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Impact of Energy Price on the Profitability of the Indian Manufacturing Industry: A Panel Data Analysis

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Abstract

The intricate relationship between energy prices, particularly oil, and the profitability of the manufacturing industry is a critical area of study for economies like India, which are heavily reliant on energy imports. The period from 2000 to 2019 has seen significant fluctuations in oil prices, impacting the cost structures and profit margins of manufacturing firms. Studies have shown that higher oil prices can lead to increased energy efficiency as firms strive to maintain profitability. However, the adverse effects of rising oil prices on production costs and investor sentiment cannot be overlooked, as they directly influence the financial performance of industries. The volatility of oil prices, driven by geopolitical tensions and market dynamics, presents a complex challenge for businesses, affecting everything from production costs to stock market performance. Understanding these dynamics is crucial for policymakers and industry leaders to navigate the economic landscape and foster sustainable growth in the face of energy price instability. The analysis of panel data using fixed effects and random effects models provides valuable insights into the determinants of profitability, highlighting the significant role of oil prices in shaping the industrial sector's financial health.

Keywords: Energy Price, Oil Price, Manufacturing, Panel Regression, Crude oil

Introduction

Energy efficiency has become a cornerstone of both production and consumption in the global economy. As energy costs fluctuate, businesses strive to minimize expenses and maximize profits by investing in more efficient technologies. This not only benefits their bottom line but also appeals to consumers who are increasingly mindful of the environmental impact of their purchases. Consequently, a virtuous cycle is created where investment in energy efficiency drives innovation, reduces costs, and enhances sustainability. Energy intensity of Indian industries is among the highest in the world and specifically the Indian manufacturing sector is the largest consumer of energy sources (Inter National Energy Agency, 2007). Energy efficiency does not just reduce the production cost, but it involves increasing revenue through greater productivity.

The trajectory of India's energy pricing policy has seen significant shifts over the past decades. The move in 2002 to allow companies to adjust retail petroleum-based product prices marked a departure from the long-standing practice of administrative pricing. This change was aimed at reflecting the global market dynamics more accurately in the domestic pricing of fuel. The partial deregulation of coal prices around 2000 was another step towards aligning India's energy sector with international practices. Energy Prices have increased substantially since then, at an average rate of about 5 per cent per year between 2001 and 2006 (Conti et al., 2009). The recent proposal by the Ministry of Petroleum and Natural Gas for the complete deregulation of crude oil prices is a continuation of these reforms. This move, approved by the Cabinet Committee on Economic Affairs, is set to take effect from October 1, 2022, and is expected to grant marketing freedom to all Exploration and Production operators, thereby ceasing the allocation of crude oil and condensate by the government. Such reforms are part of a broader strategy to stimulate investment and economic activity in the

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upstream oil and gas sector, reflecting a series of transformative reforms initiated since 2014. These reforms have been focused on transparency, ease of doing business, and operational flexibility, with the overarching goal of maximizing production and incentivizing investments. India's manufacturing sector is indeed experiencing a resurgence, marking a significant shift from the stagnation of the late nineties. Recent analyses suggest that the sector is poised for robust growth, with projections indicating a potential doubling of its GDP contribution to $500 billion within seven years. This revitalization is attributed to strategic shifts in sourcing and manufacturing footprints, aimed at enhancing reliability and resilience. Moreover, the sector's recent performance, with a 10.3 per cent year-over-year growth as of August 2023, reflects a positive trajectory that could contribute substantially to India's economic ambitions. The current surge in the manufacturing sector is touted to be much more promising than the first wave (Global Indian Leaders, **2015**). Manufacturing has emerged as one of the high growth sectors in India. India's ranking among the world's 10 largest manufacturing countries has improved by three places to sixth position in 2015 (UNIDO, 2015).

The early 2000s saw relatively stable oil prices, with West Texas Intermediate (WTI) crude ranging from $5 to $30 per barrel. However, from 2003, a significant uptrend began, with prices increasing in 29 of the 40 months up to December 2003 (Energy Information Administration, 2004). This surge was largely attributed to burgeoning demand from China and other rapidly industrializing Asian nations. The period from 2007 onwards was marked by unprecedented volatility in oil prices, characterized by steep climbs and sudden drops, influenced by the global recession which dampened oil demand across various sectors, including transportation, manufacturing, and construction.

