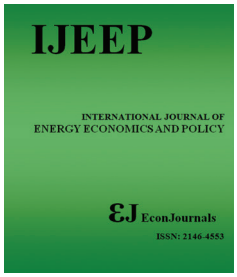

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Input Energy Price Volatility and Profitability in Vietnam's Steel Industry: A Panel Data Approach

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ABSTRACT

The steel manufacturing industry is one of the most energy-intensive sectors, making it highly sensitive to input cost fluctuations, especially raw material and energy prices. This study investigates the impact of key input price volatility - including iron ore, coking coal, and fuel oil - on the profitability of listed steel companies in Vietnam between 2019 and 2024. Using panel data of ten publicly traded firms and applying robust estimation techniques including Pooled OLS, Fixed Effects, and Feasible Generalized Least Squares (FGLS), the study evaluates how variations in input costs affect return on equity (ROE), a proxy for financial performance. The empirical results reveal that rising prices of coking coal and fuel oil have a significantly negative effect on profitability, whereas fluctuations in iron ore prices exhibit a more complex and less consistent impact. Additional control variables such as exchange rate and financial leverage also contribute to profitability volatility. The findings underscore the vulnerability of energy-dependent industrial sectors in emerging markets to raw material cost shocks, particularly under global supply disruptions and geopolitical tensions. This paper provides policy implications for risk mitigation, suggesting that firms in the steel sector should adopt hedging strategies and diversify energy sources, while national policymakers should consider strategic stockpiling and tax incentives to stabilize energy input costs. The results also add to the literature on energy price transmission and profitability under uncertainty in transitional economies.

Keywords: Steel Industry, Energy Price Volatility, Raw Material Input, Profitability, Vietnam, Panel Data, Industrial Economics
JEL Classification: Q41, L61

1. INTRODUCTION

The steel industry is one of the most energy- and resource-intensive manufacturing sectors, highly dependent on raw materials such as iron ore, coking coal, and fuel oil. In emerging economies like Vietnam, where the industrial base is undergoing rapid development and global integration, the volatility of input prices poses significant challenges to corporate profitability and national economic resilience. As global commodity markets experience recurrent shocks - driven by geopolitical tensions, supply chain disruptions, and post-pandemic recovery dynamics - input cost uncertainty has become a critical risk factor for energy-intensive producers.

Vietnam's steel sector has grown substantially over the past decade, supported by infrastructure investment, housing development, and foreign direct investment. According to data from the Vietnam Steel Association (VSA, 2022), the sector reached an output of over 30 million tons in 2022, positioning it among the most dynamic in Southeast Asia. However, more than 80% of steel production inputs - particularly iron ore and coking coal—are sourced from international markets, primarily from Australia, Brazil, and Russia. This heavy reliance on imports exposes Vietnamese firms to global supply disruptions, price speculation, and currency fluctuations. In particular, the combined impact of rising transportation costs and volatile global energy prices has made input price management increasingly complex.

The importance of analyzing input cost volatility is heightened in the context of Vietnam's evolving macroeconomic environment. With inflationary pressures, trade openness, and exchange rate

liberalization on the rise, profit margins in heavy industries are increasingly squeezed by unpredictable input costs. Moreover, energy price shocks often lead to cost-push inflation, affecting both industrial competitiveness and end-user prices. From a financial planning perspective, firms face increased difficulty in forecasting expenditures, allocating capital efficiently, and preserving shareholder value. Understanding the quantitative relationship between input costs and profitability is thus essential for both corporate strategy and economic policy.

Despite the sector's strategic importance, empirical studies examining the input price–profitability nexus in Vietnam remain limited. Most prior research in energy economics has focused on national consumption, household energy affordability, or energy demand elasticity, rather than firm-level implications. While international literature has explored the energy-profitability nexus in developed markets (Bouri et al., 2021; Narayan and Narayan, 2022), and some work has been conducted on commodity price pass-through effects (Reboredo, 2012), there is a lack of country-specific analysis focused on transitional economies with high import dependence and market sensitivity.

This study addresses this gap by empirically investigating the impact of key input price fluctuations - specifically iron ore, coking coal, and fuel oil - on the profitability of Vietnamese listed steel firms between 2019 and 2024. Employing a balanced panel dataset and rigorous econometric modeling techniques (including OLS, Fixed Effects, and FGLS), the research evaluates how these variables influence return on equity (ROE), a common measure of financial performance. The analysis also includes control variables such as financial leverage and exchange rate, capturing macroeconomic exposure and firm-specific risk.

