International Journal of Advanced Social Studies
ISSN: 3006-1776 (Print), 3006-1784 (Online)

Research Article

Impact of Energy Prices, Consumption, and Government Effectiveness on Manufacturing Output: Evidence from Pakistan

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Article History
Received: April 26, 2025
Revised: August 18, 2025
Accepted: August 21, 2025
Published: August 30, 2025

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https://doi.org/10.70843/ijass.2025.05207

Abstract
This study investigates the impacts of energy price, consumption, and government effectiveness on the yields of the manufacturing sector of Pakistan. The data is taken from 1998 to 2023. The Unit root and ADRL bound testing are used to estimate short and long run impacts of energy prices, consumption, and government effectiveness on manufacturing output along the control variables; growth domestic product growth, trade, raw material prices, foreign direct investment, covid-19 dummy. The results concluded that the foreign direct investment, gross domestic product growth, trade, energy consumption, and government effectiveness have a positive relationship with manufacturing output. While the raw material price, trade, energy prices, and COVID-19 dummy have negative associations with manufacturing output. In light of the high energy prices, energy consumption, and government effectiveness this study provides the policy suggestions based on finding that can be useful for the growth of the manufactured sector performance.
Keywords: Manufacturing output, Energy prices, Energy consumption, Government effectiveness, Economic growth, ARDL.

Introduction

Is the importance of energy as a catalyst for financial activities overstated, or does the crisis genuinely make it harder to achieve desired results? It's undeniable that energy, whether gas, oil, or electricity, has become one of the essentials of life, surpassing even food, shelter, and clothing. The demand for energy is growing in every area of life and the economy (Al Mubarak et al., 2024), exceeding the Earth's capacity to meet it (Islam et al., 2024). This has led to the ongoing energy crisis. After the Arab oil embargo in 1992, the problem became more urgent, causing the Third World to experience the crisis's effects like never before (Schramm, 2024). At the same time, this gave rise to a balance of payments crisis. Like many other developing nations, Pakistan's economy has struggled with an imbalance between energy supply and demand (Zaheer et al., 2025). The situation worsened due to increased reliance on imported boiler oil for power generation instead of hydropower, along with the tripling of global oil prices in 2007 (Aftab, 2014).

As a result, the performance of the industrial sector has been severely impacted. Energy is the primary input that drives this sector. Power generation plays a key role in the industrial sector's net returns (Ali & Zaigham, 2017). The industrial sector accounts for 34% of total power consumption (Pakistan Economic Survey, 2019). The[1] current energy sources, such as coal, natural gas, and re-gasified liquefied natural gas (RLNG), account for the majority of electricity generation, or 63% of GWh. The remaining 37% comes from hydroelectric power (25.8%), nuclear power (3%), and renewable energy sources (8.2%). The primary strain comes from the over-reliance on

[1] https://power.gov.pk/

thermal energy for power generation. This reliance has led to rising production costs due to the depletion of natural gas supplies. This high cost negatively affects the competitiveness of industrial products. Pakistan is ranked 110th out of 141st economies in the Global Competitiveness Index for industrial exports, a decline from its previous ranking of 107th (Schwab, 2019). Compared to other emerging nations, Pakistan's export-to-GDP ratio has steadily decreased, contributing to a balance of payments issue caused by a trade imbalance. According to the Bureau of Statistics2 (2023), in fiscal year 2023-24, the share of manufacturing goods in Pakistan's export is 77.35% which was 77.40% in 2019-20. Pakistan's total exports are 30.68 billion dollars in fiscal year 2023-24, which were 31.78 billion dollars in 2021-2022. Additionally, power shortages have harmed the textile industry, which accounts for 46% of total production and contributes to the export of cotton and yarn (Afzal, 2012). The decline in exports has been worsened by ineffective taxes and governance practices, as well as a shortage of raw materials (Zeshan, 2025; Malik & Majeed, 2018). Energy-related issues, such as the imbalance between supply and demand and rising energy prices, have been the main causes of poor performance in the manufacturing, industrial, and export sectors (Rehman et al., 2025). These issues led to higher production costs, decreased export competitiveness, and high operating costs (Chowdhury et al., 2025; Mahmood & Ahmed, 2017). However, since its launch in 2015, the China-Pakistan Economic Corridor has completed several power projects aimed at addressing energy challenges and improving prospects (Ashraf, 2025). Pakistan's economy is experiencing a trade deficit as our exports as a percentage of GDP are decreasing (Alvi & Mudassar, 2025).

