflation, are linked to stronger central bank credibility. Complementing this institutional perspective, Garga, Lakdawala, and Sengupta (2022) undertake an empirical evaluation of the confidentiality of the Reserve Bank of India's dedication to inflation targeting, utilizing survey-based forecasts and financial market data, financial markets perceived a more robust and systematic monetary policy response to inflation shocks. The sensitivity of policy rates to inflation, as perceived by the market, increased more than twofold, and adjustments in interest rate expectations due to macroeconomic news became much more noticeable implying that inflation expectations are better anchored and support the perspective that market participants acknowledge FIT in India as a credible commitment. In contrast to studies assessing the inflation targeting regime, Dua and Pandit (2002) provide insights into fundamental perspective on the dynamics of interest rates in India after liberalization, it offers crucial insights into how domestic and external macroeconomic factors interact as they develop with demonstrating that Indian interest rates reflected in commercial paper and Treasury bill rates are significantly affected by factors such as real money supply, government spending, inflation expectations, foreign interest rates, and forward exchange rate premiums. The results, robust across multiple specifications and inflation expectation models, highlight the ongoing prevalence of domestic monetary and fiscal influences in accounting for changes in real interest rates, even with growing integration into global financial markets. Further, Bijoy

and Shivam (2021) extend the discussion to crisis-era monetary policy, conducting a critical assessment of how the Reserve Bank of India responded to the COVID-19 shock. They emphasize its timely and multifaceted approach, which included cutting policy rates, infusing liquidity, purchasing assets, and easing regulations. To stabilize financial markets and ensure credit flow particularly given the lack of expansive fiscal space the RBI resorted to unconventional measures like LTROs and the G-SAP. It was determined that these measures were comparable in scale and scope to those implemented by central banks in advanced economies. In contrast Agarwal and Lavanya (2021) raise doubts about how effective inflation targeting is at the macroeconomic level in developing economies. Their analysis uncovers minimal evidence that targeting inflation results in structural breaks in the trends of inflation or GDP growth. In particular with regard to India, they observe that disinflation commenced before the formal implementation of inflation targeting, implying that the improvements seen may not be causally connected to the change in regime, highlighting that although inflation targeting can help with policy credibility, it is not a cure all for achieving macroeconomic stability.

In view of the literature, there are several aspects that have not been thoroughly studied. This paper aims to address the lack of analysis on monetary policy before and after the implementation of Inflation Targeting (IT) pertaining to external shocks by investigating whether there has been a shift toward a more hawkish stance following the introduction of IT. This investigation involves examining the impact of energy price shocks, especially those related to crude oil prices, on interest rates.

3. Theoretical Framework

To comprehend the consequences of crude oil price levels on monetary policy dynamics, particularly within Indian context, it is important to anchor the discussion in economic theory. The framework that supports the analysis is New Keynesian macroeconomic paradigm, with a particular focus on the expectations augmented Phillips curve, Taylor's rule, interest rate transmission and the principles underlying inflation targeting regime in open economies.

3.1 Oil prices and inflation: The Supply side shock

As an essential production and transport input, crude oil serves as a primary supply side factor influencing inflation. A positive oil price shocks results in the increased cost of input leading to cost-push inflation. The New Keynesian Phillips curve illustrates the trade-off between inflation and output levels. In its simplified expectations-augmented form:

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa(y_t - y^*) + \gamma S_t$$

On the left-hand side, π_t represents the current inflation which is a function of expected future inflation ($E_t(\pi_{t+1})$), output gap ($y_t - y^*$) and supply shock (S_t). β, κ, γ are the parameters.

In our context, crude oil enters as exogenous supply shocks, if monetary authorities do not remain vigilant, these shocks may result in second-round effects, causing inflation expectations to become unanchored and leading to increased wage demands and overall price rises.

3.2 Taylor Rule and Monetary Policy Response to Shocks

Originally suggested by John B. Taylor in 1993, the Taylor Rule offers a systematic approach to determining interest rates that is grounded in economic fundamentals, especially the difference between actual and target inflation rates and the output gap. This influential rule-based approach to monetary policy has played a significant role in understanding central bank behaviour and assessing whether policy stances are overly tight or accommodative. Woodford (2001) elaborates that the rule offers both a descriptive framework for past U.S. monetary policy and a normative benchmark based on macroeconomic theory. It helps achieve equilibrium determinacy when the policy rate responds to inflation with sufficient strength which is referred to as the Taylor principle. The rule suggests how central banks should change interest rates to account for deviations in inflation and output from their targets:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y^*)$$

where, i_t is the nominal interest rate, r^* is the real neutral interest rate, π_t is the current inflation, π^* is the inflation target and $(y_t - y^*)$ is the output gap.

Under this rule, if inflation rises because of an oil shock ($\pi_t > \pi^*$) then the interest rate should be increased. This framework reinforces the notion that credible monetary policy should systematically respond to inflationary pressures. While Woodford (2001) notes that the Taylor Rule may not always be optimal in every theoretical model, its robust properties across a range of settings make it a valuable guide for monetary policy formulation.

