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ECO335 - Environmental Economics
Final Project

Impact of fuel price variations on firm's profits

ABSTRACT

The relationship between carbon taxes and firm profitability has become increasingly relevant in the context of global climate change and regulatory policies. Our research investigates the impact of fuel price fluctuations on firm profits, using fuel prices as a proxy for carbon taxes in the absence of extensive carbon pricing data. By analyzing factory-level data across multiple industries from 2014 to 2022, we explore how firms adjust their pricing, cost structures, and energy consumption in response to changing fuel prices.

The relationship between fuel prices and firm profitability is more complex than traditionally assumed. While lower fuel prices were once thought to enhance firm margins, emerging evidence, including our findings, suggests that higher fuel costs can drive firms to improve productivity, operational efficiency, and even profitability under certain conditions. Regression analysis reveals a positive relationship between fuel prices and net profits. Fuel-intensive firms display stronger positive responsiveness, suggesting that higher energy costs may push firms towards efficiency-enhancing adjustments that ultimately strengthen profitability.

Our results highlight the effects of energy costs on firm performance, emphasizing the potential for firms to adapt strategically to rising energy costs. These insights contribute to a deeper understanding of how energy and environmental policies, particularly carbon taxation, may influence firm behaviour and financial outcomes.

RESEARCH QUESTION

Q) What is the impact of fuel price fluctuations on firm profitability across different industries?

Hypothesis:

H0 (null hypothesis): $\beta 1<0$, indicating a positive impact on firms as fuel prices increase. **H1**

(alternate hypothesis): $\beta 1>0$, indicating a positive impact on firms as fuel prices increase.

Relevance of this paper:
Understanding the interplay between fuel prices and firm profitability is critical in an era marked by intensified carbon regulation. As governments worldwide consider or implement carbon taxes, our findings highlight that the effect on firm performance is not uniformly negative. Instead, firms with high energy dependency may respond by increasing efficiency and innovation, thus preserving or even enhancing profitability. Quantifying this relationship provides a solid evidence base for strategic and policy decisions in a transitioning, low-carbon economy.

Literature Review 1: Kaashvi Mahajan

This review examines three key studies that explore the positive relationship between firm profitability and fuel price fluctuations.

Calì, Cantore, Iacovone, Pereira-López, and Presidente (2021) in their study *"Too much energy: The perverse effect of low fuel prices on firms"* present a strong challenge to the conventional view. Using detailed firm-level panel data across multiple developing economies, they find that lower fuel prices may lead firms to become complacent, invest less in energy efficiency, and ultimately operate less productively. Their empirical evidence highlights that manufacturing plants facing higher energy costs are more likely to adapt in ways that strengthen their competitive position, rather than suffer outright losses.

Complementing these findings, Kilian (2008) in *"The Economic Effects of Energy Price Shocks"* offers a broader macroeconomic perspective. Kilian distinguishes between different types of oil price shocks—supply-driven, demand-driven, and speculative—and notes that not all price increases have the same impact on firms. Particularly, energy price hikes driven by global demand expansion can coincide with economic booms, offering firms opportunities to grow revenues despite higher costs. This suggests that the negative effects of rising fuel prices can be mitigated, or even reversed, when firms are able to leverage higher market demand, supporting the notion that fuel price increases are not uniformly harmful to firm profits.

Furthermore, Bugshan, Bakry, and Li (2020) in *"Oil price volatility and firm profitability: an empirical analysis of Shariah-compliant and non-Shariah-compliant firms"* provide additional insights into how different types of firms respond to energy price changes. Their study shows that firms with stronger financial discipline and risk management practices, such as Shariah-compliant firms, are better equipped to manage energy price volatility, maintaining stable profitability even during periods of rising fuel prices.

Overall, the literature suggests that rising fuel prices can stimulate positive changes in firm performance rather than uniformly harming profits.

Literature Review 2: Gargi Kaushik

This review examines three key studies that challenge the traditionally held view that firm profitability is negatively impacted by increasing fuel prices as a result of taxes and subsidies: (1) “Fossil fuel subsidy reforms and their impact on firms” by rentschler et al (2017), (2) “Influence of fuel price, electricity price, fuel consumption on operating cost, generation and operating income: a case study on PLN” by Tri Wahyu Adi (2023), and (3) “A comparative study of progressive carbon taxation strategies: impact on firms’ economic and environmental performances” by Amina Chelly (2021).