This study holds significance in three dimensions. First, in the economic context, there is a critical gap in awareness within Pakistan's manufacturing sector. This sector is one of the key drivers of the country's exports. The output of the manufacturing sector directly affects Pakistan's economic growth. It generates employment and earns foreign exchange through exports. It also indirectly helps improve the living standards of the population. Pakistan's ongoing economic challenges demand sustainable sectoral growth, especially in industry. Identifying the key and potential factors that can improve the performance of the manufacturing sector is essential. This evidence can support sustainable and effective economic policies. The second contribution of this study relates to the energy crisis. Pakistan faces a persistent shortage of energy along with high price volatility. This situation severely slows the growth of the industrial sector. This study examines energy prices and their impact on the cost and pace of industrial growth, which in turn affects manufacturing output. A decline in industrial growth can also reduce future employment opportunities. By measuring these associations, the research proposes energy-related reforms. These reforms can help predict improvements in the energy sector and ultimately boost manufacturing output. The third contribution of this study concerns policy implications and the role of governance. It examines how the effectiveness of government influences the performance of the industrial sector, which depends heavily on manufacturing output. Weak governance, inefficient regulations, and inconsistent policies are major barriers to manufacturing growth. This research highlights the importance of government effectiveness as an indicator of institutional quality and governance. It shows how these factors affect the industrial sector and offers essential guidance for policy reform and administration.

Literature Review

A number of studies have examined the relationship between economic growth and energy consumption, with many highlighting energy as a key component in production. However, few studies specifically focus on trade or exports. Using a panel cointegration approach Sein and Sah (2025) explored the dynamic relationship between trade, GDP, and energy use in five South Asian economies from 1980 to 2009. Their findings revealed a short-term feedback loop between energy consumption and exports, as well as a long-term unidirectional relationship between exports and energy. Asiedu (2025) used the cointegration method and Granger causality tests to find unilateral causality from energy consumption to exports, suggesting that energy conservation programs do not impact exports. Similarly, Johansen cointegration tests and Auto

2 https://www.pbs.gov.pk/sites/default/files/external_trade/Annual_Analytical_Report_on_External_Trade_Statistics_of_Pakistan_FY2023.pdf

Regressive Distributed Lag (ARDL) methods were employed to study the long-term relationship between exports, energy, and economic growth in Mauritius from 1970 to 2009. The results showed that electricity, as a proxy for energy, significantly affects exports (Bakhtyar et al., 2017; Nawaz et al., 2021). Noorzai et al. (2025) examined the long-run causal relationship between real GDP, exports, and electricity consumption, applying the ARDL method and Vector Error Correction Method (VECM). In a similar vein, research conducted in Fiji from 1981 to 2011 found a long-term cointegration relationship between economic growth and energy consumption. Granger causality tests showed that exports, electricity consumption, and economic growth are interrelated (Baloch et al., 2021; Makun, 2015).

