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A Structural Macroeconomic Analysis of Oil Dependence and Inflation Dynamics in India

Chandni Mandle, Department of Economics
Govt. Niranjan Kesarwani College, Kota, Bilaspur, Chhattisgarh, INDIA

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Author

Chandni Mandle

E-mail : chandnimndl602@gmail.com

shodhsamagam1@gmail.com

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ABSTRACT

India's inflation dynamics remain highly vulnerable to movements in global crude oil prices because the country continues to rely heavily on imported oil. This dependence matters not only for energy use itself, but also because petroleum affects transportation, manufacturing, fertilizers, and other essential inputs that shape overall production costs and household spending. As a result, any sharp increase in international crude prices can spread through the economy quickly. The transmission usually works through several linked channels. First, higher oil prices increase the import bill and worsen external balances. Second, they can put pressure on the rupee, making imports more expensive and adding to domestic inflation. Third, the final effect depends on how far the government allows global prices to pass through to domestic fuel prices, especially when taxes, subsidies, or price-smoothing measures are used. Finally, oil shocks can influence inflation expectations, which may then affect wages and broader price-setting behavior. Evidence from Indian policy research suggests that even with government intervention, oil shocks can still produce a noticeable rise in headline inflation. At the same time, the strength of this pass-through is not fixed. It changes according to exchange rate movements, fiscal responses, and the credibility of monetary policy. Studies also show an important policy dilemma: full pass-through may raise inflation more sharply in the short run, while partial pass-through may reduce immediate price pressure but create costs for the budget and public sector finances. This paper builds a structural framework to examine these relationships and to evaluate alternative policy responses for managing oil-driven inflation in India.

KEY WORDS

Oil Price Shocks, Exchange Rate Channel, Inflation Pass-through, Import Dependence.

INTRODUCTION

India's inflation dynamics remain closely tied to developments in global crude oil markets because the country continues to depend heavily on imported crude. Official petroleum statistics show that crude oil import dependence has remained in the high-80% range in recent years, suggesting that international oil price shocks are transmitted into the domestic economy mainly through trade, price, and exchange rate channels rather than through domestic supply adjustments. This structural reliance makes oil price volatility a persistent macroeconomic risk for India. The oil–inflation relationship in India must also be interpreted within the country's flexible inflation-targeting framework. Since the mid-2010s, monetary policy has operated with consumer price inflation as the nominal anchor and a target band centered on 4%, which strengthens the role of policy credibility in containing second-round effects of cost shocks (Reserve Bank of India, 2025). A credible monetary regime can reduce the extent to which oil-led price increases become embedded in inflation expectations and wage-setting behavior. India's exposure to oil shocks is primarily a "small open, imported-input" problem rather than a "domestic resource" problem. Official trade and energy balance reporting indicates that crude oil imports remain a large, persistent component of India's import basket, and that the macroeconomic effect of oil shocks is therefore mediated through the import bill, the exchange rate, and domestic price/tax policy rather than through supply responses of domestic crude production (MoSPI, 2025).

Literature Review

Current import quantities are large. MoSPI's Energy Statistics tables report gross crude oil imports of 234.26 million tonnes in FY 2023–24 (Provisional), consistent with a structurally oil-importing economy (MoSPI, 2025). PPAC's monthly statistical compendium reports a low self sufficiency ratio (indigenous production relative to domestic consumption in its petroleum balance), which implies import reliance in the high 80% range in practical terms for the recent period shown (PPAC, 2024). These conditions establish why global oil price volatility is, for India, an inflation and macro-stability question, not merely a sectoral pricing issue. The transmission of oil shocks to inflation depends critically on the monetary regime because second-round effects arise through inflation expectations, indexation, and the perceived policy reaction function. India's formal flexible inflation targeting architecture sets CPI inflation at 4% with a tolerance band of 2–6%, notified for 2016–2021 via Government notification and embedded in the statutory/institutional monetary policy framework (Government of India, 2016). Earlier, the Government–RBI Monetary Policy Framework Agreement (2015) set the path toward a 4% target with a ±2% band, providing an institutional bridge to the later formal regime (Government of India, 2015). The implication for oil shocks is that credible forward-looking policy can "look through" first-round relative-price effects while acting against expectation de anchoring.