3.3 Interest rate transmission channel of monetary policy

The central bank following an inflation-targeting regime will increase the nominal policy rate in the face of oil-induced inflation spike to anchor expectations and dampen inflationary pressures. This subsequently affects short-term market interest rates such as 91-day treasury bill. In India, the T-bill rate reacts significantly to the monetary policy stance. In an inflation-targeting

framework, it serves as a leading indicator of market expectations regarding future changes to the policy rate. The policy rate and short-term interest rates interact dynamically, as shown by:

$$i_t^{Tbill} = i_t^{policy} + \delta_t$$

where, i_t^{Tbill} is the T-bill rate, i_t^{policy} is the RBI's policy rate (repo rate) and δ_t captures market expectations and liquidity conditions.

Thus, when RBI anticipates oil-driven inflation, the repo rate is raised to keep inflation at or below target levels and T-bill rate adjust accordingly. Therefore, the study uses T-bill as the proxy for the policy rate.

3.4 Open Economy Considerations and External Shocks

The open structure of India's economy means that external price shocks, especially those related to oil imports, have significant effects on inflation and exchange rates. As per the Mundell-Fleming model, in a semi-open economy with managed exchange rates, monetary policy must consider the trade-off between controlling inflation and maintaining currency stability.

Crude oil price shocks can lead to a depreciation of the rupee by enlarging the trade deficit, which in turn exacerbates inflation. In such situations, the RBI might act by raising the policy rate, thereby increasing the T-bill rate to sustain capital inflows and manage inflation expectations.

4. Data, Methodology and Empirical Model

This section discusses the methodology applied for estimating the empirical model along with data sources and definitions.

4.1 Data Source and Definitions

The study employs monthly data from January 2011 to December 2024 for various macroeconomic variables to test the hypothesis of whether the monetary policy have become Hawkish after IT regime by analysing the influence of crude oil prices on TB-rate and Weighted Average Call Money rate. Data are primarily sourced from Database on Indian Economy- RBI, Ministry of Petroleum and Natural Gas-GOI, Controller General of Accounts-Ministry of Finance, GOI. The 91day-TB rate and WACR are the dependent variables. The prices of crude oil are calculated as the average of Oman and Dubai for sour grades, and Brent for sweet grade, based on the ratio of crude processed during the previous financial year. The unit of measurement is

\$/bbl. The monthly prices are the average of daily prices. IIP growth is reported as a percentage change compared to the equivalent period in the previous year. Real Effective Exchange Rate with base year 2015-16 is based on Export Weighted 40-Currency Basket. The analysis also incorporates additional control variable i.e., US TB rate, Fiscal Deficit, Trade Balance. The Study also constructs two dummy variables, namely *Coviddummy* and *PostITdummy* to control for effects of Covid-19 and the structural change in monetary policy. The dummy variable *Coviddummy* takes the value '1' for the period March 2020 to December 2022 and '0' otherwise. The dummy variable *PostITdummy* takes the value '1' from August 2016 onwards i.e., the period from which RBI formally adopted the IT regime. Table 1 summarizes the dependent, explanatory and control variables used in study.

Table 1
Definition and source of variables

Variable	Description	Data source
India's Treasury Bill rate	Yield on 91-day Treasury Bills, representing short-term market interest rates.	Database on Indian Economy, RBI
Call Money rate	Interest rate at which short-term funds are borrowed and lent in the overnight money market	Database on Indian Economy, RBI
Crude Oil Prices	Average of Oman & Dubai for sour grades and Brent for sweet grade based on the ratio of crude processed in the last financial year (\$/bbl.)	Ministry of Petroleum & Natural Gas, GOI
IIP Growth	The percentage change in the Index of Industrial Production	Database on Indian Economy, RBI
US Treasury Bill rate	The short-term interest rate on U.S. Treasury bills	Federal Reserve Economic Data
Fiscal Deficit	Government's total expenditure minus total revenue (Rs. Crores)	Controller General of Accounts, Ministry of Finance, GOI
REER	An inflation-adjusted weighted average of the Indian currency in relation to basket of key currencies.	Database on Indian Economy, RBI
Trade Balance	Difference between the value of goods and services exported and imported. (US \$Millions)	Database on Indian Economy, RBI

4.2 Empirical Model

Our empirical models estimate the relationship between fluctuations in crude oil prices and monetary policy in India while accounting for structural changes associated with policy regime shifts and exogeneous shocks such as Covid-19 pandemic by employing two distinct specifications. In both models, the dependent variable is the 91-day Treasury Bill rate, which acts as a proxy for the short-term policy stance of the RBI and the intermediate target, Call Money rate. The main independent variable of interest is the prices of crude oil, while additional controls consist of macroeconomic indicators as mentioned in Table 1.

