

Peer-reviewed research

Linking Price and Import Demand Volatility of Crude Oil in India: A Comparative Analysis of Crude Oil Import Price Elasticities With Major Partner Countries

Kamlesh Suthar¹, Rahul Arora¹

¹ Department of Economics and Finance, Birla Institute of Technology and Science, Pilani – Pilani Campus Rajasthan, India.

Keywords: Import demand elasticity, Oil and gas, Petroleum products, DFE model, Panel SUR model

JEL Classifications: C23 Panel Data Models - Spatio-temporal Models, F14 Empirical Studies of Trade, O53 Asia including Middle East, Q37 Issues in International Trade, Q41 Demand and Supply - Prices

<https://doi.org/10.46557/001c.144074>

Energy RESEARCH LETTERS

Vol. 7, Issue 4, 2026

This paper examines how international oil and gas price fluctuations affect India's imports of crude oil, refined oil, and LPG. We show that aggregate import demand responses can mask significant country-level differences in price elasticity. Our findings highlight the importance of country-specific analysis for understanding energy trade dynamics and offer new insights for policymakers in India and other oil-importing nations managing market volatility.

I. Introduction

In this paper, we examine how fluctuations in international oil and gas prices influence the import demand for crude oil, refined oil, and liquefied petroleum gas (LPG) in India. Our hypothesis is that the price elasticity of import demand is heterogeneous, varying not only by product category but also by trading partner. This relationship is motivated by recent changes in India's energy import structure, which reflect both shifting geopolitical alliances and evolving technical requirements (Athukorala & Khan, 2015; Kobek et al., 2015; Kulakhmetov, 2024).

Understanding this heterogeneity is important because India is one of the world's largest importers of energy. Volatility in global oil and gas prices can have direct impacts on energy security, trade balances, and macroeconomic stability. Traditionally, India relied heavily on suppliers from the Middle East, such as Saudi Arabia, Iraq, and Qatar (Standing Committee on Petroleum and Natural Gas, 2023–2024). However, recent years have seen diversification in the import mix, with increased imports from Russia and North America. These changes raise critical questions about how responsive India's import volumes are to changes in global prices, and whether existing relationships shaped by long-term contracts, refinery configurations, and geopolitical considerations alter this responsiveness.

The literature suggests that refined products and LPG may exhibit higher price elasticity, reflecting market flexibility and the ability of importers to adjust sourcing in response to price differentials (Pal & Mitra, 2015; Peersman & Van Robays, 2011; Rogers, 2015). In contrast, the de-

mand for crude oil imports is often more inelastic, constrained by technical specifications of domestic refineries, the prevalence of long-term supply agreements, and strategic considerations (Caldara et al., 2016; Tordo et al., 2011; Wolf, 2009). As India continues to diversify its sources of energy, the degree of substitutability among suppliers is determined by a complex mix of price and non-price factors.

To address these questions, we employ monthly trade data from January 2006 to December 2023, covering imports from approximately 40 major exporting nations. Our empirical strategy combines an autoregressive distributed lag (ARDL) model and Seemingly Unrelated Regression (SUR) models, allowing us to estimate both aggregate and country-specific price elasticities for crude oil, refined products, and LPG. We find that while aggregate models suggest limited overall price responsiveness, disaggregated analysis uncovers substantial heterogeneity across trading partners and product categories. These findings remain robust across model specifications and after accounting for possible endogeneity and unobserved heterogeneity.

These results make two key contributions to the literature. First, we demonstrate that aggregate analysis can obscure important country-specific variation, underlining the value of a disaggregated approach to studying energy import demand. Second, our findings emphasize the role of institutional, technical, and strategic factors in shaping India's response to price shocks, offering actionable insights for policymakers managing energy security in an increasingly volatile global market.

The structure of this study is organized as follows. Section II outlines the data and methodology employed to examine the price elasticity of India's imports across crude oil, refined products, and LPG. Section III describes the estimation methods used to address both short-run and long-run relationships and to account for cross-country heterogeneity. Section IV presents empirical results, offering a detailed analysis of how variations in price influence import volumes from key trading partners. Finally, Section V concludes the study, summarizing the main findings and discussing their broader implications for policy and future research.