The fluctuations in world oil prices are influenced by a complex interplay of factors. Between 2010 and mid-2014, prices were relatively stable, but since then, there has been a significant decline, with prices dropping by approximately 65% in terms of the US dollar (Obstfeld et al., 2016). This trend reflects a slowdown in economic growth across various countries. The average rate of oil price reduction from 2015 to 2016 was about 30.97%, as reported by the World Bank (2018). Contributing factors to this decrease include increased oil production from non-OPEC countries and unexpected surges in OPEC production, particularly from Iraq, Libya, and Saudi Arabia. Additionally, demand was lower than anticipated in European and Asian markets. While there has been an influx of financial investment into the oil sector, which may have heightened price volatility, it's challenging to pinpoint speculative trading or financialization as the primary drivers of the decline. Instead, weaker demand and the availability of alternative energy sources have also played a role in reducing oil prices, alongside the broader energy commodity market.

The empirical evidence from a growing body of academic investigations and reports from government institutions clearly suggests that oil price increases pull back macroeconomic growth by increasing inflation and increasing unemployment and reduce the value of financial and other assets, at least in oil importing nations (Awerbuch and Sauter, 2003). The study of energy costs in the Indian manufacturing industry is a critical endeavor, as energy is a significant factor in the overall cost structure. By examining the correlation between energy prices and profitability, the research can provide insights into how manufacturers can optimize energy usage to enhance their competitive edge. Additionally, understanding the influence of other cost pressures, such as material and labor, can lead to a more comprehensive strategy for maintaining product quality while ensuring process reliability. This holistic approach to cost management is essential for the sustained success of the industry in a global market.

2. Reviews of Literature- The study by Woodland (1993) is a significant contribution to understanding the industrial demand for energy and the impact of fuel prices on economic performance. By analyzing a large

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cross-section of companies, Woodland was able to assess the price elasticity of different fuels and their substitution effects. The findings that oil has a higher price elasticity compared to gas and electricity suggest that industries are more responsive to changes in oil prices. This responsiveness could be due to the critical role oil plays in industrial processes, where it is often a key component. The study's use of marginal pricing strategies for gas and electricity also provides insights into how block pricing can affect consumption patterns. Overall, such research is crucial for policymakers and businesses as they navigate the complexities of energy management and strive for economic efficiency in the face of fluctuating energy prices.

The study by Khurshid and Anwar in 2013 provides a comprehensive analysis of the impact of the energy crisis on the financial performance of various industries in Pakistan. Utilizing the Return on Assets (ROA) ratio, the research scrutinized the performance of companies listed on the Karachi Stock Exchange across five major industries over a six-year period from 2004 to 2009. The study's methodology included a descriptive analysis comparing company performance before and after the energy crisis, followed by econometric tests to evaluate the differences in means for each sector. The findings indicated a significant downturn in the performance of the industries post-crisis, with textiles, cement, and engineering sectors being the most adversely affected. This decline was attributed primarily to the surge in energy prices, underscoring the critical role of stable and affordable energy in sustaining industrial growth.

The study by Janor and Hosseinidoust (2013) highlights the critical relationship between oil price volatility and stock market performance, particularly in the context of an emerging market like Malaysia. Utilizing advanced econometric models such as GARCH and EGARCH, the research provides insights into the asymmetric impacts of oil price fluctuations. The findings serve as a valuable resource for policymakers, regulators, and investors, offering guidance on managing the inherent risks associated with oil price movements and their broader economic implications.

The research by Lele (2016) delved into the effects of fluctuating global crude oil prices on the financial performance of non-financial sector companies listed in Saudi Arabia. Utilizing panel data spanning from 2010 to 2015, the study segmented the years based on oil price trends to analyze their impact. The investigation focused on three key economic indicators: Revenue Growth rate, Net Margin, and Return on Equity, revealing a significant correlation between these metrics and global oil prices. This study underscores the sensitivity of company profitability within these sectors to changes in the oil market.