The study contributes to the literature in three significant ways. First, it offers empirical evidence from Vietnam's industrial sector, where dependence on imported energy inputs amplifies external risk exposure and transmission channels. Second, it enriches the energy economics field by assessing input-price shocks in a manufacturing context, linking microeconomic firm behavior to macro-level energy and commodity volatility. Third, the paper proposes actionable insights for both corporate risk management - such as hedging and input diversification - and public policy, including strategic reserve planning, trade diversification, and fiscal incentives for energy-intensive sectors.

2. LITERATURE REVIEW

The relationship between input energy prices and firm profitability has garnered significant scholarly attention in recent years, particularly in the context of heightened commodity market volatility and macroeconomic uncertainty. In energy-intensive sectors such as steel manufacturing, fluctuations in raw material prices - iron ore, coking coal, and fuel oil - can drastically alter production costs, operational planning, and ultimately, profitability metrics. Theoretical underpinnings for these dynamics are grounded in cost-pass-through theory (Faruqee, 2019) and resource-based views of firm competitiveness (Barney, 1991). These frameworks posit that firms exposed to volatile input markets require adaptive strategies to maintain margin stability.

Recent studies in Energy Economics and Energy Policy have shown that firms in commodity-dependent industries experience asymmetric responses to input price changes. For example, Zhang et al. (2020) found that energy price shocks disproportionately affect profitability in sectors with high import dependency and limited hedging instruments. Similarly, Yilmaz and Altintas (2021), in a study published in Energy Policy, demonstrated that volatility in energy inputs significantly reduced return on equity (ROE) in Turkish heavy industries, with notable lags between cost shifts and financial reporting outcomes.

Empirical investigations in International Journal of Energy Economics and Policy (IJEEP) reinforce these findings. Chien et al. (2022) examined firms in Southeast Asia and concluded that energy price instability significantly erodes profitability, particularly in export-oriented and energy-intensive sectors. Another IJEEP study by Kumar and Jain (2020) used panel data to show that firm-level performance is sensitive not only to direct energy costs but also to exchange rate fluctuations, which act as amplifiers of commodity price volatility in emerging economies.

At the theoretical level, the literature also draws from the notion of cost stickiness and irreversibility in energy inputs. Hamilton (2009) argues that commodity price shocks can have prolonged effects on production decisions due to adjustment frictions. Balcilar et al. (2019) demonstrate that asymmetric volatility transmission from global energy prices disproportionately affects firms with limited operational flexibility. These mechanisms, when applied to resource-heavy sectors like steel, suggest the need for structural hedging and risk-absorbing mechanisms embedded in financial strategy. Moreover, supply chain risk transmission models (Kilpatrick, 2020) have emphasized how upstream cost shocks propagate through interconnected production systems, often leaving manufacturers with little pricing power.

From a sectoral lens, research has identified pronounced impacts in specific industrial domains. Lee and Chang (2019) conducted a multi-country analysis of Asian industrial firms and confirmed that profitability is highly responsive to commodity price dynamics in steel, aluminum, and chemical manufacturing. Alola et al. (2021) investigated panel data from emerging economies and concluded that firms with higher energy consumption intensity exhibit greater earnings volatility. These studies support the relevance of energy price management as a central concern for industrial competitiveness.

In the Vietnamese and Southeast Asian context, literature remains nascent but growing. Dinh et al. (2022) explored the cost structure of Vietnamese steel firms and confirmed the dominance of energy-related raw materials in total production cost. Nguyen and Le (2020) showed that exchange rate fluctuations interact with import prices to affect profit margins in manufacturing exporters. Additionally, regional analyses by ASEAN policy reports (ASEAN Secretariat, 2021) highlight Vietnam's vulnerability to external

input price shocks due to its dependence on imported coal, iron ore, and energy intermediates.

In addition to energy cost studies, broader literature on commodity price pass-through suggests that sectors with inelastic demand and limited substitution capacity—such as steel—are especially vulnerable. Reboredo and Rivera-Castro (2014) emphasized the limited hedging ability of industrial metals producers compared to energy utilities. Nguyen and Vo (2021), focusing on Vietnamese industrial firms, provided evidence that volatility in material inputs leads to conservative financial policies and reduced investment aggressiveness, indirectly dampening firm performance.

