Dynamic Effect of Electricity Cost on Manufacturing Sector Growth in Kenya.

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ABSTRACT

Manufacturing has been argued to play an important role in socioeconomic transformation, yet the sector in Kenya reports sluggish growth rate. This raises concern on its transformation capacity in the country. Literature suggest that high electricity tariffs are impediments to manufacturing activities. However, studies on electricity costs and manufacturing nexus largely ignored African countries, Kenya included. This explains the empirical gap, which motivated the need for this study and selection of electricity cost as its main variable. The analysis sought to examine the dynamic effect of electricity costs on manufacturing sector growth in Kenya. An energy augmented Solow framework underpinned this study, which relied on annual time series data from Kenya National Bureau of Statistics spanning 1965 to 2024. Its parameters were estimated using Autoregressive Distributed Lag model and Error Correction Mechanism. Findings revealed that elasticity of current long run electricity cost was (π= -0.0870, p value 0.0222) and short run was (Φ= -0.0870, p value 0.0005). This implies growth in electricity cost had a negative effect on the sector growth in the short run and current year in the long run. The study concluded that Kenya's high electricity tariffs erode competitiveness of the manufacturing sector and supress its growth. These revelations led the analysis to suggest for urgent implementation of cost reflective sector competitive tariffs in Kenya to offset the drag already done on the sector's growth.

Keywords Manufacturing, Electricity, Cost, Sector, Growth

INTRODUCTION

Kenya aspires to be a middle-income economy with high quality of life by 2030 (GoK, 2007), with manufacturing prioritized to play a leading role. However, Kenya's manufacturing performance has been sluggish and not met this expectation. High electricity cost, singled out by Andre et al. (2023), Frimpong et al. (2018), and Takentsi et al. (2022) as a key constraint to manufacturing, has been blamed for this sluggish growth. In Kenya, the high costs to the sector was decried by KAM (2024), Wangui (2019), and Mutunga and Owino (2017). This slow sector growth episode worries policy makers on the sector's ability to transform livelihoods, especially in the developing word. The discussion on manufacturing spans both theoretical and empirical literature as a significant influencer of growth in modern economies, (Kaldor, 1966; Kuznets, 1966; and Attiah, 2019).

Theoretically, classical school, Keynesian economists, neoclassical thought and endogenous growth model form some of the theories that discuss growth. The focus of their discussions are at a national outlook, with arguments advanced around free economy, government involvement, capital, labor and technological progress as important growth drivers. Without specific focuss on sectoral growth, discussions behind these theories and possibility of including additional variables made some of these theories to be used in sectoral growth studies. Empirically, several studies underscore the significant effect of manufacturing sector to economic development. Their argument was grounded on special opportunities offered by the sector. Szirmai et al. (2013) argued that manufacturing sector offered unique prospects for capital growth. This was unlike agriculture and services sectors, which usually have much lower capital accumulation. Economies of scale was another opportunity offered by manufacturing sector, according to Fagerberg and Verspagen (1999) and Kaldor (1966, 1967), which they argued to be very small in the sectors of agriculture and services. Cornwall (1977) also mentioned technical progress as a special opportunity, which according to him was more pronounced in manufacturing sector, from where it spreads to other sectors. The other sectors derive their capital goods from manufacturing sector, creating spill over effects to different sectors and sub sectors. According to Tregenna (2007), these linkages influence investments in given sectors. Transformation from farming to enterprises, and further from enterprises to services was suggested to provide a sustainable path to economic development, (Clark, 1957; Chenery, 1960; Kuznets, 1966; and Fuchs, 1980). Their investigations led to the conclusion that no country, since industrial revolution, developed without a robust manufacturing sector. The foregoing discussions underscore the special role played by the manufacturing sector in economic transformation. These deliberations further imply that sluggish manufacturing sector may slow down economic growth, shutter gains in job creation and negate on the welfare of citizens.

Electricity costs heavily influence growth of manufacturing sector. This is because the operations rely heavily on energy inputs on daily basis, making the sector more susceptible to increase in electricity prices. An increase in electricity cost drives costs of doing business, reduces profits of business entities and discourages long term investment (Frimpong et al., 2018 and Takentsi et al., 2022). Exorbitant electricity costs also have short run consequences for the manufacturing sector, Andre et al. (2023) with spillover effects to the whole economy. This was because it reduced employment and manufacturing supply, causing supply led inflation. Higher electricity costs are also burdensome to consumers and producers, as they respectively have to incur additional spending and costs. These costs are eventually transferred to the consumers of various industrial products, (Herman et al., 2023). High electricity costs reduce electric power consumption, and leads to dishonesty witnessed in illegal electricity connections by consumers who may not afford to pay such high tariffs.