Korsakienė et al. (2014) used correlation analysis to examine Lithuania's industrial sector and exports from 2000 to 2011. Their study concluded that there is no significant relationship between energy costs and exports of industrial products. In contrast, a study in Nigeria using VECM from 1990 to 2011 found a positive correlation between exports, economic growth, and energy consumption (Adenuga & Emeka, 2013; Chien et al., 2021a). Nnaji et al. (2013) found a strong correlation between energy exports and consumption, with a Granger-causality flow from exports to energy consumption. They also suggested that shocks to energy consumption positively influence exports. Qasim and Kotani (2014) used cointegration methods to investigate Pakistan's energy issues from 1971 to 2010. Their study found that capacity utilization is negatively correlated with energy consumption, while power prices have a positive correlation. They also noted that variables such as the economic crisis, industrial production, labor costs, real exchange rates, and domestic demand influence the manufacturing industry's ability to export. Although labor costs and the exchange rate were statistically insignificant, industrial production had a significant positive impact on exports between 2000 and 2011 (Basarac et al., 2015; Chien et al., 2021b; Fazal et al., 2020). Latif and Javid (2016) using GMM estimations for the period 1972 to 2013, found that real effective exchange rates and trading partner income positively influence Pakistan's textile exports. This study is significant due to the time frame it covers and the variables it uses. Notably, the impact of the energy crisis on manufactured exports, a key issue, remains unexplored in Pakistani literature (Javed et al., 2022).

Raza et al. (2015) used the ARDL method to examine the relationship between trade and energy use, proving the feedback hypothesis with time series data from 1973 to 2011. Their study revealed a long-term relationship between the two variables and bidirectional causality between GDP and energy consumption, as well as between imports, energy consumption, and exports. Babatunde (2017) applied the ARDL bounds testing approach to study industrial production and electricity consumption in Nigeria from 2000 to 2015, finding a strong positive correlation between energy consumption and exports of Nigerian manufactured goods. The study also highlighted the positive impact of foreign demand on manufactured exports. Ahmed and Awan (2020) investigated the energy crisis and trade openness using ARDL, examining macroeconomic variables such as investment, money supply, carbon dioxide emissions, inflation, industrial output, and services output from 1972 to 2017. They found long-run cointegration between these variables, adding to the knowledge on Pakistan's energy crisis. While the literature has explored the energy crisis's impact on economic growth, industrial production, and the textile sector, few studies have looked at its effect on trade, particularly manufactured exports.

However, little is known about how energy challenges and government policies specifically impact Pakistan's manufactured exports. The majority of existing research focuses on broader issues like energy crises affecting industrial production and economic growth. We are unable to find no study that has focused on the impact of government effectiveness, energy prices and consumption on manufactured outputs. This study aims to fill this gap by analyzing the specific effects of energy challenges and government effectiveness. By addressing this gap, we hope to provide policymakers with insights on how to address the challenges posed by the energy and governance issues on Pakistan's export capacity.

Methodology and Data Description

The time series data is taken from 1998 to 2023. The data is taken from WDI for Pakistan. The data period contains the covid-19 affect that is why to avoid the biasness in the results covid-19 dummy is introduced in the model.

