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Link of Energy Consumption, FDI, Urbanization and GDP with Carbon Emissions: A time series analysis of Pakistan

Dominance

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ABSTRACT

Pakistan is facing issues regarding environmental conditions in the region. In this research, see the long-term relationship of carbon emissions with foreign direct investment, trade openness, urbanization, and gross domestic product of Pakistan. Taking data of Pakistan from 1976-2018 from World Development Indicators. Now world is realized that environmental issues will be affecting the developing countries in the world. Most of the developing countries facing the problems which are causing due to environment. In this study, econometric techniques and methods were used for the empirical evidence. In this research work, the ARDL co-integration technique was used. Firstly, check the stationarity of the variables, then use co-integration, the error correction model, the bound test, the LM test for autocorrelation, the CUSUM square, and the CUSUM test for checking the stability of the model. Findings are showing that the long-run positive association of carbon emissions with FDI, GDP, EC, and UP. On the other side the long-run negative association of Carbon Emissions with trade openness. In the light of findings of results, we can say that more effective policy making and implantation of the policies regarding environment is fruitful for the country like Pakistan.

Keywords: EC, FDI, Urbanization, TO, GDP and Carbon Emissions.

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Introduction

The world has been dealing with the issue of global warming in recent years as a result of an increase in carbon emissions worldwide. Pakistan is the nation most impacted by global warming. Following the industrial revolution, using fossil fuels in industry and automobiles led to a sharp rise in greenhouse gas (GHG) emissions into the atmosphere. These gases have a long half-life and a high warming potential, which allows them to continue warming for decades or even centuries. The worldwide temperature rose by 0.76°C over the twentieth century, while Pakistan's temperature rose by 0.6°C in the first ten years of the century.

Human activity has a significant impact on the nearby environment, which frequently has disastrous consequences due to its negative repercussions and, on rare occasions, results in the total annihilation of the surrounding natural ecosystem. Climate change is one of today's most pressing global challenges, and it is primarily caused by the use of fossil fuels such as coal, oil, and natural gas. According to the Intergovernmental Panel on Climate Change (2007), this process increases greenhouse gas emissions, specifically CO2. Pakistan is a nation with extremely low environmental law and policy implementation. These are the reasons that rising energy consumption, global trade, population growth, urbanization, and CO2 emissions are disturbing the environment. major issues brought upon by the aforementioned elements. Less effective use of these resources is the cause of this. Although they are increasing, economic activity is not running smoothly. At the same time, economic and commercial activity is increasing wealth and revenue, but the national environment is bearing the burden of these developments. The goal of businesses and households is to become wealthier and earn more money. They don't consider environmental preservation or the negative effects of the sharp rise in economic activity on the environment. The primary causes of this situation are a lack of knowledge and an absence of rules and laws.

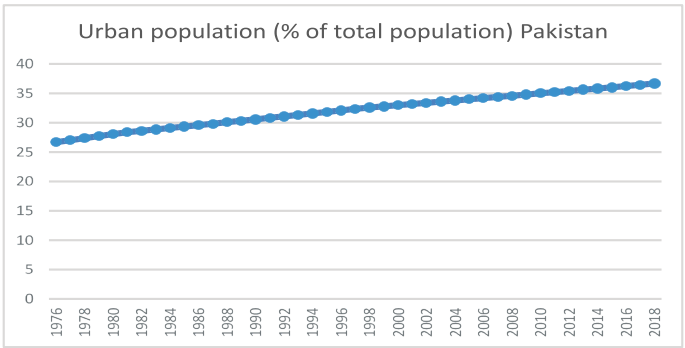
Urbanization is one of the fastest-moving societal

changes in the modern world. This phenomenon is brought about by the daily migration of significant numbers of people to cities who are motivated by a variety of social and economic reasons. In general, urbanization boosts income, productivity, and economic opportunities while also stimulating innovation, which alters the political, scientific, and artistic landscapes (Stewart and Lee 1986; Bloom et al. 2008; Glaeser 2011). Anyway, due to urbanization social problems make worse such as poverty, crime, marginalization, and environmental deterioration, as well as promotes disease transmission (Bloom et al. 2008).

Pakistan is the most urbanized country in South Asia. In the findings of Population Census of Pakistan 2023, population has increased with the growth rate 2.55% Annually. According to the facts and figures have given by PBS (Pakistan Bureau of Statistics), rural population is 61.18% of the total population and while urban population is 38.82%. Prediction of UN population division for Pakistan is that over half of the population will live in urban areas by 2025.

