A Step towards Environment Degradation Mitigation in the Manufacturing Sector of Pakistan: Do Energy Consumption, Foreign Direct Investment, and Financial Development Matter? Evidence from Symmetric and Asymmetric ARDL Approach

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A Step towards Environment Degradation Mitigation in the Manufacturing Sector of Pakistan: Do Energy Consumption, Foreign Direct Investment, and Financial Development Matter? Evidence from Symmetric and Asymmetric ARDL Approach

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ABSTRACT

The manufacturing sector is the backbone for the development of an economy. Numerous studies investigate the impact of aggregative energy consumption on environmental degradation by using typical econometric techniques. To correct this gap our study uses energy consumption and environmental degradation only in the manufacturing sector of Pakistan for the period 1985 to 2018. Our study also demonstrates the symmetric and asymmetric behaviour of energy consumption with carbon emissions by using a recently developed methodology byShin et al. (2014).The linearARDL result shows energy consumption and financial development intensifies environmental degradation. While FDI and globalization mitigate environmental sustainability also the results validate pollution halo hypotheses in Pakistan. However, nonlinear ARDL results confirm theasymmetric behaviour of energy consumption with co_2 emission. This study employs implications for policymakers in Pakistan to consider asymmetric behavior of energy consumption as well as the installation of renewable energy sources and technological improvements in the industrial sector need to mitigate environmental sustainability. Further, there is a need to enhance globalization and FDI for Pakistan to achieve its environmental targets.

Keywords: Energy Consumption, FDI, Manufacturing Sector, NARDL, Pollution Halo Hypothesis, Pakistan.

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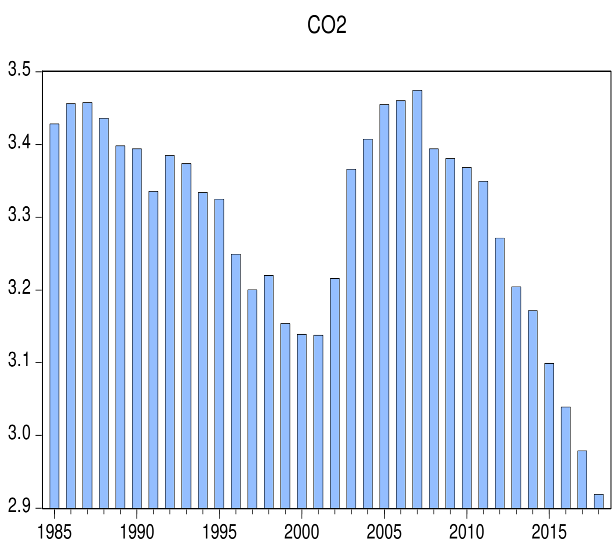
1. Introduction

Climate change and CO_2emissions are the basic component for the sustainable environment along with economic growth. It is a dilemma for developing and developed countries to maintain an inverse linkage between economic growth and carbon emissions (Du and Li, 2019; Yousaf and Lin, 2020). An increase in economic growth mostly enhances the carbon emissions i.e. Environmental Kuznets Curve (EKC) hypotheses. A lot of work is done on environmental degradation and economic growth (Abbasi and Riaz, 2016; Mirza and Kanwal, 2017). The EKC hypothesis is an inverted U-shaped curve that indicates a positive link between economic growth and environmental degradation Zubair et al., (2020). The latest report published by the International Energy Agency IEA(2019)proved CO_2emissions as the highest polluting gas among the greenhouse gases. The percentage share for GHG is mentioned as carbon dioxide CO_2 (90%), methane gas CH_4 (9%) and nitrogen gases N_2 with other gases constitute only (1%)IEA (2019). Additionally, Carbon emissions have adverse effects on human health, ecosystem, species, and their habitats along with negative effects on food quality, water resources, animals, and human health. Moreover, other factors are part of the increase in carbon emissions like soil erosion, climatic situations, deforestation, urbanization, industrialization, institutional quality, agriculture, etc.(Lin and Ahmad, 2017; Jawad et al., 2017).

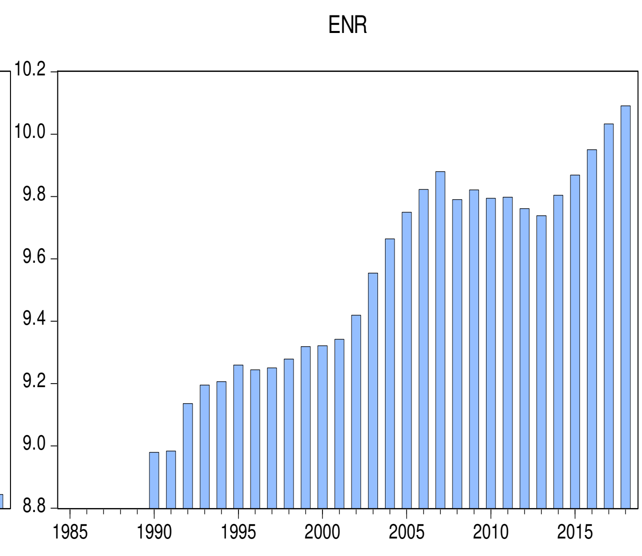
Carbon emission ratios from the various sectors of Pakistan are mentioned as energy (25%), manufacturing (21%), agriculture (24%), vehicle combustion (14%), other energy-related (10%), and buildings (6%) Economic Survey of Pakistan (2019). The global community is keen on working for the reduction of carbon emissions and environmental protection Ahmad et al.(2019). To achieve environmental sustainability all the world countries have submitted a climate change report specified as Intended National Determined Contributions (INDCs) in the conference (COP21) held in December 2015 in Paris (Lin and Raza, 2019; Abas et al., 2017).Also, Pakistan has participated and submitted the INDC in the 21st conference (COP21) held on 29 November 2015 in Paris (Lin and Ahmad, 2017; Ahmad et al., 2019). Conforming to the “German Watch Report” in the previous 20 years, Pakistan is listed among the top ten countries where climate changes adversely affected the environment. Conferring to the climate change report of the Asian Development Bank (ADB), Pakistan's annual mean temperature raised to 0.5c which produced socio-economic effects on human health, reduction in crops productivity, rivers flow, droughts, heatwaves, and effects on hydropower generation (Malik et al., 2020; Abas et al., 2017). The report of “Global Climate Change Risk Index” (GCCRI) Pakistan indicates that it suffered a huge economic loss of 0.53 per unit GDP equals $3792.52 due to rapid climatic changes from 1999 to 2018 Economic Survey of Pakistan (2019). Pakistan is focusing on modern strategies for coping with carbon emissions but it requires the adoption of modern technologies to be implanted in the agriculture, transport, manufacturing, and production sectors Ashraf et al.(2017).

The manufacturing sector is the backbone for enhancing the economic growth of any country (Lin et al, 2014; Zhang et al., 2020; Ali et al., 2019). The industrial sector plays a multiplier role in the economic growth of the country. Pakistan's industrial sector contributes 13.6% of the overall gross domestic product of the country. Pakistan’s manufacturing sector growth in 2006 was 8.45 percent which is raised to 14 percent in the year 2020 Economic Survey of Pakistan (2019). Previously Pakistan's economic growth was agriculture-based that is gradually shifted towards the industrial-led economy. Ultimately,the manufacturing sector growth requires more energy production and more energy consumption. Consequently, produces more carbon emissions and bad environmental standards Mahmood et al. (2020). Moreover, industrialization accounts for a high percentage of carbon emissions which distracts the environmental sustainability (Meng et al., 2021; Munir Ahmad and Zhao, 2018).

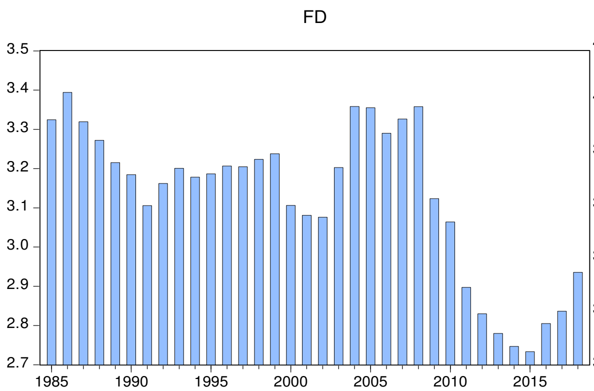
Due to the significance of a sustainable environment, the link between energy consumption, carbon emissions, and economic growth has been examined by various researchers in the different sectors of Pakistan (Buhari et al., 2020; Rehermann and Pablo-Romero, 2018; Yu, Zheng, and Li, 2018).It is governed that the manufacturing sector heavily relies on energy consumption and ultimately produces more carbon emissions Baz et al. (2019). Due to a lack of resources and technological advancement; Pakistan generates energy requirements by natural gas, oil, and coal. Energy consumption for the various sectors of Pakistan is given as overall the industrial sector consumes 37.7%, transport sector 32.2 %, and households consume 22.2% Baloch and Suad (2018). Pakistan's industrial output is declined by 12% due to the energy crisis Mirza and Kanwal (2017). Due to the massive production of energy from fossil fuel, Pakistan has to import Oil, LNG Gas, and other resources which result in economic decline and environmental pollution (Malik et al., 2020; Y. Zhang and Zhang, 2018). The following figures shows the trends of CO2 emission, energy consumption, foreign direct investment, financial development and globalization in Pakistan.