In Kenya, electricity pricing is heavily influenced by petroleum costs and consists of two main items. First is the Base Electricity Tariff, which is the retail price of electricity for various categories of consumers. One of its components is the fuel adjustment charge, a cost introduced to electricity bill to account for changes in price of petroleum products used in electricity generation. The second category is the pass-through costs, calculated by incorporating fuel cost charge as one of its components. Fuel cost charge vary depending on global price of imported petroleum products and amount of fuel consumed by thermal plants to generate electricity. These costs are shifted to electricity users, (EPRA, 2024). With Kenya's heavy reliance on imported petroleum products, also used for electricity generation, imply that cost of petroleum products was correlated with electricity cost in the country. These discussions motivated the study to consider petroleum prices as proxy for electricity cost, whose observations were not fully available over the study's period. Use of this proxy was also justified based on other empirical works, such as Habanabakize and Koekemoer (2021) in South Africa and Ekong et al. (2021) in Nigeria.

Kenya has the highest cost of electricity as compared to other African countries. For example, in 2023, a kilowatt hour (kWh) of electricity was costing 0.175 USD in Kenya, compared to Uganda's 0.124 USD, Tanzania's 0.1 USD, South Africa's 0.085 USD, Egypt's 0.037 USD, and Ethiopia's 0.023 USD. The manufacturing sector's ability to compete has been negatively impacted by the high cost of electricity. The quality, quantity and cost of production were all directly affected by the cost and availability of power. These facts made manufacturers in Kenya to decry the high cost of electricity per kWh that their businesses were paying. These high costs of electricity weakened the sector's competitiveness, (KAM, 2024). To protect their competitiveness, manufacturers association suggested that they pay at most Kenya shillings 10 per kWh for electricity. If attained, the cost of electricity will reduce drastically in Kenya, which may significantly influence the sector growth. It was worth investigating the effect of these higher electricity costs on manufacturing sector growth in Kenya.

Literature captures the effect of electricity cost and manufacturing nexus, but largely ignored African countries, Iheonu et al. (2025), Kenya included. This explains why Kenya attracted limited studies, which informed the need for this analysis and selection of electricity cost as its main variable. The studies also proxied electricity cost with petrol prices, crude oil prices, firms' profits, employment, or sales.

LITERATURE REVIEW

Ghouse (2025) investigated energy prices and consumption dynamics on manufacturing sector output in Pakistan using series sourced from World Bank's data portal from 1998 to 2023. The study variables were manufacturing output as the dependent variable; energy prices, energy consumption, and government effectiveness as explanatory variables; and gross domestic output, foreign capital investment, raw material prices, trade and a Covid-19 dummy as control variables. Basing the analysis on ARDL technique, the author reported that energy prices had significant negative shift on manufacturing performance, in both the immediate and long span periods. The study's drawback was in its consideration of energy prices in general, which could not bring out specific costs. The gap was addressed by this study bringing out the specific cost on manufacturing sector growth in Kenya.

Setshedi and Mah (2025) investigated electricity prices and their connection with energy consumption by South Africa industries over the period 1975 to 2023. Variables for their analysis were electricity consumed by manufacturing sector, mean power prices, manufacturing sector output, GDP, and workers for the manufacturing sector. The authors applied Quantile autoregressive distributed lag (QARDL) model on timeseries data. Results of their analysis found that power prices in all quantiles were detrimental to manufacturing prospects. A rise in power prices increased costs of operations and reduced profitability of firms. In such a situation, firms lowered their power consumption to mitigate the high operational costs in the long run. Firms with low margins were highly vulnerable to increased power prices, so they had to reduce their output or relocate to regions with lower power costs.

Iheonu et al. (2025) used panel data for 39 countries in SSA from 2001 to 2023 to analyze energy price volatility and industrial growth relationship. Their dependent variable was industrialization, proxied by percentage growth rate of value added of manufacturing and industry. Power price driven inflation, which proxied energy prices was the independent variable. The power price volatility was calculated in two ways – standard deviations of power prices within an interval of three years and first order autoregressive process. The control variables were population, remittances, foreign direct investment, per capita GDP, bank credit and natural resources. For robustness, the study used multiple estimation techniques, as OLS, Fixed Effects, and System GMM. The study found price volatility to negatively influence industrial and manufacturing activities. Specifically, severe effect was reported for countries with low manufacturing sector growth. Countries with robust manufacturing sector were not much affected by power price volatility. Two reasons supported this reasoning – the high ability of firms to innovate and endure such price fluctuations, and robust firms having capacity to utilize improved technologies that are energy efficient and support flexible allocation of productive resources. Despite its robust findings, consideration of industry by the study compromised the focus on manufacturing, which chiefly drives industrialization in Africa. Additionally, despite Kenya covered in the study, its panel nature made findings not reflect the situation for the country. There was need to bring out these dynamics for Kenya.