II. Data and Methodology

A. Data

This study uses a panel dataset containing monthly import quantities, Asian market average monthly oil and gas prices, and the average monthly oil production levels of exporting countries. Imports are classified as crude oil (unprocessed), refined products (such as gasoline and jet fuel), and LPG (including butane and propane). Data on imports and prices are drawn from the ITC Trade Map and various national public databases, while monthly production figures are sourced from the U.S. Energy Information Administration. The sample covers the period from January 2006 to December 2023, encompasses over 98 percent of India's crude oil imports, and includes approximately 40 major exporting countries.

B. Empirical model

The following import demand equation is used to estimate short-run and long-run price elasticities:

$$M_{it} = \alpha + \beta_1 P_{it} + \beta_2 Q_{it} + \delta_i + \tau_t + \varepsilon_{it} \quad (1)$$

where $i = 1, 2, \dots, N$ is the exporting country to India, $t = 1, 2, \dots, T$ is the time unit in months and, M is import quantity, P is the export price of the product to Asian market from country i , Q is the monthly average oil output of the exporting country i , δ is exporting country specific effects, τ is the time effect, and ε is the disturbance term.

In analyzing the panel dataset spanning January 2006 to December 2023 using Equation (1), we anticipate several potential issues that could affect the robustness of the results. First, the potential presence of non-stationary data is a significant concern, as it may lead to spurious findings (Baltagi, 2005). Second, serial correlation in the error terms could bias our estimates.

Third, cross-sectional dependence may arise due to shared global shocks or interdependencies among countries. Fourth, heteroscedasticity is a common challenge in unbalanced panel datasets, where the variance of errors may differ across time or countries. To address these issues and ensure robust results, we proceed with an autoregressive distributed lag (ARDL) model specification to uncover both long-run and short-run relationships:

$$M_{it} = \theta_1 P_{it} + \theta_2 Q_{it} + \theta_3 P_{it-1} + \theta_4 Q_{it-1} + \delta_i + \tau_t + \varepsilon_{it} \quad (2)$$

The error corrected form for the above equation is:

$$\begin{aligned} \Delta M_{it} = & \varphi_0 \Delta M_{it-1} + \varphi_1 \Delta P_{it} + \varphi_2 \Delta Q_{it} \\ & + \mu_i (M_{it-1} - \beta_1 P_{it-1} - \beta_2 Q_{it-1}) \\ & + \delta_i + \tau_t + \varepsilon_{it} \end{aligned} \quad (3)$$

In Equation (3), the coefficients represented by φ and β represent the short-run and long-run elasticities, respectively. The parameter μ signifies the speed of adjustment toward the long-run equilibrium. If the estimate of μ is negative and statistically significant, it indicates a long-term relationship between the variables, suggesting that the variables are co-integrated, meaning they tend to move together in the long-run.

The estimation process starts with Dynamic Fixed Effect (DFE) as they consider the long-run dynamic adjustment process and the heterogeneity in the model. While GMM and 3SLS estimation methods were initially considered, we recognize their limited relevance within the ARDL framework and focus on approaches better suited for dynamic long-run and short-run estimation. With emphasis on having consistent and efficient estimates in the long-run, the ARDL model ensures an efficient and consistent parameter estimates irrespective of possible endogeneity due to the presence of lags of dependent and independent variables. For cross-sectional insights, we employ Seemingly Unrelated Regression (SUR) to explore error correlations across countries (Srivastava & Giles, 1987).

III. Empirical Results

The results from Equation (3), estimated using the DFE approach and presented in [Table 1](#), indicate that the long-run adjustment coefficients are highly significant at the one-percent level. This confirms the existence of a long-run co-integrating relationship between import volumes and price changes across all three categories of petroleum products. These findings align with those of Caldara et al. (2016), who emphasized the critical role of long-term contracts and supply-demand dynamics in shaping oil price elasticities, particularly for crude oil imports.

The relatively low long-run price elasticity for crude oil (-0.4535) highlights India's dependence on refinery configurations and long-term supply agreements, mirroring global trends identified by Kilian (2020). Kilian observed that crude oil supply is typically inelastic due to production constraints and contractual obligations.