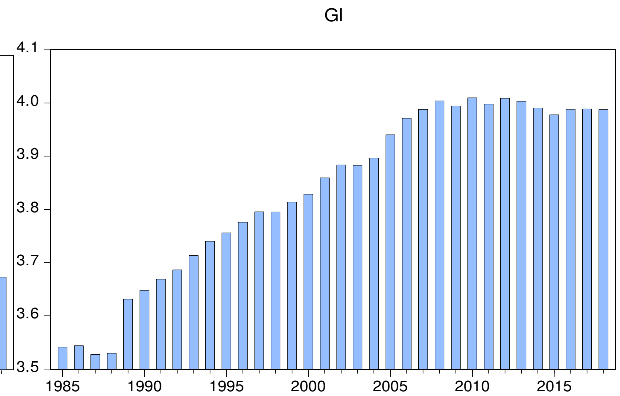
Plot # 1: CO_2 Emissions



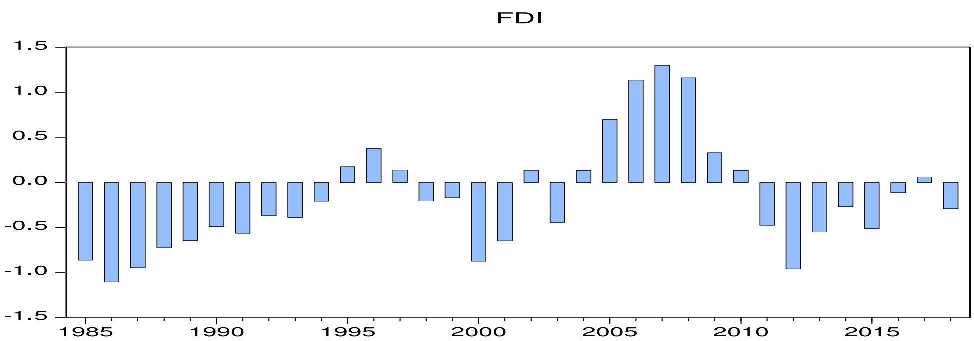
Plot # 2: Energy Consumption



Plot # 3: Financial Development



Plot # 4: Globalization



Plot # 5: Foreign Direct Investment

One way to enhance the economic growth of the country is through foreign direct investment from other countries. The relationship between CO_2 emissions and indicators of FDI (human capital, technological transfer, difference exchange rate, market size expansion) is examined by many researchers and conferred different results. (Le and Ozturk, 2020; Shahbaz.G, et al., 2019; Anser, 2019). Also, the adverse effects of FDI on CO_2 emissions are governed by various authors in the context of pollution haven and pollution halo hypothesis (Nathaniel . B, Barua, et al., 2020; Destek and Okumus, 2019; Pesaran, 2014; Khan et al., 2020). The pollution haven hypothesis works in low-income countries with weak economies and less control on environmental regulations, permits developed and developing countries to reallocate their polluting manufacturing firms in those countries, and become a haven for polluters(Bakhsh et al., 2017; Shahbaz.G, et al., 2019). As a result, FDI degrades environmental sustainability in those countries. Conversely, the pollution halo hypothesis states that FDI inflow countries strictly follow the environmental regulations, and ultimately cleaner production is possible in those countries (Ur Rahman et al., 2019; Shahbaz.B et al., 2019).

The present study focused on the case of Pakistan due to tremendous factors as mentioned. Firstly, Pakistan is termed as the best place in Asia for foreign direct investments (FDI) because of its strategic location. Secondly, Pakistan and China are working on the marvellous project of “China Pakistan Economic Corridor” (CPEC) with a huge investment of $46 billion for energy and infrastructure Ur Rahman et al. (2019). CPEC tends to open modern ways of technologies, new job opportunities, Foreign Direct Investments, infrastructure, corporate and private sector contracts, and energy development projects. CPEC project is termed as the highest investment project in the history of Pakistan. Thirdly, the Pakistan government is focused to create a friendly business environment for other countries and corporate businesses (Ur Rahman et al., 2019; Rasool et al., 2019). Fourthly, Pakistan has geographical importance with coastal ports, global airline routes, and infrastructure for imports and exports with border sharing countries (Iran, China, Afghanistan, and India) which provide the economical transit methods. These routes connect the Central Asian Republic Countries (CARC) and afford economical business transactions. In the future perspective, Gawadar Port (2,292 Acre Free Trade) connects trade association with Europe and Asia termed as Euro-Asia Transport Link (EATL). Additionally Gwadar Port will link the Middle East, China, and the United National Economic and Social Commission for the Asian and Pacific region (UNESCAP) for economic strength and collaboration with other countries Lin and Yousaf (2020).

Previous studies have focused on CO_2 emissions and financial development of Pakistan using the ARDL approach (Abbasi and Riaz, 2016; Hussain and Ur, 2014), CO_2 emissions and urbanization in the case of Pakistan with the ARDL method (Ali, Bakhsh, et al., 2019; Acheampong et al., 2019), CO_2 emissions with energy consumption and economic growth in Pakistan (B. Zhang and Wang, 2017; Jawad.S, et al., 2017; Lin and Ahmad, 2017; Mirza and Kanwal, 2017; Lin and Raza, 2019), CO_2 emissions among energy consumptions from the transport sector in Pakistan under ARDL technique (Baloch and Suad, 2018; Yousaf and Lin, 2020; Rasool et al., 2019), Carbon emissions and human activities in Pakistan by ARDL method Anser (2019). Apart from this literature, there is needed to focus on the manufacturing sector of Pakistan. The purpose of the paper is to seek the relationship of CO_2 emissions with energy consumption, globalization, FDI, and financial developmentin the context of the manufacturing sector of Pakistan. The paper contributes to the literature in many ways: Firstly,this is theunique attempt to research the manufacturing sector of Pakistan using the ARDL and NARDL methods. Secondly, this study will prove the asymmetric behaviour of energy consumption on manufacturing output in CO_2emission. Moreover, the study gives a new direction for government officials and policymakers for the formulation of policies. This study tries to prove the validation of the Pollution Halo or Haven Hypothesis in the case of Pakistan.

The remaining structure of the paper as following: The first section of the paper is given as an introduction. The literature review is briefly explained in section two. The third section puts lights on the descriptions of the variables, comprehensive methodology, and data sources. Section four comprises empirical analysis results of the study and the last section gives the conclusion of the study.

2. Literature Review

The Pollution haven model was first ever offered by Pethig (1976) which explained the Ricardian model of a trade by supposing the trade between two identical countries. Neo-classical theory of trade works in countries that generate industrial pollution like two identical countries which have a difference in carbon pollution tax one is higher than the other. The pollution difference is the reason for trade among these countries. The pollution haven hypothesis is first-ever discussed byKevinP (2008). One school of thought states that the Pollution haven theory works for developed countries to shift own polluting industries to low-income countries and save their country from environmental degradation. The FDI recipient country enhances its per capita income and pollutes its environment. The other school of thought disagrees with the first statement and says that with the enhance in FDI economic growth also improves. The improved economic position produces technological advancements in the country and reduces carbon emissions Demir and Duan(2018).

Many authors examined the positive and negative effects of foreign direct investment in the various regions of the world under pollution haven and pollution halo hypotheses (Sun.H, et al., 2020; Le.T.H, et al., 2016; Rahman et al., 2020; Shahbaz.N, et al., 2017; Hdom and Fuinhas, 2020). Some of the authors analyzed the effects of FDI for individual countries like Kazakhstan Wada et al.(2020), Pakistan (Ali.M.U, et al., 2020; Malik et al., 2020; Baloch and Suad, 2018; Abbasi and Riaz, 2016), Brazil Hdom and Fuinhas (2020), USA Shahbaz.G, et al. (2019), China (Y. Zhang and Zhang, 2018; Du and Li, 2019), Nigeria Zubair et al. (2020) and several other conducted research on the group of countries such as South Asia Rahman et al. (2020), MENA countries Shahbaz.B, et al. (2019), Sub-Saharan Africa Acheampong et al. (2019). Both the individual and group country analysis provides mixed results. The research examined by Sun.H et al. (2020) discussed the connection of CO_2 emissions with environmental pollution regulations and FDI from the manufacturing sector of China for annual data from 2001 to 2007. The results indicate that both environmental regulation styles (expenditure style & investment style) and FDI produces manufacturing pollution. Also, the study validates the EKC model for manufacturing sector pollution in China.

The connection between energy consumption and CO_2 emissions is governed by many authors(Zhang.Y, et al., 2019;Ahmad.A et al., 2016; Chang et al., 2016; Kasman and Duman, 2015) and found a strong positive connection in the results. The relationship between CO_2 emissions and energy consumption is quiteimportant for the manufacturing sector pollutions (Tian et al., 2018; Zhu and Shan, 2020; Lin et al., 2014; Zhang et al., 2020). The study of (Ma et al., 2019;Zhang et al., 2020;Tian et al., 2018)urged thatthe highest quantity of carbon dioxide is produced by China in the world due to the high industrial pollution.

The findings of Griffin and Hammond (2019) worked on the relationship of CO_2 emissions and energy consumption in the industrial sector (iron & steel) of the United Kingdom. The iron and steel industry of the UK accounts for the highest GHG emissions about 26% and the highest energy-consuming sector. The study concluded a positive association between energy consumption and carbon emissions. To reduce carbon emissions technological innovations are required in the manufacturing sector i.e., bioenergy fuel switching, energy-efficient technologies, and carbon capture storage Griffin and Hammond (2019). The research examined by Zhang et al.

(2020) focused on the connection between energy consumption from the manufacturing sector of China with CO_2 emissions and CH_4 methane gas emissions. Conferring to China's statistical yearbook (2019) manufacturing sector contributes 40% to the economic growth of the country. The results indicate that China is a manufacturing economy, which showed remarkable energy consumption in the manufacturing sector and ultimately degrades environmental sustainability. The research evaluated by Zhu and Shan (2020) explores the relationship of CO_2 emissions, economic growth, and energy consumption in the industrial sector of Beijing for annual data from 2018 to 2020. The results determined that industrial growth leads China to meet the economic growth while energy consumption and reduction in carbon dioxide emissions are not truly surpassed the 13th five-year plan of government.

Capital formation is termed as an important factor to control the nexus of environmental degradation. Financial development in a country can produce technological advancements and ultimately reduction in carbon dioxide emissions. Many researchers focused on the impact of CO_2 emissions on financial development using various indicators. Akalpler and Hove (2019) analyzed positive results for gross capital formation and reduction in carbon emissions for the Indian economy. The research investigated by Javid and Sharif, 2016; Komal and Abbas, 2015) showed the association of financial development with carbon dioxide emissions and formulated a positive relationship in the context of Pakistan. Zubair et al. (2020) determined the linkage of CO_2 emissions with fixed capital and found a negative result for Nigeria using annual time series data from 1980 to 2018. The research governed by Le and Ozturk (2020) determined a positive link between financial development and carbon emissions among the Emerging markets & developing countries using data period from 1990-2014. Hence financial development increases CO_2 emissions due to the establishment of the industrial sector without compliance with environmental standards.

Wang et al. (2020) examined the association of CO_2 emissions and an increase in globalization various factors. First, the transport sector plays a key role in enhancing CO_2 emissions by globalization. Secondly, globalization enhances industrial consumption which ultimately produces high CO_2 emissions. Trade activities between countries expand industrial activities which require more energy consumption and more CO_2 emissions.Shahbaz, Jawad et al. (2017) inspected the factors affecting globalization on carbon dioxide emissions for Japan. The results showed a negative relationship with globalization. In the case of Japan globalization posed strong economic impacts with technological improvements. Mehmood (2020) examined the association between CO_2 emissions and globalization and found negative results in the case of Pakistan and India, on the other hand,positive relationship for Srilanka, Bangladesh, Bhutan, and Afghanistan. The research inspected byUdom et al. (2020) verified a positive connection of CO_2 emissions with globalization for the Malaysian economy. The results suggest that the Malaysian economy should make ideal policies to reduce CO_2 emissions through globalization.

