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Energy Consumption and Bi-Sectoral Output in Pakistan: A Disaggregated Analysis

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ABSTRACT

The objective of study is to check the vigorous impact of energy consumption on industrial and agricultural output with disaggregated analysis by having openness in both sectors and tube wells lone in agriculture sector as controlled variables. It is essential to analyze a connection between energy consumption and bi-sectoral output in Pakistan. Industrial and agricultural outputs have been taken as dependent variable, as they are mainly dependent on energy consumption. The data from 1999-2019 is employed for the analysis. The econometric technique autoregressive distributed lag (ARDL) results are showing a strong bond between energy consumption and industrial output in disaggregated relationship. Electricity shows a negative relationship with industrial output because of developing countries power supply failure dilemma. Similarly, agriculture sector shows significance with energy consumption in disaggregated analysis. Openness of agriculture and gas consumption in agriculture shows a negative but statistically significant relationship. Capital and labor in both sectors are highly influencing regressors as par neo classical output theory, in our disaggregated energy consumption analysis. Error correction regression shows a strong short run and long run relationship of energy consumption with industrial and agricultural output. The stability diagnostic recursive estimates show the perfectly interlinked variables in both models. The present research is equally important for the academic and policy makers as it reveals a strong bond between energy consumption and bi-sector output in Pakistan. Potential measures on energy supply can increase industrial and agricultural output.

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1. Introduction

The neoclassical proposition of growth is labor and capital; along with these factors modern world economics gives weight to technological progress, advancement in human capital, cost efficient inputs, and energy consumption in producing output in industry and agriculture. These factors are responsible for sustainable growth and development of any sector(Chien, Pantamee, et al., 2021; Chien, Sadiq, Nawaz, et al., 2021). In past sixty years the world has considerably increased energy consumption. Today we are consuming 10 times more energy than the past century(Baloch et al., 2021). The obvious reason for this energy consumption is technological progress in industry and agriculture. Despite the multiple challenges in social health, environment, urbanization handling and psychological issues, the energy consumption is main factor in improving quality of life of the people through growth and production(Nawaz, Hussain, et al., 2021).

The nexus between energy uses for economic growth has become a great discussion topic among the economists dealing with growth and macroeconomic sustainability. The economic activities and production in contemporary world are confided in consumption of energy (fuel, electricity, gas etc). Production and income profoundly rely upon the energy consumption (Zamarripa, Vasquez-Galan, & Oladipo, 2017). Energy maneuvers a constitutive role in industrial and agricultural output growth. The 1970s oil price crisis led stagnation in developing countries. The surge in prices of energy products put underprivileged countries in great socio-economic complexities(Chien, Sadiq, Kamran, et al., 2021).

In advance world each country is ambitious to attain economic growth through energy consumption. The developed world uses 25 times more oil per capita than developing nations. Despite criticism to the approach energy consumption index is being used to check the region's economic growth. It is obvious that it reveals high numbers for developed world and less numbers for poor countries. The world priorities are improvements in energy efficient use in production of eco-friendly output with less emission of CO_2. Many world leaders have showed concerns over CO_2 emission but voices from developing world argues that they have not utilized energy as much as the developed world has already done. The developing countries argue that energy consumption has led the developed world to the path of productivity and enhanced output, increased their incomes, increased consumption pattern, improved standard of living and played a significant role in uplifting economies of developed world. Carbon emission and financial development has significant relationship in 21st century. Albeit concerning but energy use is helping advancement of manufacturing and construction industry (Kwakwa, 2019).

The endeavor of present study is to look into the link flanked by energy use with industrial and agricultural sector output spiraling in Pakistan. The vigorous motive of the research is to see the role of energy use on industrial and agriculture sector of Pakistan. To check the hypothesis that energy spurs industrial and agricultural growth worldwide, present study has investigated the hypothesis in context of Pakistan. The connection between industrial growth with energy consumption and agricultural growth with energy consumption has been examined in present study by Using ARDL model.

