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IMPACTS OF MONETARY POLICY SHOCKS ON GDP GROWTH: IN RELATION TO TIME SERIES ANALYSIS TO MODEL THE DELAYED EFFECTS OF POLICY CHANGES ON GROWTH OUTCOMES

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ABSTRACT

This paper investigates the dynamic effects of monetary policy shocks on GDP growth using quarterly data spanning 1990Q1 to 2022Q4 across twelve emerging and advanced economies. Employing a structural vector autoregression (SVAR) framework with sign restrictions and a Bayesian vector autoregression (BVAR) approach, we identify exogenous innovations to the short-term interest rate and trace their propagation through output and the price level. Impulse response functions reveal that a contractionary monetary shock of 100 basis points generates a peak output contraction of 0.62 percentage points, materialising with a lag of four to six quarters — consistent with classical monetary transmission theory. Forecast error variance decomposition (FEVD) attributes approximately 18–24% of GDP growth variability to monetary policy innovations at a twelve-quarter horizon. Robustness checks using local projections confirm the benchmark results. The findings carry direct implications for central bank forward guidance and for the calibration of policy reaction functions in inflation-targeting regimes.

JEL CLASSIFICATION: E32, E52, C32, C51

KEYWORDS: *Monetary policy shocks, GDP growth, SVAR, impulse response functions, transmission lags, Bayesian VAR.*

1. INTRODUCTION

Central banks occupy a uniquely powerful position in determining the trajectory of economic activity. Through the manipulation of short-term nominal interest rates, the money supply, or — in the post-2008 era — the composition of their balance sheets, monetary authorities attempt to stabilise output around potential and maintain price stability. Yet the link between a policy action today and its macroeconomic consequences tomorrow is neither instantaneous nor linear. Milton Friedman's famous dictum that monetary policy operates with *long and variable lags* has retained its relevance across decades of empirical scrutiny: the consensus estimate places peak output effects between four and eight quarters after the initial policy impulse.

Understanding the timing and magnitude of these effects is more than an academic exercise. Policymakers who miscalibrate the horizon of transmission risk either over-tightening — precipitating unnecessary recessions — or under-tightening — allowing inflationary pressures to become entrenched. The problem is compounded by the fact that real-time data are noisy, expectations adjust endogenously, and the neutral rate of interest is unobservable. This confluence of empirical and conceptual challenges motivates the present investigation.

We contribute to the literature in three concrete ways. First, we employ sign-restriction identification — following Uhlig — to avoid the price puzzle that afflicts Cholesky-decomposed VARs, whereby a tightening shock paradoxically raises the price level. Second, we complement our SVAR benchmark with Jordà's local projection method, which is robust to lag misspecification and permits non-linear dynamic responses. Third, we present a cross-country comparison that spans both inflation-targeting and non-inflation-targeting regimes, illuminating how the institutional setting modulates the speed and potency of transmission.

The remainder of the paper is organised as follows. Section 2 surveys the theoretical and empirical literature. Section 3 develops the econometric framework. Section 4 describes the data. Section 5 presents the main results. Section 6 conducts robustness checks, and Section 7 concludes with policy implications.

2. LITERATURE REVIEW

2.1 Theoretical Foundations

The theoretical scaffolding for monetary transmission rests on the IS–LM framework formalised by Hicks and subsequently extended into dynamic stochastic general equilibrium (DSGE) models by Woodford and Christiano, Eichenbaum, and Evans. In the standard New Keynesian model, a contractionary interest rate shock raises the cost of borrowing, depresses investment and durable consumption, and — through nominal rigidities — temporarily reduces output before the economy returns to its natural rate. The degree of nominal rigidity, captured by the Calvo parameter θ, determines the relative weight of real over nominal adjustment and therefore the persistence of the output gap.

The credit channel literature, pioneered by Bernanke and Gertler , emphasises an additional amplification mechanism: by raising external finance premia through reduced collateral values and tighter bank lending standards, monetary tightening suppresses investment beyond what the interest rate channel alone predicts. This financial accelerator is particularly potent during periods of elevated leverage, a prediction borne out by post-2008 data.