A key development in the international oil-macro literature (and increasingly in India-focused work) is recognising that "oil prices rise" can reflect different structural shocks: oil supply disruptions, global demand expansions, and oil-specific demand/precautionary shocks. This matters because a demand-driven oil price increase can coincide with stronger global activity, whereas a supply disruption is more stagflationary. India-focused studies that adopt sign-restricted SVAR strategies aim precisely to separate these channels, improving interpretation of impulse responses and policy trade-offs (e.g., structural VAR applications in Indian macro-oil work; see also broader SVAR practice in macro-oil identification). For India, domestic pass-through from global oil prices to retail fuel prices is mediated by a complex fiscal and administrative structure: taxes (central excise and state VAT), subsidies/support for specific fuels or consumer groups, and periodic smoothing interventions. An influential India-focused structural simulation model explicitly analyses these channels as import, price, and fiscal channels and demonstrates that the same global oil shock yields different inflation-growth outcomes depending on how much of the shock is passed to domestic prices versus absorbed fiscally (Bhanumurthy et al., 2012).

Oil is priced internationally in USD, so even if the USD oil price shock is identical, the INR oil price shock depends on INR/USD movements. ERPT is therefore central. RBI Working Paper evidence finds that roughly

15% of exchange-rate changes are passed through to CPI inflation over a few months in India, with strong evidence of non-linearities (e.g., small depreciations have stronger pass-through) and time variation (Patra et al., 2018). This is macro economically important because oil shocks can worsen the current account and raise risk premia, with depreciation then feeding imported inflation beyond fuel alone. While direct access to the underlying RBI Bulletin paper can be restricted by automated access controls at the time of writing, multiple reputable business press outlets report consistent quantitative findings attributed to the RBI-staff analysis released in July 2025: a 10% increase in international crude oil prices could raise headline CPI inflation by around 20 basis points contemporaneously (Kundu et al., 2025, as reported by Economic Times and others). For policy audiences, the key point is that this estimate plausibly incorporates the prevailing post pandemic policy environment, including partial retail pricing pass through due to tax and price-smoothing behaviour.

Energy data series that track global market structure, production, reserves, and prices remain indispensable for macro context. The Energy Institute Statistical Review of World Energy provides long-run, standardised global energy market data used widely in policy and academic work (Energy Institute, 2024; 2025). The International Energy Agency provides India-focused oil demand, refining and security analysis, including an “Indian Oil Market – Outlook to 2030” report and related country analysis pages (IEA, 2024).

Theoretical Framework

Modelling objectives and structural interpretation- The theoretical aim is to capture a small open economy (India) that imports crude oil priced in USD, faces incomplete and time-varying domestic pass-through due to fiscal policy and market structure, and operates under an inflation-targeting monetary regime. The model must:

1. Map global oil price shocks into landed oil prices in INR via the exchange rate.
2. Translate landed oil prices into domestic fuel prices via a pass-through mechanism that can be muted by tax/subsidy smoothing.
3. Propagate fuel and imported input costs into headline CPI inflation, accounting for both direct CPI fuel weight and indirect input-cost effects.
4. Allow monetary policy to respond systematically to inflation and output gaps while recognising the supply shock nature of oil.
5. Produce empirically identifiable objects: pass-through elasticities, impulse responses, and variance decompositions.

The framework is presented in a way that can be estimated as an SVAR and interpreted through a DSGE lens for counterfactuals.

Core Structural Relationships

Let p_t^{o*} be the log global oil price in USD (e.g., Brent or the Indian Basket proxy), e_t the log nominal exchange rate (INR per USD; an increase is a depreciation), and p_t^o the log landed oil price in INR. By definition:

$$p_t^o = p_t^{o*} + e_t + \kappa_t.$$

where κ_t captures shipping/insurance premia and margins (treated as exogenous or slow-moving in baseline).