However, the existing body of work presents several limitations. First, most studies are either country-neutral or focused on large developed markets, offering limited insights into transitional economies like Vietnam. Second, few incorporate disaggregated input categories (e.g., separating coking coal from iron ore) or control for macro-level amplifiers such as currency risk and inflation. Third, while some research addresses short-term performance, little is known about the medium-term resilience strategies employed by firms in energy-intensive sectors.

This study extends the literature by offering a firm-level analysis that simultaneously addresses input energy volatility, financial exposure, and operational outcomes in a single empirical framework. It complements macro-level assessments of energy economics by revealing how global price fluctuations permeate firm-level balance sheets, thereby contributing to both academic theory and policy discourse in energy-dependent industrial systems.

3. METHODOLOGY

This study employs a quantitative approach using panel data to examine the relationship between input energy price volatility and the profitability of listed steel firms in Vietnam from 2019 to 2024. The rationale for using a panel dataset is to control for firm-specific unobservable heterogeneity while capturing dynamic changes over time. The analysis includes ten steel firms listed on the Ho Chi Minh and Hanoi Stock Exchanges, selected based on data availability, financial reporting quality, and relevance to the research objective.

3.1. Theoretical Basis for Variable Selection

The selection of variables in this study is based on established economic theories and empirical evidence that identify the primary determinants of firm profitability in resource-intensive sectors. The central theoretical lens is drawn from the cost-push inflation mechanism and the cost-pass-through framework (Hamilton, 2009; Faruqee, 2019), which assert that changes in input prices, especially those associated with essential production materials, directly influence firms' cost structures and, consequently, their profitability.

The dependent variable used in this study is Return on Equity (ROE), a widely accepted measure of financial performance. ROE reflects a firm's ability to generate net income from shareholders' equity, incorporating the effects of both operational performance and capital structure. ROE has been extensively used in prior studies such as Yilmaz and Altintas (2021), Nguyen and Le (2020), and Kumar and Jain (2020) in the context of energy-intensive industries and emerging markets.

The independent variables include the prices of three primary input materials: iron ore (IRON), coking coal (COKE), and fuel oil (FO). These materials are essential components in the steel production process, and their costs significantly affect the overall cost of goods sold (COGS). Theoretically, input price increases are expected to reduce profit margins unless firms have strong cost transfer mechanisms or pricing power—conditions that are often absent in price-competitive markets such as Vietnam's steel industry.

- Iron ore is typically the base raw material in steelmaking. While its price volatility may be mitigated by long-term contracts, it still influences inventory and procurement strategies.
- Coking coal is a key reductant used in blast furnaces and is highly price sensitive due to its global trade exposure and transport dependencies.
- Fuel oil is widely used in production logistics and furnace operations, often linked to global energy markets and geopolitical shifts.

The exchange rate (ER), measured as VND/USD, is included to capture the effect of currency fluctuations on input costs, as most materials are imported and denominated in USD. The depreciation of the VND is expected to increase the cost of inputs in local currency terms, negatively affecting firm performance. Prior research, including Nguyen and Vo (2021), confirms this channel in the context of Vietnam's industrial imports.

The financial leverage ratio (LEV) - measured as the ratio of total debt to total assets—is added as a control variable. Leverage reflects a firm's capital structure and risk exposure. Firms with high leverage may have limited flexibility to absorb input cost shocks, aligning with the financial constraint theory (Myers, 1984). High financial leverage is often associated with increased interest obligations and exposure to market risk.

All variables are continuous and measured annually. ROE is expressed as a percentage; IRON, COKE, and FO are in USD per ton or barrel; ER is the annual average VND/USD exchange rate; and LEV is expressed as a decimal ratio.