2.2 Empirical Evidence

Sims introduced vector autoregressions as the canonical tool for estimating macroeconomic dynamics free of a priori restrictions on structural relationships. Early VAR work by Bernanke and Blinder [12] using the federal funds rate as the policy instrument produced impulse responses consistent with theory — a rate hike compressed output — but also yielded the price puzzle. Subsequent researchers resolved this anomaly by controlling for commodity prices (Sims [13]), imposing sign restrictions (Uhlig), or using a narrative shock series constructed from central bank documents (Romer and Romer .

For emerging economies, the literature documents shorter but less precisely estimated transmission lags relative to advanced economies, partly reflecting lower credibility of monetary institutions and higher pass-through from the exchange rate . Mishra and Montiel surveyed evidence across 33 developing countries and found interest rate pass-through to bank lending rates averaging only 40–60 cents per policy dollar, attenuating the real output response. These structural features motivate the cross-country design of our study.

A growing strand of the literature uses local projections (Jordà) to estimate impulse responses without imposing the autoregressive structure of a VAR. Ramey demonstrates that local projections and VARs yield broadly similar estimates when the shock series is truly exogenous, but diverge when identification is weak — an empirical regularity that reinforces the importance of rigorous shock identification, which we address in Section 3.

3. Econometric Framework

3.1 Structural Vector Autoregression

Let $Y_t = [\Delta y_t, \pi_t, i_t, m_t]'$ denote the vector of endogenous variables comprising the log-difference of real GDP (Δy_t), the annualised inflation rate (π_t), the short-term nominal interest rate (i_t), and the log of broad money (m_t). The reduced-form VAR of order p is given by:

$$\mathbf{Y_t = c + A_1Y_{t-1} + A_2Y_{t-2} + \ldots + A_pY_{t-p} + u_t}$$

where c is a vector of deterministic constants, A_j (j = 1,…,p) are coefficient matrices, and $u_t \sim N(0, \Sigma)$ is the vector of reduced-form residuals with covariance matrix Σ. The structural form relates reduced-form and structural shocks via $Bu_t = \varepsilon_t$, where $\varepsilon_t \sim N(0, I)$ and B is the structural impact matrix to be identified. We normalise so that $BB' = \Sigma$.

3.2 Identification via Sign Restrictions

Following Uhlig , we identify the monetary policy shock by imposing that a contractionary innovation (positive shock to i_t) produces: (i) a non-negative impulse in the nominal interest rate; (ii) a non-positive impulse in real GDP growth; (iii) a non-positive impulse in inflation; and (iv) a non-positive impulse in broad money. These restrictions are imposed for the first four quarters post-shock and are consistent with the theoretical priors derived in Section 2. No restrictions are placed on the subsequent dynamics, allowing the data to speak freely beyond the impact window.

The sign restrictions are implemented via the algorithm of Rubio-Ramírez, Waggoner, and Zha : we draw Q from the Haar measure over the space of orthogonal matrices, retain draws for which the sign conditions are satisfied, and construct the posterior distribution of impulse responses from accepted draws. We report posterior median responses and 16th–84th percentile bands.

3.3 Bayesian Estimation

We estimate the reduced-form VAR under a Minnesota prior , which shrinks coefficients toward a random walk for each variable and toward zero for cross-variable lags. The tightness hyperparameter $\lambda_1 = 0.2$ is calibrated via marginal likelihood maximisation. This prior is particularly appropriate in short samples — such as post-1990 emerging market data — where parameter proliferation would otherwise degrade inference. Posterior inference is conducted via Gibbs sampling with 50,000 draws, discarding the first 25,000 as burn-in.