Herman et al. (2023) analysed the rising energy prices and their effect on profits of firms in 16 European countries. These jurisdictions were Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, and Slovenia. The company level data was obtained from the Business Environment and Enterprise Performance Survey (BEEPS) questionnaires administered by World Bank. Business entities were selected via a simple random process, with data gathered using phones. The BEEPS questionnaire was credited for its rigour in data collection and processing. The analysis covered a total of 1342 observations in 2022 for sixteen republics in Europe. Variables considered were company profit, company size, GDP per capita, cost of electricity, and age of the company. The study's dependent variable was represented by the profits calculated as the difference between firms' revenues and profits. Dependent variables included cost of electricity, estimated in kilowatt hours by dividing company reported cost and units of electricity consumed. These costs as declared by the firms in the questionnaires were compared with costs from Eurostat. Final values considered for the analysis excluded those that deviated by below or beyond 15 percent from the two statistical comparisons. GDP was extrapolated due to lack of data for the last quarter of 2022. Applying the usual least squares (OLS) estimation procedure, the authors found an upsurge in electricity costs in 2022 reduced a company's profit. In specific terms, an increase in electricity cost by one Euro led to the reduction of business profits by 1.05 Euros. These findings emanated from the fact that firms relied heavily on electricity and any rise in power prices inflated their overall costs, which ate into their profit margins. The study's focus on profits of the firms, subsequently led to missing out on manufacturing sector growth. Survey method of data collection in the study resulted to several outliers. This forced the authors to undertake extra steps in data processing, which led to lost degrees of freedom and unreliability of the estimated parameters.

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Ganepola et al. (2023) explored the causes of shocks to electricity prices and how they affected the output of manufacturing in the United Kingdom. They considered monthly timeseries data from January 1996 to May 2022, obtained from various sources, including Amsterdam Power Exchange, Department for Business, Organization for Economic Cooperation and Development (OECD), Energy Information Administration (EIA), National Statistics Office, and Energy and Industrial Strategy. The authors relied on actual price of natural gas, supply of natural gas, industrial production, and actual cost of electricity to examine their study. Basing their analysis on the structural vector autoregression (SVAR) model, the findings indicated that electricity price shocks decreased industrial output. However, the industry recovered from the shock in two months of such price shocks. Drawback of this study was in the absence of Amsterdam Power Exchange price data from 1996 to 1999, as it was accessible from 2000 onwards and authors had to estimate data. This approach may compromise the study results. Its focus was also on price variations, which were influenced by several other factors. This study prioritized electricity cost and its effect on manufacturing sector growth in Kenya.

Arumdeben et al. (2023) used primary data to expound on the electric power distribution on small and medium enterprises in Nigeria's Southern Taraba state. Simple random sampling was used to select a sample of 114 from the population of 285 SMEs in Ibi, Wukari, Donga, Takum and Ussa through simple random sampling technique. A total of 105 completed questionnaires received from the employees were finally used for analysis. The authors grouped the responses and used component analysis to estimate variables, proxied as Performance as dependent variable, while consistency of electricity supply and cost were dependent variables. The Ordinary Least Squares method was employed to compute the study parameters, whose findings indicated that electricity costs were detrimental to performance, while stable power supply promoted performance of SMEs in Southern Taraba. Primary data may suffer from human errors, which lead to unreliable information. Grouping the responses to generate proxy variables may cause information loss. In such cases, results may not be accurate. The scope of the study was a small region, which affected its rigor in explaining the situation for an entire economy. To overcome the limitation of limited focus, this study considered the entire economy of Kenya. The author believed results obtained from such a national outlook would be more robust that the case for the previous study that focussed on a smaller region.

André et al. (2023) investigated the short run and long run energy cost–industrial productivity nexus in twenty-one European countries. Their analysis covered Belgium, Bulgaria, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Hungary, Ireland, Italy, Japan, Korea, Poland, Portugal, Romania, Slovakia, Slovenia, and Sweden, for industrial and building sectors spanning 1995 to 2020. Multifactor productivity estimated at firm level was the dependent variable. The independents were energy costs, capital proxied by fixed assets, labour proxied by number of people employed, and controls as firm size in various clusters based on number of workers, age, leverage ratio, and profitability. Energy costs were calculated as the country average costs for electricity, oil, gas and coal. Neo-Schumpeterian model of growth helped anchor the analysis, whose estimator was panel fixed effect model. Results from panel fixed effects estimation indicated that energy cost lowered productivity in the short run. The authors reported that every 5 percent increase in prices of energy reduced productivity by about 0.5 percent in the short run. The reduction was higher for heavy power dependent firms, old enterprises and small firms constrained with funding limitations. Reasons were that older firms had old machines which were energy inefficient. In the medium term, firms implement resilient measures to price shocks by investing in efficient production processes. In so doing, rising prices was found to enhance productivity. Analysis on the basis of severity of price shocks revealed that mild power price shocks led to decreased firm productivity. This decrease in productivity begin in the same period as the shock and lasts for two years after the shock. In the third year, the negative effect begins to converse and transition to a positive effect on the fourth period following the price shock. These counterintuitive results came about since firms reduce capacity utilisation in the short run in response to increase in power prices, which initially reduces their output. In the medium and long term, firms invest in more efficient technologies that increase output at reduced energy use. With a severe price shock, short run effects remained negative. The negative effects of price shock continue in the medium- and long-term horizon. This was because marginal costs of firms grew steadily to the extent that their ability to invest in productivity improvement is subdued. Large price shocks also led to reduced demand and profitability of the industrial sector. As a panel analysis, its results could not depict a single country's environment. Kenya was not part of this study and so its results could not reflect the Kenyan case. An index of energy price considered oil, gas, coal and electricity, which made the study fail to bring out the effect of price of a specific energy component. To overcome these weaknesses, this study considered Kenya, electricity prices and its effect on manufacturing sector growth.

