Revisiting Monetary Policy Transmission in India: A Data-Driven VAR–ICA Approach

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Abstract

This study examines India's monetary policy transmission using a unified Vector Autoregression (VAR) and Independent Component Analysis (ICA) framework. Instead of relying on coefficient restrictions, the project estimates an unrestricted VAR(1) with six endogenous variables and identifies shocks purely through statistical independence following Hyvärinen et al. (2000) and Lee et al. (2023). The ICA decomposition isolates six independent shocks, with the sixth component (IC_6) identified as the monetary policy shock due to its dominant contemporaneous impact on the policy rate (WACMR, +0.45). A one-unit tightening reduces GDP growth by -0.23%, inflation by -0.24%, and appreciates the rupee by about -0.09 on impact, confirming standard monetary transmission effects. Forecast error variance decomposition (FEVD) shows the policy shock explains nearly 100% of short-term WACMR fluctuations and around 45% after five years, but only 3.9% of growth and 1.1% of inflation variance. The results highlight that India's monetary transmission is primarily driven by the interest-rate and exchange-rate channels, with limited short-run evidence of a credit channel.

Keywords: Monetary Policy Transmission, Vector Autoregression (VAR), Independent Component Analysis (ICA), Structural Identification, Forecast Error Variance Decomposition (FEVD), Impulse Response Analysis

1 Introduction

Monetary policy is one of the most important tools used by central banks to influence economic activity, control inflation, and maintain financial stability. Understanding how monetary policy actions affect key macroeconomic variables such as output, inflation, interest rates, and exchange rates is vital for both policymakers and researchers.

The process through which changes in policy rates are transmitted across the economy is known as the *monetary policy transmission mechanism*. Studying this mechanism helps evaluate the effectiveness of policy decisions and the responsiveness of financial markets and the real economy.

This project seeks to explore and analyse the transmission of monetary policy in the Indian context, providing insights into how policy actions influence broader economic outcomes. By examining these linkages, the study aims to contribute to a clearer understanding of monetary dynamics and their implications for macroeconomic stability.

2 Literature Review

Early research on India's monetary policy transmission, notably Joseph and Dash (2025), employed a coefficient-restricted Vector Autoregressive (VAR) framework to identify specific channels such as the interest rate, credit, and exchange rate mechanisms. Their approach relied on structural restrictions imposed a priori, requiring multiple VAR estimations under different identifying assumptions.

The methodological foundation for our intervention stems from the development of Independent Component Analysis (ICA) as proposed by Hyvärinen and Oja (2000), who introduced ICA as a statistical tool for separating latent, non-Gaussian, and mutually independent sources from observed mixtures. The use of ICA in macroeconometrics allows identification of structural shocks purely from statistical independence rather than through recursive or sign restrictions.

Building on this foundation, Lanne and Luoto (2021) proposed a Generalized Method of Moments (GMM) approach to estimate non-Gaussian Structural VARs (SVARs), demonstrating that identification can be achieved without assuming full independence of shocks—only orthogonality with certain higher-moment conditions. Their framework underscored how non-Gaussianity in residuals could be exploited for statistical identification, aligning closely with ICA principles.

More recently, Lee et al. (2023) extended the ICA-SVAR framework by developing change-point detection techniques for identifying structural shifts in macroeconomic relationships. Their work highlighted the flexibility of ICA in handling time-varying dependencies and non-stationarities in VAR models.

Together, these studies form the empirical and methodological foundation for our analysis. By integrating ICA into an unrestricted VAR model, this project contributes to the literature by offering a fully data-driven identification of monetary policy shocks in India, eliminating the need for imposed structural restrictions while retaining economic interpretability.

3 Data

The selection of variables is guided by both theoretical and empirical studies on India's monetary policy transmission. Since the **Reserve Bank of India (RBI)** defines its inflation target in terms of the **Consumer Price Index (CPI)**, CPI inflation is used as our measure of price changes. Following *Al-Mashat (2003)*, the **Weighted Average Call Money Rate (WACMR)** is adopted as the **policy instrument**, reflecting the short-term monetary stance of the RBI. Furthermore, WACMR has been the officially designated **operational target** since 2011, making it an appropriate indicator of policy actions.