2. Literature Review

A cosmic literature is available on energy utilization for industrial and agricultural output (Mohsin, Kamran, Nawaz, Hussain, & Dahri, 2021; Shair et al., 2021). Increased energy use globally has accelerated urbanization, industrialization and human development in developing countries (Dada, 2018).The link between intensity of industrial growth and energy consumption findings imparted that there was a pragmatic correlation betwixt the energy consumption and intensity of industrial expansion in China(Han, 2019). Energy consumption and growth of agriculture sector and economy divulged a positive liaison in Pakistan. It was an efficient factor in growth of agriculture and economy as whole (Faridi & Murtaza, 2013). The energy use had consequential impact on urban economic growth in India(Mahalik & Mallick, 2014). A bidirectional link of energy use and economic development was observed in Turkey. Energy was not impartial to economic growth but asway and limiting factor causing a direct impact on economic growth (Erdal, Erdal, & Esengün, 2008; Li et al., 2021; Nawaz, Seshadri, et al., 2021). Petroleum consumption showed a direct link with economic growth but gas consumption had not showed any considerable impact with industrial and agricultural sector progress in Pakistan. Electricity manifested a guided role in economic escalation(Aqeel & Butt, 2001).A causal relationship between energy consumption with industrial and economic expansion had been observed in Kenya (Onuonga, 2012), United States of America (Aldy, 2007; Kiran, 2010; Mazur, 1994), China (Wang, Kitson, Bridle, Gass, & Attwood, 2016; Zhou et al., 2012), Australia (Salahuddin & Khan, 2013), Saudi Arabia (Alqudair, 2011; Alrajhi & Al-Abdulrazag, 2018), Romania (Pirlogea & Cicea, 2011), Iran (Rastegaripour, Karbasi, & Pirmalek, 2019), Congo (Odhiambo, 2014), Ethopia (Genet, 2018) Eastern European countries (Sineviciene, Sotnyk, & Kubatko, 2017), Latin American countries (Campo & Sarmiento, 2013), OECD countries (Matei, 2017) and many other countries.

The literature of studies divulged that there was a momentous association between the energy consumption and economic escalation through different sectors in many countries. More than a billion population of developed world consumed 60 percent of total energy while the underdeveloped world of more than 5 billion consumed rest of 40 percent of total energy supply (Ramachandra, Loerincik, & Shruthi, 2005).This section of study is arranged to look deep inside the fundamentals and literature review on the subject. Section 2 deals with data and methodology, section 3 deals with findings and discussion and section 4 deals with conclusion.

Chen et al, (2020) identified corrosion of energy use and its decoupling with economic intensification in world agriculture manufacturing. The study revealed that advancement in technology triggered energy use in agriculture sector. The research illustrated that 89 countries considered in the study showed a significant relationship between energy use and agriculture production.

A wide research gap exists on the subject. The use of energy in industrial and agriculture sector has not been addressed in recent studies conducted for Pakistan. While the country has faced fragility in energy and it's used in all sectors. The present research is also not free from shorting comings; there can be number of other variables influencing industrial and agricultural output like technology use. The present research includes nonrenewable energy consumption and has not analyzed the impact o renewable energy use on industrial and agricultural output. Another shortcoming of the study is that it has not included data of 2020 because of exceptional year due to Covid-19. Future studies can include the year to see the impact.

3. Data and Methodology

3.1. Data Source

The study employed data from 1999-2019 from Pakistan. Industrial and agricultural data is taken real terms at constant local currency unit (LCU) from World Bank. Data of LABI, LABA (Labor in industry and agriculture), CAPI, CAPA (Capital in industry and agriculture), OILI, OILA (Oil consumption in industry and agriculture), ELCI, ELCA (Electricity consumption industry and agriculture), GASI, GASA (gas consumption industry and agriculture) is taken from economic surveys of Pakistan. Openness OPENSI, OPENSA is measured as sum of exports and imports (industry and agriculture) to the ratio of Industrial and agricultural income. To check the energy consumption in agriculture, data of numbers of TUBW tube well is taken from economic surveys of Pakistan.