Bijnens et al. (2022) analysed the consequence of energy prices on industrial jobs in fourteen countries in western Europe. They included Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, Spain, Sweden, and United Kingdom. A panel data aided their analysis as derived over the duration 2008 to 2016 from Eurostat. The study variables were electricity prices for consumers which were not households, full time employment, total personnel costs (a proxy for wages), investment, and value-added per full time employee (to proxy labour productivity). The authors specified the ordinary leased squares method (OLS) and the GMM to estimate their parameters. Their results revealed that electricity price was detrimental to manufacturing employment, as employment declined by 0.19 percent (OLS) and 0.14 percent (GMM model) for every increase in electricity prices. The study focussed on manufacturing sector jobs, hence did not address the objectives of this study, which was interested in manufacturing sector growth. At the same time, the data for electricity prices consumed beyond 150,000 megawatt hours (MWh) were not available. They had to rely on data provided by Deloitte (2018) whose report was limited to peak load and base load, with the authors calculating the averages from the two data points. These calculations may have compromised the information used for analysis, which might affect robustness of findings. This study considered complete dataset for costs and manufacturing sector growth, without constructing any data set.

Ayivi et al. (2022) explored electricity prices and their effect on SMEs growth in Ashanti region, Ghana. Their study used monthly data from January 2016 to April 2019 as sourced from the SMEs for profits, electricity prices, and producer price index. Vector Error Correction Mechanism (VECM) and Johansen cointegration strategy was used to estimate the parameters. The study results confirmed that electricity prices were negatively associated with growth. Specifically, a percentage rise in prices reduced SMEs profits by 0.68 percent in the long run and 0.35 in the short run. The focus on SMEs in one region and their profitability limited the study's findings in a segment of manufacturing entities. It could therefore not provide the effect of electricity prices on the manufacturing sector in the entire economy. The present study addressed this gap by considering prices and the entire manufacturing sector in Kenya.

Cali et al. (2021) investigated the link energy prices had with performance of firms in 48 emerging countries. A panel dataset was used for the study variables which included energy price index, total employment, sales over total employment, value added divided by the total employees, return on sales and exports share. Their observations spanned 1995 to 2015 and were sourced from World Bank Enterprise Surveys and the International Energy Agency. Fixed effects model was used and findings revealed that energy prices in a negative way, significantly affected sales productivity, value-added based productivity and return on sales. However, the energy price index computed from diverse energy sources and used in the study could not reveal specific effects of electricity prices. The study filled this gap by considering specific contributions of power prices.

In South Africa, Habanabakize and Koekemoer (2021) evaluated how manufacturing and food and beverages sold were impacted by the instability of electricity, rising general price level, and prices of fuel. Quantec Easy Data website provided monthly data from January 2002 to December 2019 for food stuff and beverages produced and sold in millions of Rands, GWh of voltage supplied, inflation (proxied by consumer's price index expressed as percentage change in GDP deflator) and petrol prices in cents per liter variables. The authors modelled their study on Cobb Douglas theory of production and used the initial tests for long run equilibrium and causal nexus, alongside short run dynamics by using error correction method. In the long span of time, electricity supply promoted sales volume by about 0.73 percent, while petrol price curtailed it by 0.03 percent. In the short run, a lagged electricity supply reduced production and sales, while petrol price had no influence on production and sales, with coefficients of one lag and two lags respectively reporting positive and negative signs. The study focused on the sub sectors of food and beverages, which made its findings weak in explaining the dynamics for the whole manufacturing sector.

Marin and Vona (2019) scrutinised the outcome of power prices on manufacturing establishments in France. They considered panel data covering the period 1997 to 2015. Their study variables were average energy prices (calculated as total energy expenditure divided by total power consumption), full time employment, average wage, total energy consumption, and carbon emissions. Using the OLS technique, the authors discovered that rising energy prices hurt French manufacturing companies. In particular, a ten percent increase in energy prices decreased total factor production and employment by 0.8 and 1.7 percent respectively. Considering the average energy price does not provide specific details of electricity cost faced by manufacturing firms. This study addressed the identified void by considering electricity prices.