The review concluded that a lot of work is done on the association between carbon dioxide emissions and energy consumption in Pakistan(Baz et al., 2019;Mirzaand Kanwal, 2017;Lin and Raza, 2019;Lin and Ahmad, 2017; Chandia et al., 2018; Javid and Sharif, 2016; Zaidi et al., 2018). The idea of carbon dioxide emissions and energy consumption in Pakistan is also analyzed in various sectors like transport and vehicles(Yousafand Lin, 2020;Baloch and Suad, 2018;Lin and Yousaf, 2020;Rasool et al., 2019), financial development(Komaland Abbas, 2015;Shahzad et al., 2017), urbanization (Ali.R, et al., 2019b), Agriculture sector (Qureshi et al., 2016). All the above-mentioned studies focused on the relationship between CO_2 emissions and energy consumption in the various sectors of Pakistan while so far the manufacturing sector carbon emissions have rarely been inspected byAttari et al. (2016) to a little extent. His study model was based on the carbon dioxide emissions and manufacturing sector income, apart from considering other important factors such as energy consumption, FDI, globalization, etc. which are now briefly focused on in the present study.In light of the above review, the present study endeavours to empirically analyze the effects of carbon dioxide emissions, energy consumption, FDI, globalization, and financial development in the context of the manufacturing sector of Pakistan using the linear and non-linear ARDL method.

3. Data and Methodology

The empirical analyses utilized the annual data from the period 1985 to 2018 for the manufacturing sector of Pakistan. CO_2 emissions (% of total fuel combustion) from the manufacturing sector are used to analyze environmental quality.Total energy consumption from the manufacturing sector is obtained in kilotons of oil.Foreign direct investmentis measured in percentageof GDP.Domestic credit to the private sector is obtained in the percentage of GDP as a proxy of financial development. The data for variables CO_2 emissions, FDI, Financial development, are extracted from the World Development Indicators database.Total energy consumption data is obtained from the International Energy Agency. Globalization is accessed generally, and its data is obtained from KOF Swiss Economics Institute. The details and descriptions of the variables for the present study are mentioned in Table 1.

Table 1 Variable name, symbols, descriptions, and data source.

Variable	***Symbol***	***Description***	***Data Source***
Carbon emission	*CBN*	*CO2 emissions from manufacturing industries and construction*	*World Bank*
Energy Consumption	*ENR*	*Manufacturing Energy Consumption includes Coal, Oil, Bio-fuels, Electricity, and Natural gas (kiloton of oil equivalent)*	*International Energy Agency*
Foreign direct investment	*FDI*	*Foreign direct investment, net inflows*	*World Bank*
Financial Development	*FD*	*Domestic credit to the private sector*	*World Bank*
Globalization Index	*GLOB*	*Globalization index*	*Swiss Economic Institute*

3.1 Econometric Strategy

In view of research work conducted in a literature review about CO_2 emissions and energy consumption in the various sectors. The present study examined an econometric model with CO_2emissions from the manufacturing sector as the dependent variable. Energy consumption from the manufacturing sector and FDI are analyzed as the independent variable. Financial development and globalization index are focused as the explanatory variables in the present research. All the variables data are converted into the natural logarithm form to get smooth results. To cover the asymmetric results of positive and negative shocks of FDI, we employed the NARDL method founded by Shin (2014). The non-linear ARDL approach is the extension work of the ARDL method presented by Pesaran (2001). This technique evaluates the dynamic asymmetries raised due to the positive and negative shocks of the econometric variables between the long and short term. The importance of the NARDL approach is that it works regardless of the stationary values of the series I(0), I(1), or a mixed stream of integration. Additionally, it works for the small sample size of the data and provides the hidden co-integration values detected by Granger (2002). Therefore, the difference between the typical ARDL and the non-linear ARDL approach gives multiplier advantages that's why many researchers implemented the NARDL approach for econometric analysis (Ur Rahman et al., 2019; Mahmood et al., 2020; Malik et al., 2020).

The present study employed the linear-ARDL approach leading towards the non-linear ARDL method. ARDL approach is used to find the long-run and short-run relationship of the variables. ARDL approach has several advantages over the former techniques like Granger and Engle model for (two variables). Conversely, the Johansen co-integration technique works for (more than two variables). ARDL technique has various advantages over the traditional econometric methods like Johansen and Julius co-integration and Engle and Granger techniques. Firstly, the ARDL approach is employed on the small data size. Secondly, it works for the variables for stationary at level, first difference, and mixed order co-integration. Thirdly, the data generation process (DGP) works on appropriate lags of the data. Fourth, by simple ordinary least square (OLS) technique, it gives the Error Correction Term (ECM) by applying the bounding test. ECM provides separate details about the long-run and short-run interactions of the variables. Fifth, ARDL techniques give unbiased long-run results while using the dependent variable as repressors. Moreover, the ARDL approach makes the model dynamic by using different lag values.

The foundation of Pesaran (2001) is based on greater F statistic value than upper bound 1(0). Error correction term reported by Banerjee et al. (1998) provides a good way to verify the existence of a long-run relationship for variables under investigation. The ECM term must be significant and with a negative coefficient value for the validation of the long-run relationship. Finally, the ARDL techniques employ stability tests for the short-run and long-run relationships of the variables by the two criteria. These stability tests criteria's are Cumulative Sum of values

(CUSUM) and Cumulative Sum of Square values specified by Brown et al. (1975). Further, ARDL method extended by Shin et al (2014) to check the asymmetric association of variables.

3.2 Model Specification

The present study examined the relationship between CO_2 emissions, total energy consumption from the manufacturing sector, FDI, globalization, and financial development in the case of Pakistan. The model is specified below.

$$CO_2 = f(ENR, FDI, FD, GLOB) \qquad \textbf{(1)}$$

Where CO_2 is the carbon emissions from the manufacturing sector, ENR is the energy consumption from the manufacturing sector, FDI is the foreign direct investment net inflows, FD is the proxy of financial development which is taken in terms of domestic credit to the private sector, and GLOB is the globalization index. CO_2 emissions havea strong link with energy consumption, financial development, globalization, and FDI Le & Ozturk, (2020) and Rasool et al. (2019). The manufacturing sector's carbon emissions and energy consumption are increasing at a fast rate Gao et al. (2017) and Yang et al. (2020). The manufacturing sector mainly relies on the oil sector for energy consumption. Globalization is used as the control variable in the study to examine the international level growth in the FDI from developed countries.

$$CO_{2t} = \beta_1 + \beta_2 ENR_t + \beta_3 FDI_t + \beta_4 FD_t + \beta_5 GLOB_t + \mu_t \qquad \textbf{(2)}$$

The coefficients $\beta_2, \beta_3, \beta_4,$ and β_5 are the elasticities of CO_2 emission concerning energy consumption, foreign direct investment, financial development, and globalization. The study implemented ARDL and NARDL (for asymmetric behaviour) approaches to estimate our results. This is unique methodology gives results for different lag values, works for the small size of data, convenient to use, and provides good results of estimations(Pesaran, 2001; Faheem and Chin, 2021). To estimate the above model, we apply the ARDL bounds approach by using the following specified model:

$$\begin{aligned}\Delta CO_{2t} = {} & \alpha_0 + \sum_{i=1}^{l} a_{1i}\Delta CO_{2t-1} + \sum_{i=0}^{p}\alpha_{2i}\Delta ENR_{t-i} + \sum_{i=0}^{q}\alpha_{3i}\Delta FDI_{t-i} + \sum_{i=0}^{r}\alpha_{4i} FD_{t-i} + \sum_{i=0}^{s}\alpha_{5i}\Delta GLOB_{t-i} + \\ & + \beta_1 CO_{2t-1} + \beta_2 ENR_{t-1} + \beta_3 FDI_{t-1} + \beta_4 FD_{t-1} + \beta_5 GLOB_{t-1} + \mu_t \qquad \textbf{(3)}\end{aligned}$$

In the above-mentioned equation, Δ indicates the first difference estimate of the concerned variable and the determined drift parameter equations α_0.

The unrestricted error correction model (ECM) estimated as follows:

$$\begin{aligned}\Delta CO_{2t} = {} & \alpha_0 + \sum_{i=1}^{l} a_1\Delta CO_{2t-i} + \sum_{i=0}^{p}\alpha_2\Delta ENR_{t-i} + \sum_{i=0}^{q}\alpha_3\Delta FDI_{t-i} + \sum_{i=0}^{r}\alpha_4\Delta FD_{t-i} + \sum_{i=0}^{s}\alpha_5\Delta GLOB_{t-i} \\ & + \lambda ECT - 1 + vt_t \qquad \textbf{(4)}\end{aligned}$$

In the above-mentioned equation, λ defines the speed of adjusting parameter and error correction term which describes the residual values from the estimation model. Further, the non-linear model is estimated that shows asymmetric behaviour of energy consumption conforming to the non-linear autoregressive distributed lag technique where energy consumption is decomposed into positive and negative sections.

$$CO_{2t} = \beta_1 + \beta_2^{+} ENR^{+}{}_t + \beta_2^{-} ENR_t^{-} + \beta_3 X_t + \mu_t \quad \textbf{(6)}$$

Based on the non-linear model Equation (6), β^{+}_2shows energy consumption impact on CO_2emission in long runin equation (7), which is expected to be positive. And β^{-}_2 in equation (8) indicates the reducing impact between energy consumption and CO_2 emission.

$$\beta_2^{+} ENR_t^{+} = \sum_{j=1}^{t} \Delta ENR_j^{+} = \sum_{j=1}^{t} \max(\Delta ENR_j, 0) \quad \textbf{(7)}$$

$$\beta_2^{-} ENR_t^{-} = \sum_{j=1}^{t} \Delta ENR_j^{-} = \sum_{j=1}^{t} \max(\Delta ENR_j, 0) \quad \textbf{(8)}$$

The main objective is to examine whether energy consumption symmetrically or asymmetrically impacts CO_2 emissions.Shin et al. (2014)introduced NARDL setting with the extension of ARDL as:

$$\Delta CO_{2t} = \alpha_0 + \sum_{i=1}^{l} a_{1i} \Delta CO_{2t-1} + \sum_{i=0}^{p1} \alpha^{+}{}_{2i} \Delta ENR^{+}{}_{t-i} + \sum_{i=0}^{p2} \alpha^{-}{}_{2i} \Delta ENR^{-}{}_{t-i} + \sum_{i=0}^{q} \alpha_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{r} \alpha_{4i} \Delta FD_{t-i} + \sum_{i=0}^{s} \alpha_{5i} \Delta GLOB_{t-i} + \quad \textbf{(9)}$$
$$+ \beta_1 CO_{2t-1} + \beta_2^{+} ENR_{t-1}^{+} + \beta^{-}{}_2 ENR^{-}{}_{t-1} + \beta_3 FDI_{t-1} + \beta_4 FD_{t-1} + \beta_5 GLOB_{t-1} + \mu_t$$

Equation (9) captures the positive and negative shocks of energy consumption on the CO_2 emissions for the manufacturing sector of Pakistan. The long-run and short-run asymmetry is measured by $\beta_2^{+}$and β_2^{-}, α_2^{+} and α_2^{-} respectively by taking the following hypotheses:

H_0: $\beta_2^{+} = \beta_2^{-} = 0$

$$H_0 : \sum_{i=0}^{p1} \alpha^{+}{}_{2i} = \sum_{i=0}^{p2} \alpha^{-}{}_{2i}$$

For all values i=0,….,p.