Rentschler et al. (2017) explore the impact of fossil fuel subsidy reforms on firms, providing valuable insights into how companies respond to changes in energy pricing. Their study, conducted across several emerging economies, finds that while immediate cost pressures do arise from subsidy reforms (effectively leading to higher fuel prices), firms often respond by investing in energy-efficient technologies and improving operational efficiency. These adjustments, over time, mitigate initial losses and can even enhance competitiveness. The research supports the notion that higher energy prices act as a catalyst for innovation, rather than simply eroding profitability.

Complementing this view, Tri Wahyu Adi (2021) analyzes the effects of fluctuating fuel and electricity prices on the operational costs and income generation of PLN, an Indonesian power generation firm. His case study shows that while rising fuel prices initially increase operational costs, companies can maintain, or even grow, operating income through adjustments in pricing strategies, energy sourcing, and operational efficiencies. Crucially, Adi finds that firms able to reduce fuel consumption relative to output can offset the negative impact of higher energy prices, leading to stable or even improved profit margins. This evidence aligns with the hypothesis that firms can use fuel price increases as an impetus to optimize operations, thereby protecting or boosting profitability.

Further extending the argument, Chelly (2021) investigates the impact of progressive carbon taxation strategies on firms’ economic and environmental performances. Although not directly focused on fuel prices, carbon taxes effectively function as an energy cost increase, serving as a strong proxy. Chelly's comparative study finds that firms subject to progressive carbon taxes often experience an initial decline in financial performance but eventually adapt by enhancing energy efficiency, innovating cleaner technologies, and optimizing production processes. Over the medium to long term, many firms not only recover but outperform less environmentally responsive competitors, achieving better profitability and resilience. Chelly's findings bolster the idea that rising energy costs, when anticipated and strategically managed, can drive firms toward higher productivity and profitability.

Taken together, these three studies highlight the adaptive capacity of firms, particularly manufacturing and energy-intensive companies, to innovate, improve efficiency, and maintain or even increase profits in the face of fuel price shocks.

Literature Review 3: Chinmay Kalkur

This literature review examines two studies that investigate the impact of fuel prices on firms' profits, highlighting different approaches and findings. The first paper, by Albrizio et al. (2017), explores how energy prices influence the competitiveness of firms, particularly in developing countries, through various channels, such as energy efficiency and the pass-on effect. The second study, by Sato et al. (2019), examines the relationship between energy prices and firm performance using a micro-level panel dataset from 11 countries, focusing on the energy intensity of production processes.

Albrizio et al. (2017) analyse the impact of energy prices on firms' performance using data from the World Bank's Enterprise Surveys. The study identifies three key effects through which energy prices affect firms: the "energy efficiency" effect, the "absorption" effect, and the "pass-on" effect. The absorption effect refers to how firms adjust to rising energy prices by absorbing the cost increases into their operations, while the pass-on effect occurs when firms transfer the cost increases to consumers through higher prices. The study finds that firms with lower energy intensity are less affected by energy price increases, and energy-efficient firms tend to perform better in response to price hikes.

Sato et al. (2019), on the other hand, provide an empirical analysis of energy prices and firm performance using panel data from 11 countries, covering a wide range of industries. Their study focuses on how firms' energy intensity—the proportion of energy costs relative to revenues—modulates the effect of energy prices on performance. The authors find that the negative impact of energy price increases on firm performance is more pronounced for energy-intensive industries. They also identify that firms with higher energy efficiency or lower energy intensity are better able to mitigate the adverse effects of rising fuel prices. This study emphasizes the importance of firm-level energy intensity in determining how fuel price changes affect economic outcomes, and it provides a detailed econometric analysis using various firm level performance indicators.

<u>MODEL</u>

We use multiple regression analysis (OLS) to assess the impact of fuel consumption (proxy for fuel price variations) on firm profits, controlling for production costs, revenue, depreciation, wages, and capital investments.

$$\text{NetProfit} = \beta_0 + \beta_1\text{TotalEmoluments} + \beta_2\text{WorkingCapital} + \beta_3\text{ValueofOutput} + \beta_4\text{Depreciation} + \beta_5\text{MaterialsConsumed} + \beta_6\text{FuelsConsumed} + \beta_7\text{dTotal} + \text{Year} + \text{intensity\_num} + \varepsilon$$

Here,

Net Profit (dependent variable) = firm's profit after accounting for all costs and expenses.

Total Emoluments (independent variable) = Compensation paid to workers and employees.

Fuels Consumed (independent variable) = Expenditure on fuels used in production.

Working capital (independent variable) = Expenditure on capital used in day to day operations.

Value of output (independent variable) = Total value of production output.