Abeberese (2017) studied the relationship between electricity costs and performance of manufacturing firms in India. The author used a panel dataset collected from Indian Annual Survey of Industries (ASI) over the period 2001 to 2008. Modelling his study on Solow growth model, and using ordinary least squares (OLS) approach, he found that higher electricity prices forced firms to decrease their electricity consumption and switch to less electricity-intensive production processes. This led to lost productivity-enhancing opportunities. The author demonstrated that higher electricity prices negatively affected firm output, labour productivity and equipment intensity. These results led to the recommendation that the government of India facilitate production of affordable and interruptible electricity. Since India’s manufacturing sector context was different from Kenyan context, the study findings may not be used to generalize the situation for Kenya.

METHODOLOGY

Data and Sources

Secondary time series data was identified for this study and collected over the period 1965 to 2024 from the Kenya National Bureau of Statistics. Variables of interest were manufacturing growth rate as the dependent variable, electricity cost as independent variable with labor and capital as control variables.

Model Statement

The energy augmented Solow (1956) model was used to anchor this study, as stated below.

$$Y = AK^{\lambda}L^{\curlywedge}E^{\phi} \qquad 1.1$$

Where,

Y is manufacturing value added to GDP

A is technical progress,

K is capital

L is labor

E represent electricity cost.

ϕ denoted elasticity of sector yield with respect to electricity cost.

Unpacking model (1.1) alongside relevant transformations, yielded models 1.2 and 1.3 respectively for long run ARDL and short run ECM. These were used to estimate the study parameters.

$$LNM_t = \Phi_0 + \sum_{m=1}^{u} \pi_{1m} LNM_{t-m} + \sum_{m=1}^{u1} \pi_{2m} LNE_{t-m} + \sum_{m=1}^{u2} \pi_{3m} LNL_{t-m} + \sum_{m=1}^{u3} \pi_{4m} LNC_{t-k} + \varepsilon_t \qquad 1.2$$

$$\Delta LNM_t = \mho_0 + \sum_{m=1}^{x} \Phi_{1m} \Delta LNM_{t-m} + \sum_{m=1}^{x1} \Phi_{2m} \Delta LNE_{t-m} + + \sum_{m=1}^{x2} \Phi_{3m} \Delta LNL_{t-m} + \sum_{m=1}^{x3} \Phi_{4m} \Delta LNC_{t-m} - \lambda ECM_{t-m} + \mu_t \qquad 1.3$$

Where:

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LNM_t denoted logarithm of manufacturing value added over period t

LNM_{t-m} represented lagged natural log of manufacturing value added lagged to the m^{th} value

LNE_{t-m} captured the previous period natural logarithm of electricity cost lagged to the m^{th} value

LNL_{t-m} denoted the lagged natural logarithmic form for labour lagged to the m^{th} value

LNC_{t-m} indicated the lagged natural log notation of capital lagged to the m^{th} value

Φ_0, indicate constant;

εt was the error term over period t

π_{1m}……….. π_{4m}were long run estimates and slopes for k = 1, 2...........4

$u, u1$………$u3$ and $x, x1$............. 3 denoted the appropriate lag structure

Δ was the first difference operator

$\mho_0$ was the short run drift component;

ECM_{t-i} was error correction term lagged once;

Φ_{1m}, ……… Φ_{4m} were short-time span elasticities for k equals 1, 2......................... 4

λ was the estimate of ECM, which measures the duration taken by the system to fall back equilibrium after a short-term disturbance. As a rule of thumb, it ranges between -1 and 0 to avoid illogical speed of adjustment. The condition for a cointegrating association is that the estimate of ECM_{t-i} must be negative and statistically significant (Engle & Granger, 1987). The greater this coefficient, the faster the system recovers from short-term shocks, (Coakley et al., 2004).

Unit Root Test

This test was carried out to detect presence or absence of unit roots in the data. Stationarity or non-stationarity determines the behaviour of each series as it evolves. For example, a shock dies when it is introduced to the series with stationarity, unlike to the series with non-stationarity. This implies any analysis done using non-stationary series results to spurious test statistics, which Granger and Paul (1974) say is due to non-constant means and variances. Spurious results are statistically significant even when no economic postulate explains the link between the variables. It was necessary to perform stationarity testing before model estimation to evade the challenges of untrue findings. The Augmented Dickey-Fuller (ADF) test include automatic modification to the Dickey-Fuller (DF) test to allow for successively interrelated residuals. The results were displayed in Table 3.1 below.

Table 1.1: ADF Unit Root Test Results

Variable	Level	Order of Integration	First Difference	Order of Integration
LNM	-3.4725 (0.0521) *	I (0)		
LNE	-1.2141 (0.8981)		-9.5765 (0.0000) **	I (1)
LNC	-4.3180 (0.0058) **	I (0)		
LNL	-1.8082 (0.6883)		-6.3793 (0.0000) **	I (1)

Results in Table 1.1 showed that without differencing, LNM, and LNC upheld the null hypothesis of a unit root at 5 percent significance level. This implied the observations were stationary at level. However, the null hypothesis of a unit root was rejected for LNE and LNL only after first differencing. These ADF test results indicated that these variables were stationary at level I(0) and on first difference I(1). These orders of integration justified the ARDL method for estimating parameters of this empirical task.