Model 1: Pooled Estimation with Structural Dummies and Interaction term

In this, specification is estimated over the full sample period and as discussed earlier, includes an interaction term that combines crude oil prices with a dummy variable *PostITdummy* denoting the post-inflation targeting regime i.e., it takes value of 1 from August 2016 to December 2024 and is 0 at all other times. This interaction term allows for the identification of differential marginal effects of crude oil prices within the new monetary policy framework. Furthermore, a dummy variable representing the COVID-19 period which takes value of 1 from March 2020 to December 2024 and 0 otherwise is added to account for the exogenous shock brought about by the pandemic. The standard form of model is presented as:

$$IndTBrate_t = \beta_0 + \beta_1 CrudeOilPrices_{t-k} + \beta_2 IIPGrowth_{t-k} + \beta_3 USTBrate_{t-k} + \beta_4 FiscalDeficit_{t-k} + \beta_5 Reer_{t-k} + \beta_6 TradeBalance_{t-k} + \beta_7 Oil_PostITDummy_{t-k} + \beta_8 CovidDummy + u_t \quad (1.1)$$

$$CallMoneyrate_t = \beta_0 + \beta_1 CrudeOilPrices_{t-k} + \beta_2 IIPGrowth_{t-k} + \beta_3 FiscalDeficit_{t-k} + \beta_4 Reer_{t-k} + \beta_5 TradeBalance_{t-k} + \beta_6 Oil_PostITDummy_{t-k} + \beta_7 CovidDummy + u_t \quad (1.2)$$

Where IndTBrate is India's 91-day Treasury Bill rate, The Call Money rate represents the interest rate for overnight loans between banks in the call money market., Oil_PostITDummy is the interaction term of crude oil prices and Post-IT Dummy (Crude oil prices × Post IT Dummy), CovidDummy is dummy variable for COVID-19 period. Additionally, other control variables described earlier include: IIP Growth, US Treasury Bill rate (USTBrate), Fiscal Deficit, REER and Trade Balance.

Model 2: Sub Sample Estimation for Pre and Post- IT periods

The second model assesses the interplay of crude oil prices and monetary policy separately for the periods before and after the introduction of IT wherein Sample 1 is from January 2011 to July 2016 and Sample 2 is from August 2016 to December 2024. This method of estimating sub-samples allows for complete parameter heterogeneity between the two monetary policy regimes, thus facilitating an unrestricted comparison of the magnitude and direction of the influence of crude oil prices on interest rates. The model for each period takes the standard form as:

$$IndTBrate_t = \beta_0 + \beta_1 CrudeOilPrices_{t-k} + \beta_2 IIPGrowth_{t-k} + \beta_3 USTBrate_{t-k} + \beta_4 FiscalDeficit_{t-k} + \beta_5 Reer_{t-k} + \beta_6 TradeBalance_{t-k} + u_t \quad (2.1)$$

$$CallMoneyrate_t = \beta_0 + \beta_1 CrudeOilPrices_{t-k} + \beta_2 IIPGrowth_{t-k} + \beta_3 FiscalDeficit_{t-k} + \beta_4 Reer_{t-k} + \beta_5 TradeBalance_{t-k} + u_t. \quad (2.2)$$

Additionally, in Sample 2 the Covid Dummy which equals 1 for March 2020 to December 2022 and 0 otherwise is included to account for the effect of the Covid-19. This specification permits the crude oil interest rate relationship to develop naturally as a reaction to structural changes in the monetary policy framework by estimating the model independently for each regime, without imposing any constraints between the two sub-periods. This allows for a direct comparison of the estimated effects to assess how much the monetary policy response to energy price shocks has changed since the adoption of the inflation-targeting regime.

4.3 Methodology

Using time series data methodology, the study estimates the proposed relationship. We employ the ARDL cointegration method introduced by Pesaran et al. (2001) to investigate the cointegrating characteristics of the estimated equation. The most significant benefit of this testing and estimation method is its applicability regardless of whether the regressors are stationary or non-stationary at level i.e., it is suitable for mixed order integration I (0) and I (1). Moreover, the challenge of endogeneity is less of a problem if the model is free of residual correlation as it accommodates lagged values of the independent variables and incorporates an error correction term. The ARDL approach generates estimates for short-run dynamics as well as long run equilibrium relationships; however, this study primarily focuses on the interpretation of long-run coefficients, which reflect the enduring effect of explanatory variables on the 91-day Treasury bill rate and Call Money rate. Before applying ARDL, the study conducts precautionary tests to ensure that the data is free from potential econometric errors. We employ the Augmented Dickey-Fuller test (ADF) to examine whether the variables are stationary at level or at first difference for testing stationarity. After estimating the ARDL model with the optimal lag length selected using AIC, a bounds cointegration test is performed to show whether the variables in the model are cointegrated. With this step, we can test the null hypotheses $\beta_1 = \beta_2 = \beta_3 = \dots = \beta_i = 0$. A rejection of the null hypothesis suggests that the variables represented by the model exhibit a joint movement over the long term, indicating the presence of long-run cointegration among them.