Domestic fuel-price formation with fiscal smoothing

Let π_t^f be domestic retail fuel inflation and τ_t a fiscal/tax-subsidy wedge (net tax/subsidy changes; positive values represent stronger cushioning, i.e., lower pass-through). A reduced-form structural relationship is:

$$\pi_t^f = \phi_o \Delta p_t^o - \phi_\tau \Delta \tau_t + \varepsilon_t^f,$$

where ϕ_o is the (possibly time-varying) pass-through elasticity from landed oil prices to domestic fuel inflation and ε_t^f is an idiosyncratic pricing shock. The central insight of Indian simulation work is that changing the pass-through regime (partial vs full) materially changes inflation and output outcomes (Bhanumurthy et al., 2012).

CPI inflation equation (hybrid open-economy Phillips curve)

Let π_t be CPI inflation, x_t the output gap, and π_t^e an expectations term. A stylised hybrid Phillips curve incorporating oil/fuel costs is:

$$\pi_t = \beta\pi_t^e + \gamma\pi_{t-1} + \lambda x_t + \omega\pi_t^f + \eta\Delta e_t + u_t.$$

where ω captures the direct/indirect fuel-cost contribution and η captures additional imported inflation beyond fuels (consistent with ERPT evidence). For India, ERPT to CPI inflation is estimated at around 15% cumulatively over about five months in one influential study (Patra et al., 2018).

Aggregate demand and external balance channel

Oil shocks affect aggregate demand via the terms-of-trade/import-bill mechanism:

$$x_t = \rho x_{t-1} - \chi(p_t^{o*}) + \psi q_t + v_t,$$

where q_t denotes real exchange rate or external demand conditions. MoSPI explicitly notes that global energy price increases raise the import bill and can worsen the trade balance, supporting this channel's relevance (MoSPI, 2025).

Exchange rate dynamics and risk premium

A tractable UIP-type relation with risk premium rp_t is:

$$\Delta e_t = \alpha(i_t - i_t^*) + rp_t + \varepsilon_t^e,$$

with i_t domestic policy rate, i_t^* global rate, and potentially affected by oil shocks through external vulnerability.

Monetary policy rule under inflation targeting

Under flexible inflation targeting, a simplified policy reaction function is:

$$ i_t = \rho_i i_{t-1} + (1-\rho_i)\left[\bar{i} + \phi_\pi (\mathbb{E}_t \pi_{t+h} - \pi^{*}) + \phi_x x_t \right] + \varepsilon_t^{mp}, $$

with $ \pi^{*}=4\% $ and tolerance band 2–6% as notified (Government of India, 2016).

How Oil Dependence Enters Structurally: Oil import dependence modifies the strength of the external and cost channels. A practical structural mapping is to let key elasticities (e.g., , , or 's sensitivity) scale with an oil dependence index (e.g., import dependence or inverse of self-sufficiency). PPAC's low self-sufficiency ratios in recent years illustrate why is large for India (PPAC, 2024).

Data and Methodology

Explicit assumptions and unspecified choices

Because the user request does not specify exact series and frequency, this paper adopts the following explicit choices (and flags feasible alternatives):

- **Sample Period:** 1990–2025 (inclusive), aligned to the request. Where series are unavailable at high frequency before the late 1990s/early 2000s (notably consistent CPI and survey expectations), estimation will either (i) use a shorter effective sample for those specifications or (ii) use WPI/legacy CPI components for robustness.
- **Inflation Measure:** CPI headline as the primary dependent variable for policy relevance (consistent with the inflation-targeting framework), with WPI inflation used as a robustness metric where useful (Government of India, 2016).
- **Oil Price Benchmark:** Preferably the Indian Basket (policy-relevant) or Brent (global benchmark). In practice, many empirical applications use Brent because of longer history and availability; Indian Basket can be used where coverage exists.
- **Frequency:** Quarterly for the baseline SVAR/DSGE-informed SVAR for 1990–2025 feasibility, given early-data constraints; monthly specifications can be estimated for later subsamples (e.g., 2000 onward) where CPI, exchange rate and oil price series are consistent.
- **Fiscal Smoothing Proxy:** A practical proxy is needed because a clean monthly “net fuel tax/subsidy” series is often not available for the full sample. The baseline proposes a constructed “fuel tax-smoothing” index using known tax rate changes and retail fuel price changes; a simpler alternative is to use domestic pump price inflation directly and interpret the residual pass-through as fiscal/administrative smoothing.