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Bounds Test for Cointegration

This piece of work considered bounds test procedure, designed by Pesaran and Shin (1999). Unlike other usual cointegration approaches, bounds test is applicable to series with dissimilar orders of integration. The integration must however, be of order zero I(0), or order one I(1), but not order two I(2), (Pesaran et al., 2001). This approach was appropriate for analyses with few observations as this study. It generates accurate and unbiased parameter estimates even in the presence of endogeneity, and incorporates short span dynamics and long horizon equilibrium without compromising information. These arguments influenced the choice of bounds testing for this study. The null hypothesis of no cointegrating affiliation between manufacturing sector value added to GDP and each of the explanatory variables was tested. The F statistic generated through Wald test was compared with the lower bound I(0) and upper bound I(1) critical values. If the computed F statistic is less than the lower bound critical value, i.e. I(0), the test concludes no cointegration (Pesaran et al., 2001 and Narayan, 2004). In contrast, the bounds testing outcome rejects null hypothesis and finds long run connection if F statistic is greater than the upper bound critical value, i.e. I(1). The test result is inconclusive if the computed F statistic falls between I(0) and I(1) critical values. These results were captured in Table 1.2 below.

Table 1.2: Bounds Testing Results

Test Statistic	Value	Level of Significance.	I(0)	I(1)
F-statistic	6.76	5%	2.45	3.61

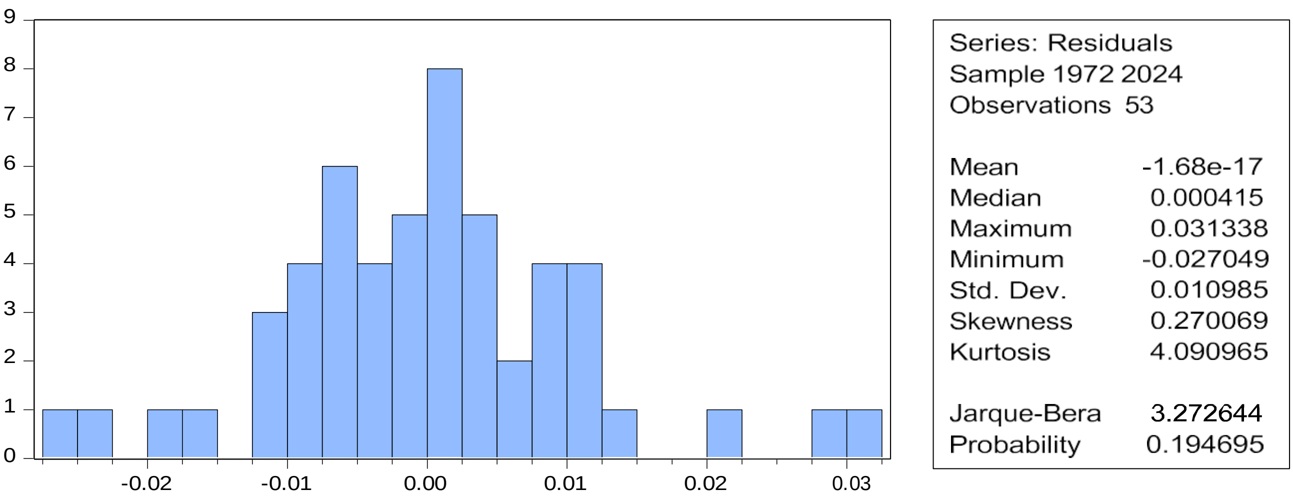
Table 1.2 showed the calculated F statistic from the bounds testing was 6.76. Having fallen above the 3.61 upper bound I(1) critical value at 5 percent statistical threshold, led to rejection of the null hypothesis and a cointegrating equation is confirmed. The outcome justified the estimation of ARDL coefficients and the associated ECM model to capture immediate dynamics and speed of change towards long run equilibrium following a shock.

Diagnostic Tests

It was necessary to run post estimation tests to diagnose adherence to the regression assumptions. This process is part of key steps in evaluating a research process. These tests were Breusch-Godfrey LM for testing autocorrelation; Breusch-Pagan-Godfrey for heteroskedasticity test; normality testing by Jarque-Bera test for normality; and CUSUMSQ testing for stability.

Jarque-Bera Test for Normality

Figure 1.1: Results for Jarque Bera Test for Normality



Jarque-Bera test for normality reported statistic (3.2726) which was not so far from zero with a probability value (0.1947) beyond the 0.05 threshold. These results failed to discard the null hypothesis of a normal distribution and concluded that residuals were bell shaped.