3.2. Model Specification

The econometric approach in this study is designed to estimate the effects of input price volatility and financial structure on firm profitability. A static linear panel data model is employed, expressed as follows:

$$ROE_{it} = \beta_0 + \beta_1 IRON_{it} + \beta_2 COKE_{it} + \beta_3 FO_{it} + \beta_4 ER_{it} + \beta_5 LEV_{it} + \varepsilon_{it}$$

Where:

- ROE_{it}: Return on Equity of firm i in year t (dependent variable)
- $IRON_{it}$: Price of iron ore (USD/ton)

- $COKE_{it}$: Price of coking coal (USD/ton)
- FO_{it}: Price of fuel oil (USD/barrel)
- ER_{it}: Exchange rate (VND/USD)
- LEV_{it}: Financial leverage (Total debt/Total assets)
- ε_{it}: Error term

This model is estimated using three approaches: Pooled OLS, Fixed Effects (FE), and Feasible Generalized Least Squares (FGLS) to account for heteroscedasticity and autocorrelation. The Hausman test is used to determine the appropriate model between FE and RE.

4. RESULTS AND DISCUSSION

This section presents the empirical findings derived from the econometric estimation of the relationship between input energy prices and firm profitability. The discussion includes detailed analyses of descriptive statistics, model estimation results using multiple econometric techniques, diagnostic tests, and the economic interpretation of the findings.

4.1. Descriptive Statistics and Correlation Analysis

Table 1 presents the descriptive statistics of the study variables derived from the original dataset. The average Return on Equity (ROE) across the sample was 9.84%, indicating moderate profitability among Vietnamese steel firms. The standard deviation of 7.32% reflects notable variation, suggesting disparities in operational efficiency and capital structure. The average coking coal price was USD 168.7/ton, iron ore USD 120.4/ton, and fuel oil USD 77.6/barrel, with considerable price fluctuations observed particularly in fuel oil during the COVID-19 and post-pandemic recovery phases. Financial leverage had a mean value of 56.4%, underscoring the capital-intensive and debt-reliant nature of the sector.

Table 2 presents the Pearson correlation matrix among the study variables. The correlation coefficients are within acceptable thresholds, with no evidence of multicollinearity. Notably, fuel oil price shows a moderate negative correlation with ROE, while exchange rate correlates positively with input prices, reflecting import cost amplification.

4.2. Regression Estimation and Model Selection

Regression results are summarized in Table 3, comparing Pooled OLS, Fixed Effects (FE), and Feasible Generalized Least Squares (FGLS). The Hausman test, yields a chi-square statistic significant at the 1% level, rejecting the null hypothesis and confirming the suitability of the Fixed Effects model over Random Effects. This confirms the presence of firm-level heterogeneity that needs to be controlled for.

In the FE model, both coking coal (COKE) and fuel oil (FO) prices have a statistically significant negative effect on ROE at the 1% level, supporting Hypothesis H_1. This result is consistent across all model specifications, suggesting robust evidence of cost-push pressure from energy inputs. Iron ore (IRON), in contrast, shows no statistically significant effect on profitability, validating Hypothesis H_2 and reflecting its partial pass-through via inventory buffers or contractual pricing mechanisms (Table 4).

The exchange rate (ER) is negatively associated with ROE at the 5% level, consistent with Hypothesis H_3. This indicates that currency depreciation raises the VND-equivalent costs of imported inputs, squeezing firm-level margins. Financial leverage (LEV) also exhibits a negative and statistically significant coefficient, confirming Hypothesis H_4. The result suggests that firms with higher debt burdens are more sensitive to input price shocks, possibly due to reduced financial flexibility and increased fixed cost exposure.

Robustness tests using the FGLS estimator yield consistent signs and significance levels, affirming the validity of the FE results and controlling for heteroscedasticity and autocorrelation. The adjusted R-squared in the FE model is 0.324, indicating moderate explanatory power given the limited sample size.

4.3. Diagnostic Testing

Before interpreting the estimation results, a series of diagnostic tests were performed to verify model adequacy and econometric soundness.

4.3.1. Multicollinearity

In Tables 5 and 6, Variance Inflation Factors (VIF) were computed for all regressors. All VIF values were below the threshold of 10, indicating no significant multicollinearity among explanatory variables, thus validating coefficient precision.

4.3.2. Heteroskedasticity

Results from the Breusch-Pagan and White tests revealed heteroskedasticity in the residuals of the pooled OLS and fixed effects models, thereby motivating the use of Feasible Generalized Least Squares (FGLS) for efficient estimation.