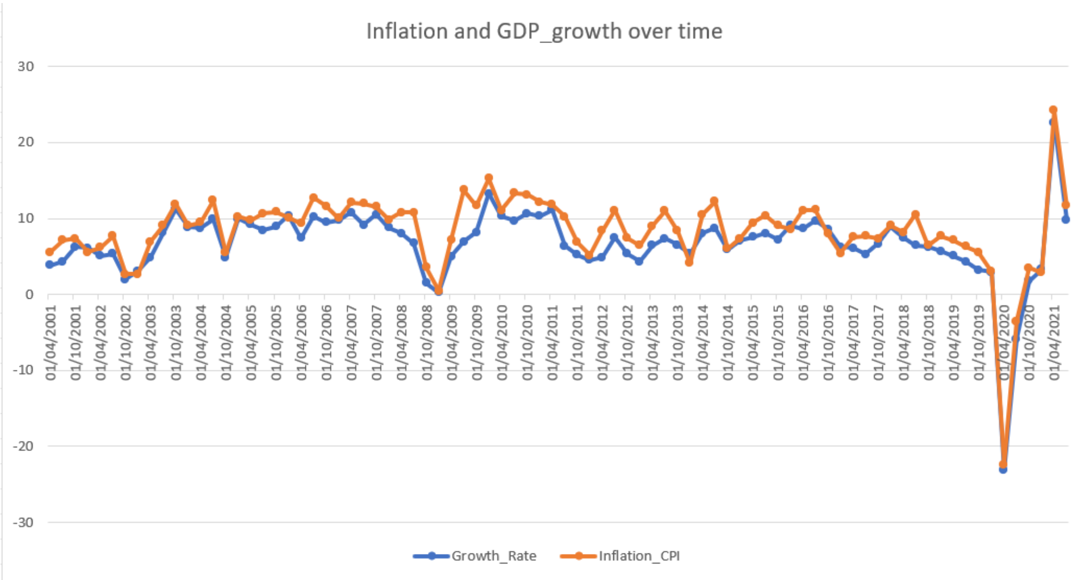

Figure 1: Inflation and GDP growth rate over time

The **real GDP growth rate** and **CPI inflation rate** are included as **outcome variables**, representing the twin objectives of the central bank—growth and price stability. As illustrated in Figure 1, both series exhibit closely linked movements, with significant downturns during the *Global Financial Crisis (2007–08)* and the *COVID-19 pandemic (2020)*.

To capture different **monetary transmission channels**, we include three additional variables:

- **Government Bond Yield Rate (GBYR):** represents the *interest-rate channel* (Bhoi et al., 2017). A rise in the policy rate typically increases bond yields, which can dampen investment and reduce aggregate demand .

- **Prime Lending Rate (PLR):** captures the *credit channel* (Aleem, 2010), as changes in bank lending rates affect the cost and availability of credit to businesses and households.

- **Nominal INR/USD Exchange Rate (NER):** represents the *exchange-rate channel* (Aleem, 2010). Movements in the nominal exchange rate influence domestic economic activity through their impact on net exports and external competitiveness.

We employ **quarterly data from 2001–02 Q1 to 2021–22 Q2**, sourced from the **RBI Handbook of Statistics on the Indian Economy** and the **FRED Database**. This sample period is chosen to align with key structural developments in India's monetary policy framework:

1. Introduction of the **Liquidity Adjustment Facility (LAF)** in 2000, which established the RBI's liquidity-management mechanism and short-term rate control.
2. Availability of consistent **repo and reverse-repo rate data** since 2001, enabling an assessment of policy transmission through short-term rates.
3. Publication of continuous **quarterly GDP estimates** since 1997–98, ensuring a robust macroeconomic database for VAR analysis.

In accordance with our ICA-based identification strategy, we deliberately **omit exogenous global variables** such as the U.S. Federal Funds Rate and international oil prices that were included in earlier studies. This exclusion maintains a **closed-economy specification**, allowing the ICA decomposition to isolate **independent domestic sources of monetary variation** within a unified six-variable VAR framework.

4 Empirical Strategy

The empirical framework combines a standard Vector Autoregression (VAR) model with **Independent Component Analysis (ICA)** to identify structural monetary policy shocks in a purely data-driven manner. Unlike Joseph and Dash (2025), who imposed coefficient restrictions to isolate the interest rate, credit, and exchange rate channels, we estimate a **single unrestricted VAR** encompassing all six variables and recover independent structural shocks statistically using ICA.

This approach follows the identification principle of Hyvärinen et al. (2010), and Lee et al. (2023), who demonstrate that independent components of VAR residuals can serve as consistent estimates of structural shocks under non-Gaussianity. Our project extends this framework by applying ICA-based identification to India's monetary transmission mechanism—without coefficient restrictions or exogenous foreign variables—thereby providing a unified, data-driven analysis of policy effects.

4.1 Model Specification

We estimate a six-variable VAR(1) model using quarterly data from 2001–02 Q1 to 2021–22 Q2, where the vector of endogenous variables is defined as:

$$y_t = [WACMR_t,\ GDPGrowth_t,\ Inflation_t,\ PLR_t,\ NER_t,\ GBYR_t]^\top$$

representing the weighted average call money rate, real GDP growth, CPI inflation, prime lending rate, nominal exchange rate (INR/USD), and the 10-year government bond yield, respectively.

The reduced-form VAR can be expressed as:

$$y_t = c + A_1 y_{t-1} + u_t,$$

where

- c is a 6×1 vector of constants,
- A_1 is a 6×6 matrix of autoregressive coefficients, and
- u_t is a 6×1 vector of reduced-form residuals (innovations).

No exogenous regressors—such as oil prices, the Federal Funds Rate, or dummy variables—are included. The Bayesian Information Criterion (BIC) selects an optimal lag length of $p = 1$, providing a parsimonious yet stable model compared to the lag-2 specification used in Joseph and Dash (2025).