3.4 Local Projections

As a robustness check we estimate the impulse response at horizon *h* via the local projection of Jordà,

$$\mathbf{y_{t+h} - y_{t-1} = \alpha_h + \beta_h\, \varepsilon_t^{MP} + \Gamma_h\, X_t + \nu_{t+h}}$$

where ε^{MP}_t is the identified monetary policy shock, X_t is a vector of control variables (lags of all endogenous variables), and ν_{t+h} is a potentially serially correlated error. We compute Newey-West standard errors with bandwidth 2(*h*+1) to account for the moving-average structure induced by the overlapping forecast windows. The sequence $\{\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_h\}$ traces the impulse response function without restricting the dynamics to lie on an autoregressive manifold.

4. Data

We use quarterly data from 1990Q1 to 2022Q4 — 132 observations per country — for a panel of twelve economies: six advanced (United States, United Kingdom, Germany, Japan, Canada, Australia) and six emerging (Brazil, South Africa, India, South Korea, Mexico, Poland). The sample begins in 1990 to avoid the structural breaks associated with the breakdown of Bretton Woods and the disinflation episodes of the early 1980s [14].

Table 1: Variable Definitions and Sources.

Variable	Description	Transformation	Source
Δy_t	Real GDP	Log-difference × 400	OECD / World Bank
π_t	CPI inflation	Year-on-year % change	IFS / Haver Analytics
i_t	Policy / short-term rate	Levels (% p.a.)	BIS / Central Banks
m_t	Broad money (M2/M3)	Log-difference × 400	IMF IFS
com_t	Commodity price index	Log-level	IMF PCPS

Note: IFS = International Financial Statistics. PCPS = Primary Commodity Prices. All variables tested for unit roots; i_t found I(1) in 7/12 countries and included in first differences for those cases.

All series are seasonally adjusted using the X-13ARIMA-SEATS procedure. We include the commodity price index — following Sims — as an informational variable in the VAR to mitigate the price puzzle. Unit root tests (Augmented Dickey–Fuller and Phillips–Perron) indicate that real GDP growth and inflation are stationary in levels for all countries, while the interest rate is borderline in several cases; we therefore enter i_t in first differences for countries where a unit root cannot be rejected at the 5% level, consistent with the practice of Christiano et al.

5. MAIN RESULTS

5.1 Impulse Response Functions

Figure 1 (discussed below) depicts the median impulse response of real GDP growth to a one standard deviation contractionary monetary shock, together with the 68% and 90% posterior credible intervals, for the pooled sample of advanced economies. The response is qualitatively consistent with theory and with the meta-analytic evidence surveyed by Ramey: GDP growth declines on impact, reaches a trough at approximately quarter five ($\hat{\beta}_5 = -0.62$, posterior std. dev. = 0.14), and returns to baseline by quarter twelve. The trough response translates to a cumulative output loss of roughly 1.8 percentage points summed over the twelve-quarter window, using the formula:

Cumulative IRF = $\Sigma_{h=0}^{12}$ $\hat{\beta}$ ≈ −1.84 pp

For emerging economies, the trough occurs somewhat earlier (quarter four) and is of comparable magnitude ($\hat{\beta}_4 = -0.58$), though with substantially wider credible intervals reflecting greater parameter uncertainty in shorter and more volatile samples. This earlier peak is consistent with the hypothesis that higher exchange rate pass-through accelerates the transmission of monetary tightening in open emerging economies.

5.2 Forecast Error Variance Decomposition

Table 2 presents FEVD results at the four-quarter, eight-quarter, and twelve-quarter horizons. Monetary policy shocks account for a modest share of GDP growth variability at short horizons — approximately 5–8% at four quarters — but their contribution grows substantially over time, reaching 18–24% at twelve quarters for advanced economies and 12–17% for emerging economies. The dominant driver of GDP growth variability at all horizons is aggregate demand shocks (identified as shocks to GDP growth itself in the recursive ordering), consistent with the findings of Galí.

Table 2: Forecast Error Variance Decomposition (% of GDP Growth Variance).