Variables and Primary Data Sources

The following table lists a feasible quarterly dataset aligned to 1990–2025 while prioritising official sources. (In practice, detailed data extraction would use RBI’s DBIE for macro/financial series; PPAC and MoSPI for oil/energy; and IEA/Energy Institute for global context.)

Table 1: Variables, frequency, and primary sources for an India oil–inflation SVAR/DSGE-informed dataset (illustrative 1990–2025 design)

Block	Variable (symbol)	Definition/ transformation	Frequency	Primary source
Global	Global oil price (p^{o*})	log level; shock scaled to +10%	M/Q	IEA; Energy Institute Statistical Review
Global	Global activity (y^*)	industrial production or global PMI proxy	M/Q	IEA/OECD-style datasets (as available)
Domestic oil	Oil import dependence index (D)	1 − self-sufficiency ratio; or import share	A/Q	PPAC; MoSPI
Domestic prices	CPI inflation (π)	y/y %; optionally core	M/Q	Official CPI (via RBI/MoSPI)
Domestic prices	Fuel/transport inflation (π^f)	relevant CPI sub-index y/y	M/Q	Official CPI components
External	Exchange rate (e)	log INR/USD; Δlog for depreciation	M/Q	RBI/market data
Real activity	Output gap (x)	HP-filtered log real GDP; alt: IIP gap	Q	MoSPI / national accounts
Policy	Policy rate (i)	repo or operating target; Δ or level	M/Q	RBI
Fiscal proxy	Fuel policy wedge (τ)	constructed smoothing index	M/Q	PPAC + budget/tax documentation

Identification Strategy

A structural identification of oil shocks should prevent conflating oil demand booms with oil supply disruptions. The recommended strategy is a block-exogenous SVAR (or SVAR X) where global variables are ordered first and treated as contemporaneously exogenous to India (a plausible small open economy assumption for India in global oil markets). The domestic block includes exchange rate, fuel prices, CPI inflation, output, and policy rate.

Two implementable identification approaches are recommended:

1. Sign-restricted SVAR (preferred for "oil shock type" identification): Impose sign restrictions consistent with standard oil-macro theory:
2. Oil supply shock: $p^{0*}\uparrow$, $y^{*}\downarrow$ (or weak), domestic output "!, inflation '!.
3. Global demand shock: $p^{0*}\uparrow$ and $y^{*}\uparrow$
4. Precautionary/oil-specific demand shock: $p^{0*}\uparrow$ with muted y^{*} response.

   This improves structural interpretation relative to simple recursive orderings.
5. DSGE-informed Bayesian SVAR (hybrid): Use priors informed by India-specific pass-through evidence for key parameters (e.g., ERPT H" 0.15 over a few months; pass-through regime differs by period), allowing the SVAR to remain data-driven while retaining a structural interpretation consistent with the theoretical model (Patra et al., 2018).

Estimation and Robustness Checks

Baseline estimation:

- Bayesian SVAR with sign restrictions and block exogeneity; quarterly for 1990–2025 feasibility.

Robustness:

- Alternative oil prices (Brent vs Indian Basket).
- CPI vs WPI (especially where early CPI comparability is limited).
- Subsample splits reflecting regime changes (pre-/post-inflation targeting notification; pre-/post-major fuel pricing reforms).
- Time-varying parameter (TVP) extensions for ERPT and pass-through, motivated by documented time variation in ERPT (Patra et al., 2018).
- Alternative output gap measures (HP filter vs production function; IIP-based proxies).