To put on valuable insight and check the relationship among the variables used in the study, twenty year's time series data from 1999-2019 from Pakistan is being employed. In this study two models are formed. In our first model the dependent variable is industrial output (in constant local currency unit). In our second model the dependent variable is agricultural output (in constant local currency unit).The endeavor of research is to see significance of dependent variables in both models with labor, capital and energy consumption variables. Additionally, openness in both sectors used as controlled variable, while number of tube wells is used as controlled variable in agriculture sector specifically. The Autoregressive distributed lag (ARDL) model is maneuvered to test the long run association among our variables.

3.2. Model Specification

Two models are formed in this study. One shows the interconnection between energy utilization and industrial productivity while other confirms the linkage flanked by energy consumption and agricultural yield in this disaggregated analysis.

MODEL 1 Impact of Energy Consumption on industrial Output

IND = f (LABI, CAPI, OILI, ELECI, GASA, OPNSI)

Where IND= Industrial Output (in constant Local Currency Unit), LABI = labor employed in industry, CAPI = capital employed in industry, OILI = Oil consumption in industry, ELECI = Electricity consumption in industry in megawatts, GASA = Gas consumption in industry (in cubic feet), OPNSI = Openness of industry (ratio of sum total of manufacturing exports and imports to the income of industry).

Degree of openness (Industry) = $\frac{\text{Exports in Industry + Imports in Industry}}{\text{GDP (Industry)}}$

$$\Delta(IND)_t = \varphi_0 + \varphi_1(IND)_{t-1} + \varphi_2(CAPI)_{t-1} + \varphi_3(ELECI)_{t-1} + \varphi_4(GASI)_{t-1} + \varphi_5(OILI)_{t-1} + \varphi_6(LABI)_{t-1} + \varphi_7(OPNSI)_{t-1} + \sum_{k=1}^{n} \omega_1\Delta(IND)_{t-k} + \sum_{k=0}^{n} \omega_2\Delta(CAPI)_{t-k} + \sum_{k=0}^{n}\omega_3\Delta(ELECI)_{t-k} + \sum_{k=0}^{n}\omega_4\Delta(GASI)_{t-k} + \sum_{k=0}^{n}\omega_5\Delta(OILI)_{t-k} + \sum_{k=0}^{n}\omega_6\Delta(LABI)_{t-k} + \sum_{k=0}^{n}\omega_7\Delta(OPNSI)_{t-k} + \varepsilon_t \quad (1)$$

Long run equation

$$IND_t = \varphi_o + \sum_{k=1}^{n} \omega_{1k}\Delta(IND)_{t-k} + \sum_{k=0}^{n} \omega_{2k}\Delta(CAPI)_{t-k} + \sum_{k=0}^{n}\omega_{3k}\Delta(ELECI)_{t-k} + \sum_{k=0}^{n}\omega_{4k}\Delta(GASI)_{t-k} + \sum_{k=0}^{n}\omega_{5k}\Delta(OILI)_{t-k} + \sum_{k=0}^{n}\omega_{6k}\Delta(LABI)_{t-k} + \sum_{k=0}^{n}\omega_{7k}\Delta(OPNSI)_{t-k} + \varepsilon_t \quad (2)$$

Short run equation

$$\Delta(IND)_t = \varphi_0 + \sum_{k=1}^{n} \omega_1\Delta(IND)_{t-k} + \sum_{k=0}^{n} \omega_2\Delta(CAPI)_{t-k} + \sum_{k=0}^{n}\omega_3\Delta(ELECI)_{t-k} + \sum_{k=0}^{n}\omega_4\Delta(GASI)_{t-k} + \sum_{k=0}^{n}\omega_5\Delta(OILI)_{t-k} + \sum_{k=0}^{n}\omega_6\Delta(LABI)_{t-k} + \sum_{k=0}^{n}\omega_7\Delta(OPNSI)_{t-k} + \varepsilon_t \quad (3)$$

MODEL 2 Impact of Energy Consumption on Agricultural output

AGR = f (LABA, CAPA, OILA, ELECA, GASA, OPNSA, TUBW) (4)

Where AGR= Constant Agricultural local currency Unit (in real terms), LABA = Labor force employed in Agriculture, CAPA = Gross fixed Capital formation employed in Agriculture, OILA= Oil Consumption in Agriculture, ELECA = Electricity Consumption in Agriculture, GASA= Gas consumption in Agriculture OPNSA = Openness of agriculture (ratio of sum of agricultural exports and imports to the income from agriculture)