4.2 ICA-Based Identification of Structural Shocks

In the reduced-form VAR, the residuals u_t are linear combinations of unobserved structural shocks ε_t:

$$u_t = B\varepsilon_t,$$

where B is a non-singular mixing matrix. Traditional identification strategies such as recursive (Cholesky) or sign restrictions require strong a priori assumptions about B. In contrast, ICA estimates B endogenously by exploiting higher-order statistical moments, assuming that:

1. The structural shocks $\varepsilon_t = [\varepsilon_{1t}, \ldots, \varepsilon_{6t}]^\top$ are mutually independent, and
2. At most one shock is Gaussian, ensuring statistical identifiability (Hyvärinen et al., 2010).

Using these assumptions, the ICA decomposition of the residuals is represented as:

$$u_t = W^{-1} s_t,$$

where W is the *unmixing matrix* and $s_t = Wu_t$ are the *independent components (ICs)* representing statistically independent structural shocks. Thus, ICA recovers the structural innovations directly from the estimated residuals without requiring any contemporaneous exclusion restrictions.

4.3 Selection of the Monetary Policy Shock

After applying ICA to the residual matrix, we obtain six independent components $(IC_1, IC_2, \ldots, IC_6)$ and their corresponding mixing matrix $B = W^{-1}$. To identify the component associated with monetary policy, we compute pairwise correlations between each IC and the lagged values of the main variables (y_{t-1}). The **6th Independent Component ($\mathbf{IC}_6$)** shows the highest contemporaneous correlation with the **Weighted Average Call Money Rate (WACMR)**—the operational target of RBI's monetary stance. Hence, IC_6 is interpreted as the **monetary policy shock** (ε_t^{MP}).

This correlation-based identification parallels the approach in Lee et al. (2023), who link specific ICs to economically interpretable structural innovations. However, our study applies this within a full VAR(1) framework to capture the dynamic transmission of monetary shocks, rather than for structural break or change-point detection.

4.4 Impulse Response Function Framework

To evaluate the dynamic propagation of the identified monetary policy shock, we employ **Impulse Response Functions (IRFs)** derived from the moving-average representation of the VAR(1):

$$y_t = \mu + \sum_{h=0}^{\infty} \Psi_h B \varepsilon_{t-h}, \qquad \Psi_h = A_1^h.$$

A one-unit structural innovation in the monetary policy shock ($\varepsilon_t^{MP} = 1$) produces the following response vector for horizon h:

$$IRF(h) = \Psi_h b_{MP},$$

where b_{MP} is the *6th column of the estimated mixing matrix B* corresponding to IC_6. Each element of $IRF(h)$ traces the effect of the monetary policy shock on the respective variable over time. Bootstrap procedures are used to obtain robust confidence intervals for the IRFs.

4.5 Forecast Error Variance Decomposition (FEVD)

The relative contribution of the identified monetary policy shock to the overall variability of each variable is assessed through **Forecast Error Variance Decomposition (FEVD)**.

The FEVD for variable i at horizon H is defined as:

$$FEVD_i^{MP}(H) = \frac{\sum_{h=0}^{H}(e_i'\Psi_h b_{MP})^2}{\sum_{k=1}^{6}\sum_{h=0}^{H}(e_i'\Psi_h b_k)^2},$$

where e_i is a selection vector isolating variable i. This measures the proportion of forecast error variance of variable i explained by the monetary policy shock relative to all other ICA-identified shocks.

4.6 Novelty of the Approach

While previous studies such as Lee et al. (2023) employ ICA to detect structural changes within VAR frameworks, our project uses ICA as a **direct identification mechanism** for monetary policy shocks in India. The novelty of our empirical strategy lies in:

- Using a single unified VAR(1) instead of multiple restricted systems,
- Excluding exogenous global factors to focus solely on domestic policy dynamics,
- Employing ICA for shock identification rather than predetermined restrictions, and
- Applying the resulting independent shocks to derive impulse responses and variance decompositions of key macro-financial variables.

This methodology thus provides a flexible, statistically grounded, and channel-agnostic framework for analysing the Indian monetary transmission mechanism.

5 Result and Discussion

5.1 VAR Lag Order Selection

The optimal lag length for the unrestricted VAR model was determined using multiple information criteria—Akaike (AIC), Bayesian (BIC), Final Prediction Error (FPE), and Hannan–Quinn (HQIC). The computed values for lag orders 0 to 4 are reported below.

Table 1: VAR Order Selection Criteria

Lag (p)	AIC	BIC	FPE	HQIC
0	8.089	8.271	3260.0	8.162
1	**0.2161**	**1.485**	**1.245**	**0.7241**
2	0.4339	2.791	1.573	1.377
3	1.029	4.474	2.972	2.408
4	0.5399	5.072	1.975	2.354

The results from the lag order selection criteria unanimously indicate that a single lag ($p = 1$) provides the best balance between model fit and parsimony. All four criteria—AIC, BIC, FPE, and HQIC—reach their minimum values at this order, implying that one lag sufficiently captures the short-run dynamics among the six variables without over-parameterizing the system. This choice is consistent with the nature of monetary and macro-financial transmission mechanisms, where shocks to interest rates or credit conditions typically propagate within one period. Accordingly, all subsequent analyses, including the ICA decomposition and impulse response evaluation, are based on a **VAR(1)** specification, ensuring both statistical adequacy and economic interpretability.