3 Sources of data- Secondary data source has been used to analyse the impact of changes in the Indian crude basket prices and manufacturing profitability. The PROWESS database by the Centre for Monitoring Indian Economy (CMIE) and the Petroleum Planning and Analysis Cell (PPAC) data are crucial sources for analyzing economic trends. They provide comprehensive firm-level data and crude oil price information, respectively, which are essential for research spanning from 2000 to 2019. Such datasets enable a deep dive into the economic impacts of oil price fluctuations on businesses within India, offering valuable insights for policymakers and economists alike. We have selected 748 Indian manufacturing firms from 3 digits NIC (National industry classification) industries for a period of 20 years from 2000 to 2019, thus forming a panel of 14960 observation.

4 Methodology- The panel data regression is used to capture the relation between oil price, sales volume, and return on asset, material cost, energy consumption, wage or salary as independent variables and net profit margin as a dependent variable.

Logarithmic transformation is indeed a powerful technique in regression analysis, especially when dealing with non-linear relationships. By applying a logarithmic scale to variables, one can often linearize the

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relationships, stabilize the variance, and make the data conform more closely to the normal distribution. This approach not only helps in improving the model's interpretability but also in meeting the assumptions of regression models, thereby enhancing the accuracy of predictions. Here, the natural log of selected independent variables namely sale, salary, power and material are given. The panel data estimation methods of fixed effects (FE) and random effects (RE) model is used to estimate the impact of oil price on profitability of Indian manufacturing industry with the following model.

$$NPM_{it} = \alpha_{1i} + \alpha_2 Oil_{it} + \alpha_3 lnsale_{it} + \alpha_4 lnsalary_{it} + \alpha_5 lnpower_{it} + \alpha_6 lnmaterial_{it} + \alpha_7\ ROC_{it} + u_{it}$$

Here "α" unknown intercept for each individual and finally, u_{it} is the error term associated with the model.

Table 1
Variables and description

Variable	Description	Definition
NPM	Net profit margin	Percentage of revenue left after deduction of all the expenses to its net sales
Oil	Oil price	Crude oil price, Indian basket*
Sales	Sales volume	Yearly quantity of sales
Material	Material cost	Annual production cost
Energy	Energy consumption	Expenses on energy usage
Wage	Wage	Average payment made to workers annually
ROC	Return on capital	Return from capital investment

*The composition of Indian Basket of Crude represents Average of Oman & Dubai for sour grades and Brent for sweet grade in the ratio of crude processed during previous financial year.

Crude oil prices measure the spot price of west taxes intermediate (WTI). WTI crude oil is of very high quality, because it has low sulphur content. There is a negative relationship between the oil price and industry return (Kuwornu and Owusu-Nantwi, 2011). Thus, it may be in India, oil price and Indian manufacturing profitability have negatively related. The main goal of the industry is to maximise the revenue that the increase in sales will always continue. Past literature review indicates study on sales growth and profitability and performance of ASEAN economy, Mohammed and Hoshino (2013) states that sales and industry profitability are positively related. This study uses salary or wages workers as an explanatory variable in adds to capture the impact of decrease or increase this variable on the profitability of Indian manufacturing industry. Return on asset is the backbone of the industry study made by Basha (2016), showed that there was a statically significant positive relationship between net profit margin and return on asset. This study hopes to find whether the study holds the same with respect to Indian manufacturing industry. An increase in input cost or material cost would impact the profitability of the industry negatively. Hence this study includes material cost as an explanatory variable to analyse its impact on the profitability of the Indian manufacturing industry. Another important factor which determines the profitability an industry is the expense increased on energy consumption, a higher cost on energy consumption is likely to reducing the profitability of the industry. Hence, the study also takes the cost of energy consumption as an independent variable to analyse its impact on profitability of the industry.

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Profitability is a multifaceted aspect of any industry, crucial for sustaining growth and expansion. It hinges not only on effective pricing strategies and sales volume but also on the intricate balance between the cost of sales and production costs. A thorough understanding of these elements can lead to more informed decision-making and strategic planning, ultimately enhancing the financial health and competitive edge of a business in the market.Market Size, research and development, industrial policies and strategies also play a significant role in determining profitability (Samuels and Smyth, 1968; Marcus, 1969). Profitability is also determined by goodwill of the firms, product diversification, elaboration of capacities and sales return (Agarwal, 1999).