Degree of openness (Agriculture) = $\frac{\text{Exports in Agriculture+Imports in Agriculture}}{\text{GDP (Agriculture)}}$

$$\Delta(AGR)_t = \varphi_0 + \varphi_1(AGR)_{t-1} + \varphi_2(CAPA)_{t-1} + \varphi_3(ELECA)_{t-1} + \varphi_4(GASA)_{t-1} + \varphi_5(OILA)_{t-1} + \varphi_6(LABA)_{t-1} + \varphi_7(OPNSA)_{t-1} + \varphi_8(TUBW)_{t-1} + \sum_{k=1}^{n} \omega_1\Delta(IND)_{t-k} + \sum_{k=0}^{n} \omega_2\Delta(CAPA)_{t-k} + \sum_{k=0}^{n}\omega_3\Delta(ELECA)_{t-k} +$$

$$\sum_{k=0}^{n}\omega_4\Delta(GASA)_{t-k}+\sum_{k=0}^{n}\omega_5\Delta(OILA)_{t-k}+\sum_{i=0}^{k}\omega_6\Delta(LABA)_{t-k}+\sum_{k=0}^{n}\omega_7\Delta(OPNSA)_{t-k}+\sum_{k=0}^{n}\omega_8\Delta(TUBW)_{t-k}+\varepsilon_t \quad (5)$$

LONG RUN EQUATION

$$AGR_t=\varphi_o+\sum_{k=1}^{n}\omega_{1k}\Delta(AGR)_{t-k}+\sum_{k=0}^{n}\omega_{2k}\Delta(CAPA)_{t-k}+\sum_{k=0}^{n}\omega_{3k}\Delta(ELECA)_{t-k}+$$

$$\sum_{k=0}^{n}\omega_{4k}\Delta(GASA)_{t-k}+\sum_{k=0}^{n}\gamma_{5k}\Delta(OILA)_{t-k}+\sum_{k=0}^{n}\gamma_{6k}\Delta(LABA)_{t-k}+\sum_{k=0}^{n}\omega_{7k}\Delta(OPNSA)_{t-i}+\sum_{k=0}^{n}\omega_{8k}\Delta(TUBW)_{t-k}+\varepsilon_t \quad (6)$$

SHORT RUN EQUATION

$$\Delta(AGR)_t=\varphi_0+\sum_{k=1}^{n}\omega_1\Delta(AGR)_{t-k}+\sum_{k=0}^{n}\omega_2\Delta(CAPA)_{t-k}+\sum_{k=0}^{n}\omega_3\Delta(ELECA)_{t-k}+$$

$$\sum_{k=0}^{n}\omega_4\Delta(GASA)_{t-k}+\sum_{k=0}^{n}\omega_5\Delta(OILA)_{t-k}+\sum_{k=0}^{n}\omega_6\Delta(LABA)_{t-k}+\sum_{k=0}^{n}\omega_7\Delta(OPNSA)_{t-k}+\sum_{k=0}^{n}\omega_7\Delta(TUBW)_{t-k}+\varepsilon_t \quad (7)$$

3.3. Hypothesis of Research

Null Hypothesis: No Relationship exists among energy consumption and industrial output.
H0: $\lambda_1=\lambda_2=\lambda_3=\lambda_4=\lambda_5=\lambda_6=\lambda_7=\lambda_8$ (Short and long run connection do not prevail)

Alternative Hypothesis: Integration exists amongst the variables in short-run and long-run.
H1: $\lambda_1\neq\lambda_2\neq\lambda_3\neq\lambda_4\neq\lambda_5\neq\lambda_6\neq\lambda_7\neq\lambda_8$ (Relationship exists in short-run and long-run)

4. Findings and Discussion

To check stationarity of data unit root test is used. After checking stationarity of data short-run and long-run results are analyzed through autoregressive distributed lag (ARDL) model and error correction regression model. The disaggregated relation of industrial output and agricultural output with energy consumption is tested on empirical grounds; in results of empirical analysis the study draws conclusions.