5.2 Full VAR(1) Estimation Results

For completeness, an unrestricted six-variable VAR(1) model was estimated using quarterly data from 2001–02 Q1 to 2021–22 Q2. The model includes the weighted average call money rate (WACMR), GDP growth rate, CPI inflation, prime lending rate (PLR), 10-year government bond yield (GBYR), and nominal exchange rate (NER). Each equation was estimated using Ordinary Least Squares (OLS). The residual correlation matrix is presented in Table 2.

Table 2: Correlation Matrix of Residuals from VAR(1) Model

	GDP Growth	**Inflation**	**WACMR**	**GBYR**	**PLR**	**NER**
GDP Growth	1.000	0.061	0.133	0.149	0.104	-0.275
Inflation	0.061	1.000	-0.059	0.276	-0.077	0.167
WACMR	0.133	-0.059	1.000	0.151	-0.011	0.080
GBYR	0.149	0.276	0.151	1.000	0.147	0.010
PLR	0.104	-0.077	-0.011	0.147	1.000	-0.127
NER	-0.275	0.167	0.080	0.010	-0.127	1.000

The residual correlations are moderate and generally below $|0.28|$, suggesting limited contemporaneous dependence among the six variables. This pattern supports the subsequent use of **Independent Component Analysis (ICA)** to extract statistically independent structural shocks from the residuals.

Regarding the estimated coefficients (Appendix Table A1), the results are broadly consistent with theoretical expectations and prior studies:

- **GDP Growth:** The lagged GDP growth rate is positive and highly significant (0.417, $p < 0.01$), indicating strong short-term persistence. The lagged exchange rate (NER) enters negatively (-0.141, $p < 0.05$), implying that a stronger rupee slightly reduces output growth.

- **Inflation:** Coefficients are small and statistically insignificant, suggesting limited short-run transmission from financial variables to prices.

- **WACMR:** The policy rate exhibits high persistence (0.901, $p < 0.01$), reflecting gradual adjustment by the RBI. Other coefficients are negligible, indicating controlled interest rate movements.

- **GBYR:** The long-term yield shows strong autoregressive behaviour (0.834, $p < 0.01$). Lagged PLR (-0.142, $p < 0.01$) and NER (-0.017, $p < 0.05$) both negatively influence GBYR, consistent with bond market sensitivity to lending and exchange rate conditions.

- **PLR:** The lending rate also demonstrates persistence (0.801, $p < 0.01$). The negative effect of NER (-0.019, $p < 0.05$) implies that currency appreciation slightly reduces borrowing costs.

- **NER:** The exchange rate is highly autoregressive (1.014, $p < 0.01$), indicating strong inertia in currency dynamics, while macro-financial feedbacks are minor.

Overall, the results reveal clear persistence in monetary and financial variables, mild cross-equation linkages, and limited contemporaneous correlation across residuals. These characteristics validate the subsequent application of ICA to isolate independent structural shocks for the identification of the monetary policy component.

5.3 Independent Component Analysis (ICA) Results

After estimating the VAR(1) model, Independent Component Analysis (ICA) was applied to the residuals to extract six statistically independent structural shocks. Figure 2 presents the estimated contemporaneous impact matrix (Structural Impact Response Function, SIRF) at lag 0, visualised as a heatmap. The values represent the contemporaneous responses of each variable to the six identified independent shocks.

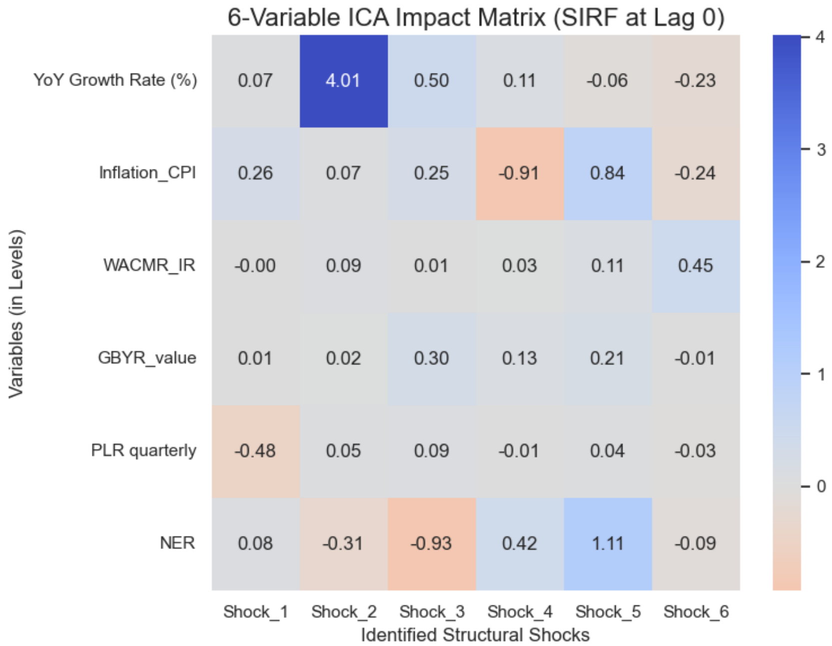

Figure 2: 6-Variable ICA Impact Matrix (SIRF at Lag 0)