Positive Association of Economic Boom and Urbanization in mostly industrialized countries, where urban population is increase due to economic boom. According to the calculation cities generate more than 80% of global GDP. In the areas where population density is high in urban areas where more job and business opportunities and high per capita income. Economic Boom and technological enhancement have positively affected to the urbanization.

Figure 1: Urban Population of Pakistan



The following data illustrates the proportion of Pakistan's total population that resides in urban regions between 1976 and 2018. The trend shows a steady rise in urbanization, with the percentage of people living in cities growing from 26.681% in 1976 to 36.666% in 2018. This indicates a substantial shift in the country's lifestyle toward urban living over the years, with implications for social, economic, and infrastructure changes. Factors like industrialization, economic development, and migration from rural to urban areas are frequently correlated with urbanization. The growing urban population presents both opportunities and difficulties for governments to solve concerns with housing, jobs, infrastructure, and environmental sustainability. Comprehending and evaluating this urbanization trend might offer valuable perspectives on Pakistan's demographic patterns and contribute to the formulation of sustainable urban development plans for the future.

The nation is becoming more urbanized, which is leading to rural-to-urban migration. because of the national trend toward urbanization, which is brought about by rural-to-urban migration as a result of urban pull factors like job opportunities and other amenities. They are prepared for any kind of task, even when they are unaware of how dangerous it may be. That is among the causes of it. One of the main reasons for environmental disturbance in the country's rural areas is the lack of development in these areas.

Over half of the world's population lives in urban areas, according to a 2014 UN estimate, and by 2050, that number is expected to rise to 70%. 90% of the world's urban expansion in the continent of Africa and Asia expected, where the majority of this urbanization is anticipated to take place. Given that their combined urban population is expected to account for 37% of the global urban population by 2050, India, China, and Nigeria are well-positioned to lead this trend of urbanization. Notably, the World Bank calculated that 50.84% of Nigerians lived in urban areas in 2013. In academic debate, urbanization is increasingly acknowledged as a critical element influencing

emissions.

According to researchers like Hossain (2011), Sharma (2011), and Farhani et al. (2013), energy consumption, trade, income, and urbanization are some of the factors that affect emissions when they are considered an independent exogenous variable. The growing number of people living in cities tends to increase energy consumption, which in turn promotes economic growth and increases trade with other countries, both of which increase CO2 emissions.

The ecology will benefit if we work on free trade agreements (Werner Antweiler, 2001). (Liddle, 2001). However, the issue with free trade agreements is that they do not promote mutual benefit because the participating countries have divergent goals and motivations. We occasionally see that although free trade benefits the environment, it causes numerous issues for the nations involved. Trade has increased people's wealth levels in developing nations, giving them the power to demand stricter environmental protection laws. When businesses that create commodities with high levels of pollution are subject to stricter environmental regulations in emerging nations, they relocate to areas with lower environmental requirements. Regarding Pakistan's economy, the country's informal sector means that the government has no control over Environmental Regulations. As a result, many international businesses invest there because the country's environmental requirements are lax.

Main reason of mobility of capital is Legislation regarding environment. When country's environmental standards start to high, it causes mobility of the capital from high environment standard country to low environment standard country. One of the reasons behind FDI and capital mobility is tighter environment policies. This kind of investment we see in the world, many of developed countries import pollution intensive goods from the developing and under developing countries, and where they build plants and factories where environmental standards are very low. Another thing is that into the developing countries and under developed countries FDI ratio is increasing, in these countries investors production cost is low and they are easily to

increase the profit of him and other way they are causing to increase the economic activities in developing and under developed countries. This is because of economy of scale. Due to tighter environmental standards and environmental taxes his cost is to produce polluting intensive goods is increasing they are finding the destinations where environmental standards are very low, they are investing in which countries where environmental standards are low, FDI is initially helpful for developing and under developed countries to boost up the economy. In many countries we see that FDI play a vital role in to improving the macro-economic variables. In Bangladesh FDI brings boom into his economy, due to this increasing in employment opportunities and economic activities. FDI is used as a tool to boost up the economic activities and employment opportunities, but in beginning country may bear the environment cost. Due to FDI and capital mobility is affecting the international trade, because due to mobility of capital and FDI increasing towards developing and less developed countries, in which countries environmental standards are high, they are import the goods from the developing and under developed countries. Linkage of international trade and FDI is the real phenomena into all over the world is proven. When economy moves towards growth and they are able to adopts the advance technology and producing goods on advance level where they are achieved the economies of scale and they are producing goods on large scale Economic expansion affects quality of environment through three effects: scale effects, technology effects, and composition effects (Krueger, 1991). When economy is growing and developing, we see that structural changes come into the economy and economy is able to produce goods on large scales where their cost is to minimize and profit is to maximize. Then they are thinking about to prevent his environment from different types of pollutions and used the efficient production techniques in their production methods. Its recent example is that the use of solar energy system and fuel free transport vehicles. Relationship between CO2 emissions and growth is inverted U Shaped, in beginning of when economy is in initial stage CO2 emissions