4. Results and Discussion

4.1 Descriptive Statistics and Correlation matrix

Descriptive statistics and correlation of the variables are discussed in table 2. Descriptive statistics include mean, median, maximum, minimum, skewness, standard deviation, and probability values. The highest value of mean is for energy consumption and the lowest value is for foreign direct investment. Conforming to the Jarque-Bera statistics all the values are normally distributed. The values for carbon emissions, energy consumption, financial development, and globalization index are negatively skewed on the other hand FDI is positively skewed. It is seen from the summary of correlations that CO_2 emissions are negatively correlated with energy consumption. Financial development has a positive correlation with CO_2 emissions while negatively correlated with energy consumption. The foreign direct investment shows a positive correlation with CO_2 emissions, energy consumption, and financial development. Globalization index examined positive correlation with energy consumption and FDI, while negatively correlated with CO_2 emissions and financial development.

Table 2 Descriptive statistics:					
	CO2	*ENR*	*FD*	*FDI*	*GLOB*
Mean	*3.2690*	*9.5533*	*3.0963*	*-0.0609*	*3.8825*
Median	*3.3248*	*9.6639*	*3.1619*	*-0.2062*	*3.8964*
Maximum	*3.4745*	*10.090*	*3.3581*	*1.2997*	*4.0095*
Minimum	*2.9188*	*8.9789*	*2.7334*	*-0.9601*	*3.6479*
Std. Dev.	*0.1461*	*0.3267*	*0.1936*	*0.5761*	*0.1199*
Skewness	*-0.6554*	*-0.1695*	*-0.5557*	*0.8698*	*-0.5211*
Kurtosis	*2.6386*	*1.7061*	*2.1296*	*3.2241*	*1.8630*
Jarque-Bera	*2.2343*	*2.1619*	*2.4083*	*3.7179*	*2.8747*
Probability	*0.3272*	*0.3392*	*0.2999*	*0.1558*	*0.2375*
Sum	*94.8017*	*277.0463*	*89.7949*	*-1.7663*	*112.5927*
Sum Sq. Dev.	*0.5982*	*2.9902*	*1.0496*	*9.2951*	*0.4027*
Observations	*29*	*29*	*29*	*29*	*29*
CO2	*1*				
ENR	*-0.251*	*1*			
FD	*0.656*	*-0.411*	*1*		
FDI	*0.433*	*0.310*	*0.562*	*1*	
GI	*-0.194*	*0.953*	*-0.415*	*0.278*	*1*

4.2 Unit Root Test

ARDL approach works if the variables are stationary at the level and first difference. However, the study of Ouattara (2004) examined that ARDL does not accept the stationary values of the variables at the second difference I(2). Due to this reason, all the variables of the study are checked by the unit root test that none of the variables is stationary at I(2) difference. For the sake of unit root test two tests are implemented that are Augmented Dickey-Fuller test (ADF), and the Phillips-Peron test (PP). All the variables of the study found stationary at first difference. Details of the unit root test are mentioned in Table 4.

Table 4 Unit root tests:				
	Level		***First difference***	
Variables	***ADF***	***PP***	***ADF***	***PP***
Log CO_2	*2.957110*	*-2.954021*	*-2.957110**	*-2.957110**
Log FDI	*-2.963972*	*-2.954021*	*-2.957110**	*-3.653730***
Log FD	*-2.957110*	*-2.954021*	*-2.957110**	*-3.653730***
Log ENR	*-2.981038*	*-2.981038*	*-3.724070***	*-2.986225**
Log GLOB	*-2.105256*	*-2.195449*	*-3.653730***	*-2.957110**

Note: *and ** for 5% and 1 % respectively.

4.3 ARDL Bound Test Results

Incorporating the results from F-statistic and bound test values from table 5, it is clear that there is a long-run relationship among the variables of the present study for equation (2). F-statistic values in table 5 are above than the upper critical values of Narayan (2005) table at constant values and significant. Another way of examining the long-run relationship of the variables is through the error correction term. It is commended that if the error correction term gives a significant statistic value with a negative sign Pesaran, (2001) validates the existence of a long-run association of variables.

Table 5: Bounds test estimates: (ARDL)

F-bounds test statistic		*Null hypotheses: No level relationships*		
		Significance	*I(0) Bound*	*I(1) Bound*
F-statistic	*14.938***	*10%*	*2.45*	*3.52*
k	*4*	*5%*	*2.86*	*4.01*
		2.5%	*3.25*	*4.49*
		1%	*3.74*	*5.06*

Note: *, **, ****, and **** for 10%, 5%, 2.5% and 1 % respectively.

4.4 Linear ARDL Estimation Results

Long-run and short-run dynamics are examined in Table 6. The ARDL results for the relationship of CO_2 emissions is significant and positive with total energy consumption for both the long and short-run in the scenario of the manufacturing sector of Pakistan, thus suggests that an increase in energy consumption degrades the environment badly in the short and long-run. Our results are in line with the previous work of Munir Ahmad and Zhao (2018) in China, Pata (2018) for Turkey, Shahbaz.G, et al. (2019) for the United States of America, (A. Ahmad et al., 2016) for India, Lin and Raza, (2019) and Mirza and Kanwal (2017) for Pakistan. Previously, Pakistan's economy was based on agriculture which is gradually shifted toward an industrial economy. The development of the manufacturing sector in Pakistan produces environmental degradation. Pakistan is still based on conventional sources (80%) for energy production like Coal, Natural Gas, and Oil, which badly pollutes the environment. As the global economies are focusing on renewable energy production mechanisms, the government of Pakistan should need to invest in renewable energy resources to mitigate the climate-changing effects.

In the case of financial development there exists a positive significant relationship with CO_2 emissions in both the and long and short-term. Our results support the previous researches conducted by Abbasi and Riaz (2016) in the case of Pakistan, Manzoor Ahmad et al. (2019) for China, Le and Ozturk (2020) for Emerging markets and developing countries EMDCs, Pata (2018) for Turkey, and Ahmad.N and Du (2017) for Iran. The results indicate that the increase of financial development in Pakistan would enhance the CO_2 emissions in the short and long-run. Financial development improves the purchasing power of the communities. Financial development provides modern ways of investments in various projects and industrialization development. Pakistan is a country that is based on old technologies in the transportation, energy production, and industrialization sector which deteriorate environmental sustainability.

For FDI and CO_2 emissions our results showed a significant negative relationship in the long-run and a significant positive relationship in short term. The findings revealed that 1% increase in

FDI inflows decreses CO_2 emissions by 0.626%. Our results are the same asAcheampong et al. (2019) for Sub-Saharan African countries, Zubair et al. (2020) for Nigeria, and Zakaria & Bibi (2019) for South Asia. Also, the long-term positive results validate the existence of the pollution halo hypothesis in Pakistan. The short-run findings indicate a significant positive association between FDI and CO_2 emissions. In short-run FDI imparts bad impacts on the environment but in the long-run with the continuous inflow of FDI will improve the financial development which ultimately provides better conditions for improvements in production technologies of Pakistan. Comparative findings demonstrated that FDI inflow will improve sustainable technologies and reduce CO_2 emissions. The long-run result of FDI suggests that Pakistan is moving towards good policies for environmental sustainability. Additionally, the present study validates the pollution halo hypothesis for Pakistan. On the other hand, some authors find a positive relationship between FDI and CO_2 emissions (pollution haven) in the various regions of the world like Y. Zhang and Zhang (2018) for China, Shahbaz.B et al. (2019) for Middle-East and North African countries (MENA), and (Baloch & Suad, 2018; Malik et al., 2020) for Pakistan.

The results demonstrated that globalization has a significant negative relationship with CO_2 emissions in both the short and long-run. Surprisingly our results are consistent with the studies i.e.,Shahbaz, Kumar et al. (2019) for 87 countries of the world including high developed, medium developed, and low developed countries,You and Lv (2018) for 83 world countries,Shujah-ur-Rahman et al. (2019) for Central and European countries, Zaidi et al. (2019)for Asia Pacific counties,Mehmood(2020) showed the negative relationship of globalization and CO_2 emissions for Pakistan and India, Shahbaz, Jawad et al. (2017), and Umar et al. (2020)for China.The justification of the negative association of CO_2 emissions with globalization in Pakistan suggests that globalization reduces CO_2 emissions with technological advancements and expert manpower. Moreover, Pakistan is adopting modern ways of energy production, technological improvements, and economic corridors. CPEC project is one of the milestones for Pakistan that is a live example of globalization. Conforming to the CPEC project many energy productions, road infrastructure, and development projects are initiated in Pakistan.

Table 6: Long-run and Short-run dynamics estimates (ARDL)

Long-run estimates				
Variables	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
ENR	*3.037****	*0.431*	*7.040*	*0.005*
FD	*4.224****	*0.353*	*11.942*	*0.001*
FDI	*-0.626****	*0.098*	*-6.385*	*0.007*
GLOB	*-6.411****	*0.879*	*-7.288*	*0.005*
CONSTANT	*-13.737****	*1.887*	*-7.277*	*0.005*
Short-run estimates				
Variables	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
D(ENR)	*1.116****	*0.113*	*9.855*	*0.002*
D(ENR(-1))	*0.017*	*0.182*	*0.095*	*0.929*
D(ENR(-2))	*-0.610***	*0.202*	*-3.020*	*0.056*

D(ENR(-3))	*-0.293*	*0.140*	*-2.085*	*0.128*
D(FD)	*0.740****	*0.112*	*6.593*	*0.007*
D(FD(-1))	*-1.418****	*0.202*	*-7.013*	*0.006*
D(FD(-2))	*0.292***	*0.084*	*3.449*	*0.040*
D(FD(-3))	*-1.443****	*0.213*	*-6.772*	*0.006*
D(FDI)	*0.085***	*0.029*	*2.916*	*0.061*
D(FDI(-1))	*0.133****	*0.021*	*6.273*	*0.008*
D(FDI(-2))	*0.099***	*0.028*	*3.499*	*0.039*
D(FDI(-3))	*0.116****	*0.022*	*5.080*	*0.014*
D(GGLOB)	*-7.069****	*1.330*	*-5.313*	*0.013*
D(GLOB(-1))	*6.956****	*0.945*	*7.355*	*0.005*
D(GLOB(-2))	*-6.495****	*1.060*	*-6.125*	*0.008*
D(GLOB(-3))	*-0.466*	*0.473*	*-0.985*	*0.397*
ECT	*-0.626****	*0.112*	*-5.587*	*0.011*

*Shows 10%, **Shows 5%, and ***Shows 1% significance level, respectively.