Table 1
Unit root

Variable	ADF Unit Root (Levels)	ADF (1st Difference)	Order of integration
MODEL 1	*IND= f(CAPI, LABI, ELECI, GASI, OILI, OPNSI)*		
IND	-0.77	-3.9	I(0)
CAPI	0.26	-3.74	I(1)
LABI	0.95	-3.9	I(1)
ELECI	-1.2	-4.8	I(1)
GASI	-2.1	-5.3	I(0)
OILI	-2.7	-4.3	I(1)
OPNSI	0.75	-2.9	I(1)
MODEL 2	*AGR= f(CAPA, LABA, ELECA, GASA, OILA, OPNSA, TUBW)*		
AGR	-0.41	-5.6	I(1)
CAPA	1.5	-4.3	I(1)
LABA	-3.7	-3.6	I(0)
ELECA	-2.0	-3.6	I(1)
GASA	-1.1	-4.6	I(1)
OILA	-6.8	-1.5	I(0)
OPNSA	1.08	-3.6	I(1)
TUBW	-1.3	-4.7	I(1)

Table 1 illustrates the stationarity of variables in unit root test using Schwarz info Criterion. Some variables show stationarity at levels while other show stationarity at first difference. the results provide good reason to apply ARDL model.

Table 2
Bounds F-Test (Industry)

Test-Statistic	Values	Significance.	$I_{(0)}$	$I_{(1)}$
			Asymptotic: n=1000	
F statistic	6.29	10%	1.9	2.9
K	6	5%	2.3	3.3
		2.5%	2.6	3.6
		1%	2.9	3.9

Table 2explains the rejection of null hypothesis which states that there is no liaison among the variables. The bond between industrial performance and energy consumption exists in long-run(Li et al., 2021). The value of F-statistics shows inclusive camaraderie of our model in for long haul. This disaggregated analysis articulates that industrial output potential is highly correlated with energy usage, share of labor in industry, share of capital in industry and openness of industry. F-statistics lies above the upper limit $I_{(1)}$ which shows that there is co-integration among variables.

Table 3
Short-Run (Industry) results

Regressors	Slope Coefficient	S.E	t-Statistic	Prob. value
D(CAPI)	2.274	0.618	3.670	0.021
D(LABI)	0.051	0.227	0.220	0.494
D(ELECI)	-0.067	0.004	-3.260	0.031
D(GASI)	0.003	0.001	3.820	0.002
D(OILI)	0.000	0.000	0.520	0.633
D(OPNSI)	6.508	3.484	1.860	0.135
C	1.482	0.097	3.880	0.018
ECT	-0.989	0.039	-1.080	0.002

Table 3 elucidates short run results of liaison among the variables. There is prevalence of a well-built and pertinacious link between energy use and industrial output in short-run. The lagged values of capital in industry, labor in industry, gas and oil consumption in industry has positive and significant impact on industrial output in short run. While electricity consumption is showing an inverse relation with industrial output in short-run. Pakistan being a developing country has always faced a chronic shortfall of electricity which in result has not contributed in industrial output. Similar results have been seen in many other studies(Sun et al., 2021). The goodness of fit of data or R-square is very high which explains reliability and validity of data. The co-integration (with one lag) equation shows a significant relation in long-run. The short-run results co-integrate in long run by 0.98 which again is a strong and significant relation among the variables in short run and long run.

Table 4
Long-Run results Industry

Regressors	Slope Coefficient	S.E	t-Statistic	Prob. value
CAPI	1.441097	0.605168	2.38	0.0364
ELECI	-0.033009	0.022316	-1.39	0.1910
GASI	0.001728	0.000541	3.19	0.0085
LABI	0.016223	0.223165	0.72	0.4899
OILI	0.000066	0.000056	1.17	0.2649
OPNSI	7.228178	2.890050	2.50	0.0291
C	6.113587	3.623910	1.68	0.0355