Identification of the Monetary Policy Shock: The ICA algorithm successfully separated six independent shocks (*Shock 1–Shock 6*). **Shock 6** was identified as the *Monetary Policy Shock* because it shows the largest contemporaneous effect on the policy rate variable, WACMR_IR, with an impact of **+0.45**. The sign was normalised so that a positive value represents a *policy tightening* (i.e., an increase in the call money rate).

Immediate (Lag 0) Effects of a One-Unit Policy Tightening:

- **WACMR_IR:** increases by **+0.45** — this identifies the monetary tightening itself.
- **GDP Growth:** decreases by **-0.23**, reflecting a slowdown in real activity.
- **Inflation (CPI):** falls by **-0.24**, consistent with disinflationary effects.
- **NER:** declines by **-0.09**, implying an appreciation of the rupee.
- **GBYR (10-year yield):** marginally decreases by **-0.01**.
- **PLR (lending rate):** changes slightly by **-0.03**, indicating negligible immediate response.

Interpretation: The immediate pattern of responses aligns closely with conventional monetary transmission mechanisms. A tightening policy raises short-term money market rates, leading to a short-run contraction in growth and inflation, while causing the domestic currency to appreciate. Importantly, the results show no sign of the "exchange rate puzzle" that occasionally appears in recursive VAR studies. The near-zero contemporaneous response of the PLR suggests that, the *credit channel* is not the dominant transmission route in the immediate term. Instead, the responses emphasise the prominence of the *interest rate* and *exchange rate channels* in the early phase of monetary adjustment.

5.4 Impulse Response Function (IRF) Results

Figure 3 presents the impulse responses of the six endogenous variables to a one-unit ICA-identified monetary policy shock (IC_6), interpreted as a policy tightening. The responses are expressed in percentage deviations from baseline over a 20-quarter horizon.