5. Results and Discussions

5.1 Stationarity Results

As the ARDL estimation method depends on the integration order and stationarity characteristics of the variables, we start our analysis by verifying whether the variables are of mixed order integration specifically, I (0) and I (1). To confirm the statistical properties of each variable and determine their order of integration, we use the ADF unit root test. In the context of the ADF test, the null hypothesis posits that a unit root is present (indicating non-stationarity), whereas the alternative hypothesis contends that the series is stationary. The test is applied to variable in their level form as well as on their first difference. Table 2 reports the results of stationarity for both Model 1 and Model 2 which shows that In Model 1, all variables are non-stationary at level except for IIP Growth and Fiscal Deficit; however, when we take the first difference, all variables become stationary. Similarly, in Model 2- Pre IT Call Money rate, IIP Growth, Fiscal Deficit and Trade balance are stationary at level while others are non-stationary. After taking the first difference, all variables became stationary. In Post-IT, IIP Growth, Fiscal Deficit and REER are stationary at level whereas all other variables are non-stationary. All variables became stationary at first difference. These results confirm that variables are mix of I (0) and I (1) therefore, ARDL is the best suited approach.

Table 2

Tests for Stationarity		IndTBrate	CallMoney	CrudeOilPrices	IIPGrowth	USTBrate	FiscalDeficit	REER	TradeBalance
Model 1									
	Level	-1.251	-1.384	-2.011	-5.298***	-2.005	-7.696***	-2.072	-2.137
	First Difference	-9.559***	-15.691***	-8.239***	-8.367***	-2.663***	-9.966***	-8.659***	-7.645***
Model 2									
PRE IT									
	Level	-2.337	-3.532**	-2.052	-3.610***	-2.154	-8.515***	-2.006	-3.756**
	First Difference	-6.268***	-4.943***	-5.207***	-5.651***	-4.759***	-13.652***	-4.149**	-6.156***
POST IT									
	Level	-1.083	-1.468	-1.986	-4.041**	-1.927	-8.581***	-3.419**	-1.843
	First Difference	-11.396***	-3.079**	-6.299***	-8.330***	-2.239**	-15.424***	-4.473***	-5.897***

, **, and * show the significance of results at the level of 10%, 5%, and 1%, respectively”

5.2 ARDL Results

The lag order of the model had to be established prior to estimating the long-term coefficient. The actual statistics of the sample data were used to identify the optimal lag order for each variable in model using Akaike Information Criteria (AIC). This paper restricted the maximum lag order for each variable to 3 considering the length of sample data.

5.2.1 Model 1

The long run results of the Model 1- pooled estimation from January 2011 to December 2024 i.e., the entire period are reported in Table 3 with dependent variable as IndTBrate and Call-Moneyrate. With IndTBrate as dependent variable, we note that crude oil prices have a statistically positive coefficient at a 1% level suggesting that indicating that rises in crude oil prices are linked to tighter monetary policy positions. The interaction term for crude oil prices after the implementation of inflation targeting (Oil_PostITDummy) is negative and significant at a 1% level which suggests that the responsiveness of interest rates to crude oil shocks has diminished in the period following the adoption of inflation targeting. There is a notable positive impact of US Treasury bill rates on Indian short-term interest rates, represented by a coefficient of 0.18991, which is significant at the 5% level. Among the macroeconomic controls, the real effective exchange rate (REER) shows a significant adverse relationship with the dependent variable at the 5% level suggesting that an appreciation of the REER is associated with a decrease in domestic short-term interest rates. Other factors, including IIP growth, fiscal deficit, and trade balance, do not have statistical significance in accounting for the variation in the 91-day Treasury bill rate. On the other hand, the COVID-19 dummy shows a strong negative value that is significant at the 1% level which reflects the expansionary monetary stance adopted during the pandemic period.

The results of the alternative specification, which uses the call money rate as the dependent variable, are generally consistent with those of the prior estimation. Prices for crude oil retain their positive significance at the 5% level, whereas the interaction term maintains a negative sign, thereby confirming a moderated policy response after IT. Both REER and trade balance show considerable negative impacts, whereas the fiscal deficit exhibits weak significance at the 10% level. Like in the preceding model, the COVID-19 dummy variable is highly significant and negative, providing further corroboration of the evidence for an accommodative policy during the crisis period.

5.2.2 Model 2

Model 2 provides estimates of long-run relationships for the periods before and after inflation targeting (pre-IT and post-IT, respectively) to complement the pooled estimation in Model 1. With this approach, a structural comparison can be made of how the sensitivity of short-term interest rates to shocks in crude oil prices and other macroeconomic factors may have changed following the formal adoption of inflation targeting in India. Separate ARDL models were estimated for each sub-period, which ensured that the long-run cointegrating relationships corresponded to the respective monetary policy frameworks. The emphasis stays on the long-run coefficients, in line with the main aim of assessing persistent monetary policy responses instead of short-run volatility. Table 4 and Table 5 reports the results of pre-IT and post-IT respectively. In the **pre-IT period**, the 91-day Treasury Bill rate seemed to react to both international and domestic macroeconomic indicators. The T-Bill rate is significantly influenced by crude oil prices, the US Treasury Bill rate, and the real effective exchange rate (REER). The findings

imply that rises in global oil prices correlated with a strengthening of short-term interest rates, whereas currency appreciation might have mitigated inflationary pressures and facilitated lower rates. It is noteworthy that the adverse correlation with the US interest rate suggests a potential divergence in policy direction or effects on capital flow. The trade balance appears as a factor that is somewhat significant. Similar patterns can be seen with regard to the call money rate. The call rate is significantly influenced by crude oil prices, with REER and trade balance also playing a role. The results suggest that in the pre-IT phase, short-term liquidity rates reacted to external cost-push shocks and changes in the exchange rate. Nonetheless, factors like IIP growth and fiscal deficit have little effect on either rate, indicating that domestic output and fiscal policy have limited influence on short-term rates in this regime.