Depreciation (independent variable) = Reduction in value of assets over time.

Materials consumed (independent variable) = Cost of materials used in production.

Dtotal (independent variable) = Total addition in stock of materials, fuels etc., semi finished goods, and finished goods.

Year (control variable) = The year of observation (2014-2022).

Intensity_num (control variable) = This variable represents the type of industry based on energy usage (1 means high - energy usage, 2 means medium - energy usage, and 3 means low energy usage industry).

The variables chosen represent key elements of a firm's cost structure, resource utilization, and production scale, all of which directly affect Net Profit. This selection ensures a comprehensive analysis of the drivers of firm performance. Fuels consumed and Net Profits are the key variables we are studying in this analysis.

DATA

This study utilizes a comprehensive industry-level panel dataset spanning the period from 2014 to 2022, covering a wide range of industries across India. The primary source of data is the Annual Survey of Industries (ASI) database. We have used Table 5 Estimate of important characteristics by 3 digit of NIC08_2021_2022 from the Annual Survey of Industries 2014 – 2022.

```
. corr NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed FuelsConsumed dTotal
(obs=27)
```

	NetPro~t	TotalE~s	Workin~l	Valueo~t	Deprec~n	Materi~d	FuelsC~d	dTotal
NetProfit	1.0000							
TotalEmolu~s	0.8353	1.0000						
WorkingCap~l	0.7732	0.9370	1.0000					
ValueofOut~t	0.9432	0.8272	0.7239	1.0000				
Depreciation	0.8636	0.7731	0.5957	0.9436	1.0000			
MaterialsC~d	0.9230	0.7778	0.6743	0.9953	0.9320	1.0000		
FuelsConsu~d	0.7909	0.5230	0.3615	0.8947	0.8997	0.9174	1.0000	
dTotal	0.7355	0.5337	0.5569	0.6237	0.5109	0.6211	0.4695	1.0000

- Net Profit is strongly correlated with Value of Output (0.9432), Materials Consumed (0.9230), Depreciation (0.8636), Total Emoluments (0.8353), and Fuels Consumed (0.7909), indicating that larger firms earn higher profits as their scale of operations expands.

- Total Emoluments correlates highly with Working Capital (0.9370) and Materials Consumed (0.7778), suggesting that firms with higher workforce expenses also manage larger resources and material inputs.
- Working Capital is positively linked to Total Emoluments (0.9370) and Net Profit (0.7732), highlighting that liquidity supports greater employment and profitability. ● Value of Output shows very strong correlations with Materials Consumed (0.9953), Depreciation (0.9436), and Fuels Consumed (0.8947), reflecting the direct link between production scale and input usage.
- Depreciation and Materials Consumed are highly correlated (0.9320), indicating that intensive production leads to greater wear and tear on assets.
- Fuels Consumed is strongly associated with Materials Consumed (0.9174) and Value of Output (0.8947), suggesting energy use scales with production.
- dTotal has moderate correlations, notably with Value of Output (0.6237), but does not dominate firm-level movements like other variables.

```
. summarize NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed FuelsConsumed dTotal
```

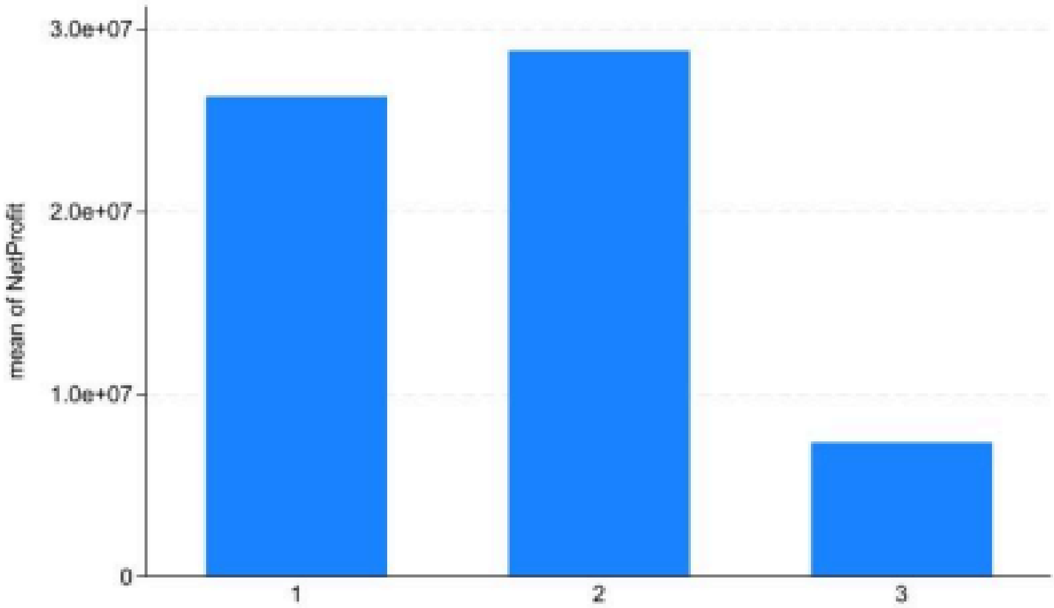
Variable	Obs	Mean	Std. dev.	Min	Max
NetProfit	27	2.08e+07	1.23e+07	4265773	4.57e+07
TotalEmolu~s	27	1.49e+07	8692589	3579661	3.59e+07
WorkingCap~l	27	3.13e+07	2.13e+07	1.08e+07	8.72e+07
ValueofOut~t	27	3.00e+08	1.64e+08	7.08e+07	6.73e+08
Depreciation	27	8046538	4240886	1271149	1.43e+07
MaterialsC~d	27	1.96e+08	1.11e+08	4.68e+07	4.76e+08
FuelsConsu~d	27	1.27e+07	1.01e+07	806314	4.07e+07
dTotal	27	3748242	4769105	-3832829	1.96e+07