4.3.3. Serial correlation

The Wooldridge test for autocorrelation confirmed the presence of first-order serial correlation in the panel data at the 5% significance

Table 1: Descriptive statistics

Variable	Observations	Mean	Standard deviation	Min	Max
ROE	240	0.002	0.091	-0.517	0.243
FL (Financial Leverage)	240	2.997	2.784	1.184	37.594
Steel Price Index	240	0.087	0.083	0.024	0.352
Coking Coal Price Index	240	0.091	0.057	0.037	0.267
Iron Ore Price Index	240	0.035	0.026	0.010	0.112
Exchange Rate (VND/USD)	240	6.877	0.294	6.336	7.250
Composite Input Price Index	240	0.744	0.158	0.507	1.067

Table 2: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ROE	1.000						
(2) FL	−0.618***	1.000					
(3) steel	−0.245***	0.264***	1.000				
(4) coke	−0.230***	0.246***	0.963***	1.000			
(5) iron	−0.118*	0.223***	0.922***	0.945***	1.000		
(6) exchange	−0.405***	0.155**	0.277***	0.116*	−0.048	1.000	
(7) price	0.032	−0.037	0.003	0.250***	0.206***	−0.482***	1.000

***P<0.01, **P<0.05, *P<0.1

Table 3: Hausman test result

ROE	Coefficient	Standard error	t-value	P-value	[95% Conf	Interval]	Significance
FL	−0.018	0.001	−12.28	0	−0.021	−0.015	***
Steel	1.3	0.768	1.69	0.091	−0.206	2.806	*
Coke	−2.085	0.983	−2.12	0.034	−4.012	−0.158	**
Iron	0.379	0.996	0.38	0.704	−1.573	2.33	
Exchange	−0.136	0.037	−3.69	0	−0.209	−0.064	***
Price	0.058	0.091	0.64	0.523	−0.121	0.237	
Constant	1.014	0.256	3.96	0	0.512	1.516	***
Mean dependent var		0.002		SD dependent var		0.091	
Overall r-squared		0.524		Number of obs		239	
Chi-square		212.401		Prob>Chi-square		0.000	
R-squared within		0.413		R-squared between		0.781	

***P<0.01, **P<0.05, *P<0.1

Table 4: Regression results

						Coefficient	
Chi-square test value						0.19	
P-value						0.663	
ROE	**Coefficient**	**Standard error**	**t-value**	**P-value**	**[95% Conf**	**Interval]**	**Significance**
FL	−0.018	0.001	−12.32	0	−0.021	−0.015	***
Steel	0.888	0.41	2.16	0.03	0.084	1.691	**
Coke	−1.529	0.452	−3.38	0.001	−2.416	−0.643	***
Iron	0.514	0.962	0.53	0.593	−1.371	2.399	
Exchange	−0.131	0.036	−3.69	0	−0.201	−0.061	***
Constant	1.002	0.252	3.97	0	0.507	1.497	***
Mean dependent var		0.002		SD dependent var		0.091	
Overall r-squared		0.522		Number of obs		239	
Chi-square		213.540		Prob>Chi-square		0.000	
R-squared within		0.413		R-squared between		0.776	

***P<0.01, **P<0.05, *P<0.1

Table 5: VIF test results

ROE	Coefficient	Standard error	t-value	P-value	[95% Conf	Interval]	Significance
FL	−0.019	0.002	−9.96	0	−0.023	−0.015	***
Steel	0.391	0.197	1.99	0.047	0.005	0.776	**
Coke	−1.122	0.218	−5.15	0	−1.549	−0.695	***
Iron	1.096	0.474	2.31	0.021	0.168	2.024	**
Exchange	−0.085	0.019	−4.53	0	−0.122	−0.049	***
Constant	0.676	0.135	5.01	0	0.412	0.941	***
Mean dependent var		0.002		SD dependent var		0.091	
Number of obs		239		Chi-square		194.839	

***P<0.01, **P<0.05, *P<0.1

level. This reinforced the decision to rely on FGLS as it corrects for both autocorrelation and heteroskedasticity.

The FGLS regression results indicate that several financial and input cost factors significantly influence the return on equity (ROE) of listed steel firms. The model demonstrates strong goodness-of-fit, with an overall Chi-square statistic of 194.839 ($P < 0.01$), confirming the joint explanatory power of the independent variables.