increasing with decreasing rate, but when CO2 emissions in go to his peak and declining after it when income is increasing manners. According to Economic Survey of Pakistan 2017-2018 the use of energy by kinds is household, commercial, industrial and agriculture. Mostly consumption of energy by household which is 51% in 2018, commercial is 8%, industrial is 25% and agriculture is 10%. This is showing the contribution of household into CO2 emissions is more than the commercial and industrial sectors.

Objective of research is that to see the impact of FDI, Urbanization, GDP per capita and Trade openness ratio on CO2 emissions per capita in the context of Pakistan economy and Pakistan environmental conditions. Pakistan is one of effected countries by global warming. These independent variables mostly affect to the environment. To check these variables are causing to disturb the environment in real manners or not. In this research paper we are taken 43 years data which is show that linked between CO2 emissions per capita and energy consumption, FDI, GDP, Urbanization and Trade openness ratio of Pakistan. We are seeing in this research paper these variables (independent) are causing to increase in CO2 emissions or not, and there is a long run association among the variables exists or not.

Literature Review

In the finding through data in which 1% rise in GDP growth causing to increase carbon emissions by 0.84% and other side growth of 1% energy intensity causing emissions increased by 0.24%. According to the co-integrating vector findings adjusted for GDP growth, the coefficients of EI growth and CO2 emissions growth have a substantial and positive influence on the level of development of 0.3% and 1.2%, respectively. This demonstrates that Pakistan's economic development is dependent on energy consumption, and that CO2 emissions led to considerable and positive economic growth. The finding prove that the consumption of energy

is inefficient has a negative influence on environmental quality. Adopt energy efficient technology for both production and consumption. These methods would help the environment, boost long-term productivity, and save energy.

As income increases, individuals want to achieve advanced modern way of living and become more concerned with the environmental quality of their surroundings. This heightened create demand for a better environmental quality drives technological changes in the economy, which typically reduces environmental degradation. When talking about EKC, the most popular thing that is discussable is that the country goes toward adoption of modern living methods, and people are highly concerned regarding environmental amenities (Pezzey, 1989; Daqing, 1994; Baldwin, 1995). During the preliminary stages of economic growth, pollution grows faster than income, but as the economy continues to develop, pollution grows more slowly relative to GDP. Connection of economic development and environmental quality described systematically in EKC.

The inverted U connection receives its name from the work of Kuznets (1955). In H O theory describe about the specialization in developing countries in to the factor abundance products (which is may be labor intensive goods) and developed countries specialization into factor abundance (which is may be the capital abundance products) under free trade agreements which is effect by the international trade. If free trade is occurring into the world all countries produce about his specialization and trade with each other. Free trade agreements have a positive impact on the environment and strengthen the role of developing countries in producing labor-intensive goods and services globally (Grossman and Krueger, 1991; Bandyopadhyay, 1992; al, 1996); Chapman, 1998; Cole, 2003; Cole, 2004; Hooi Hooi Lean, 2010); Sharma, 2011; Hussain, 2012; Kohler, 2013; Kivyiro, 2014; and Baek, 2015). The work by Halicioglu (2009) was the first to empirically include the trade openness ratio variable into econometric calculations of the Environmental

Money supply and inflation

Kuznets Curve (EKC). When economies are developed and enter into the growing stage and his wealth is increasing, they are able to consume on Research and Development that the reason behind it developed countries is Capital abundant countries. They are discovered new innovations which is very beneficial for the society. International trade promotes the diffusion of clean technology (Martin, 1992); Reppelin-Hill, 1999).

(PANAYOTOU, 1997) Taking the facts and figures of 30 developed and developing homelands during the time period of 1982 to 1994 calculate a decomposition equation through these facts and figures. He is indicating that policies regarding income and environment linkages. If you break it down more specifically, like size, sectoral mix, and pollution intensity impacts. According to his findings indicating that effective laws and institutions have an important role to reduce pollution and carbon emissions at low-income levels, and this accelerates as wealth increases.