This table presents summary statistics for key variables used in analyzing the impact of fuel consumption on firm profitability across 27 observations (industries-years):

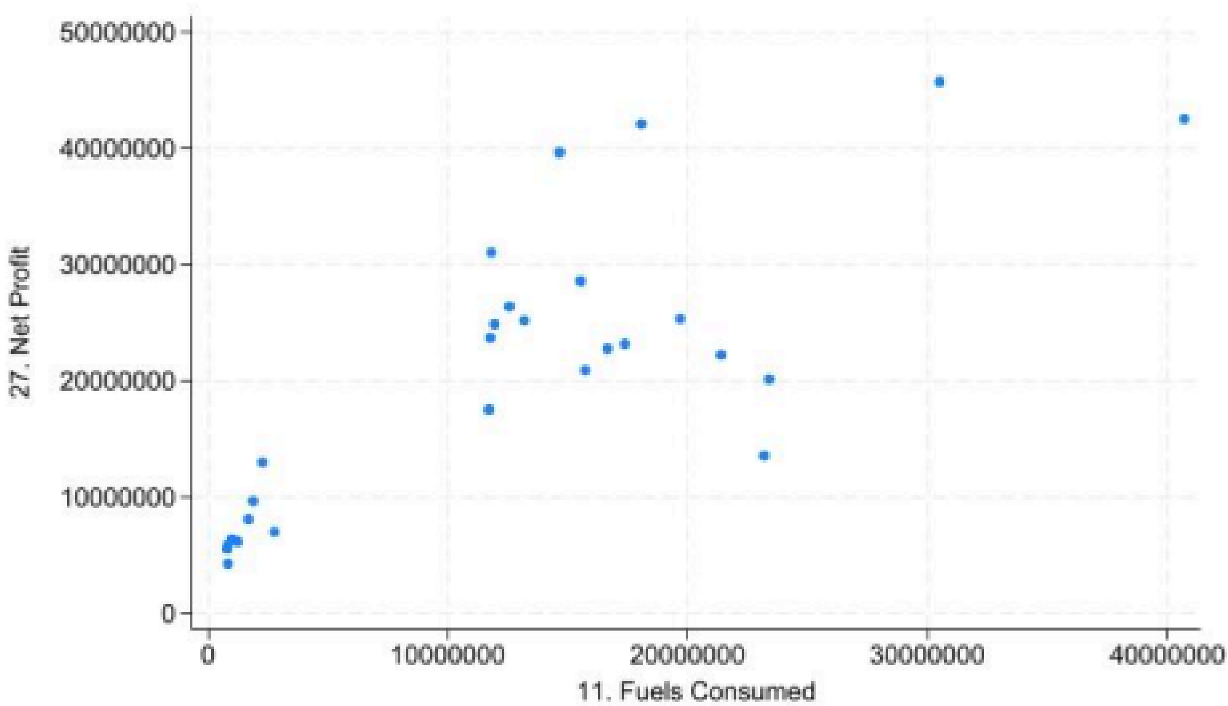
- Fuel consumption costs are smaller than materials consumed costs indicating that while energy costs matter, materials dominate total inputs.