In contrast, refined petroleum products show a higher long-run price elasticity (-1.1947), demonstrating a greater sensitivity to price fluctuations. This observation is consistent with Paital et al. (2019), who attribute this responsiveness to expanding refinery capacities and cost-optimization efforts in emerging economies like India. The findings suggest that India's strategic adjustment of refined product imports in response to cost advantages reflects broader global trends, in which refining capacity is a key determinant of international trade flows.

For LPG, the notably low long-run price elasticity (0.3570) underscores its status as an essential commodity with limited storage options. This result is consistent with Ziramba (2010), who found similar patterns for essential energy products in other developing countries. Short-run elasticities for all product groups are smaller, indicating

Table 1. Estimation from DFE model

	Crude Oil	Refined Oil	Gases
Error correction term	-0.5095*** (0.0246)	-0.6277*** (0.0271)	-0.6256*** (0.0291)
Long-run coefficients			
Price (<i>P</i>)	-0.4535*** (0.0390)	-1.1947*** (0.1324)	0.3570* (0.1910)
Production (<i>Q</i>)	0.6128*** (0.1423)	0.9262*** (0.2131)	0.9175*** (0.2410)
Short-run coefficients			
Price (<i>P</i>)	-0.1292*** (0.0365)	-0.7202*** (0.1339)	-0.6513*** (0.1025)
Production (<i>Q</i>)	0.3498*** (0.0219)	0.4504*** (0.1221)	0.2179*** (0.0795)
Number of Observations	5714	3315	2147
Number of Countries	47	32	28
SSE (full form)	8144.1	6560.2	1956.5
MSE (full form)	1.4371	1.9982	0.9233
Breusch-Pagan Test (p-values)	0.3776	0.3142	0.4789

Notes: Standard errors are reported in parenthesis.***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Estimates for the time trend and constants are not reported.

Table 2. Long-run price elasticity for middle eastern oil and gas exporting countries

Long-run price coefficients	Crude Oil	Refined Oil	Gases
Saudi Arabia	-1.0373*** (0.0222)	-1.6070*** (0.6111)	-0.0179 (0.2255)
United Arab Emirates	-1.0174*** (0.0373)	-0.5728** (0.2268)	0.4442 (0.6475)
Oman	-0.7491*** (0.0630)	0.0886 (0.5415)	-0.3602 (0.3794)
Kuwait	-0.8659*** (0.0662)	-0.0501 (0.9005)	0.8662** (0.3425)
Bahrain	1.1460*** (0.0439)	0.4767 (0.6999)	1.8924*** (0.0526)
Iraq	-0.9473*** (0.0525)	-2.5381*** (0.4380)	-0.3423 (0.2538)

Note: Standard errors are reported in parenthesis.***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

that immediate adjustments to price changes are limited. This is further supported by Caldara et al. (2016), who noted that short-term supply and demand rigidities often impede prompt responses to price volatility.

The results from the Seemingly Unrelated Regression (SUR) model, shown in Table 2, further highlight supplier-specific relationships. For instance, the long-run elasticities for crude oil imports from Saudi Arabia (-1.0373) and the United Arab Emirates (-1.0174) underscore the strategic significance of these partnerships. As Kilian (2020) points out, such relationships often result in near-unit elasticities due to negotiated pricing arrangements. In contrast, the elasticity for LPG imports from Bahrain (1.8924) reflects India's diversification strategy, aligning with global efforts to strengthen energy security through flexible, multi-sourced imports.

IV. Conclusion

This study analyzes how global oil and gas price fluctuations affect India's import demand for crude oil, refined petroleum products, and LPG. The results reveal that refined products are the most sensitive to price changes, while crude oil imports are only moderately responsive—largely due to long-term contracts and specific refinery requirements. In contrast, LPG imports display minimal price elasticity, reflecting their essential nature and limited substitutability.

These findings underline the importance of considering both price and non-price factors—such as technological constraints and strategic partnerships—when evaluating India's energy import patterns. Overall, the study adds to the literature by demonstrating considerable variation in

price responsiveness across different petroleum products and supplier relationships.