Researchers discover that many impoverished countries concentrate in polluting-intensive commodities, whereas rich countries specialize in anti-polluting goods that do not disrupt their consumption habits. Poor countries export damaging items, while wealthier countries import them (Saint Paul, 1994). In the factor endowment hypothesis, trade patterns are opted by a country, which is indicating the wealth condition of a country. Many countries have a specialty in both labor-intensive and capital-intensive products; on the other side, pollution-intensive goods production required significant capital investment (Antweiler et al., 2001; Cole and Elliott, 2003).

Another perspective on the import and export of harmful commodities, stringent environmental laws in industrialized nations, they levy large taxes on polluting intensive items because this businessman fly his capital in countries where environmental standards are low (Adam B Jaffe, 1995); Mani and Wheeler,1998). When we look at industrialized countries, we observe that the government encourages the production of less polluting

items by investing in research and development projects. As a result, they have developed new ideas and strategies to improve the country's output while reducing economic pollution levels. The policymakers created policies to protect their ecology and climate. That is why, in industrialized countries, the sickness ratio attributable to pollution is decreasing.

International trade facilities the spread of clean technology (Martin and Wheeler, 1992; (Reppelin-Hill, 1999). Environmental institutions are crucial for protecting the environment by implementing effective policies. Numerous studies have examined the relationship between total energy consumption and environmental quality. For example, Matthew Cole (1997) and Suri and Chapman (1998) found that energy consumption tends to be lower in developed countries compared to less developed countries. Urbanization is another element that contributes to higher energy use. This is caused by inefficient energy utilization. Urbanization causes demographic changes in the country. Urbanization is attracting people to migrate from rural to urban areas for jobs, work, and other services like education and health facilities. They are more commonly eaten in metropolitan areas due to the increased demand for energy-intensive commodities. For example, in recognition of the relevance of urbanization to socioeconomic growth, the Chinese government changed urbanization policy during the economic reform era, significantly increasing urbanization (Neill, 2004).

Another difference between established and developing economies is that both have formal economies. ACT (2001) analyses three possibilities in their research. If country have a weak regulation regarding environment where free trade increase carbon emissions if country have a competitive advantage in production of pollution intensive goods. The formal economy allows the government to quickly identify who produces harmful commodities. Who produces harmful items if government policy is to reduce pollution? It may be levying large charges on damaging products production. According to Susmita Dasgupta (2002), environmental regulation and enforcement rise with income, with the greatest increases

occurring at low to middle income levels. Increased regulations are expected as returns fall. When formal controls are insufficient, polluting-intensive commodities are produced through alternate routes, such as local manufacturers. The ensuing pollution equilibrium reflects the community and plant's respective bargaining power (Wheeler, 1996).

Another problem is the Race to Bottom between the economies, the relocation of investment and manufacturing practices from developed countries to less developed countries will place their environmental requirements high. To maintain their growth and development they are sacrifice the investment. Due to these developing countries have a chance to develop his structure and patterns of production through adopting new techniques of production.

Lopez (11994) employs a general theoretical framework to demonstrate that if producers bear the social marginal cost of pollution, what is the link between CO2 emissions and per capita income? It is determined by the sort of technology employed, as well as societal interests and tastes. Lopez's model included the terms "homothetic" and "non-homothetic." The term "homothetic" refers to a function of two or more variables in which the ratio of the partial derivatives is determined solely by the ratio of the variables, not their value, and the ratio of commodities sought by the ratio of their prices.

If nations preferences are homothetic means that they demanding the goods which is causing to increase in the pollution, peoples are spending on pollution intensive goods and if preferences of peoples are non-homothetic it means that they are spending on less polluting intensive goods and their income is rising and they have wanted a better environment.

Theoretical Framework and Model Specification

Firstly, when we are talking about the theoretical frame work and background of trade and environment relationship we are first describing the EKC theory. In 1955 (Kuznets, 1955) find the relationship between Environmental degradation and per capita income, he finds that when economy is in its initial way environmental degradation increasing time by time but at a time when economy is goes on a peak, when income level is high of this country environmental degradation starts to declining. EKC present inverted U-shaped Environmental Kuznets Curve. Kuznets proved that relationship between CO2 emissions and level of income of country's residents. In many other cases mostly in the developed countries cases EKC results are proved. But when we are talking about developing and under developed country's (because they are in an initial developed stages of economy) CO2 emissions are high because in these countries people's per capita income is low that why in these countries CO2 emissions is high in respect to developed countries where peoples per capita income is high if we compare it to developing and under developed countries. There are many reasons behind the low per capita income. Mostly low per capita income country's economies are the agricultural economies. In these countries peoples living standards and other social services are very poor. Literacy rate, poverty, health facilities and other social indicators not present good picture of these countries. When we talk about human development, they have less developed and many people mostly work in the agriculture sector. Another quality of these countries, they are labor surplus country's population of these country's is increasing with a high ratio if we are relating it to the developed country's rate of increase in population. Theoretically is proved EKC relationship between co2 emissions and per capita income.