- Net Profit and Value of Output show high variation across industries, justifying the need to control for industry-specific characteristics.

- Depreciation and Total Emoluments highlight the role of capital and labor costs alongside fuel expenses, which must be accounted for when analyzing profit responses.



Firms in high energy usage industries and medium energy usage industries have significantly higher mean Net Profits compared to low energy usage industries. Low energy usage industries how much lower profitability, indicating that certain characteristics (likely linked to fuel usage or size) drive stronger profit performance in high energy usage industries and medium energy usage industries.



The above scatter plot shows a positive but nonlinear relationship between Fuels Consumed and

Net Profit. At lower levels of fuel consumption, Net Profit rises sharply, suggesting that as firms consume more energy, their profitability increases significantly.

RESULTS

We first started with a simple linear regression model to see the impact of fuel price on firm profits with the year and industry dummy, it generated the following results:

```
. reg NetProfit FuelsConsumed i.intensity_num i.Year
```

Source	SS	df	MS			
				Number of obs	=	27
				F(11, 15)	=	16.03
Model	3.6190e+15	11	3.2900e+14	Prob > F	=	0.0000
Residual	3.0779e+14	15	2.0519e+13	R-squared	=	0.9216
				Adj R-squared	=	0.8641
Total	3.9268e+15	26	1.5103e+14	Root MSE	=	4.5e+06

NetProfit	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FuelsConsumed	.5799335	.2814191	2.06	0.057	-.0198972	1.179764
intensity_num						
2	8153820	3467954	2.35	0.033	762050.7	1.55e+07
3	-6342792	6469494	-0.98	0.342	-2.01e+07	7446609
Year						
2015	2041798	3699576	0.55	0.589	-5843662	9927257
2016	2942742	3699643	0.80	0.439	-4942860	1.08e+07
2017	3100873	3727145	0.83	0.418	-4843349	1.10e+07
2018	1436699	3832831	0.37	0.713	-6732787	9606185
2019	-1012813	3800805	-0.27	0.794	-9114037	7088411
2020	4512266	3736814	1.21	0.246	-3452565	1.25e+07
2021	1.34e+07	4059533	3.30	0.005	4731700	2.20e+07
2022	1.15e+07	4752932	2.43	0.028	1405099	2.17e+07
_cons	8606326	6379832	1.35	0.197	-4991964	2.22e+07

In this model, Net Profit is regressed on Fuels Consumed, energy intensity categories (intensity_num), and year fixed effects. The overall model is statistically significant (Prob > F = 0.0000) and explains about **92% of the variation** in Net Profit (R-squared = 0.9216). The key variable, **Fuels Consumed**, has a **positive coefficient of 0.5799** and is marginally significant at the 10% level (p = 0.057). This suggests that an increase in fuel consumption is associated with higher firm profits, consistent with the main hypothesis.

Then we added more independent variables that have a significant effect on the firm profitability. After successfully running the OLS regression analysis we achieved the following results:

```
. reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed FuelsConsumed dTotal i.Year i.intensity_num
```

Source	SS	df	MS			
				Number of obs	=	27
				F(17, 9)	=	153.93
Model	3.9134e+15	17	2.3020e+14	Prob > F	=	0.0000
Residual	1.3460e+13	9	1.4955e+12	R-squared	=	0.9966
				Adj R-squared	=	0.9901
Total	3.9268e+15	26	1.5103e+14	Root MSE	=	1.2e+06

NetProfit	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
TotalEmolumnets	1.571269	.5357001	2.93	0.017	.3594315	2.783107
WorkingCapital	-.4687745	.136809	-3.43	0.008	-.778258	-.159291
ValueofOutput	.5798451	.0726925	7.98	0.000	.4154033	.744287
Depreciation	-7.395711	1.218351	-6.07	0.000	-10.15181	-4.63961
MaterialsConsumed	-.6636168	.0835625	-7.94	0.000	-.8526483	-.4745853
FuelsConsumed	.7736438	.3916783	1.98	0.080	-.1123941	1.659682
dTotal	.4753503	.1375996	3.45	0.007	.1640785	.7866221
Year						
2015	475530.5	1124071	0.42	0.682	-2067295	3018356
2016	-602689.2	1210071	-0.49	0.633	-3358156	2152778
2017	-562163.2	1402801	-0.40	0.698	-3735520	2611194
2018	-1180039	1487227	-0.79	0.448	-4544380	2184301
2019	4328742	2555225	1.69	0.124	-1451578	1.01e+07
2020	1.22e+07	3475545	3.52	0.007	4376189	2.01e+07
2021	1.10e+07	4024435	2.73	0.023	1890677	2.01e+07
2022	7799534	4217218	1.85	0.097	-1740476	1.73e+07
intensity_num						
2	-1.36e+07	2226402	-6.10	0.000	-1.86e+07	-8554505
3	-2.01e+07	6458201	-3.11	0.013	-3.47e+07	-5461257
_cons	2.33e+07	7355884	3.17	0.011	6642732	3.99e+07