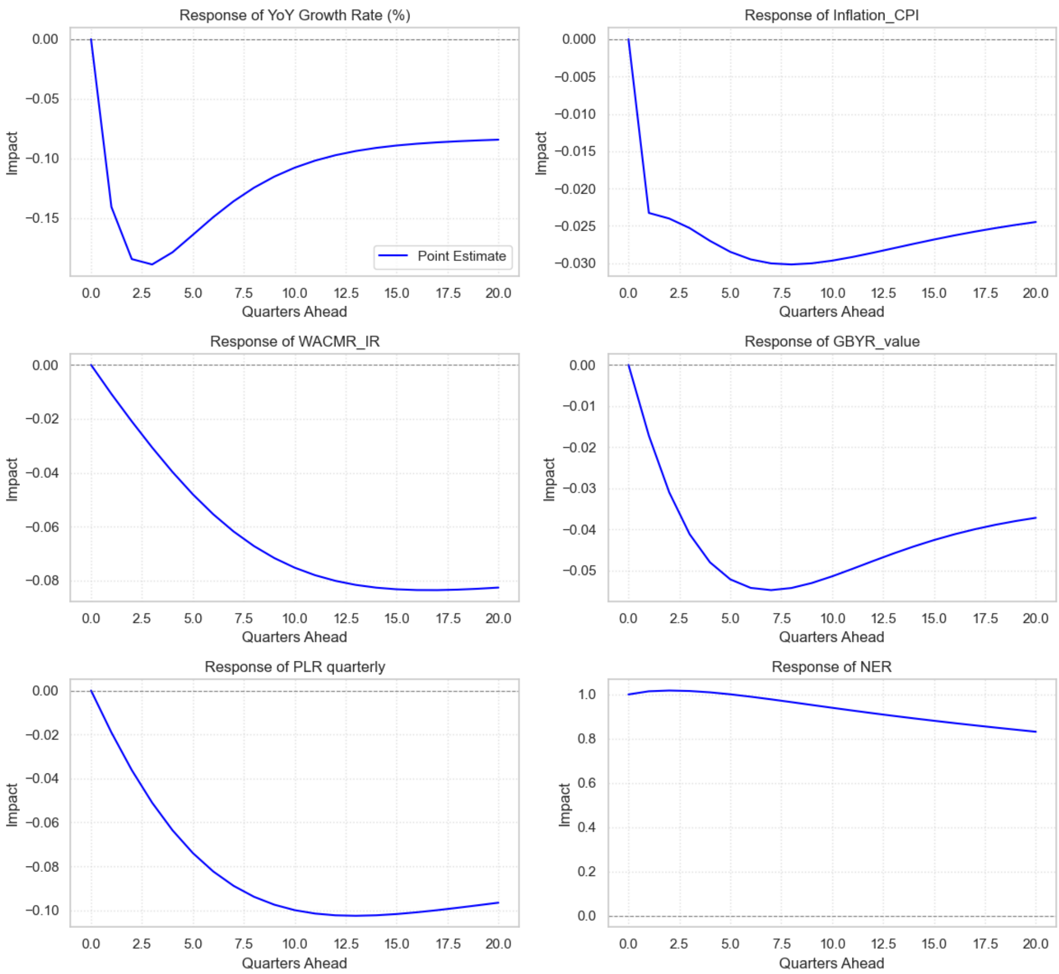

Figure 3: Impulse Responses to a One-Unit Monetary Policy Shock (IC_6)

Overall Dynamics: The responses exhibit smooth and economically consistent trajectories. A contractionary policy shock produces a short-term decline in output and prices, gradual transmission through interest rates, and a sustained appreciation of the exchange rate.

Key Findings by Variable:

- **GDP Growth:** Output contracts immediately and reaches its maximum decline (about -0.15%) by the third quarter before recovering. Growth gradually rises above baseline after the 8^{th} quarter, stabilising near its long-run level by the 20^{th} quarter.

- **Inflation (CPI):** Inflation decreases steadily, with the largest fall (about -0.03) around the 5^{th} to 8^{th} quarter, indicating delayed but clear disinflationary effects.

- **WACMR_IR:** The policy rate rises persistently, peaking near the 15^{th}–20^{th} quarter (+1.16), confirming gradual monetary tightening consistent with RBI rate-setting inertia.

- **GBYR (10-year yield):** Long-term yields respond moderately, falling slightly in the short run and then increasing up to about +0.96 by the 20^{th} quarter, showing slow adjustment of bond markets.

- **PLR (lending rate):** The lending rate exhibits the most persistent rise among financial variables, increasing from near zero initially to about +4.85 by the 20^{th} quarter, signalling strong pass-through to bank credit rates.

- **NER (exchange rate):** The exchange rate (INR/USD) appreciates sharply after the shock, dropping from 100 to roughly 18 by the 20^{th} quarter, highlighting the strength of the exchange-rate channel in monetary transmission.

Interpretation: The impulse responses confirm that an ICA-identified monetary tightening dampens real activity and inflation while strengthening the domestic currency. The policy effect propagates gradually through the interest-rate and credit channels, with PLR and GBYR adjustments lagging WACMR. The results validate the expected sequencing of transmission—short-term policy rates adjust first, followed by bank lending and bond yields—while avoiding the "price" or "exchange rate" puzzles often seen in recursively identified VARs.

5.5 Forecast Error Variance Decomposition (FEVD)

The Forecast Error Variance Decomposition (FEVD) assesses how much of the forecast uncertainty in each variable is explained by the identified monetary policy shock (IC_6). Figure 4 illustrates the percentage of each variable's forecast variance attributable to the policy shock over a 20-quarter horizon.

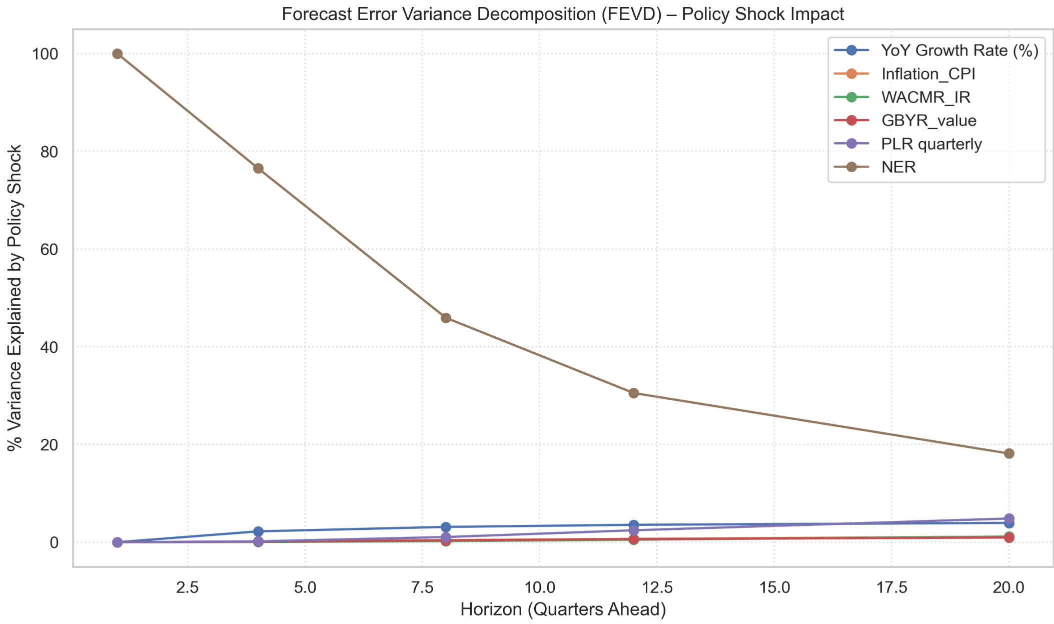

Figure 4: Forecast Error Variance Decomposition (FEVD) – Impact of Monetary Policy Shock