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Breusch-Godfrey Serial Correlation LM Test

The test for serial correlation was conducted and results outlined in Table 1.3 below.

Table 1.3: Breusch-Godfrey Serial Correlation Lagrangian Multiplier Test

F-statistic	1.119056	Prob. F(2,15)	0.3524

The autocorrelation test results in Table 1.3 reported the probability value for the F-statistic as (0.3524). Since the value of probability was higher than five percent benchmark for statistical significance, the study did not reject the null hypothesis and concluded that residuals were serially uncorrelated.

Breusch-Pagan-Godfrey Test for Heteroskedasticity

This test results for Heteroskedasticity was based on the regression of squared residuals on squared fitted values.

Table 1.4: Results of Breusch-Pagan-Godfrey Test for Heteroskedasticity

F-statistic	0.457103	Prob. F(35,17)	0.9753

Breusch-Pagan-Godfrey Test for Heteroskedasticity results in Table 1.4 had a probability value (0.9753) for the F-statistic which went beyond 5 percent benchmark. The results failed to reject the homoscedasticity assumption and confirmed that residuals did not suffer from heteroscedasticity. These post estimation findings led the study to conclude that the model adhered to the regression assumptions of normality, absence of multicollinearity, no serial correlation, and homoscedasticity.

Stability Tests

CUSUMSQ test was adopted for the study to guarantee that the model's elasticities were not subject to structural fluctuations in both short and long horizons. Brown, et al. (1975) came up with the cumulative sum of squares (CUSUMSQ) control chart, which depicts sum of recursive residuals on cumulative values and the 5 percent critical line against time span. If the cumulative sum stays inside the areas indicated by the 5 percent bound lines, then a conclusion is made that there is parameter stability. This confirms that regressors are truly exogenous, as they are uncorrelated with the disturbance term. The results were contained in Figure 1.2 below.

Figure 1.2: CUSUMSQ Results

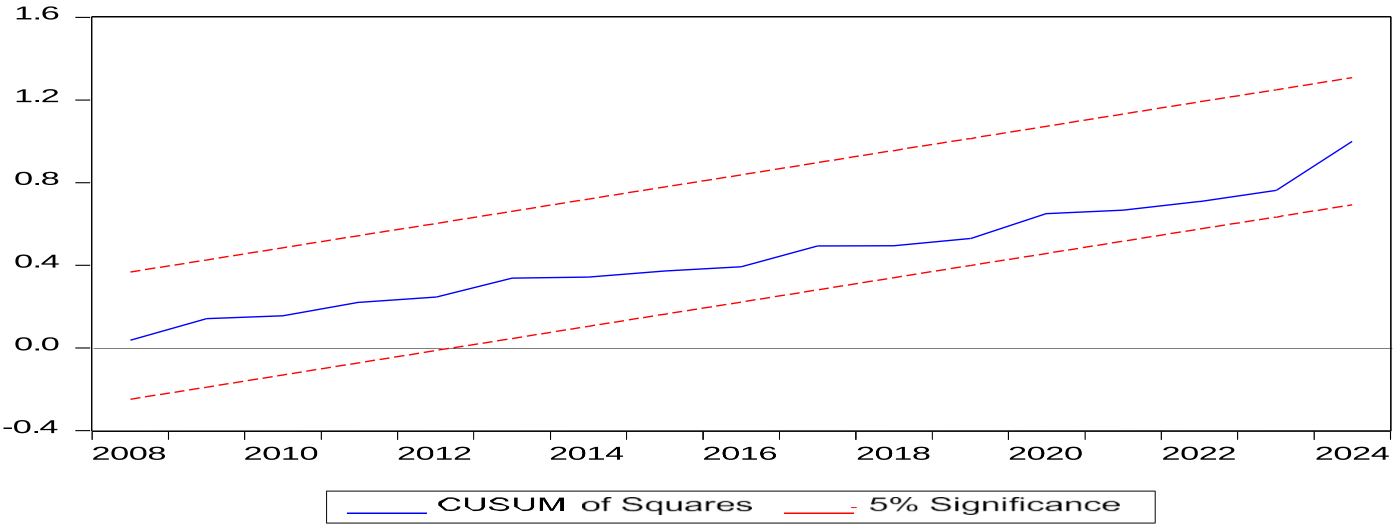

Figure 1.2 contains the outcome for CUSUMSQ. Brown et al. (1975), opines that if residuals derived from CUSUMSQ process remain within the 5 per cent lines, the empirical study concludes variance stability. Based on these results, this work concluded that each explanatory variable and random disturbance term were not interrelated.

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These deliberations imply that estimation process passed all the econometric tests and demonstrated adherence to ARDL assumptions. Having passed these tests, the author interpreted and discussed statistical tests results in line with economic theory and previous empirical results with confidence that the analysis's output was devoid of incorrect inferences and recommendations.