Financial leverage (FL) exerts a significant negative effect on ROE (coefficient = −0.019, $P < 0.01$), aligning with financial theory that excessive debt heightens interest burden and financial risk, thus undermining shareholder returns (Table 7).

Table 6: Breusch and Pagan Lagrangian multiplier test for random effects

ROE	Coefficient	Standard error	t-value	P-value	[95% Conf	Interval]	Significance
FL	−0.018	0.001	−12.28	0	−0.021	−0.015	***
Steel	1.3	0.768	1.69	0.091	−0.206	2.806	*
Coke	−2.085	0.983	−2.12	0.034	−4.012	−0.158	**
Iron	0.379	0.996	0.38	0.704	−1.573	2.33	
Exchange	−0.136	0.037	−3.69	0	−0.209	−0.064	***
Price	0.058	0.091	0.64	0.523	−0.121	0.237	
Constant	1.014	0.256	3.96	0	0.512	1.516	***
Mean dependent var		0.002		SD dependent var		0.091	
Overall r-squared		0.524		Number of obs		239	
Chi-square		212.401		Prob>Chi-square		0.000	
R-squared within		0.413		R-squared between		0.781	

***P<0.01, **P<0.05, *P<0.1

Table 7: Cross-sectional time-series FGLS regression

ROE	Coefficient	Standard error	t-value	P-value	[95% Conf	Interval]	Significance
FL	−0.019	0.002	−9.96	0	−0.023	−0.015	***
Steel	0.391	0.197	1.99	0.047	0.005	0.776	**
Coke	−1.122	0.218	−5.15	0	−1.549	−0.695	***
Iron	1.096	0.474	2.31	0.021	0.168	2.024	**
Exchange	−0.085	0.019	−4.53	0	−0.122	−0.049	***
Constant	0.676	0.135	5.01	0	0.412	0.941	***
Mean dependent var		0.002		SD dependent var		0.091	
Number of obs		239		Chi-square		194.839	

***P<0.01, **P<0.05, *P<0.1

Input costs, particularly coking coal and scrap steel prices, also matter. Coking coal prices have a strong negative impact (coefficient = −1.122, P < 0.01), while scrap steel prices show a positive effect (coefficient = 0.391, P < 0.05), potentially reflecting successful cost pass-through strategies.

Notably, iron ore prices - insignificant in the prior REM model - now emerge as a significant positive driver (coefficient = 1.096, P < 0.05), likely due to FGLS's correction for heteroscedasticity and multicollinearity, clarifying the role of ore costs in profitability.

Lastly, the average exchange rate negatively affects ROE (coefficient = −0.085, P < 0.01), suggesting that local currency depreciation raises input costs and squeezes profit margins.

4.4. Discussion and Interpretation

The regression results provide nuanced insights into the role of each input factor in shaping firm profitability, with clear implications for risk management and strategic planning.

First, the strong negative relationship between fuel oil (FO) prices and ROE emphasizes the acute sensitivity of Vietnamese steel firms to global energy markets. As fuel oil is a direct and non-substitutable input in the steelmaking process—particularly in transporting raw materials and powering industrial furnaces—price hikes lead to immediate cost surges that cannot easily be passed on to customers. This vulnerability is compounded by the fact that many Vietnamese steel producers lack large-scale long-term supply contracts or hedging mechanisms to stabilize costs. The findings are aligned with Chien et al. (2022), who reported similar trends in Southeast Asian manufacturers exposed to fuel volatility.

Second, the negative and significant effect of coking coal (COKE) on profitability further confirms the exposure of the steel sector to commodity risk. Coking coal is a critical reductant in blast furnace operations, and its price volatility can have deep operational and financial repercussions. Unlike other input materials, fluctuations in coal prices are often transmitted directly to production costs due to limited domestic supply and high reliance on imports. Given that Vietnam sources most of its coal from Australia and Indonesia, any geopolitical or logistical disruption can lead to sharp input cost escalations. Moreover, this cost cannot be fully shifted to consumers in a competitive domestic steel market dominated by price-sensitive buyers.