Empirical Evidence and Counterfactual Analysis

This section reports (i) stylised event context, (ii) published India-specific structural evidence (simulation and SVAR) that aligns closely with the framework above, and (iii) disciplined counterfactuals consistent with those estimates. Where the results are from published work rather than newly estimated in this paper, they are explicitly labelled as such.

Table 2: Key parameters for oil-to-inflation transmission in India

Parameter / object	Magnitude (illustrative)	Interpretation	Source
Oil price shock → CPI inflation (contemporaneous)	≈ +0.20 pp per +10% oil price	Short-run CPI impact under contemporary environment (reported)	Kundu et al., 2025 (as reported in major business press)
ERPT to CPI inflation (cumulative)	≈ 15% over ~5 months	A 1% depreciation raises CPI inflation by ~0.15 pp cumulatively over several months	Patra et al., 2018

Oil price shock (10%) → growth (year of shock)	−0.6% (partial pass-through) / −0.9% (full pass-through)	Output loss depends on domestic pass-through regime	Bhanumurthy et al., 2012
Oil price shock (10%) → inflation (year of shock)	+0.3 pp (partial pass-through) / +0.6 pp (full pass-through)	Inflation rises more when domestic prices adjust fully	Bhanumurthy et al., 2012
Oil price shock → CPI inflation (contemporaneous)	≈ +0.20 pp per +10% oil price	Short-run CPI impact under contemporary environment (reported)	Kundu et al., 2025 (as reported in major business press)
ERPT to CPI inflation (cumulative)	≈ 15% over ~5 months	A 1% depreciation raises CPI inflation by ~0.15 pp cumulatively over several months	Patra et al., 2018

SVAR Evidence: Variance Decomposition and Medium-run Channels

A useful complement to simulation-model counterfactuals is SVAR-based evidence on dynamic responses and contribution to forecast error variance. An India-focused SVAR study that includes oil prices, output, inflation, money variables and the exchange rate reports the following illustrative variance decomposition for oil price shocks: at a longer horizon (18 steps in their setup), oil shocks explain about 10.7% of output variation and 13.5% of exchange-rate variation; contributions to CPI inflation are smaller in their reported specification (Ghosh, 2016).

Table 3: Illustrative variance decomposition: share explained by oil price shocks (selected horizons from an India SVAR)

Horizon (steps)	Output (%)	Inflation (%)	Exchange rate (%)
12	9.7	5.0	9.5
18	10.7	7.8	13.5
24	8.5	7.5	11.3

Two analytical implications follow:

First, even when CPI inflation's explained share appears modest in one CPI-based SVAR, oil shocks can be meaningful through the exchange rate and output channels—consistent with the model's imported inflation and external balance mechanisms. Second, horizon matters: policymaking that focuses only on impact effects may understate medium-run exchange-rate amplification and macro adjustment costs.

Counterfactual Simulation: Subsidy Removal/full pass-through vs Managed Pass-through

This counterfactual uses the NIPFP simulation model as a disciplined "policy experiment" about pass-through rather than a claim about a precise forecast. The model's summary result for the year of an oil shock is explicit:

- **Partial pass-through:** a 10% rise in international oil prices → growth "0.6% and inflation +0.3%.
- **Full pass-through:** a 10% rise in international oil prices → growth "0.9% and inflation +0.6%.

Interpreting "subsidy removal/full pass-through" as a regime shift from partial to full pass-through implies (relative to partial pass-through), for a 10% oil shock in the year of shock:

The deeper policy interpretation is a trade-off: fiscal cushioning dampens measured near-term inflation, but shifts the burden to (i) the fiscal account, (ii) quasi-fiscal liabilities, or (iii) deferred adjustment that can still return via the exchange rate and external balance. The same NIPFP study shows that the "no pass-through" scenario (full fiscal absorption) raises current account deficits and can depress growth even if inflation is initially muted (Bhanumurthy et al., 2012).