We use the panel data regression to find the relation between oil price and profitability of Indian manufacturing firms. We have used sales volume, and return on asset, material cost, energy consumption, wage or salary as independent variables and net profit margin as a dependent variable. Panel data estimation methods of fixed effects (FE) and random effects (RE) models are employed to estimate the impact of oil price on profitability of Indian manufacturing industry.

5. Data Analysis- This part shows the empirical findings of the study. As it has been discussed in methodology section, the study has used panel data methods of fixed effects and Random affects models for estimating the analysis for estimating the relationship between oil price and NPM, with the help of STATA statistical program. In order to choose the most appropriate estimation model from FE and RE we have used the Hausman specified test.

5.1 The Regression summary- Table 2 shows the sample's descriptive statistics from 2000 to 2019. The mean value of the industry sales volume lies at 2,58,898.90 with a maximum value of 3,84,00,000. The mean salary of the sample is 8,037.8. The mean Return on capital of the Industry is calculated to be 31.88 from 2000-2019. The mean raw material expenses and the power expenses are calculated to be 131287.7 & 5382.5 respectively. The diversity in firm performance, as reflected in profit margins, is a testament to the varied strategies and market conditions faced by companies. A mean net profit margin of -288.72 indicates challenges in the industry, while the range from -90634.06 to 695.60 suggests that some firms have found successful approaches or niches. This variance highlights the importance of strategic management and the need for firms to adapt to rapidly changing market dynamics to improve their financial health.

Table 2
Descriptive statistics of the sample

Variable	Observations	Mean	Std. Dev.	Min	Max
Sales	748	258898.9	1915311	12.3	38400000
Salaries	748	8037.831	37354.17	1.1	669483.60
Roc	748	31.88291	396.0323	-5806.16	1794.49
Raw material	748	131287.7	950945.3	0	17600000
Power	748	5382.594	30385.44	0	440107.70
Oil price	748	44.40976	93.03797	0	1541.80
NPM	748	-288.7203	3555.349	-90634.06	695.60

Source: Own estimates from PROWESS database, CMIE

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The summary of the result of panel data analysis has been given in Table 3; from this we can see that coefficient of the explanatory variables is different in two models, but the statistical significance is same in oil price, which shows 1% significant level. As far as R^2 values are concerned both the models nearly 40% of variations in NPM of manufacturing industry explained by the independent variables. Table 3 presents the results of panel estimation on the influence of oil price on return net profit margin of manufacturing industry in India using the fixed effect and random models.

Table 3
Determinants of net profit margin of Indian Manufacturing Industry

Variables	Fixed effect	Random effect
	Coefficient	Coefficient
Oil	-28.7634	-28.547
	(.3629)***	(.3481)***
In sale	23.3823	-6.9348
	(9.8264)**	(5.9298)**
In salary	-1.8274	-1.6792
	(4.6766)*	(3.9169)*
Roc	0.03955	0.0811
	(.08741)*	(.0831)**
In power	12.8245	21.0689
	(4.5306)***	(3.1060)***
In raw material	-0.0005	-4.0645
	(3.9110)*	(2.7078)**
_cons	-127.2881	84.30656
	(53.8891)**	(27.8514)***
F- test	1087.49***	6910.87***
Hausman Test	42.88***	42.88***
R^2	0.3758	0.3810
No of observations	14960	14960
No of groups	748	748
Rho	0.0864	0.0144

Source: Own estimates from PROWESS database, CMIE.
*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

The result of fixed effect regression of NPM against oil prices shows that there is an existence of encouraging relationship between the two. The coefficient is -28.76 which means 1% increase in the industry NPM will reduce oil price at 28.8 percent. The regression result illustrates that the coefficient is statistically significant at the 95% confidence level. Moreover, there is an existence of the negative effect of crude oil prices upon the

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Indian manufacturing industry profitability. The relationship between the oil prices and the NPM negative. The coefficient value of oil price indicates this relationship.