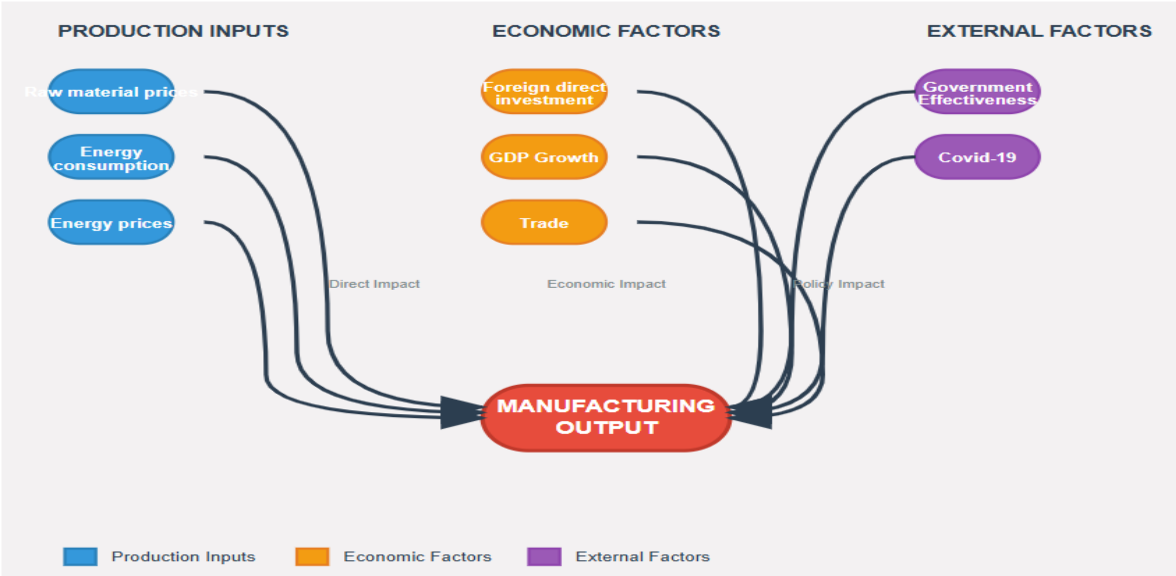

Figure 1. The dimension of variables.

Figure 1 illustrates the dimensions of exogenous factors that determine the growth of the manufacturing sector in Pakistan. The first dimension is the input side, which includes raw material prices, energy consumption, and energy prices. The second dimension is the economic side, comprising foreign direct investment, GDP growth, and trade. The third dimension covers external factors, represented by government effectiveness and the impact of COVID-19. Together, these three dimensions predict the growth of the manufacturing sector in Pakistan. The functional equation is as follows:

$$MO = f(EP, EC, GE, GDP, FDI, RMP, TRA, DCOV) \quad (1)$$

The Econometric equation of the model is:

$$MO_t = \gamma_0 + \gamma_1 EP_t + \gamma_2 EC_t + \gamma_3 GE_t + \gamma_4 GDP_t + \gamma_5 FDI_t + \gamma_6 RMP_t + \gamma_7 TRA_t + \gamma_8 DCOV_t + e_t \quad (2)$$

Equation 2 shows the model specification, where MO represents manufacturing output (log-transformed as LMO); EP denotes energy prices; EC represents energy consumption; GE indicates government effectiveness; GDP stands for gross domestic product (with GDPPC used as a proxy); FDI refers to foreign direct investment; RMP represents raw material prices; TRA denotes trade; and DCOV is a Covid-19 dummy variable (included to control for the Covid-19 effect).

The unit root testing results given below in Table 2 indicate that the variables are stationary at different level. In this scenario, we applied the ARDL bound testing technique to quantify the short-run and long-run results.

Results and Discussion

Table 1 presents the descriptive statistics of the variables. The mean values range from 183.69 to 0.2, indicating considerable variation among the variables. The highest mean is for raw material prices, while the lowest mean (0.2) corresponds to the COVID-19 dummy variable. Standard deviations also vary: the highest is 9 (for raw material prices), and the lowest is 0.408 (for the COVID-19 dummy). Minimum values range from 0 to 168.79, and maximum values range from 1 to 199.97. For the quartiles, the first quartile (25th percentile) ranges from a high of 177 to a low of 0; the second quartile (50th percentile/median) ranges from 183 to 0; and the third quartile (75th percentile) ranges from a high of 190 to a low of 1. These variations highlight the differences in the descriptive statistics across the variables.

Table 1. Descriptive statistics.

Variable	LMO	FDI	GDPG	EP	EC	RMP	TRA	GE	DCOV
mean	23.796	0.952	4.133	47.387	84.266	183.690	28.862	8.1	0.2
std	0.603	0.747	1.981	2.527	8.437	9.000	3.838	2.761	0.408
min	22.849	0.310	-1.274	42.100	70.265	168.791	21.460	3	0
25%	23.262	0.515	2.748	46.430	76.998	177.110	25.472	6	0
50%	23.948	0.696	4.396	47.040	87.123	183.090	29.470	10	0
75%	24.267	0.846	5.777	48.130	91.832	190.610	32.320	10	0
max	24.631	3.036	7.547	51.610	94.935	199.970	34.349	10	1

For the dependent variable, manufacturing output, the mean value is 23.79, with a minimum of 22 and a maximum of 24, indicating only slight variation. The first quartile is 23.26, the second quartile is 23.94, and the third quartile is 24.26, showing an upward trend across quartiles. This suggests a positive trend in manufacturing output over time.