In contrast, the **post-IT** results indicate a significant reduction in the number of substantial macroeconomic determinants for the T-Bill rate. Only the trade balance and the Covid-19 period dummy are found to significantly affect the rate among all variables. The relatively low importance of crude oil prices, US interest rates, and REER suggests that the inflation-targeting regime may have contributed to shielding policy rates from global shocks. The T-Bill rate’s significant drop during the Covid-19 period illustrates the central bank’s accommodating reaction. For the call money rate, the post-IT results show a shift in dynamics. IIP growth becomes a significant determinant, pointing to a more procyclical behaviour of overnight rates. Fiscal deficit also gains significance, suggesting a tighter liquidity response to fiscal expansion. However, the call rate no longer responds meaningfully to crude oil prices, REER, or trade balance, indicating reduced sensitivity to external shocks.

Table 3
Results of Long Run estimation

Dependent Variable: IndTBrate					
Variables	Coefficients	Std. Error	T-test	P value	
Crude Oil Prices	0.01849***	0.0056	3.29	0.001	
IIP Growth	0.01620	0.0126	1.29	0.201	
US TB rate	0.18991**	0.0923	2.06	0.041	
Fiscal Deficit	-1.16e-06	1.05e-06	-1.10	0.272	
REER	-0.0737**	0.0336	-2.19	0.030	
Trade Balance	-0.00002	0.00002	-1.00	0.321	
Oil_PostITDummy	-0.0236***	0.0052	-4.55	0.000	
Covid Dummy	-2.0339***	0.3027	-6.72	0.000	
Dependent Variable: CallMoneyrate					
Crude Oil Prices	0.01475**	0.0064	2.27	0.024	
IIP Growth	0.01980	0.0164	1.20	0.231	
Fiscal Deficit	-2.46e-06*	1.33e-06	-1.85	0.067	
REER	-0.0997**	0.0395	-2.52	0.013	
Trade Balance	-0.00009***	0.00003	-3.01	0.003	
Oil_PostITDummy	-0.01528**	0.0047	-3.20	0.002	
Covid Dummy	-1.8498***	0.3078	-6.01	0.000	

“, **, and *** show the significance of results at the level of 10%, 5%, and 1%, respectively”

Table 4
Results of Long Run estimation pre-IT

Dependent Variable: IndTBrate				
Variables	Coefficients	Std. Error	T-test	P value
Crude Oil Prices	0.0137***	0.0036	3.76	0.000
IIP Growth	0.0118	0.0226	0.52	0.605
US TB rate	-4.9445***	1.019	-4.85	0.000
Fiscal Deficit	4.37e-06	3.29e-06	1.33	0.190
REER	-0.0735***	0.0209	-3.52	0.001
Trade Balance	0.00005*	0.00002	1.95	0.057
Dependent Variable: CallMoneyrate				
Crude Oil Prices	0.0115**	0.0064	2.27	0.024
IIP Growth	-0.0157	0.0164	1.20	0.231
Fiscal Deficit	-4.33e-06*	1.33e-06	-1.85	0.067
REER	-0.0911**	0.0395	-2.52	0.013
Trade Balance	-0.00005***	0.00003	-3.01	0.003

“*, **, and *** show the significance of results at the level of 10%, 5%, and 1%, respectively”

Table 5
Results of Long Run estimation- post IT

Dependent Variable: IndTBrate				
Variables	Coefficients	Std. Error	T-test	P value
Crude Oil Prices	0.0022	0.0094	0.24	0.813
IIP Growth	0.0175	0.0144	1.22	0.228
US TB rate	0.0879	0.0747	1.18	0.243
Fiscal Deficit	2.30e-02	7.53e-07	0.03	0.976
REER	-0.0632*	0.0359	-1.76	0.083
Trade Balance	-0.00007***	0.00002	-2.84	0.006
Covid Dummy	-2.3495***	0.2112	-11.12	0.000
Dependent Variable: CallMoneyrate				
Crude Oil Prices	0.0035*	0.0018	1.92	0.058
IIP Growth	0.0067***	0.0025	2.68	0.009
Fiscal Deficit	-5.45e-07***	1.79e-07	-3.05	0.003
REER	0.0021	0.0095	0.22	0.823
Trade Balance	-3.51e-06	5.16e-06	-0.68	0.498
Covid Dummy	0.1266	0.0917	1.38	0.171

“*, **, and *** show the significance of results at the level of 10%, 5%, and 1%, respectively”

Prior to carrying out the long-run estimation, a bounds test for cointegration was performed on all model specifications to confirm whether a long-run relationship existed among the variables. In all instances, the computed F-statistic surpassed the upper critical bound at conventional significance levels, thus validating the presence of a stable long-term relationship between the dependent and independent variables. This outcome validates the use of the ARDL method to investigate long-term dynamics in the selected macroeconomic framework.