Shock	h = 4 (Adv.)	h = 4 (Em.)	h = 8 (Adv.)	h = 8 (Em.)	h = 12 (Adv.)
Monetary Policy (i_t)	6.2	5.1	15.3	11.4	21.1
Aggregate Demand (Δy_t)	54.8	61.2	48.1	55.3	43.0
Price Level (π_t)	22.7	19.4	20.5	17.8	21.4
Money Supply (m_t)	16.3	14.3	16.1	15.5	14.5

Note: Adv. = Advanced economies; Em. = Emerging economies. Columns sum to 100%. Posterior medians reported. h = forecast horizon (quarters).

5.3 Cross-Country Heterogeneity

Panel heterogeneity is assessed by estimating country-specific VARs and comparing the cumulative twelve-quarter output responses. The United States, United Kingdom, and Canada exhibit the largest cumulative responses (ranging from −2.1 to −2.6 pp), consistent with their deep financial markets and high household leverage, which amplify the credit channel . In contrast, South Africa and India display the smallest cumulative responses (−0.9 to −1.1 pp), reflecting both lower financial depth and a larger share of output generated in the informal sector that is less sensitive to formal credit conditions. These cross-country differences are statistically significant at the 5% level based on pairwise tests of the posterior distributions.

6. Robustness Analysis

6.1 Local Projections

Panel (B) of Figure 1 overlays local projection estimates on the SVAR impulse responses. The LP estimates yield a peak trough of −0.57 pp at quarter five (95% CI: −0.91 to −0.24), compared with −0.62 pp from the SVAR. The two methods are statistically indistinguishable at all horizons, corroborating the robustness of the SVAR findings and addressing concerns about potential lag misspecification. The wider confidence bands of the LP estimate at longer horizons are expected and reflect the greater flexibility — and lower efficiency — of the non-parametric approach.

6.2 Alternative Lag Lengths and Identification

We re-estimate the SVAR with p = 2 and p = 6 lags (the Akaike and Hannan-Quinn criteria select p = 4 as the benchmark). The qualitative results and the position of the trough are unchanged. We also consider a narrative shock series constructed from central bank policy statements following Romer and Romer [14], available for the United States and United Kingdom subsample. The narrative-based IRF trough (−0.71 pp at quarter six) lies within the sign-restriction credible interval, further validating our identification.

6.3 Zero Lower Bound Episodes

The 2009–2015 period for advanced economies represents an extended episode at the zero lower bound (ZLB), during which conventional interest rate policy was supplanted by quantitative easing. We re-estimate excluding this subsample and find that the estimated transmission lags shorten marginally (peak at quarter four rather than five) and the magnitude of the trough increases to −0.74 pp — consistent with the hypothesis that near-ZLB periods attenuate the measured interest-rate channel even as unconventional measures provide partial substitution.

7. CONCLUSION

This paper has employed a battery of time series methods — sign-restricted SVAR, Bayesian estimation, and local projections — to characterise the delayed effects of monetary policy shocks on GDP growth across twelve economies. Three main conclusions emerge.

First, contractionary monetary shocks generate hump-shaped output responses with a peak contraction materialising four to six quarters after the initial impulse. This confirms Friedman's long-and-variable-lags hypothesis and underscores that the appropriate evaluation horizon for monetary policy is not a single quarter but a multi-year window.

Second, monetary policy shocks account for a non-trivial but minority share of GDP growth variability — roughly 18–24% at twelve quarters in advanced economies. This finding suggests that while monetary policy materially influences the business cycle, demand shocks and price-level disturbances remain the dominant drivers of growth fluctuations. Policymakers should accordingly resist the temptation to treat monetary policy as an all-purpose stabilisation instrument.

Third, transmission is faster and somewhat less potent in emerging economies, consistent with the lower financial depth and greater informality that characterise these markets. Central banks in emerging economies may therefore need to move more aggressively — or pre-emptively — to achieve equivalent macroeconomic stabilisation relative to their advanced-economy counterparts.

Future work should extend the analysis to unconventional monetary policy instruments — quantitative easing and forward guidance — which have assumed greater prominence since 2008 and whose transmission lags may differ fundamentally from those of the interest rate channel. Incorporating high-frequency identification strategies [21] and machine-learning-augmented VARs also represents a fruitful avenue for improving shock measurement precision.

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