In econometrics, taking the logarithm of an independent variable while leaving the dependent variable in its original scale is a common transformation. This approach, known as a semi-logarithmic model, allows for a straightforward interpretation: a one percent change in the independent variable results in a change in the dependent variable that is equal to 1/100th of the regression coefficient. This transformation is particularly useful when dealing with exponential relationships or when the independent variable spans several orders of magnitude. Here we have taken the natural log of sales for the estimation, and the correlation coefficient of the sale is positive value. This means 1% increase in the industry sales volume will lead to an increase of 0.233 units in industry net profit margin, and in the case of salary to the workers, 1% increase in the industry salary will reduce 0.012 per cent industry NPM. Industry power consumption and net profit margin in positively correlated. Percentage increase in the power consumption expense will lead to an increase of 0.13 units in industry NPM; it follows statistically significance at 1% level. In fixed estimation model results shows that there is no significant relation between NPM and expense for raw materials.

In general, the results of fixed effect estimation show that oil price is an important determinant factor in determining net profit margin of the Indian manufacturing industry. The F-statistic is highly significant meaning that all coefficients in the model oil, sale, salary, and ROC, power, and raw material expenses are not equal to zero. This brings to the conclusion that the model is a good fit in explaining the relationship.

5.2 The result of random effect model- Random effect model is another model for estimating panel data. Random effects estimates are considered to as discussed in methodology be consistent and effective. William H. Greene calls the random effects estimation a regression with a random constant term (Greene, 2003). The random model allows varying all coefficients, intercepts as well as time.

Here the coefficient of oil price is negative and statically significant in this model. The coefficient value is -28.5. Here we have taken natural log of sale, salary; power and raw material to normalize our data. It is interesting to note that, the industry sales volume is negatively related with the Industry NPM, statistically significant at 5% level. One percent increasing industry sales volume, salary to the workers and raw material expenses will reduce industry NPM at 0.07, 0.017, and 0.04 per cent respectively.

The Wald test is a critical component in statistical analysis for comparing models. A significantly higher Wald value suggests that the fixed effects model is more appropriate than the random effects model for your data. Here the Wald statistic has 6 degrees of freedom. This is because the fixed effects model accounts for heterogeneity within individual firms, which seems to be a significant factor in explaining the variance in Net Profit Margin (NPM). The R-squared values within and between groups indicate that the variables you've chosen explain a consistent amount of variation in NPM across firms, reinforcing the suitability of the fixed effects model for your analysis.

5.3 Hausman specification test- We also use the Hausman specification test; to decide between fixed or random effects we can run a Hausman test where the null hypothesis is that the preferred model is random effect vs. the alternative the fixed effects (Green, 2008). Here χ^2 value is 42.88 and it is statically significant, so we reject the null hypothesis, which reasons, fixed effect model is more appropriate. It would be more

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correct to say that if the p-value for the Hausman test, where we compare random and fixed-effects, the value is <0.05 then the random-effects estimator is not appropriate model. The fixed-effects estimator is more efficient; comparing with Random model, as far as R^2 values are concerned both the models nearly 40% of the variations in NPM of manufacturing industry explained by the independent variables.

6 Conclusion- In this paper, we have analysed the relationship between profitability of manufacturing industry in India, taking net profit margin as dependent variable and oil price, sales volume, salary, ROC, energy expense, input expense as independent variables. The study of fixed estimation Correlation coefficient between industry sale and Net Profit Margin 23.3823 indicates that there is a positive linkage between sales and NPM growth. Employer salary or wage rate have inversely related with industry NPM, the coefficient of the result shows the negative value. Measuring industry profitability with random estimation model, the effects of industry specific variables were not very much different from the results of the with random effect model.

We have used panel data model of fixed effect and Random effect estimation models to analysis the relationship. Study establishes that increasing crude oil prices have industrial effect, by reducing profitability of Indian manufacturing industry. The positive coefficient of the sales shows that there is positive relationship between industry sales volume and net profit margin. Hausman test results suggest that fixed effect model is more appropriate, correlated to random effect model of panel estimation in our case. The volatility of crude oil prices can have a profound impact on the profitability of manufacturing industries. As you've noted, direct effects are observed through increased production costs when oil prices rise, affecting industries that rely heavily on oil as a raw material or energy source. Indirectly, investor sentiment can be influenced by anticipated reductions in profit margins, which may lead to a decrease in stock market indices, reflecting a bearish outlook on the affected industries. The period from 2000 to 2019 offers a substantial dataset to analyze these trends within the Indian manufacturing sector. Statistical analysis of this data can provide valuable insights into the correlation between oil price fluctuations and industrial profitability, potentially guiding future economic strategies and policies to mitigate such impacts.

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