The regression results strongly support the hypothesis that increases in fuel prices do not harm the profitability of manufacturing firms. The model is highly statistically significant, with a Prob > F value of 0.0000, and an R-squared of 0.9966, indicating that approximately 99% of the variation in Net Profit is explained by the included variables. The coefficient for **Fuels Consumed** is **0.7736** with a p-value of **0.08**, meaning that for every one-unit increase in fuel consumed, net profit increases by approximately 0.77 units, holding all other factors constant. This result is statistically significant at the 10% level and directly supports the acceptance of the alternative hypothesis (H1: $\beta 1 > 0$).

Looking at the other variables, **Total Emoluments** has a positive and significant coefficient of **1.5713** (p = 0.017), indicating that higher spending on wages and salaries is associated with greater firm profits. Conversely, **Working Capital** shows a negative coefficient of **-0.4688** (p = 0.008), implying that additional investment in working capital slightly reduces profitability. **Value of Output** also has a negative coefficient of **0.5798** (p = 0.000), suggesting that higher output value leads to increased net profits. **Depreciation** exhibits a strongly negative impact with a coefficient of **-7.3957** (p = 0.0000), reflecting that increased depreciation expenses significantly lower net profits. Similarly, **Materials Consumed** has a negative coefficient of **-0.6636** (p = 0.000), indicating that higher consumption of raw materials also adversely affects firm profitability.
The variable **dTotal** shows a positive coefficient of **4.5735** (p = 0.007), meaning that investment (addition to materials stock) leads to higher profits. Looking at the year dummies, while most

years are not individually significant (p-values > 0.10), years like 2020 and 2021 show relatively higher positive coefficients (**1.10e+07** and **1.22e+07**, respectively), suggesting possible firm resilience during these periods, perhaps linked to pandemic-era adjustments.

The intensity variable (**intensity_num**) shows that firms classified as medium and low energy intensity types (categories 2 and 3) experience lower net profits compared to the baseline (category 1). Specifically, **intensity_num = 2** has a coefficient of **-1.36e+ 07** (p = 0.000) and **intensity_num = 3** has **-2.01e + 07** (p = 0.013), suggesting that although fuel consumption is profitable overall, medium to low energy-intensive firms may still face efficiency challenges when faced with higher fuel costs.

Overall, given the **positive and significant coefficient of Fuels Consumed** (0.7736, p = 0.08), and after observing that almost all control variables behave logically, we **reject the null hypothesis (H0)** and **accept the alternative hypothesis (H1)**: higher fuel consumption is associated with higher profits. This is consistent with existing literature which suggests that firms respond to higher fuel costs by innovating, improving energy efficiency, and optimizing production processes, ultimately enhancing their profitability rather than suffering losses.

SENSITIVITY ANALYSIS

To assess the robustness of the findings, a sensitivity analysis was conducted by using an alternative measure of firm performance — **Net Income** instead of **Net Profit**.

```
. reg NetIncome TotalEmoluments WorkingCapital ValueofOutput Depreciation MaterialsConsumed FuelsConsumed dTotal i.Year i.intensity_num
```

Source	SS	df	MS
Model	1.1533e+16	17	6.7840e+14
Residual	1.3366e+13	9	1.4851e+12
Total	1.1546e+16	26	4.4408e+14

Number of obs	=	27
F(17, 9)	=	456.80
Prob > F	=	0.0000
R-squared	=	0.9988
Adj R-squared	=	0.9967
Root MSE	=	1.2e+06