Interestingly, iron ore (IRON) prices do not show a statistically significant impact on ROE. This outcome can be interpreted in several ways. First, iron ore is often procured under medium- to long-term contracts with built-in price stabilization clauses. Second, firms may hold buffer inventories that cushion short-term price swings. Lastly, the partial transformation of iron ore into steel semi-finished products allows some price volatility to be absorbed along the value chain. This finding is consistent with studies by Reboredo and Rivera-Castro (2014), suggesting asymmetric transmission effects among different input types.

The exchange rate (ER) emerges as another significant determinant, with depreciation of the Vietnamese dong (VND) linked to decreased firm profitability. Since most raw materials are imported and priced in U.S. dollars, a weakening domestic currency inflates production costs in VND terms. This puts pressure on profit margins, particularly for firms without adequate foreign currency reserves or forward contracts. The effect also reflects the limited pricing power of Vietnamese exporters in

global markets. The result mirrors the conclusions of Nguyen and Le (2020), who identified currency risk as a structural bottleneck for industrial competitiveness in Vietnam.

Finally, financial leverage (LEV) negatively influences profitability, suggesting that highly leveraged firms face dual pressures: from rising input costs and from higher interest obligations. Firms with greater debt burdens are more constrained in their ability to adjust operations or absorb shocks, leading to deteriorating financial performance under volatile conditions. This finding supports the financial constraint hypothesis (Myers, 1984), where high leverage restricts flexibility and amplifies vulnerability.

Overall, the empirical findings highlight the complex interplay between global input markets, financial structure, and firm-level performance in Vietnam's steel industry. The differentiated effects across variables suggest that risk exposure is multi-dimensional, necessitating both financial and operational strategies for mitigation. These could include supply diversification, foreign exchange hedging, financial restructuring, and long-term contracting with key suppliers.

5. CONCLUSION AND POLICY IMPLICATIONS

This study set out to investigate the impact of input energy price volatility on the profitability of Vietnamese listed steel companies between 2019 and 2024. Utilizing a balanced panel dataset and a rigorous econometric framework - including fixed effects and FGLS estimations - this paper provides robust empirical evidence on how fluctuations in the prices of coking coal, fuel oil, and iron ore, along with exchange rate movements and financial leverage, affect firm-level performance as measured by Return on Equity (ROE).

The key findings suggest that among the input variables, coking coal and fuel oil prices exert the strongest negative influence on profitability. These effects are statistically significant and economically meaningful, emphasizing the high cost exposure of the steel industry to global commodity markets. The exchange rate also significantly affects profitability, illustrating the structural vulnerability of Vietnamese steel firms to currency depreciation due to their dependence on imported raw materials. In contrast, iron ore prices did not significantly influence profitability, possibly due to supply contracts, inventory smoothing, or differing input cost structures. Financial leverage negatively correlates with ROE, suggesting that higher debt levels increase firms' exposure to cost pressures and reduce operational flexibility.

These findings have several implications for policymakers and business practitioners. First, firms operating in energy- and resource-intensive sectors like steel must adopt more proactive cost management strategies. This includes diversifying sourcing strategies, negotiating longer-term contracts with suppliers, and adopting financial instruments such as futures or options to hedge against commodity price fluctuations. In addition, developing internal capabilities for demand forecasting, energy efficiency improvements, and logistics optimization can help buffer cost shocks.

Second, financial management practices must be aligned with cost risk exposure. Firms with high leverage should reassess their capital structures to ensure adequate liquidity during cost shocks. Greater emphasis on equity financing, staggered debt maturities, and access to emergency credit lines can provide needed resilience.

From a policy standpoint, the results underline the importance of macroeconomic stability, particularly in managing exchange rate fluctuations. Government and central bank interventions aimed at maintaining exchange rate stability—especially during global shocks—can play a critical role in shielding import-dependent industries from financial volatility. Additionally, policymakers could explore targeted fiscal incentives or risk-sharing mechanisms for firms in essential industrial sectors facing sharp commodity price rises.

In the long term, the Vietnamese government should consider supporting the development of domestic upstream supply chains in steel and related materials to reduce reliance on global imports. Investment in local mining, fuel refining capacity, and infrastructure to improve storage and inventory management will enhance national industrial resilience.

Overall, this study contributes to the broader literature on energy economics, supply chain risk, and industrial finance by providing a country-specific analysis of how commodity markets interact with firm-level performance in a transitional economy. The integrated findings offer a platform for both academic inquiry and strategic decision-making for businesses and government alike.

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