EC = IND - (1.44*CAPI -0.033*ELECI + 0.00172*GASI +0.0162*LABI+0.000067*OILI + 7.22*OPNSI + 6.11

The capital has showed a significant rapport with industrial output the results show that an increase in capital in industry would increase industrial output by 1.44 (hundred billion, LCU). Shockingly, electricity has revealed an inverse relationship with industrial output as in most of the developing countries the power supply is often typify as the erratic, inconsistent and inefficient because of increase in cost of production for the operating firms. Instability of power is negatively affecting the industrial output by -0.033(hundred billion, LCU). Similar results are observed in Nigeria(Sani, Mukhtar, & Gani, 2017), and Ghana where power instability was affecting manufacturing sector negatively(Abokyi, Appiah-Konadu, Sikayena, & Oteng-Abayie, 2018).Pakistan is still facing the instability of power supply which in turn is affecting manufacturing sector of Pakistan by increasing cost of production. Consumption of the gas has significant impact on industry and it shows an increase of 0.00172(100 billion, LCU) in industrial sector for each increase in gas cubic feet. While the oil in industry shows insignificant but positive results, oil consumption is increasing industrial growth by 0.000067(100 billion, LCU) for each ton of oil consumed. Yet, it is insignificant. Labor employed in industry also shows insignificant a result, which means labor has lesser contribution in industrial output in Pakistan. In our disaggregated analysis the controlled variable openness is showing significant relationship with industrial output which means the openness of industry has greater impact on increasing industrial output(Chien, Kamran, et al., 2021). Imports of inputs increases the output capacity and exports increases the production of industrial sector(Zhuang et al., 2021). As par results, an increase in openness increases the industrial output by 7.22 (100 billion, LCU) which shows a greater significance.

MODEL 2 Impact of Energy Consumption on Agricultural output

Table 5
Bounds F-Test (Agriculture)

Test Statistic	Values	Significance	$I_{(0)}$	$I_{(1)}$
			Asymptotic: n=1000	
F-stat	46.32	10%	1.92	2.890
K	7	5%	2.17	3.210
		2.5%	2.43	3.510
		1%	2.73	4.0

Table-5 shows F-bounds test for our agriculture model which shows the overall significance of the model in long run. As the test suggests the long run relationship exists among the variables. F-statistics is far greater than the upper value $I_{(1)}$ which clearly shows that there is strong co-integration among the variables.

Table 6
Short-Run Results (Agriculture)

Regressors	Slope Coefficient	S.E	t-Statistic	Prob. value
C	9.855522	1.425511	6.913674	0.0203
D(CAPA)	0.735562	0.083188	8.842121	0.0126
D(ELECA)	0.051944	0.006886	7.542993	0.0171
D(GASA)	-0.001951	0.000247	-7.887974	0.0010
D(LABA)	0.432217	0.077791	5.55616	0.0309
D(OILA)	0.001430	0.000241	5.921965	0.0274
D(OPNSA)	-18.00810	2.543828	-7.079132	0.0194
D(TUBW)	0.000429	0.000459	9.353293	0.00112
CointEqu (-1)	-1.335	0.020238	-14.51208	0.0047
R^2				0.996697
Adjusted R^2				0.993395
AI criterion				4.940817
Durbin-Watson stat				2.466516

Table 6illustrates impact of energy use on agriculture output. The short-run results show implication of our explanatory variables with dependent variable. Which means that capital in agriculture, electricity consumption in agriculture, labor in agriculture, and number of tube wells in agriculture are increasing agricultural in short run. Capital in agriculture and labor in agriculture are showing a positive and significant link with agriculture output in short-run. While gas consumption and openness are showing a negative connection with agriculture output with -0.001951 and -18.0 slope coefficients respectively. Electricity, oil consumption and increase in number of tube wells increases agricultural output in short run by 0.051944, 0.001430 and 0.000429 respectively. The value of co-integration equation with one lag is -1.335 which means the variables would converge to equilibrium by 1.33 each year it shows a stable and integrated relationship among all variables in short run and long run.