5.3 Model Stability: CUSUM test results

To assess the stability of the long-run parameters, the CUSUM test was employed. The CUSUM (Cumulative Sum) test examines the stability of a model's coefficients over time by analyzing the cumulative sum of recursive residuals. Model parameters are considered stable when the CUSUM line stays within the limits of 5% significance. Exceeding the limits indicates a possible structural instability in the estimated relationship. The cumulative sum of recursive residuals, as shown in the Figures, remains within the 5% critical bounds, signifying that all models preserve structural stability over the sample period.

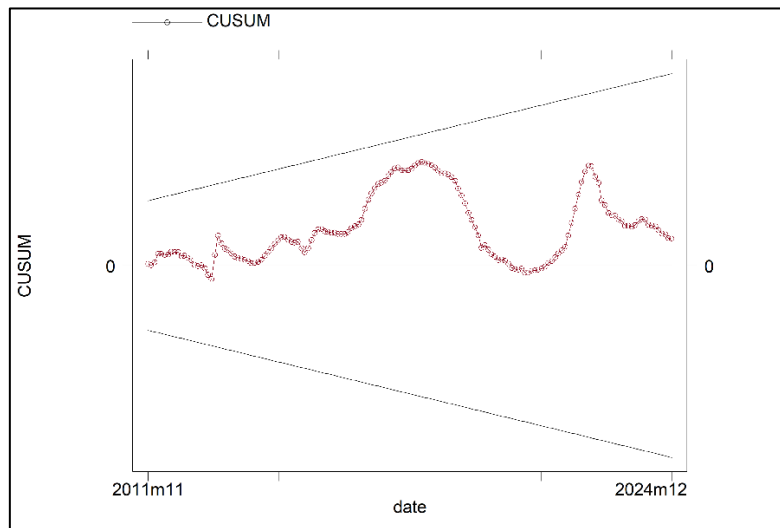


Fig. 2. Model 1- Pooled estimation, Dependent variable-IndTBrate

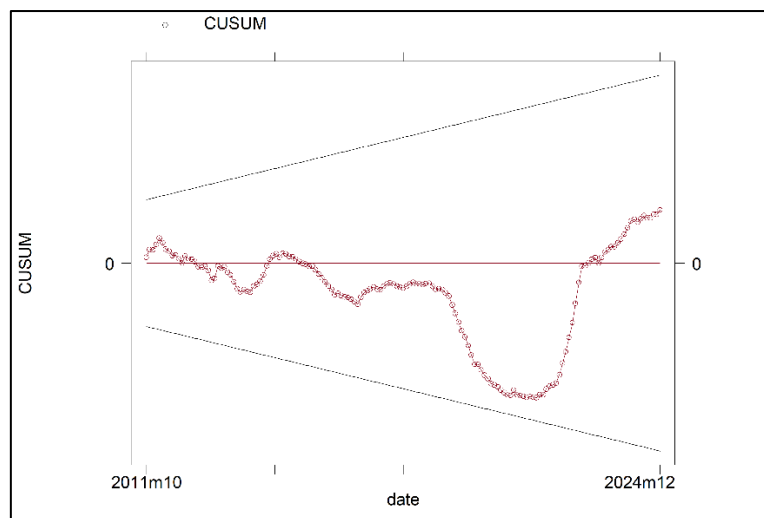


Fig. 3. Model 1- Pooled estimation, Dependent variable -Call Money rate

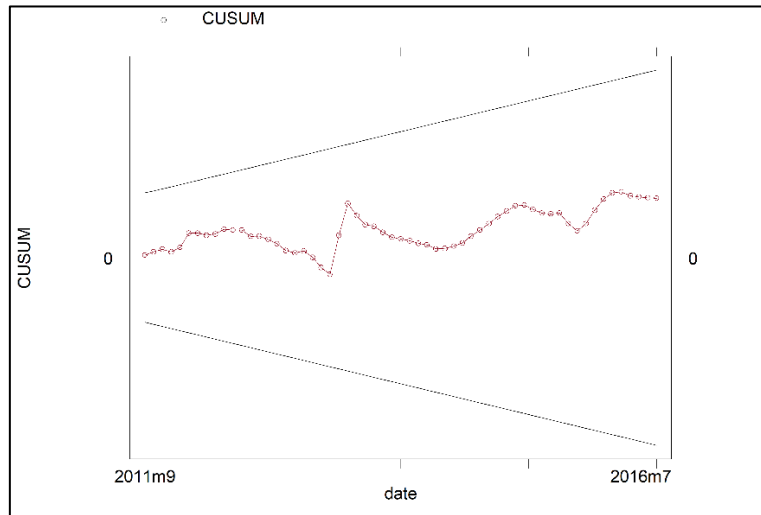