4.5 Diagnostic Tests Results

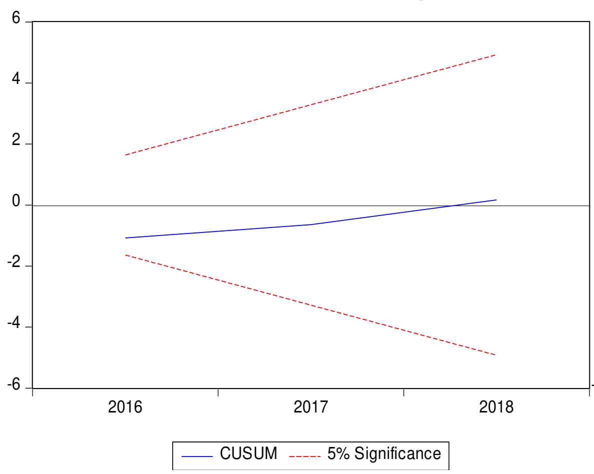
Diagnostic results are demonstrated Table 7 that shows the estimated model is free from issues like heteroscedasticity, autocorrelation and model is structurally stable.

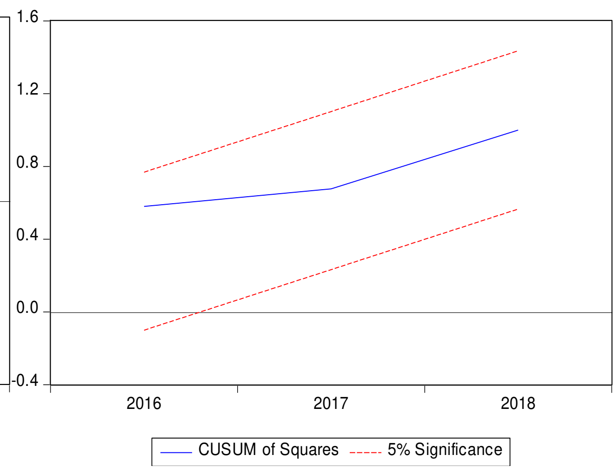
Table 7: Diagnostic Tests

Diagnostic tests	***Statistics***
R^2	*0.999*
Adj R^2	*0.995*
D.W Stat	*2.588*
LM test	*14.46746 (0.182)*
J.B test	*0.230046 (0.891)*
Hetro test	*1.552552 (0.474)*
Ramsey reset test	*0.006827 (0.9417)*

Note: P-value is in parenthesis ( ).

However, CUSUM and CUSUMQ indicated stability in our model showed in plots 6 and 7.





Plot # 6: CUSUM **Plot # 7: CUSUMQ**

4.5 Linear ARDL Estimation Results

The non-linear ARDL bound test results are represented in Table 8 which shows the F-statistic value is significant at a 5% level and greater than the upper bound that is surety of long-run association.

Table 8: Bounds test estimates (NARDL)

F-bounds test statistic		*Null hypotheses: No level relationships*		
		Significance	*I(0) Bound*	*I(1) Bound*
F-statistic	*11.0555***	*10%*	*2.75*	*3.79*
k	*5*	*5%*	*3.12*	*4.25*
		2.5%	*3.49*	*4.67*
		1%	*3.93*	*5.23*

Note: *, **, ****, and **** for 10%, 5%, 2.5% and 1 % ,respectively.

The non-linear ARDL results for the long and short-run are represented in Table 9. The long-run results declare a significant positive estimation for an increase in energy consumption and also positive for a decrease in energy consumption with insignificant value. The results of estimated elasticity for both increase and decrease suggest that 1% increase in CO_2 emissions makes (0.4146) percent energy consumption, while a decrease in value is insignificant. The results suggest that an increase in energy consumption produces more CO_2 emissions also;a decrease in energy consumption gives positive insignificant results. Pakistan needs to focus on the energy consumption sources which require moving from non-renewable energy resources towards renewable energy sources. Financial development shows negative insignificant results. FDI imparts a negative significant relationship with CO_2 emissions, 1% increase in FDI reduces 0.15 percent of CO_2 emissions.The negative relationship of FDI shows the validation of the Pollution Halo hypothesis in the case of Pakistan. Our results for the pollution halo hypothesis are similar for Repkine and Min(2020) foreign enterprises in China, Zubair et al. (2020) for Nigeria,Vadlamannati et al. (2009) for BRICS countries, and Zakaria and Bibi, (2019) for South Asian countries. In contrast, some studies proved the pollution haven hypothesis in Pakistan (Kamran et al. 2019;Malik et al. 2020). The reason for validation of the Pollution Halo-hypothesis in Pakistan is that the country is much more focused on environmental sustainability, and adopting strict measures for improvements in technology. Globalization significantly increases CO_2 emissions in the case of Pakistan.

On the other hand, short-run results for positive and negative energy consumption show that positive energy consumption significantly enhances CO_2 emissions, however, negative energy consumption has insignificant positive results. Financial development shows negative insignificant results, FDI shows positive significant results, and globalization gives significant positive results for Pakistan. In the next, it is determined that a significant error correction term with a negative coefficient validates the existence of the long-run relationship between variables

Pesaran (2001). The ECT obtained (-0.4434) gives negative and significant results for non-linear ARDL.

Table 9: Short and Long-Run dynamic estimates (NARDL)

Long Run Coefficients				
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
ENR^+	*1.4146******	*0.2542*	*5.5638*	*0.0000*
ENR^-	*0.4104*	*0.7320*	*0.5606*	*0.5828*
FD	*-0.1316*	*0.1620*	*-0.8122*	*0.4285*
FDI	*-0.1572******	*0.0443*	*-3.5434*	*0.0027*
GLOB	*4.6080******	*0.6169*	*7.4688*	*0.0000*
C	*-12.6535******	*2.2488*	*-5.6266*	*0.0000*
TREND	*-0.1326******	*0.0130*	*-10.1646*	*0.0000*
Short Run estimates				
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
$D(ENR^+)$	*1.3642******	*0.2019*	*6.7555*	*0.0000*
$D(ENR^-)$	*0.1820*	*0.2951*	*0.6168*	*0.5460*
D(FD)	*-0.0583*	*0.0712*	*-0.8197*	*0.4244*
D(FDI)	*-0.0349******	*0.0148*	*-2.3543*	*0.0317*
D(GLOB)	*0.4758*	*0.5763*	*0.8254*	*0.4212*
D(TREND())	*-0.0588******	*0.0167*	*-3.5097*	*0.0029*
ECT	*-0.4434******	*0.1309*	*-3.3860*	*0.0038*

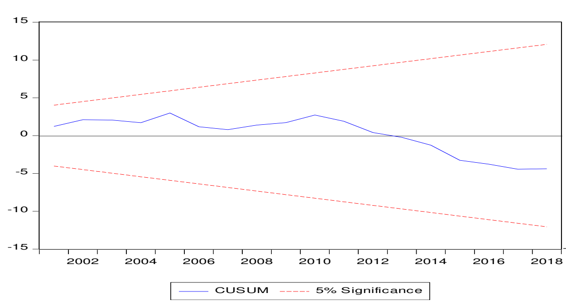
*Shows 10%, **Shows 5% , and ***Shows 1% significance level, respectively.

Diagnostic test estimates are presented in Table 10 that shows model is clear from all problem. The model's stability is verified by CUSUM and CUSUMQ in Plot 8 and 9 respectively. Both the graphs are stable and remained in boundary lines.

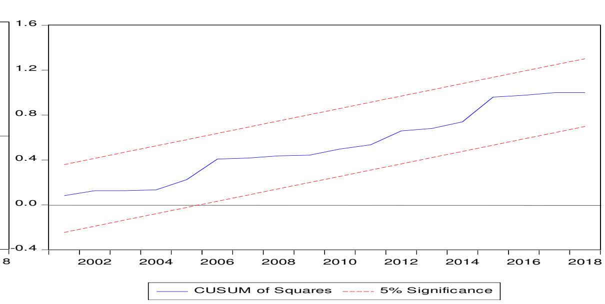
Table 10: Diagnostic Tests (NARDL)

Diagnostic tests	*Statistics*
R^2	*0.235*
Adj R^2	*-0418.*
LM test	*2.1619 (0.152)*
J.B test	*0.0657 (0.967)*
Hetro test	*0.5036 (0.863)*
Ramsey reset test	*1.7323 (0.1037)*

Note: P-value is in parenthesis ( ).



Plot # 8: CUSUM (NARDL)



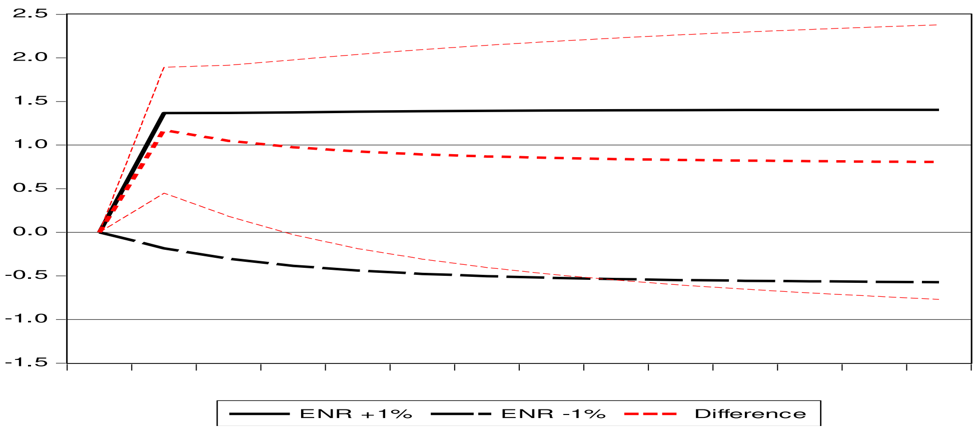
Plot # 9: CUSUMQ (NARDL)

Additionally, the results of the Wald test in Table 11 determine that long estimated null hypotheses of the symmetric are accepted, but short-run does not exists. Verifying the existence of long-run effects of energy consumption. Additionally, the dynamic cumulative multiplier graph is obtained for positive and negative shocks for energy consumption.

Table 11: Non-Linear Wald test

Test	F-statistic	Probability	Decision
W_{LR}	6.7678	0.0167	Long-run asymmetry association exists
W_{SR}	1.0308	0.3215	Short-run asymmetry association does not exists

Note: W_{LR} donates the Wald test for long-run symmetry hypotheses testing, and W_{SR} represents the Wald testing results for short-run symmetry hypotheses evaluation.



Plot # 10: Cumulative effects of Energy Consumption on CO_2 Emissions.