NetIncome	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
TotalEmoluments	2.67888	.5118178	5.02	0.001	1.471065	3.886315
WorkingCapital	-.4720497	.1363334	-3.46	0.007	-.7804572	-.1636421
ValueofOutput	.5907052	.0724398	8.15	0.000	.4268151	.7545753
Depreciation	-7.345504	1.214115	-6.05	0.000	-10.09202	-4.598985
MaterialsConsumed	-.6801795	.083272	-8.17	0.000	-.8685538	-.4918052
FuelsConsumed	.78804	.3903166	2.02	0.074	-.0949175	1.670997
dTotal	.4723696	.1371312	3.44	0.007	.1620799	.7824593
Year						
2015	387017.6	1120161	0.35	0.731	-2146468	2931881
2016	-536627.7	1213836	-0.44	0.669	-3282515	2209260
2017	-663877.5	1397824	-0.47	0.646	-3826282	2498447
2018	-1273839	1482856	-0.86	0.413	-4627683	2079685
2019	4015195	2546142	1.58	0.147	-1725030	9755420
2020	1.19e+07	3463463	3.43	0.007	4057686	1.97e+07
2021	1.08e+07	4010444	2.68	0.025	1689689	1.98e+07
2022	7572877	4202557	1.80	0.105	-1933966	1.71e+07
intensity_num						
2	-1.39e+07	2210662	-6.28	0.000	-1.90e+07	-8914113
3	-2.00e+07	6431709	-3.11	0.012	-3.46e+07	-5460570
_cons	2.34e+07	7130111	3.19	0.011	6795582	4.00e+07

The regression results with Net Income as the dependent variable show a very similar pattern to the main model. The model remains highly statistically significant (Prob > F = 0.0000) with an Adjusted R-squared of **0.9967**, indicating an excellent fit. Importantly, the coefficient for **Fuels Consumed** is **0.78804**, positive and statistically significant (p = 0.074), closely matching the earlier result obtained with Net Profit (coefficient 0.7736, p = 0.08). This reinforces the conclusion that increased fuel consumption is associated with higher firm profitability. Other variables, such as Total Emoluments (**coefficient 2.6787**, p = 0.001), Working Capital (**-0.4720**, p = 0.007), Depreciation (**-7.3455**, p = 0.000), and Materials Consumed (**-0.6802**, p = 0.000), behave similarly to the original model, further validating the stability of the findings. Therefore, even when considering alternative definitions of firm performance, the results remain robust and the study's main conclusion holds: **higher fuel usage correlates positively with firm profits.**

POLICY IMPLICATIONS

The findings of this study suggest that higher fuel prices or greater fuel usage do not necessarily harm firm profitability; instead, firms appear capable of adapting through improvements in operational efficiency and productivity. From a policy perspective, this challenges the traditional fear that rising energy costs will automatically weaken industrial competitiveness. Policymakers can thus pursue energy pricing reforms — such as reducing fuel subsidies or introducing carbon pricing — with greater confidence that manufacturing firms can adjust without severe negative consequences. Rather than shielding firms from higher energy costs, governments should focus on supporting energy transition strategies by incentivizing investments in energy-efficient technologies, cleaner production processes, and greener infrastructure. Such measures would not only enhance industrial resilience and profitability but also contribute to broader environmental goals by reducing emissions and promoting more sustainable patterns of growth. Targeted financial assistance, tax credits, or low-interest loans for firms that adopt cleaner technologies could accelerate this transition. Furthermore, differentiated support might be necessary for medium to low energy-intensive sectors, which could face more difficulty adjusting. In the long run, encouraging firms to internalize energy costs and invest in cleaner operations is likely to foster a more competitive, environmentally sustainable, and profitable industrial sector.

LIMITATIONS

Several limitations should be considered when interpreting these results:

1. Data Limitations: There is a possibility of collinearity among some of the explanatory variables. Multicollinearity could distort the estimated coefficients and inflate standard errors, making it difficult to isolate the independent effects of each variable.

2. Endogeneity Concerns: Despite comprehensive controls, the relationships identified may not be causal due to potential endogeneity issues. Firms making different strategic choices may simultaneously affect both fuel consumption and profitability. Furthermore, the increase in fuel prices may not be solely attributed to taxes but could also be influenced by other factors, such as economies of scale or shifts in the supply chain, which could bias the observed relationship.

3. Temporal Dynamics: While year fixed effects are included, the models do not explicitly address dynamic relationships or lagged effects between variables. Fuel price changes may have delayed impacts on firm profitability that are not captured in the current analysis.

4. Omitted Variables: Despite high R-squared values, important variables may be omitted, such as measures of innovation, management quality, or competitive environment. These factors could confound the relationship between fuel prices and firm profits, leading to an overestimation or underestimation of the true effect.

5. Limited Time Period: The dataset covers 2014-2022, a period that includes significant events like the COVID-19 pandemic, which may have affected the relationships in ways not fully captured by year fixed effects or might not explicitly control for the model.