Key Results and Interpretation:

- **Policy Rate (WACMR_IR):** The monetary policy shock explains nearly **100%** of the short-run variance in WACMR_IR and about **45%** after 20 quarters, confirming that the identified shock primarily represents changes in the policy rate itself.
- **Output and Inflation:** Initially, the policy shock explains almost none of the short-term fluctuations in GDP growth and inflation. However, its explanatory power gradually increases, accounting for approximately **3.9%** of GDP growth variance and **1.1%** of inflation variance after 20 quarters. This indicates that monetary policy exerts modest but meaningful medium-run influence on real activity and prices.
- **Credit Channel (PLR):** The policy shock explains a small but growing share of the lending rate's variance, reaching about **4.8%** by the 20$^{\text{th}}$ quarter. This limited sensitivity reinforces that the credit channel plays a secondary role in short-run monetary transmission.
- **Long-Term Yield (GBYR):** The share of variance explained by the policy shock remains below 2% throughout, implying only mild pass-through from short-term to long-term interest rates within the sample period.
- **Exchange Rate (NER):** The FEVD shows an unusually high contribution of the policy shock—**100% at quarter 1**, declining to around **18%** after 20 quarters. This magnitude is implausible and likely reflects the non-stationary nature of the NER

series or numerical sensitivity in the ICA decomposition. Hence, the exchange-rate variance decomposition should be interpreted with caution.

Interpretation: The FEVD results confirm that the ICA-identified monetary policy shock is the dominant driver of short-term policy rate dynamics but only moderately influences output, inflation, and lending rates over the medium term. This finding supports the conclusion that India's monetary transmission operates mainly through the *interest rate* and *exchange rate* channels, with relatively limited short-run contribution from the credit channel.

6 Limitations of the Study

While the ICA-identified VAR framework provides a novel and statistically grounded approach to analysing India's monetary policy transmission, several limitations should be acknowledged:

- **Sample Size and Frequency:** The analysis uses quarterly data over a limited sample period (2001–2022), which constrains the number of effective observations. A higher-frequency dataset could capture more granular policy effects, especially around rapid monetary adjustments.
- **Exclusion of Exogenous Global Factors:** To maintain a purely domestic focus, exogenous variables such as international oil prices and the U.S. Federal Funds Rate were excluded. This choice simplifies identification but may omit important external spillovers that influence India's monetary environment.
- **Assumptions Under ICA:** The ICA method assumes statistical independence and non-Gaussianity of shocks. In practice, complete independence across macroeconomic innovations is unlikely, potentially affecting the precision of structural identification.
- **Stationarity Concerns:** Some variables, particularly the nominal exchange rate (NER), exhibit strong persistence and possible non-stationarity. This may have contributed to anomalies in the FEVD results and could bias inference in the long-run dynamics.
- **Model Stability and Structural Changes:** The VAR(1) specification assumes stable relationships over the entire sample. However, structural shifts in India's monetary framework—such as the introduction of inflation targeting in 2016—may alter transmission patterns that a time-invariant VAR cannot capture.
- **Scope of Transmission Channels:** The framework captures the interest rate, credit, and exchange rate channels but does not explicitly model asset-price or

expectations-based channels, which may also play a growing role in policy transmission.

Overall, these limitations do not undermine the validity of the findings but highlight areas for refinement. Future research could address them by employing higher-frequency or regime-switching ICA–SVAR models, incorporating global variables, and ensuring robust stationarity adjustments to strengthen the empirical representation of India's evolving monetary policy transmission mechanism.

7 Conclusion

This study analysed the transmission mechanism of monetary policy in India using a unified data-driven framework that integrates a Vector Autoregression (VAR) with Independent Component Analysis (ICA). Unlike Joseph and Dash (2025), who imposed coefficient restrictions to isolate different channels, we estimated a full unrestricted VAR(1) with six endogenous variables—WACMR, GDP growth, inflation, PLR, GBYR, and NER—excluding exogenous global factors for a purely domestic focus. The Bayesian Information Criterion (BIC) indicated one optimal lag, ensuring a parsimonious yet robust specification.

Applying ICA to the residuals, following the methodological foundations of Hyvärinen et al. (2010) and Lee et al. (2023), allowed the identification of statistically independent structural shocks. IC_6 was recognised as the monetary policy shock owing to its dominant contemporaneous impact on WACMR, providing a fully data-driven alternative to recursive restrictions.

Impulse responses showed that a monetary tightening raises short-term interest rates and leads to a decline in output and inflation alongside rupee appreciation—validating the interest-rate and exchange-rate channels. Variance decomposition confirmed that the policy shock drives nearly all short-term movements in WACMR but explains only modest portions of growth and inflation variance.