5. Conclusion and Policy Implications:

Our study examined the symmetric and asymmetric effect of energy consumption with environmental degradation in the manufacturing sector of Pakistan with foreign direct investment, financial development, and globalization as control variables for the period 1985 to 2018. The paper made a unique attempt to focus on the manufacturing sector of Pakistan apart from past work which is done on the various other sectorslike transport, energy consumption, and financial development(Abbasi and Riaz, 2016;R. Ali et al., 2019a;Bin Zhang and Wang, 2017;Baloch and Suad, 2018;Rasool et al., 2019;Anser, 2019;Yousaf and Lin, 2020;Komal and Abbas, 2015;Lin and Raza, 2019;Shahzad et al., 2017;Mirza and Kanwal, 2017).The ARDL results of the study shows that energy consumption significantly shows positive relationship with CO_2 emissions both in long and short-run. In terms of energy consumption, Pakistan needs to move towards updated energy sources i.e. renewable energy sources like solar energy on large scale with cheap costs. In case of FDI, CO_2 emissions showed a significant negative relationship for FDI inflows in long run and show significant positive results in the short-run. The results for the validation of the pollution halo hypothesis for FDI suggest that Pakistan is taking good initiatives for environmental sustainability. Moreover, Pakistan's vision (2018) focused on the modern ways of energy production, mitigation of climate change, and self-sufficient in energy requirements. The government of Pakistan has initiated many environmental sustainability activities. First, it launched an Eco-system restoration initiative for moving Pakistan to green environment and adopting climate friendly strategies. Second, “Clean Green Cities Index” is operated in the 20 big cities where no use of plastic bag is strictly followed. Due to this project burning of plastic bags is strictly reduced to a great extent. Third, it established a National Committee on Establishment of Carbon Market (NCECM). Fourthly, under a big environmental friendly project launched in 2017 “Green Pakistan” by which 100 million trees are to be planted till the year 2021 Economic Survey of Pakistan (2019). Financial development determines significant positive association with carbon emissions both in long and short-term. Pakistan requires to working on the technological improvements with the financial development. In terms of globalization, it gives a significant negative relationship with CO_2 emissions both in the short and long-term. This implies that globalization improves Pakistan’s environmental conditions. As Pakistan is a developing country, so it needs to focus on globalization to become a developed nation.

The asymmetric results of the study focused on the positive and negative shocks of energy consumptions in the manufacturing sector of Pakistan with CO_2 emissions. Our results indicate that in the long-run increase in energy consumption significantly enhances carbon emissions while in the short-run decrease in energy consumption insignificantly increases CO_2 emissions in the manufacturing sector of Pakistan. The study results are in line with R. Ali et al. (2019b) for Pakistan, Le and Ozturk (2020) for Emerging markets and developing countries (EMDCs), and Munir Ahmad and Zhao(2018) for China. Financial development gives insignificant negative results with carbon emissions both in the short and long-run. In the case of FDI asymmetric results are in line with symmetric that FDI mitigates environmental sustainability significantly both in the short and long-term. The results for FDI are consistent with the study of Zubair et al. (2020) for Nigeria, and Zakaria and Bibi (2019) for South Asian countries. Conversely, for globalization, asymmetric results indicate globalization shows a significant positive relationship with CO_2 emissions in the long-term, while in the short-run globalization gives positive insignificant results.

Pakistan should provide subsidies atthegovernment level for renewable energy installation projects to reduce the energy crisis and sustainable energy productions for the manufacturing sector. The government should make standards for the manufacturing sector technological improvements and environmentally friendly production processes. Transformation towards renewable energy sources will improves the efficiency of the manufacturing sector with low-cost products. The policymakers should focus on the financial development structures to strengthen renewable energy productions. The government of Pakistan and bureaucrats should involve technical professionals for initiating modern technologies for the production sector. The proper utilization of financial resources will make Pakistan's Asian Tiger in the Asian region of the world. The policymakers in Pakistan should reserve some specific budget for the technological advancements in the manufacturing sector of Pakistan to get rid of the energy crisis and environmental sustainability. Right now, Pakistan formulated good strategies for the utilization of FDI inflows which make Pakistan a pollution halo country. Still, Pakistan needs to work to enhance the FDI inflows by creating friendly relationships with neighboring countries. Most of the developed countries of the world make environmental improvements through high inflows of investments. Pakistan launched an exemplary economic corridor project with China known as the CPEC project. China Pakistan's economic corridor is a big example of globalization. The policymakers in Pakistan need to get maximum benefits for the development in the manufacturing sector and renewable energy mix productions through this project.

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The authors declare that there is no financial interest and competition among each other that influence the work reported in the study.

Ethical Approval:

It is stated that the manuscript is only submitted in ESPR. The submitted manuscript is original and not forwarded any where for proof reads or other. ESPR is authorized to verify plagiarism of the manuscript.

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All the authors are agreed to submit the manuscript with affilations of institutes mentioned in the manuscript, also agreed to submit in ESPR.

Consent to Participate:

All the authors have personel consent to perform the completion of manuscript. No any authors is forced to perform the work. All the manuscript is mutually cooperated by authors.

Author's Contribution:

Mr. Arsalan Tanveer: Complete writing, Data analysis, Software working, Econometric modeling, Methodology. **Professor Dr Huaming Song:** Supervision, Conceptualization. **Dr. Muhammad Faheem:** Software working, Mathematical investigation, revision and verification of the analysis. **Mr.Abdul Daud:** Proofreading, Methodology review. **Miss Saira Naseer:** Review, editing, references verification, and resources verification.