Table 2 presents the results of unit root tests for all variables. The manufacturing output variable is stationary at level. The p-value is significant. The null hypothesis of the ADF unit root test states that the series is non-stationary, while the alternative states that the series is stationary. The p-value is 0.000. This means we reject the null hypothesis and accept the alternative. Therefore, the variable is stationary at level.

Table 2. Results of unit root testing.

Variable	Transformation	ADF Statistic	P-value
LMO	Level	-4.956	0.000
LMO	First Difference	-1.101	0.715
FDI	Level	-1.501	0.533
FDI	First Difference	-3.681	0.004
GDPG	Level	-2.415	0.137
GDPG	First Difference	-4.682	0.000
EP	Level	-1.796	0.382
EP	First Difference	-3.724	0.004
EC	Level	-1.387	0.589
EC	First Difference	-4.897	0.000
RMP	Level	2.347	0.999
RMP	First Difference	-2.351	0.006
TRA	Level	-1.732	0.415
TRA	First Difference	-4.148	0.001
GE	Level	-3.200	0.006
GE	First Difference	-2.210	0.203
DCOV	Level	-3.439	0.003
DCOV	First Difference	-4.796	0.000

The FDI variable is also stationary at level because its p-value is 0.0004. This also leads to rejecting the null hypothesis. The GDP variable is non-stationary at level. Its p-value at level is 0.137, so we accept the null hypothesis. However, GDP becomes stationary at first difference because its p-value there is 0.000, meaning we accept the alternative hypothesis. Energy prices are stationary at the first difference. Energy consumption is also stationary at the first difference. Raw material prices are stationary at the first difference as well. The trade variable is stationary at level. Government activeness is also stationary at level. The COVID dummy variable is stationary at level too.

Table 3. Results of bounds testing.

F-Statistics	27.34			
	5%		1%	
Bounds	I(0)	I(1)	I(0)	I(1)
Asymptotic C.V	2.11	3.15	2.62	3.77

Table 3 presents the results of the bounds test. The F-statistic, which is the bounds test value, is 27.34. We compare this with the critical values at the 5% and 1% significance levels. At the 5% level, there are two critical bounds. The lower bound value is 2.11, and the upper bound value is 3.15. Since 27.34 is greater than the upper bound value of 3.15, this indicates cointegration at the 5% significance level. At the 1% level, the lower bound value is 2.62 and the upper bound value is 3.77. Again, the F-statistic of 27.34 is greater than the upper bound value of 3.77. This also confirms cointegration at the 1% significance level. For a long-run relationship, two conditions are needed: cointegration and non-stationarity. Both conditions are met in this model. Therefore, the variables are associated in the long run.

Table 4. Short run results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EC)	0.4086	0.0484	8.4515	0.0000
D(EP)	-0.3954	0.0454	-8.7150	0.0000
D(GDPG)	0.9441	0.4711	2.0040	0.0152
D(GE)	0.1650	0.0683	2.4171	0.0071
D(RMP)	-0.1467	0.0710	-2.0663	0.0328
D(TRA)	0.1721	0.0135	12.7539	0.0000
D(DCOV)	-0.1389	0.0812	-1.7114	0.0691
COINTEQ*	-0.6937	0.0703	-9.8730	0.0000