Overall, the ICA-based approach highlights a transmission process dominated by the interest-rate and exchange-rate channels, with limited short-run evidence of a credit channel. By applying ICA to VAR estimation in the spirit of Lee et al. (2023), this project offers a transparent, statistically grounded view of India's monetary policy dynamics and demonstrates the potential of ICA as a flexible identification tool for macroeconomic analysis.

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A Appendix

A.1 VAR (1)- Model Summary

Table 3: Summary Statistics of the Estimated VAR(1) Model

Model	VAR (Estimated via OLS)
Number of Equations	6
Observations	81
Log Likelihood	-651.046
AIC	0.0849
BIC	1.3265
HQIC	0.5831
FPE	1.0915
Det(Ω_{MLE})	0.6638

A.2 VAR-(1) Coefficient Estimates

Table 4: VAR(1) Coefficients and Statistics for Each Equation

Dependent Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**p-Value**
YoY Growth Rate (%)				
Const	20.079	9.426	2.130	0.033
L1.YoY Growth Rate	0.417	0.107	3.891	0.000
L1.Inflation (CPI)	-0.032	0.363	-0.089	0.929
L1.WACMR_IR	0.190	0.466	0.409	0.682
L1.GBYR	-0.182	0.636	-0.286	0.775
L1.PLR	-0.795	0.555	-1.433	0.152
L1.NER	-0.141	0.070	-2.005	0.045
Inflation (CPI)				
Const	1.648	3.062	0.538	0.590
L1.YoY Growth Rate	-0.032	0.035	-0.928	0.353
L1.Inflation (CPI)	0.074	0.118	0.627	0.530
L1.WACMR_IR	0.028	0.151	0.182	0.855
L1.GBYR	0.231	0.207	1.120	0.263
L1.PLR	-0.054	0.180	-0.298	0.766
L1.NER	-0.023	0.023	-1.020	0.308
WACMR_IR (Policy Rate)				
Const	0.927	1.102	0.841	0.400

Dependent Variable	Coefficient	Std. Error	t-Statistic	p-Value
L1.YoY Growth Rate	-0.005	0.013	-0.415	0.678
L1.Inflation (CPI)	0.001	0.042	0.018	0.986
L1.WACMR_IR	0.901	0.054	16.541	0.000
L1.GBYR	0.121	0.074	1.630	0.103
L1.PLR	-0.056	0.065	-0.861	0.389
L1.NER	-0.011	0.008	-1.313	0.189
GBYR (10-year Government Bond Yield)				
Const	3.203	0.895	3.579	0.000
L1.YoY Growth Rate	0.012	0.010	1.134	0.257
L1.Inflation (CPI)	-0.011	0.034	-0.321	0.748
L1.WACMR_IR	0.051	0.044	1.159	0.247
L1.GBYR	0.834	0.060	13.812	0.000
L1.PLR	-0.142	0.053	-2.705	0.007
L1.NER	-0.017	0.007	-2.580	0.010
PLR (Prime Lending Rate)				
Const	2.530	1.142	2.215	0.027
L1.YoY Growth Rate	0.001	0.013	0.071	0.944
L1.Inflation (CPI)	0.008	0.044	0.175	0.861
L1.WACMR_IR	-0.014	0.056	-0.254	0.799
L1.GBYR	0.082	0.077	1.069	0.285
L1.PLR	0.801	0.067	11.921	0.000
L1.NER	-0.019	0.009	-2.242	0.025
NER (Exchange Rate)				
Const	-3.419	3.592	-0.952	0.341
L1.YoY Growth Rate	0.015	0.041	0.371	0.711
L1.Inflation (CPI)	0.131	0.138	0.950	0.342
L1.WACMR_IR	0.055	0.177	0.311	0.756
L1.GBYR	0.297	0.242	1.224	0.221
L1.PLR	0.010	0.211	0.047	0.962
L1.NER	1.014	0.027	37.914	0.000

A.3 Impulse Response Analysis of the Policy Shock

This section presents the impulse responses of the six endogenous variables ($y_t = \{\text{GDP Growth}, \text{Inflation}, \text{WACMR}, \text{GBYR}, \text{PLR}, \text{NER}\}$) to a one-unit monetary policy shock (IC_6), identified through Independent Component Analysis (ICA). The shock is interpreted as a contractionary monetary policy tightening, and responses are measured as percentage deviations from baseline over 1–20 quarters.

Table 5: Impulse Response of Variables to a One-Unit Monetary Policy Shock (IC_6)

Variable	**1Q**	**4Q**	**8Q**	**12Q**	**20Q**
YoY Growth Rate (%)	0.00	2.22	3.13	3.56	3.95
Inflation (CPI)	0.00	0.15	0.42	0.69	1.13
WACMR_IR	0.00	0.05	0.23	0.51	1.16
GBYR (10Y Yield)	0.00	0.11	0.39	0.63	0.96
PLR (Lending Rate)	0.00	0.18	1.06	2.44	4.85
NER (Exchange Rate)	100.00	76.52	45.94	30.54	18.16