Fig. 4. Model 2- Pre-IT, Dependent variable – Ind TB rate

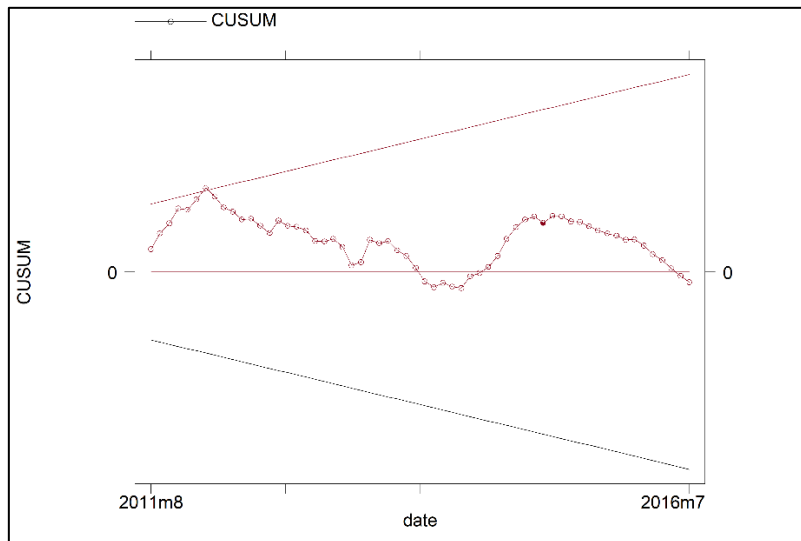


Fig. 5. Model 2- Pre-IT, Dependent variable – Call Money rate

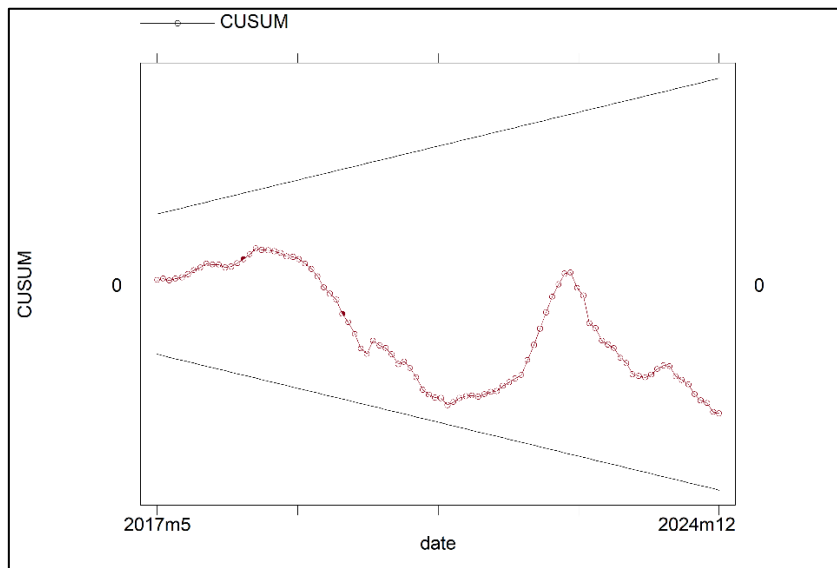


Fig. 6. Model 2- Post-IT, Dependent variable – Ind TB rate

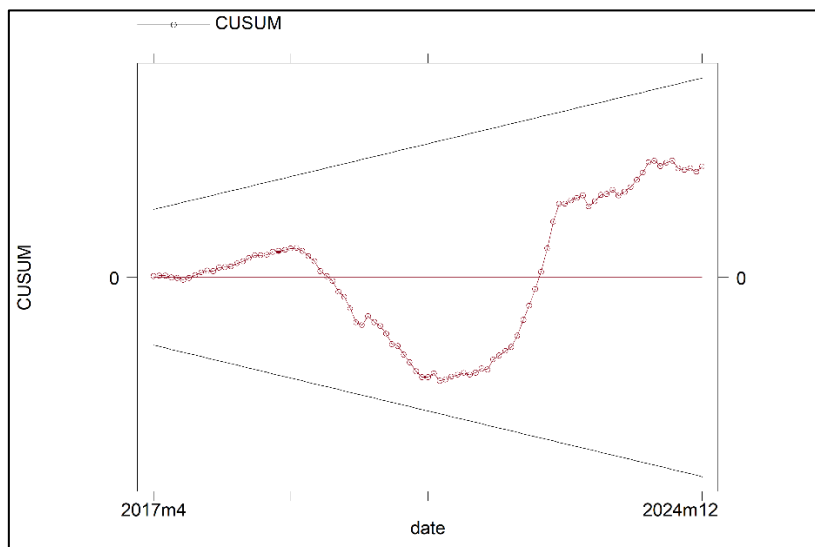


Fig. 7. Model 2- Post-IT, Dependent variable – Call money rate

6. Conclusion and Policy Implications

This research investigated the evolving connection between short-term interest rates in India and crude oil price shocks, particularly in the context of the formal implementation of an inflation targeting (IT) framework in 2016. Using an ARDL modelling approach, two empirical strategies were implemented: the first pooled the complete dataset while including an interaction term between crude oil prices and the IT regime; the second estimated separate models for the periods before and after IT to capture regime-specific dynamics.