Table 7
Long run Equation Agriculture

Regressors	Slope Coefficient	S.E	t-Statistic	Prob. value
CAPA	0.735562	0.083188	8.842121	0.0126
ELECA	0.051944	0.006886	7.542993	0.0171
GASA	-0.002924	0.000308	-9.496433	0.0109
LABA	0.432217	0.077791	5.556163	0.0309
OILA	0.002889	0.000494	5.842205	0.0281
OPNSA	-15.69078	2.168976	-7.234191	0.0186
TUBW	0.000429	0.0000459	9.353293	0.0112
C	9.855522	1.425511	6.913674	0.0203

EC = AGR - (0.735562*CAPA + 0.051944*ELECA -0.002924*GASA+0.432217*LABA +0.002889*OILA -15.69078*OPNSA + 0.000429*TUBW)

Table 7 shows long run relationship among variables. The results explain that a unit increase in agricultural capital increases agriculture output by 735562 (hundred billion, LCU) while it is 0.051944 (hundred billion, LCU) for one MW of electricity. Consumption of gas in agriculture shows negative but significant relationship with --0.002924 (hundred billion, LCU) slope co-efficient, it can be interpreted as there is less or nearly zero use of gas as input in agriculture that's why it affect the agricultural output negatively. An additional unit of labor employed in agriculture leads to increase agricultural output by 0.432217(hundred billion, LCU). Oil consumption increases agricultural output by 0.002889 (hundred billion, LCU) with each ton of oil consumed as input in agriculture. Openness is showing negative relationships which can be interpreted as the export prices of agriculture are lesser than the imported agricultural machinery prices. An increase in tube well increases the agricultural output by 0.000429 (hundred billion, LCU). The results show significance among all variable which shows that there exists a strong relationship between agriculture output and energy consumption in this disaggregated analysis.

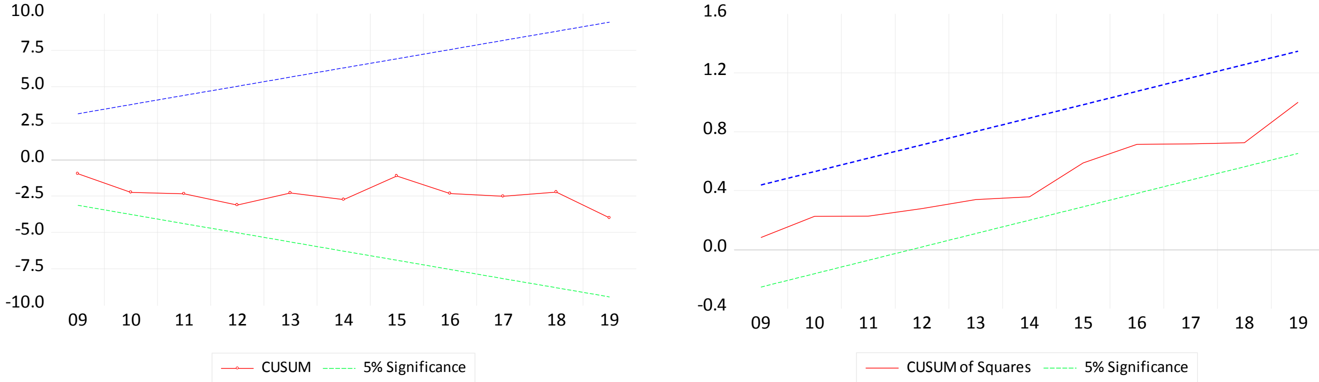
4.2. Stability Diagnostics Recursive Estimates

The study plots the cumulative sum of recursive residual and sum of squares of recursive residuals to test stability of models, suggested by (Pesaran & Pesaran, 1997; Pesaran, Shin, & Smith, 2001) at 5% significance levels. The plots show that our models are stable in short run and long run as the graphs lie in critical bounds. The graphs represent that CUSUM and CUMSUMSQare converging to zero, which in other words show absence of divergence.

Stability Diagnostics Recursive Estimates for Model I (Industry)

Energy consumption and industrial output shows stability in this research which is being tested by stability diagnostics recursive estimates. The cumulative sum of recursive residual and sum of squares of recursive residuals results show a stable relationship between industrial output and energy consumption variables.