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Figures

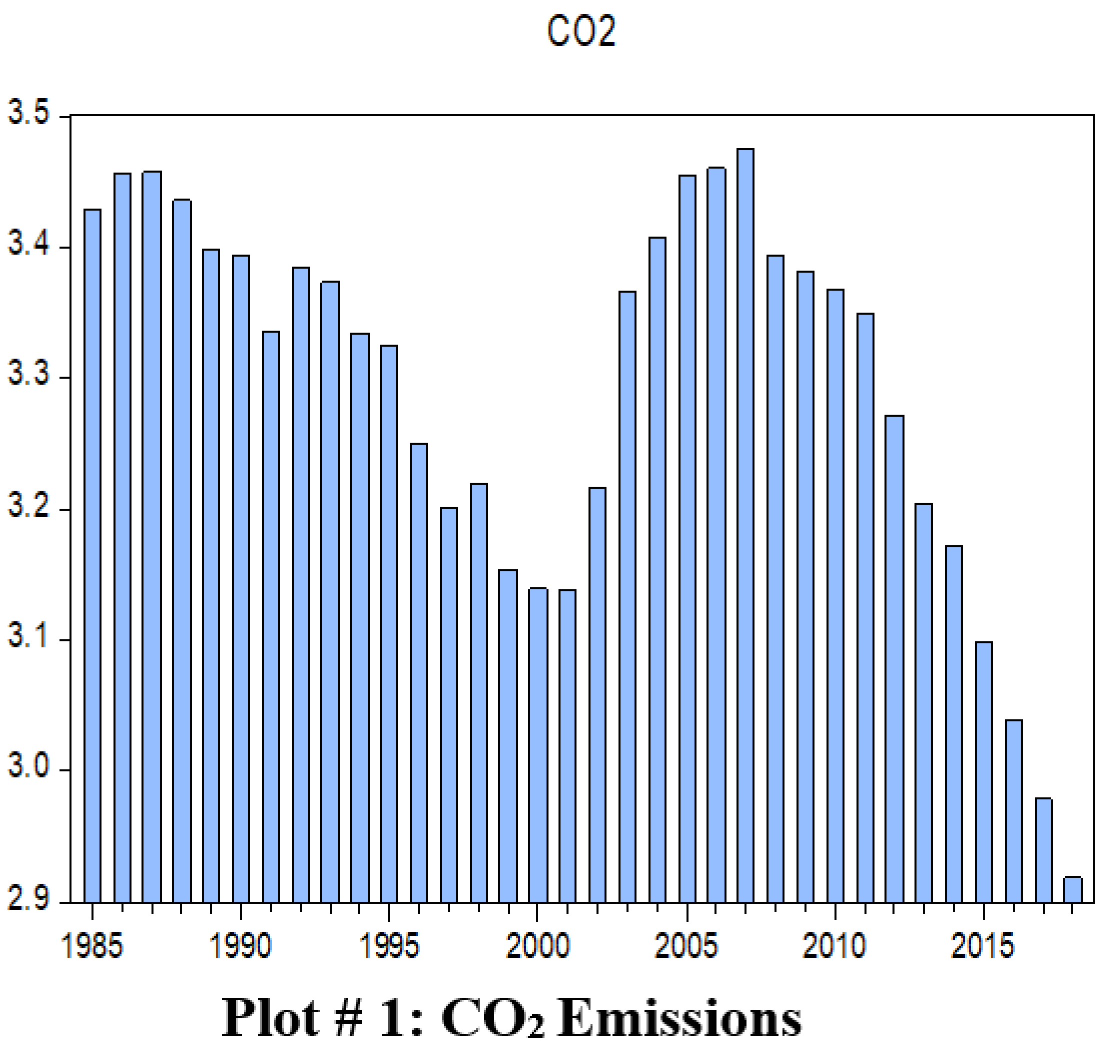


Figure 1

Plot # 1: CO2 Emissions

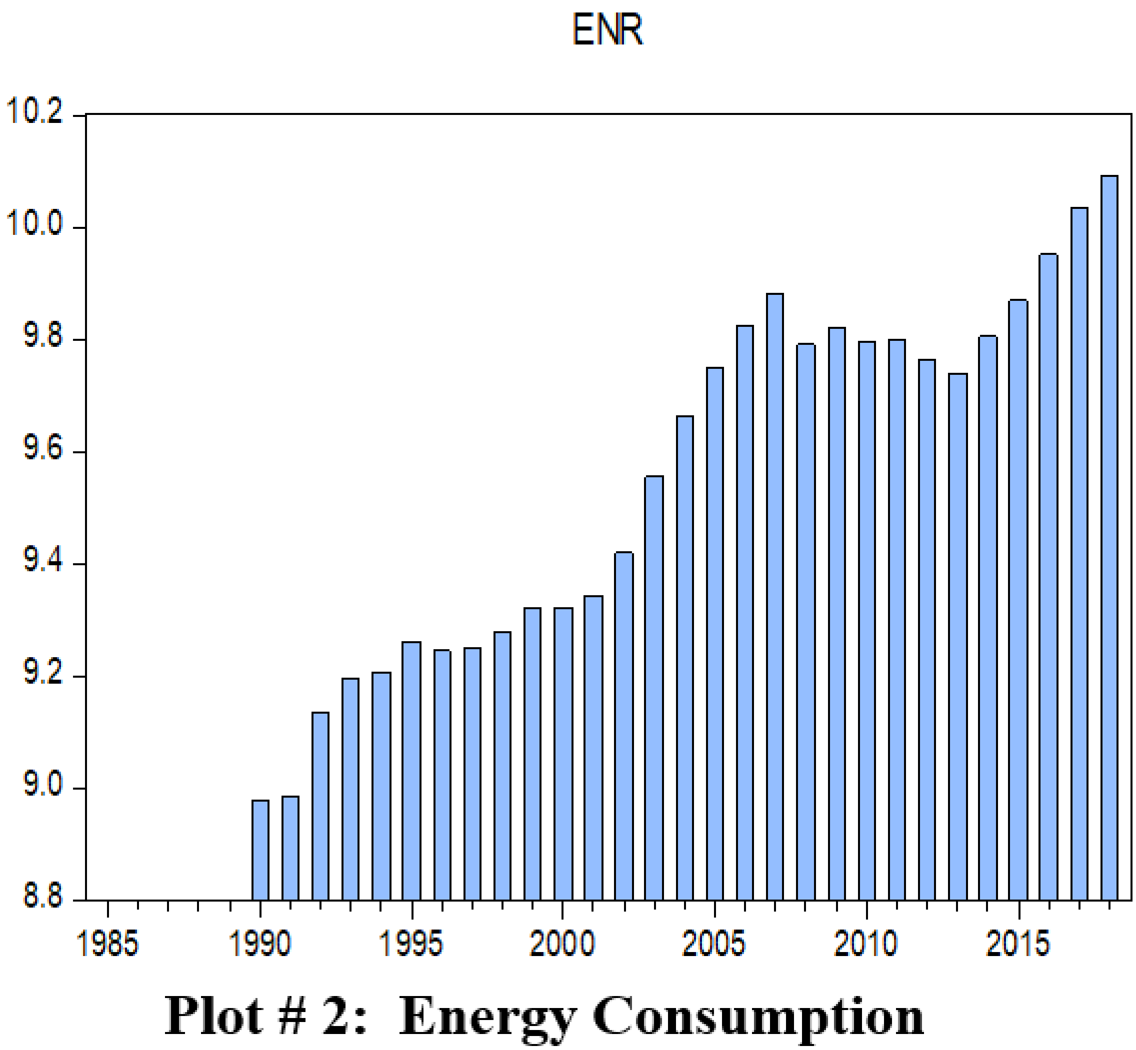
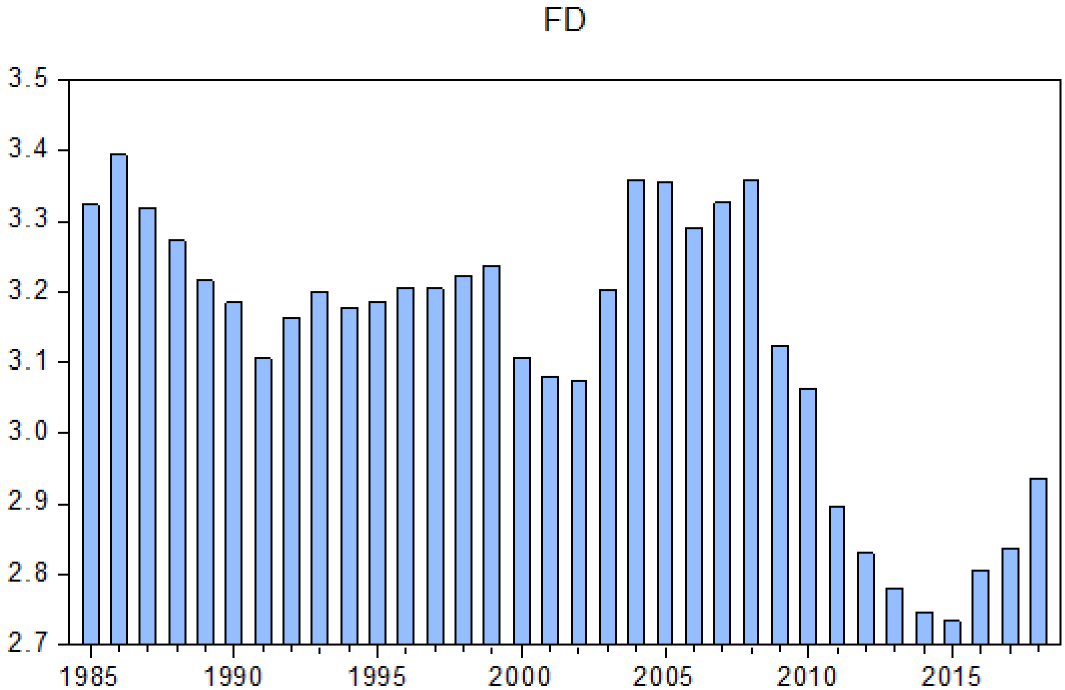