In accordance to the results from Model 1, when evaluating the interaction with the IT regime, crude oil prices have a statistically significant long-run effect on **the short-term interest rate** (as measured by the 91-day Treasury bill rate and call money rate). This implies that there has been a structural change in how oil prices affect monetary policy, with the post-IT framework transforming the intensity of the Reserve Bank of India's (RBI) response to variations in global energy prices. Notably, the interaction term between crude oil prices and the post-IT period is significant and negative. This indicates that the interest rate response to oil price shocks decreased after the inflation targeting framework was implemented. The negative sign indicates that in the post-IT period, the RBI was more inclined to lower interest rates in response to oil price shocks—possibly reflecting a shift in policy focus from headline to core inflation and a preference for stabilizing medium-term expectations rather than reacting strongly to supply-side disturbances.

Model 2, which involved separate estimations for the pre- and post-IT periods, reveals a clearer distinction between regimes. During the pre-IT period, there was a statistically significant long-term correlation between crude oil prices and interest rates, aligning with a monetary policy approach that was more responsive to headline inflation influenced by commodity price changes. In the post-IT period, however, crude oil prices lose their statistical significance, indicating that the monetary policy response to external price shocks has become less pronounced under the rule-based IT framework. Furthermore, when the call money rate served as the dependent variable in the post-IT model, explanatory factors such as oil prices were still insignificant. This strengthens the idea that short-term operating targets are now influenced more by domestic liquidity management than by unpredictable global price fluctuations.

These findings have significant policy implications. To begin with, they affirm that the adoption of the **inflation targeting** framework **has aided in creating a monetary policy** environment in India **that is more** disciplined and forward-looking. The diminished sensitivity of interest rates to oil price shocks in the post-IT period illustrates an increasing focus on core inflation targeting, which protects monetary decisions from short-term supply-side fluctuations. The RBI seems to be adhering to best practices in line with contemporary inflation targeting frameworks by concentrating on core inflation and medium-term inflation expectations instead of responding to every temporary supply shock. The negative coefficient on the interaction term indicates that, during episodes of rising oil prices within the IT framework, the RBI may have adopted a more accommodative stance rather than engaging in pro-cyclical tightening. Secondly, the findings highlight how important institutional reform is for strengthening the credibility of policies

and for establishing a foundation for inflation expectations. The inflation targeting framework has fostered greater stability and predictability in policy by separating monetary policy from the noise generated by transitory external shocks. The short-term rates becoming decoupled from fluctuations in oil prices has a positive effect on how credible the inflation targeting regime is viewed. When markets trust that the central bank will not overreact to temporary shocks, inflation expectations stabilize better, which diminishes the necessity for drastic interest rate changes. This contributes to macroeconomic stability by reducing fluctuations in interest rates and increasing the foreseeability of monetary policy. This credibility-based interpretation is reinforced by the negative interaction term in the pooled model and the insignificant crude oil coefficients in the post-IT period. Nevertheless, the ongoing lack of relevance of oil prices for short-term rates in the post-IT period indicates that inflationary pressures linked to oil are now handled by means other than monetary policy. To alleviate external vulnerabilities, policymakers need to supplement monetary stability with wider fiscal and structural measures, including reforms of fuel taxes, diversification of energy sources, and establishment of strategic oil reserves. Furthermore, because global shocks continue to influence inflation indirectly via expectations and imported cost pressures the RBI should persist in improving its communication strategy to uphold public confidence in its commitment to inflation targeting. This underscores the need for supplementary actions such as mechanisms for stabilizing energy prices, tax modifications, and diversification of energy sources.

In summary, this research demonstrates that a structural change in the way India conducts its monetary policy has occurred since it adopted an inflation targeting framework. The changing reaction to crude oil price shocks demonstrated in the outcomes of the two models highlights a movement toward a monetary policy regime that is more rule-based and focused on expectations. It is important to highlight that in the post-IT period; interest rates show reduced sensitivity to changes in oil prices. This is evidenced by the negative and significant interaction term in Model 1, as well as the overall insignificance of crude oil prices in the post-IT estimation. This implies a decreased reactivity of monetary policy to supply-side shocks, showing a shift from a hawkish orientation to a more measured and accommodative approach. The RBI seems to be focusing on anchoring medium-term inflation expectations and differentiating between transient and persistent sources of inflation, rather than responding to external price pressures with aggressive tightening. As a result, the inflation targeting framework has created a policy environment that is more stable and oriented toward the future one that mitigates immediate market fluctuations while strengthening confidence in the central bank's dedication to long-term price stability.