Table 4 shows the short-run results of the ARDL bound test. The cointegration term is significant. There are three basic requirements for the cointegration term: it should be less than one, the coefficient should be negative, and it should be significant. All three conditions are met, indicating a short-run relationship between the variables. The first variable is energy consumption. Its coefficient is 0.40, meaning that a one-unit increase in energy consumption leads to a 0.40-unit increase in manufacturing output. This variable is significant, as its p-value is 0.0000, which is less than 0.05. Energy price has a negative impact on manufacturing output. The coefficient is -0.3954, and the p-value is 0.0000. A one-unit increase in energy price results in a 0.39-unit decrease in manufacturing output. The GDP growth variable is also significant, with a p-value of 0.0152, which is less than 0.05. In government effectiveness, the coefficient is 0.1650, and the p-value is 0.0007. This means that a one-unit increase in government effectiveness leads to an increase in manufacturing output. Raw material prices have a negative impact on manufacturing output. As raw material prices increase, the cost of manufacturing output rises, leading to a reduction in demand for it. This negative relationship is significant. Trade has a significant positive relationship with manufacturing output. The coefficient is 0.17, meaning that a one-unit increase in trade leads to a 0.172 unit increase in manufacturing output. The COVID dummy variable shows a negative and significant impact on manufacturing output.

Table 5. Long run results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EC	0.3199	0.0628	5.0966	0.0000
EP	-0.2525	0.0224	-11.2783	0.0000
GDPG	0.3004	0.0963	3.1210	0.0002
GE	0.5624	0.1547	3.6355	0.0001
RMP	-0.1647	0.0868	-1.8969	0.0816
TRA	0.9130	0.0768	11.8909	0.0000
DCOV	-0.2450	0.1409	-1.7392	0.0691

Table 5 shows the long-run results of the ARDL bound test. Energy prices, raw material prices, and the COVID-19 dummy variable have a negative and significant impact on manufacturing output. In contrast, all other variables have a positive and significant impact on manufacturing output. The coefficient for energy consumption is 0.3199, and it is significant. The GDP coefficient is 0.3004. Energy prices have a negative impact with a coefficient of -0.2525. Government effectiveness has a positive impact with a coefficient of 0.56. Raw material prices also show positive effects, with a coefficient of 0.1647. The trade coefficient is 0.9130, and the COVID dummy coefficient is -0.2450. All variables are significant and have a notable impact on manufacturing output in the long run, as indicated by the magnitude of their coefficients.

Conclusions and Recommendations

This study focuses on a critical topic: the manufacturing output, which plays a major role in Pakistan's total exports. It is essential for the growth of the industrial sector, and industrial growth, in turn, significantly contributes to Pakistan's GDP. An increase in manufacturing output leads to industrial growth, which ultimately boosts the country's GDP. The aim of this study is to analyze the impact of energy consumption, energy prices, and government effectiveness on the manufacturing output of Pakistan's industrial sector. Energy consumption has a positive impact on manufacturing output. This means that an increase in energy consumption results in higher manufacturing output. However, energy consumption in the industrial sector is closely tied to energy prices. When energy prices rise, it increases the cost of manufacturing, which in turn affects the competitiveness of manufacturing output in international markets. Higher prices could lead to a reduction in the demand for Pakistani-manufactured goods, creating a negative relationship between energy prices and manufacturing output. Government effectiveness, as shown in the study, plays a crucial role. A strong institutional hierarchy and good governance create an environment conducive to industrial sector development. Effective government policies provide room for growth in manufacturing output. Raw material prices have a negative impact on manufacturing output. Trade, however, has a positive impact. The COVID-19 pandemic, however, led to a decrease in manufacturing output. Due to disruptions in the global supply chain and countries closing borders to prevent the spread of the virus, international trade was severely affected. This led to a sharp decline in manufacturing in Pakistan.

The aforementioned findings highlight the need for such policy proposals that, given the current energy crisis, may effectively address the problem of the manufacturing sector's performance, which has been a top priority for policymakers for some time. In order to boost local production and facilitate exports, the government should act right now to create additional energy. In order to conserve energy, creative solutions should be used together with effective energy legislation. It is necessary to take action to move away from expensive thermal energy sources and towards more affordable hydroelectric ones. Furthermore, the government should focus on advancing the industrial sector to not simply increase its bulk for production but also to raise its manufacturing sector. This calls for the creation of industrial policies. Additionally, actions must be taken to maintain a stable exchange rate over time. In order to draw in international demand, manufactured exports should also be made more competitive, which necessitates the use of efficient techniques for managing input costs and adjusting prices.

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