Figure 2

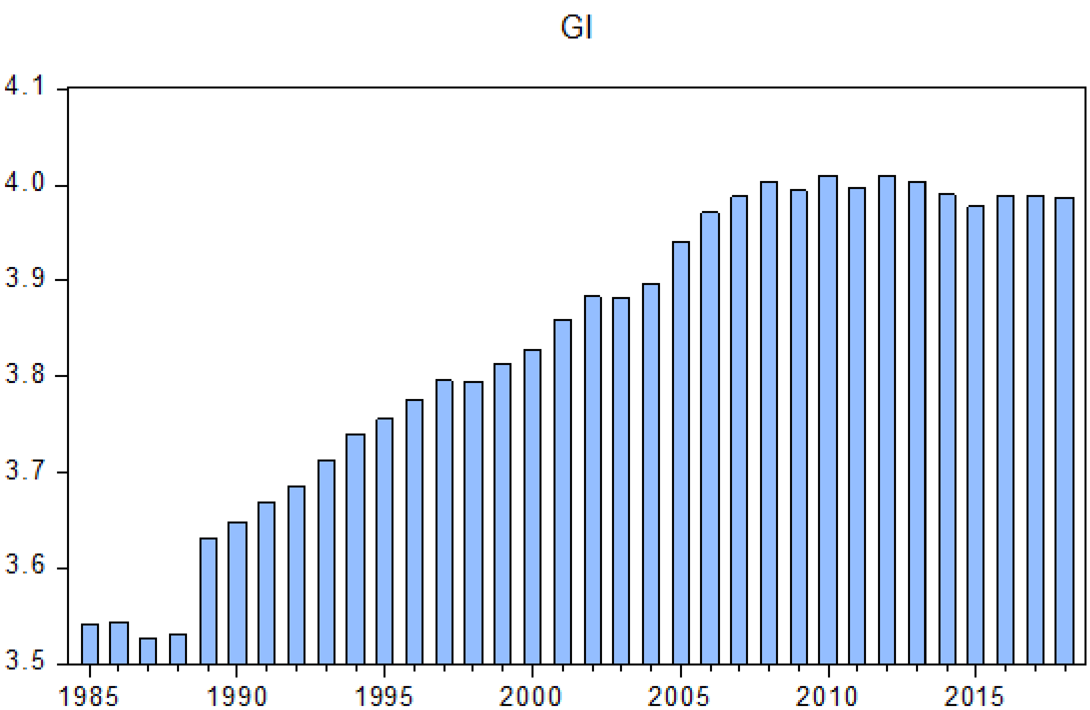
Plot # 2: Energy Consumption



Plot # 3: Financial Development

Figure 3

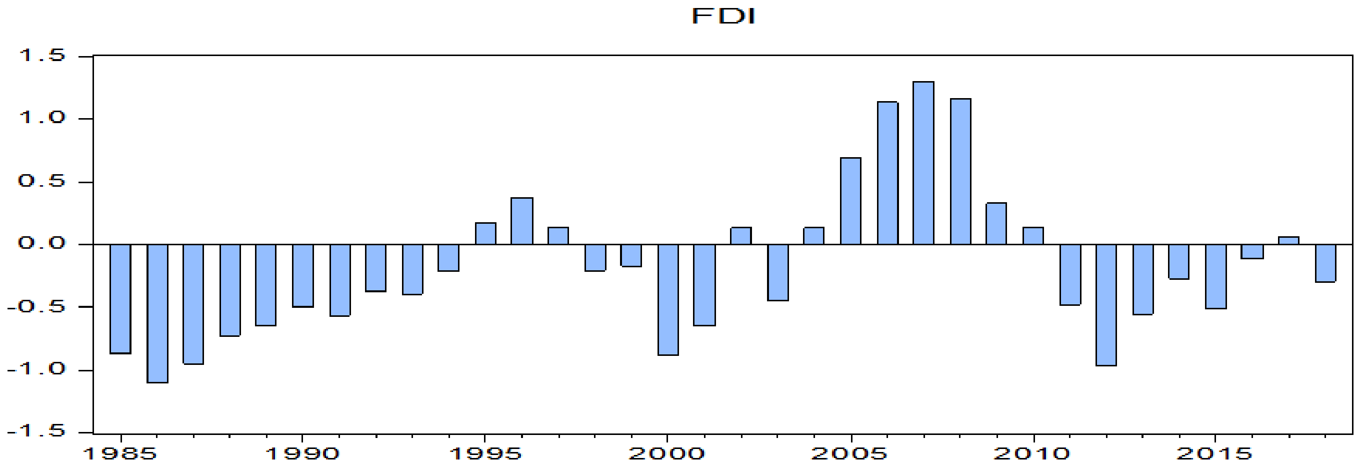
Plot # 3: Financial Development



Plot # 4: Globalization

Figure 4

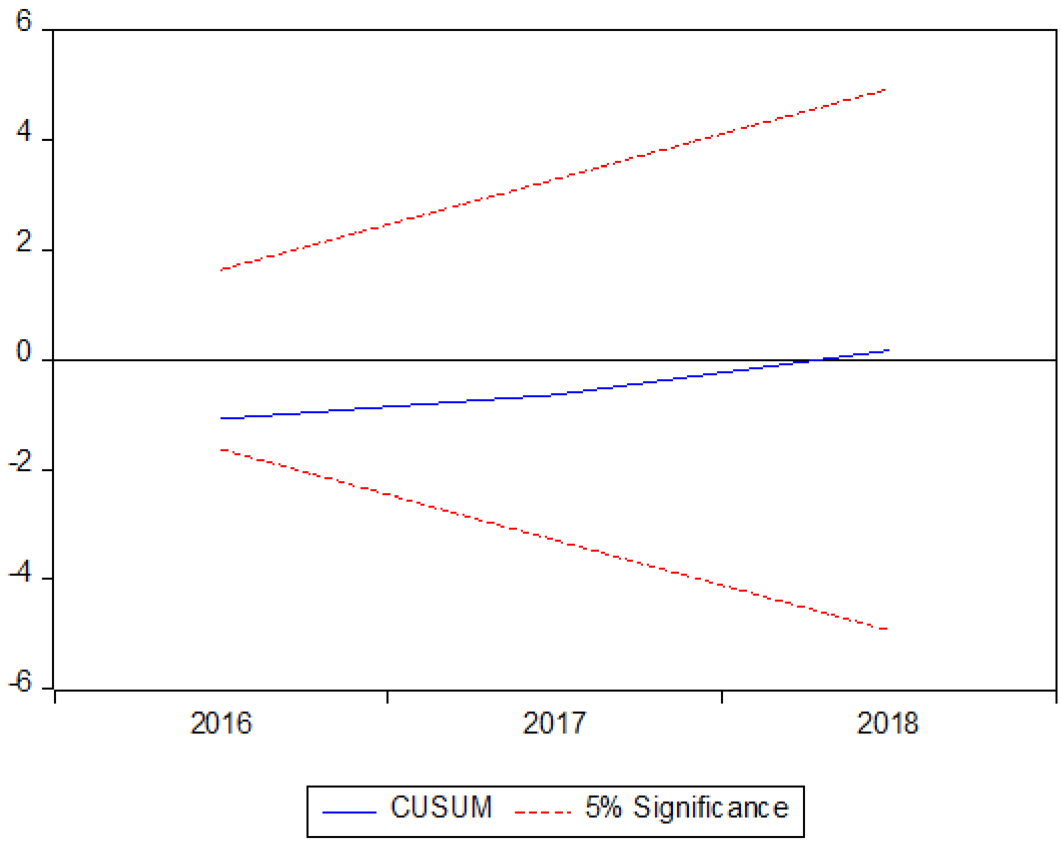
Plot # 4: Globalization



Plot # 5: Foreign Direct Investment

Figure 5

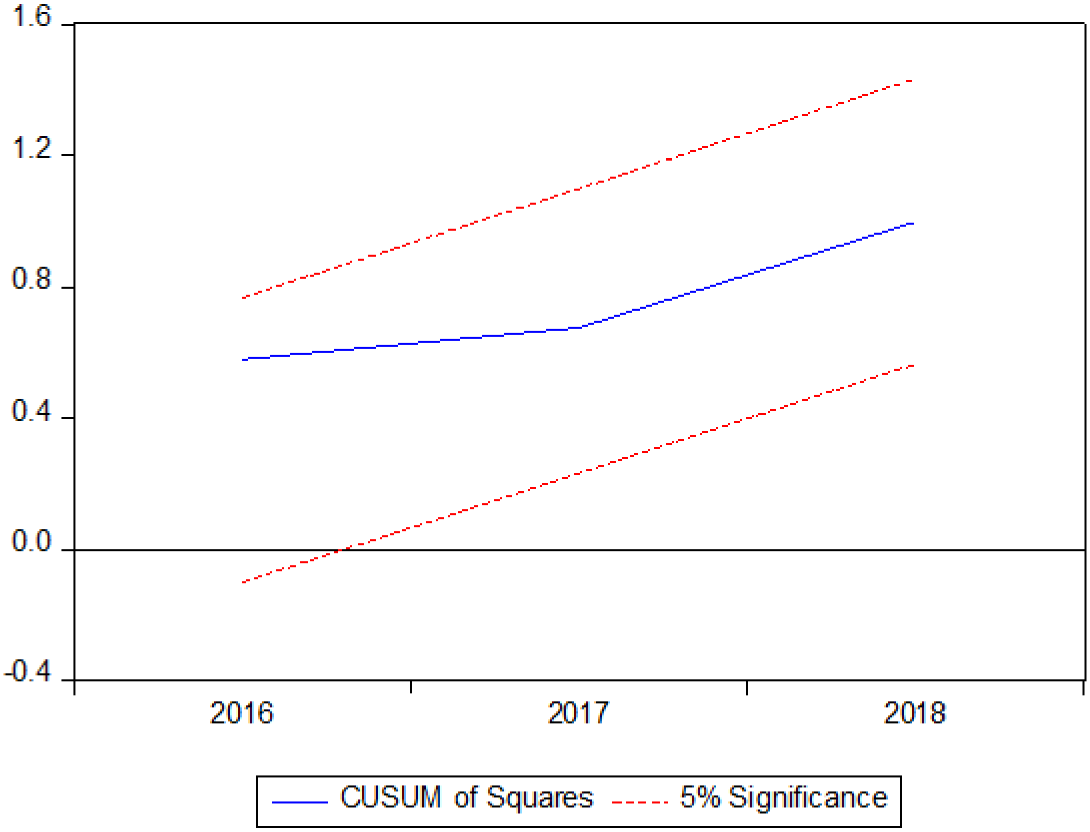
Plot # 5: Foreign Direct Investment



Plot # 6: CUSUM

Figure 6

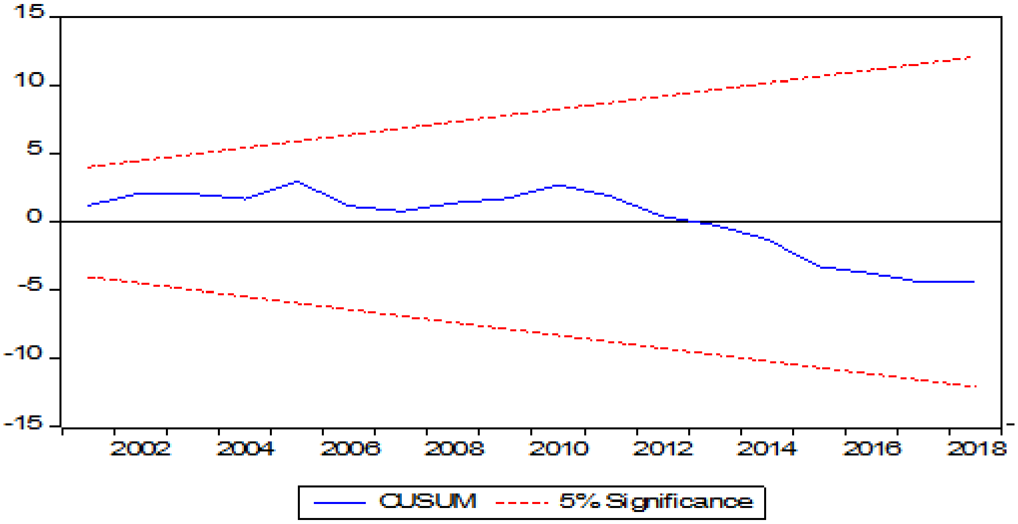
Plot # 6: CUSUM



Plot # 7: CUSUMQ

Figure 7

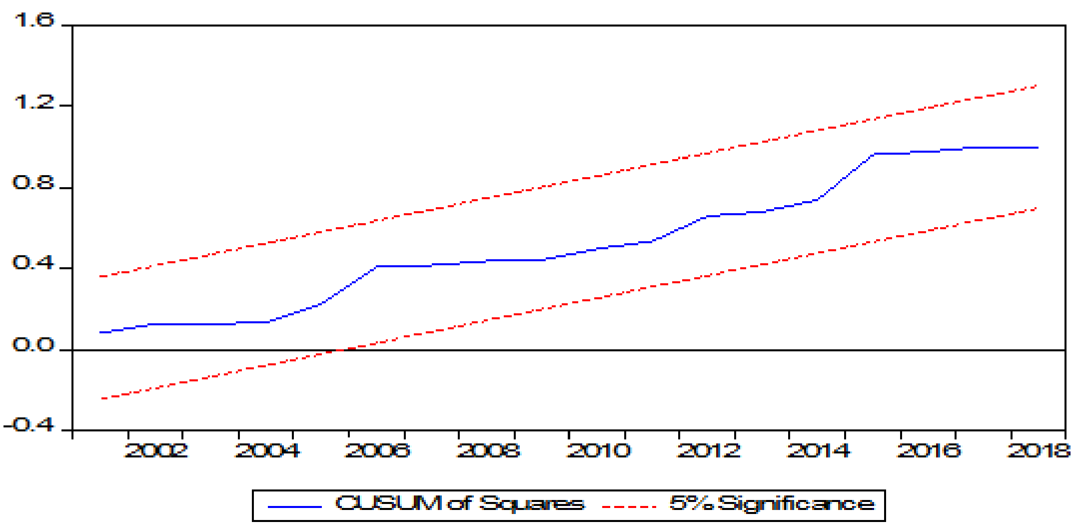
Plot # 7: CUSUMQ



Plot # 8: CUSUM (NARDL)

Figure 8

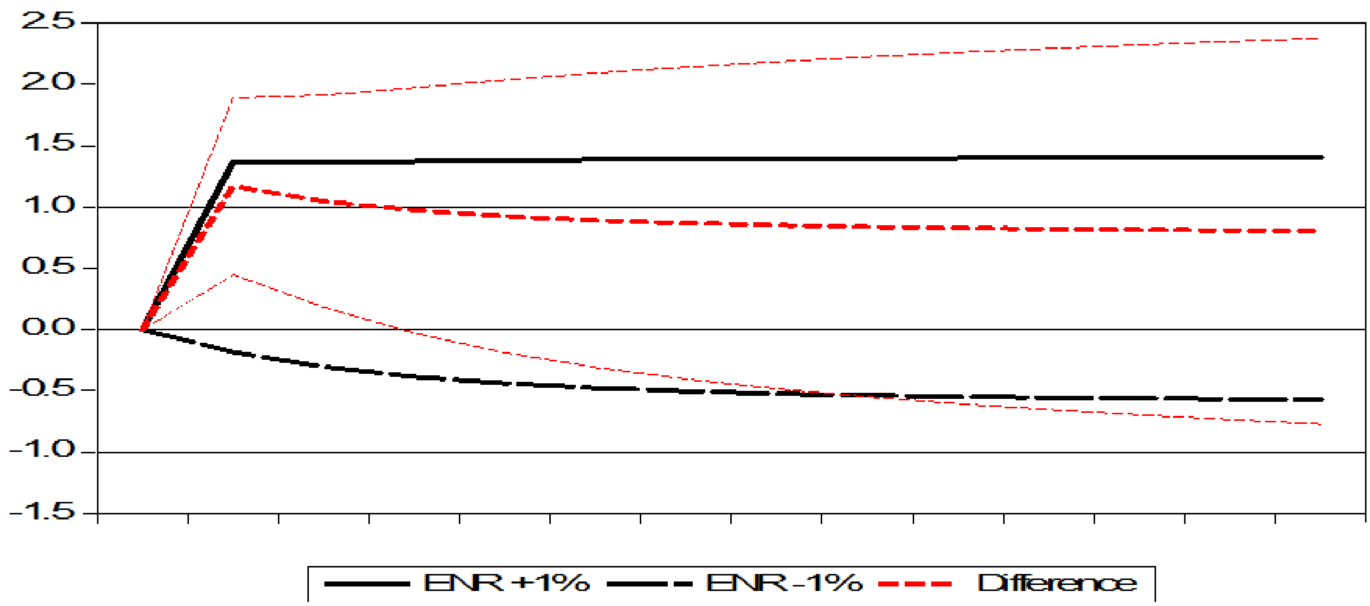
Plot # 8: CUSUM (NARDL)



Plot # 9: CUSUMQ (NARDL)

Figure 9

Plot # 9: CUSUMQ (NARDL)



Plot # 10: Cumulative effects of Energy Consumption on CO_2 Emissions.

Figure 10

Plot # 10: Cumulative effects of Energy Consumption on CO2 Emissions.