RESULTS

The study's analysis results were presented in Table 2.2 (long run results) and Table 2.2 (short run dynamics).

Table 2.1: Long Run (ARDL) Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNE	-0.086988	0.034578	-2.515730	0.0222
LNE(-1)	-0.066373	0.031251	-2.123893	0.0487
LNE(-2)	0.043994	0.037423	1.175598	0.2560

Table 2.2: Short Run (ECM) Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Δ(LNE)	-0.086988	0.020247	-4.296312	0.0005
Δ(LNE(-1))	-0.043994	0.027801	-1.582463	0.1320
Cointegration Eq(-1)	-0.709175	0.088658	-7.998983	0.0000

DISCUSSION

The objective of this empirical work was to examine the dynamic effect of electricity cost on manufacturing sector growth in Kenya. The null hypothesis was that electricity cost had no statistically significant effect on manufacturing sector growth in Kenya.

The long run model results in Table 2.1 reported elasticity of electricity cost as $\pi = -0.087$, p-value (0.0222) in the current year (LNE) and $\pi = 0.0440$, p-value (0.2560) in the second year (LNE(-2)). The short run model results in Table 2.2 reported this elasticity as $\Phi = -0.0870$, p-value (0.0005) (Δ(LNE)). Having their respective p-values below 0.05 led to rejection of the null hypothesis at 5 percent level and to a conclusion that electricity cost had a statistically significant negative effect on the manufacturing sector growth in Kenya.

The negative elasticity implied that a ten percent increase in electricity cost reduced manufacturing sector growth by approximately 0.87 percent over the respective timelines. This aligned with industry complaints that Kenya's high-power tariffs erode competitiveness and supress growth. The results suggest that manufacturing operations in Kenya were heavily reliant on electricity, but the sector seems limited to innovative and invest in efficient power use. Consequently, the sector is subdued from navigating the consequences of higher electricity tariffs, resulting to short term and long span negative outcomes. Implementing cost reflective but competitive industrial tariffs would go a long way in offsetting the negative drag of higher costs on the sector growth.

These findings were a priori expected and tend to corroborate the high cost of electricity decried by KAM (2024), Wangui (2019), and Mutunga and Owino (2017) to be a great impediment to sector performance. Resonating with these findings were results by André et al. (2023) in Europe's 21 countries, Ghouse (2025) in Pakistan, Ayivi et al. (2022) in Ghana's Ashanti region, and Inedu et al. (2022) in Nigeria who reported negative effects in both long run and short run; and Habanabakize and Koekomoer (2021) in South Africa who found petrol prices to negatively affect the sector in the long run. Other similar reports were derived by Setshedi and Mah (2025) in South Africa; Iheonu et al. (2025) in 39 countries in SSA; Ganepola et al. (2023) in United Kingdom; Herman et al. (2023) in 16 countries in Europe; Arumdeben et al. (2023) in Nigeria's Southern Taraba state; Bijnens et al. (2022) in Western Europe's 14 nations; Cali et al. (2021) in 48 emerging countries; and Marin and Vona (2019) in France. These negative and significant results implied vulnerability of manufacturing sector to rising cost of electricity. The sector vulnerability was drawn from inefficiency of power use, low capacity to invest in alternative power sources and invest in energy efficient productive tools and equipment.

Contrary to these findings, Idogun (2025) in Nigeria found long and short span significant positive influence of electricity cost on manufacturing sector output. On their part, Habanabakize and Koekemoer (2021) obtained no influence of petrol price in South Africa over the short-term, as Oyeyimi and Onuoha (2020) reported inadequate long span impact of electricity prices on Nigeria's industry**.** The implication of contradiction was the unending debate, which stems from different methodological approaches, robustness of sectors and scopes of the studies.

The speed of adjustment term (Coint Eq(-1)) had a negative elasticity (-0.7092) with a probability value estimated at (0.0000). Theoretically, the significant negative elasticity of this adjustment term was expected. This suggest that approximately 71 percent of variations stemming from a short-term disturbance were corrected towards long run equilibrium within the current year.

CONCLUSION AND RECOMMENDATIONS

The results suggested that electricity cost had a significant negative effect on the manufacturing sector growth in the short run and in the long run. This might be a pointer that the sector was paying high electricity costs. These findings led to the rejection of the null hypothesis and to a conclusion that electricity cost had a statistically significant negative effect on the manufacturing sector growth in Kenya. Based on the findings, the study proposed urgent implementation of cost reflective sector competitive tariffs to help offset the drag already

done on the sector's growth.

The study also recommended that future research considers electricity prices when information is available and firm level dataset to provide objective analysis. Findings from such approach will help validate or invalidate the findings derived in this study.

Study Limitation

Use of petroleum prices to proxy electricity costs was a key limitation. As much as electricity tariffs in Kenya are influenced by prices of petroleum products, taxes and supply dynamics also come to play.

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