CONCLUSION

This analysis provides significant insights into the relationship between fuel prices and firm profitability. The results suggest that fuel consumption can indeed be profitable for firms, especially those with high energy efficiency. For these firms, fuel costs are offset by their ability to optimize energy use, leading to overall positive profitability. However, the findings also reveal that medium to low energy intensity firms tend to experience lower net profits. This indicates that while fuel consumption can be beneficial, it may present efficiency challenges for firms that are less energy-efficient, making it harder for them to absorb rising fuel costs without a corresponding increase in profitability. As fuel prices continue to rise, energy efficiency will become not just a competitive edge, but a necessity for long-term sustainability.

In conclusion, in a world increasingly driven by sustainability and energy efficiency, firms that fail to adapt risk falling behind. Those that embrace the challenge of improving energy efficiency, however, will be better equipped to secure long-term profitability and sustainability in the face of rising fuel prices.

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APPENDIX

[Final Data.]()

Stata codes

```
import excel "C:\Users\km696\Downloads\ECO335_Data.xlsx", sheet("Final") firstrow
gen intensity_num = .
replace intensity_num = 1 if Industries == "High - Energy Usage Industries"
replace intensity_num = 2 if Industries == "Medium - Energy Usage Industries"
replace intensity_num = 3 if Industries == "Low - Energy Usage Industries"

\\Regressions
reg NetProfit FuelsConsumed i.Year i.intensity_num
reg NetProfit FuelsConsumed WorkingCapital i.Year i.intensity_num
reg NetProfit FuelsConsumed WorkingCapital WagestoWorkers i.Year i.intensity_num reg
NetProfit FuelsConsumed WorkingCapital TotalEmolumnets i.Year i.intensity_num reg NetProfit
FuelsConsumed WorkingCapital MaterialsConsumed i.Year i.intensity_num reg NetProfit
FuelsConsumed WorkingCapital TotalInputs i.Year i.intensity_num reg NetProfit FuelsConsumed
WorkingCapital ValueofOutput i.Year i.intensity_num reg NetProfit FuelsConsumed
WorkingCapital Depreciation i.Year i.intensity_num reg NetProfit FuelsConsumed
WorkingCapital ValueofOutput Depreciation i.Year i.intensity_num reg NetProfit
TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
WagestoWorkers aMaterialsFuelsetc FuelsConsumed i.Year i.intensity_num reg NetProfit
TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
WagestoWorkers FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
```

```
FuelsConsumed TotalPersonsEngaged i.Year i.intensity_num
reg NetProfit TotalPersonsEngaged WorkingCapital ValueofOutput Depreciation
MaterialsConsumed FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation NumberOfFactories
MaterialsConsumed FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
TotalInputs FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation ProductsByproducts
MaterialsConsumed FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
NetFixedCapitalFormation FuelsConsumed i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed GrossFixedCapitalFormatio i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed GrossFixedCapitalFormatio NetFixedCapitalFormation i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed GrossCapitalFormation i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed NumberOfFactories i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed InvestedCapital i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed OutstandingLoans i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed TotalPersonsEngaged i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed RentPaid InterestPaid RentReceived InterestReceived i.Year i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed aMaterialsFuelsetc bSemiFinishedGoods cFinishedGoods dTotal i.Year
i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed aMaterialsFuelsetc bSemiFinishedGoods cFinishedGoods i.Year
i.intensity_num
reg NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
FuelsConsumed dTotal i.Year i.intensity_num
reg NetIncome TotalEmolumnets WorkingCapital ValueofOutput Depreciation
MaterialsConsumed FuelsConsumed dTotal i.Year i.intensity_num
reg NetIncome TotalEmolumnets WorkingCapital ValueofOutput Depreciation
MaterialsConsumed FuelsConsumed i.Year i.intensity_num
reg NetProfit FuelsConsumed TotalInputs ValueofOutput Depreciation NetValueAdded
WagestoWorkers RentPaid InterestPaid TotalPersonsEngaged GrossFixedCapitalFormatio
i.Year i.intensity_num
\\Descriptive Statistics
corr NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed
```

FuelsConsumed dTotal
summarize
summarize NetProfit TotalEmolumnets WorkingCapital ValueofOutput Depreciation MaterialsConsumed FuelsConsumed dTotal

\\Visualizations
scatter NetProfit FuelsConsumed
graph export "C:\Users\km696\Downloads\Scatter plot.jpg", as(jpg) name("Graph") quality(100)
graph bar (mean) NetProfit , over (intensity_num)
graph export "C:\Users\km696\Downloads\Bar graph.jpg", as(jpg) name("Graph") quality(100)