For longer-horizon planning, the NIPFP model also reports multi-year scenario paths under larger (50%) oil price shocks, showing that full pass-through raises inflation appreciably in the shock year and reduces growth relative to baseline, while improving fiscal deficit ratios via reduced subsidy needs (Table 4 of the paper) (Bhanumurthy et al., 2012).

Counterfactual Simulation: Exchange Rate Regime and "Inr Oil Price" Amplification

A key structural identity is that the INR oil price change equals the USD oil price change plus the INR depreciation:

Therefore, an oil shock that triggers depreciation is mechanically larger in INR terms even before accounting for broader imported inflation.

Using the ERPT evidence for CPI inflation (cumulatively over about five months), a stylised but disciplined regime comparison can be made (Patra et al., 2018).

Assumption (explicit, for illustration): A +10% global oil price shock triggers either (A) a 0% INR depreciation (more rigid exchange-rate management) or (B) a 2% INR depreciation (more flexible regime with partial absorption in the exchange rate). This is not an estimate; it is a scenario choice to translate ERPT magnitudes into policy-relevant orders of magnitude.

Then the incremental CPI inflation via ERPT under scenario (B) is:

This is economically comparable to the year-of-shock inflation difference between partial and full domestic pass-through in the simulation model (+0.3 pp), implying that "exchange rate management" and "fuel tax/subsidy smoothing" are quantitatively similar levers in short-run inflation outcomes though with very different macro-financial costs and risks.

Policy Implications for India

1. Temporary fuel price suppression may reduce CPI inflation in the short run, but it can worsen fiscal and external balances.
2. Excise and VAT should adjust counter cyclically within clear limits, while welfare support should be delivered through targeted transfers instead of broad price controls.
3. Savings from lower subsidies should be redirected toward productive spending, such as capital expenditure, to support medium-term growth.
4. Monetary policy should avoid overreacting to first-round fuel price increases but must prevent second-round inflation effects.
5. The RBI should clearly separate the effects of fuel prices, exchange-rate depreciation, and domestic demand conditions when explaining inflation pressures.
6. Since pass-through changes over time, inflation forecasting should not rely on a fixed coefficient.
7. This can reduce disorderly volatility without fully blocking adjustment, which would otherwise strain reserves and liquidity.
8. Oil reserves improve energy security and also help reduce inflation risk during extreme global supply disruptions.
9. Strategic reserves work best when combined with clear tax and pricing policies for emergency release periods.

CONCLUSION

India's oil dependence makes the oil–inflation link structurally persistent. The structural model and evidence converge on a central policy message: inflation outcomes under oil shocks are shaped as much by domestic policy "valves" (tax/subsidy pass-through and exchange-rate dynamics) as by the global oil price itself. Simulation evidence quantifies the pass-through trade-off between inflation and growth in the short run, while ERPT evidence shows that exchange-rate amplification can be comparable in magnitude. A coherent policy package transparent fiscal smoothing, expectation-anchoring monetary strategy, resilience-oriented exchange rate management, adequate strategic reserves, and credible diversification provides the most robust inflation stabilisation under global oil volatility.

Limitations

This paper has some important limitations. It develops a structural framework and draws on evidence from published studies, but it does not provide new SVAR or DSGE estimates for 1990–2025 based on a single harmonized dataset. Instead, the empirical discussion relies on published simulation results, SVAR findings, and careful counterfactual calculations using already available parameter estimates. This approach supports transparency and policy relevance, but it does not replace a full original replication study. Another limitation is the difficulty of ensuring data consistency over a long time period, since comparable quarterly CPI data, CPI components, and fiscal pass-through measures may not be available for all years from 1990 onward.

Future Research

A promising area for future research would be the estimation of a state-dependent or time-varying parameter SVAR based on a consistent quarterly dataset. Such an approach could distinguish between supply, demand, and precautionary oil shocks through sign restrictions. It could also include a fiscal smoothing index reflecting fuel taxes and subsidies, while allowing exchange-rate pass-through and fuel pass-through to change over time. This would be especially useful in the Indian context, where earlier studies suggest that exchange-rate pass-through is not constant over time.

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