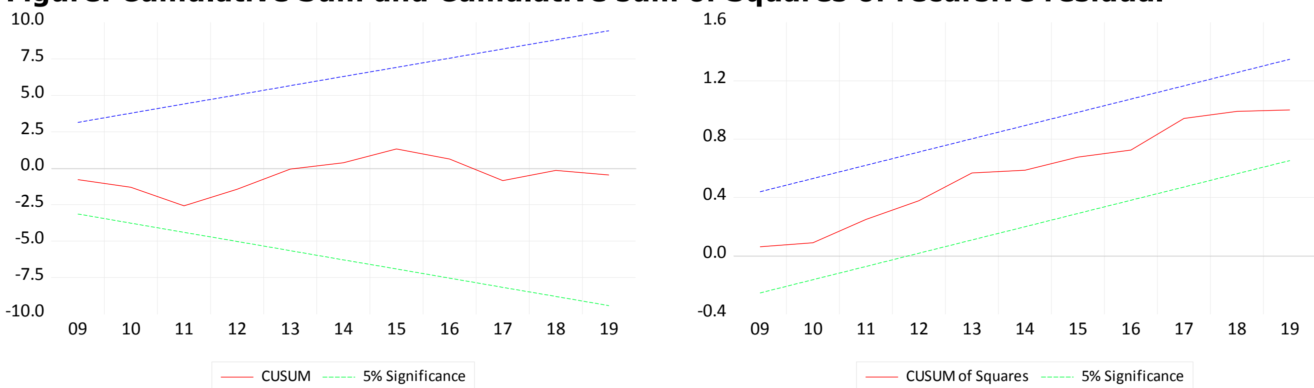
Figure 1: Cumulative Sum and Cumulative Sum of Squares of Recursive Residual



Stability Diagnostics Recursive Estimates for Model II (Agriculture)

Agricultural output is also showing a stable connection with disaggregated energy use in short-run and long-run through recursive residual and sum of squares of recursive residuals plots.

Figure: Cumulative Sum and Cumulative sum of Squares of recursive residual



Stability diagnostics recursive estimates illustrate that our models are well established as the CUSUM and CUSUMSQ lies within the graphs and there is no overlapping in the graphs for both models at 5% significance.

5. Conclusion

The core objective of the study is to analyze the dynamic bond of energy utilization with industrial and agricultural output in short-run and long-run. The study has employed ARDL econometric technique for this purpose to analyze the results. The findings of this disaggregated study show that there is strong connection between energy consumption and agriculture output along with openness of agriculture and numbers of tube wells as controlled variables. There is significant and positive relationship of agriculture output with Capital in agriculture (CAPA), labor in agriculture (LABA), electricity in agriculture (ELECA) and oil consumption in agriculture (OILA). Gas consumption in agriculture (GASA) and openness of agriculture (OPNSA) shows negative (-15.69078) results. In similar fashion the energy consumption is showing strong bond with disaggregated industrial output. Industrial output is greatly influenced by variable like capital in industry (CAPI), labor in industry (LABI), gas in industry (GASI), openness of industry (OPNSI) and oil consumption in industry (OILI). Albeit oil consumption in industry shows insignificant relationship but it has positive impact on industrial output. Electricity has showed a negative relationship (-0.033009) with industrial output because the dilemma of developing countries is power supply failure. All things considered both models show a strong and significant relationship in short run and long run with disaggregated energy consumption analysis.

The present study on energy consumption and bi-sector output growth has number of policy conclusions. The empirical analysis has revealed the strong bond between energy consumption and industrial, agricultural output sector. Energy triggers the production in both sectors and the continuous energy supply can increase the growth rate of both sectors. Oil and gas consumption is largely influencing production of industrial sector and contributing a greater part in economic growth. Openness of industrial sector can prompt the improvements in balance of payments by increasing industrial exports. Similarly, Agriculture output is showing a strong positive relationship with energy use which can contribute to greater extent in economics growth. Country's potential energy sources should be mobilized for producing output. Energy plants should be given due attention and the continuous energy supply should be ensured for industrial and agricultural sector as they are contributing in economic growth of the country. Further studies can be conducted to check the impact of renewable energy consumption and its impact in industrial and agricultural sector output.

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