However, this study is not without limitations; it primarily focuses on price elasticities without delving into broader economic factors or potential shifts in energy policy. Future research should explore these dimensions, including the impact of renewable energy adoption and changing geopolitical landscapes on India's petroleum import strategies.

.....

Acknowledgement

The authors are grateful to the reviewers and editors of the journal for their valuable comments and constructive suggestions, which have greatly improved the quality of this manuscript.

Submitted: January 22, 2025 AEDT. Accepted: June 11, 2025 AEDT. Published: April 03, 2026 AEDT.



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-SA-4.0). View this license's legal deed at <https://creativecommons.org/licenses/by-sa/4.0> and legal code at <https://creativecommons.org/licenses/by-sa/4.0/legalcode> for more information.

References

- Athukorala, P., & Khan, F. (2015). Global production sharing and the measurement of price elasticity in international trade. *Economics Letters*, 139, 27–30. <https://doi.org/10.1016/j.econlet.2015.09.038>
- Baltagi, B. H. (2005). *Econometric analysis of panel data* (3rd ed.). John Wiley & Sons. <https://library.wbi.ac.id/repository/27.pdf>
- Caldara, D., Cavallo, M., & Iacoviello, M. (2016). Oil price elasticities and oil price fluctuations. *International Finance Discussion Papers*, 1173, 1–59. <https://doi.org/10.17016/ifdp.2016.1173>
- Kilian, L. (2020). Understanding the estimation of oil demand and oil supply elasticities. *Federal Reserve Bank of Dallas, Working Papers*, 2027. <https://doi.org/10.24149/wp2027>
- Kobek, M. L. P., Ugarte, A., & Aguilar, G. C. (2015). Shale gas in the United States: Transforming energy security in the twenty-first century. *Norteamérica*, 10(1), 7–38. <https://doi.org/10.20999/nam.2015.a001>
- Kulakhmetov, T. (2024). *Russia's turn to the East: Energy exports to China and India*. Innovation and Reform Project. <https://innovationreform.org/wp-content/uploads/2024/03/2024-02-Russia-energy-china-and-india.pdf>
- Paital, R. R., Dutta, S., & Dash, A. K. (2019). Crude oil import elasticity of demand in India: An empirical analysis 1987–2016. *Applied Econometrics and International Development*, 19(2), 125–136. http://ideas.repec.org/a/eea/aeinde/v19y2019i2_8.html
- Pal, D., & Mitra, S. K. (2015). Asymmetric impact of crude price on oil product pricing in the United States: An application of multiple threshold nonlinear autoregressive distributed lag model. *Economic Modelling*, 51, 436–443. <https://doi.org/10.1016/j.econmod.2015.08.026>
- Peersman, G., & Van Robays, I. (2011). Cross-country differences in the effects of oil shocks. *Energy Economics*, 34(5), 1532–1547. <https://doi.org/10.1016/j.eneco.2011.11.010>
- Rogers, H. (2015). *The impact of lower gas and oil prices on global gas and LNG markets* (No. NG 99). Oxford Institute for Energy Studies. <https://doi.org/10.26889/9781784670337>
- Srivastava, V. K., & Giles, D. E. A. (1987). *Seemingly unrelated regression equations models: Estimation and inference*. CRC Press. <https://doi.org/10.1201/9781003065654>
- Standing Committee on Petroleum and Natural Gas. (2023–2024). *Review of policy on import of crude oil (Twenty-third report)*. Lok Sabha Secretariat, Parliament of India. https://sansad.in/getFile/lsscommittee/Petroleum%20%26%20Natural%20Gas/17_Petroleum_And_Natural_Gas_23.pdf?source=loksabhadocs
- Tordo, S., Tracy, B. S., & Arfaa, N. (2011). *National oil companies and value creation* (World Bank Working Paper No. 218). World Bank. <https://doi.org/10.1596/978-0-8213-8831-0>
- Wolf, C. O. H. (2009). The petroleum sector value chain. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1514593>
- Ziramba, E. (2010). Price and income elasticities of crude oil import demand in South Africa: A cointegration analysis. *Energy Policy*, 38(12), 7844–7849. <https://doi.org/10.1016/j.enpol.2010.08.044>