Another variable we are taking in the model is energy consumption. Energy consumptions per capita are high in developing and under developed countries. Due to inefficient allocation of resources in these countries CO2

emissions is increasing. Positive relationship find in the developing countries between CO2 emissions and energy consumptions is proved theoretically.

Most rising and underdeveloped countries rely heavily on coal and oil to generate their energy. Which is the most harmful to the environment and generates pollution. That is only due to wasteful use of technology, whereas wealthier countries find innovative ways to produce energy. For example, using solar or wind energy. That is an efficient use of resources. If measure energy efficiency sees towards the technology used in the economy. If technology is efficient in the economy means that less energy (Baek and J., 2015). These findings were expected to have positive coefficients as CO2 emissions increased. This means that energy usage is dependent on efficient technology. If efficient technology is employed to make items, they may be ecologically friendly; otherwise, they are not. When living conditions improve, people tend to use more energy-efficient goods. People in industrialized countries have a high quality of living. The people. The reason for this is the effective utilization of energy-consuming products. After all of the discussions I've had thus far, energy has always been related with the country's growth. If we lower our energy usage, it will naturally decline, harming economic growth. So, in an expanding economy, energy is a must. Investigate novel energy sources that are more efficient than previously available ones. Any mature economy does not arrive directly at its peak point. They must move beyond the economy's development stage. When a point enters the economy, it is directed towards more efficient sources of energy, which is more beneficial to the economy. To keep an economy on track, renewable energy exploration should be prioritized because It can decrease dependency on foreign energy sources to satisfy domestic energy demands, promote energy efficiency, avoid energy crises, and improve environmental quality (Tzeremes, 2013). Only energy efficiency come into the producing goods and services not sufficient it will come into the household and transportation. After this we can say the efficient use of energy is in the economy. Strong legislation must on this and describe the level and standards for the minimum

level of efficiency.

Foreign Direct Investment is using as a tool to attract the foreign investors into the country. Mostly developing countries to attracting the foreign investors they are lowering his environmental standards and give them all facilities and tax relaxations. Investor producing pollution intensive goods in developing countries and exports these goods to developed countries where environmental laws are very strong. After gives relaxation in environmental laws countries is not able to higher their environmental standards due to fear of capital outflow. Countries engage in a "race to the bottom" when it comes to environmental norms in order to attract or retain money. In the words of Daly (1993), "unrestricted trade imposes lower standards". At a time when attract foreign investors, local industry has demanded to low environmental standards for their production, and they are competing with their international competitors in the international markets. These situations are causing the failures of the institutions in countries with low standards (Neumayer, 2000). FDI have a positive relation with CO2 emissions per capita. Because increasing in pollution in developing countries is one the reason is FDI. If we can say this, FDI is not good for the environment if it is based on lowering environmental standards. It is true that pollution in developing countries is more than the developed countries its main reason of manufacturing of pollution intensive output. Developing countries have a comparative advantage in a dirty industry so that's why FDI is come in to these countries, production of pollution intensive goods at a low cost due to not tax imposition and less environmental institutions approaches to the producer of it. Due to FDI transferred low carbon technology, equipment and production processes to the host country to help its development of low carbon economy. According to Acharyya (2009), Javorcik (2002), and Jørgensen (2007), foreign direct investment (FDI) can dramatically increase the host country's carbon footprint. (Romer) (1999) discovered that financial development draws foreign direct investment, and that as it grows, improved research and development

improves environmental circumstances. When a country reaches a certain degree of development, its economy naturally begins to grow, and at this point, the country is able to make effective use of energy-consuming commodities and produce energy-efficient things. At times, FDI has a good impact on the environment. A link is discovered between CO2 emissions, efficiency, and scale effects.

Through the free trade agreements carbon emissions will boost in which countries where weak rules & regulations regarding environment, in this situation developed countries take benefit for this situation. The association of carbon emissions and trade differs by country (positive in some, negative in others), depending on economic growth. Grossman and Krueger (1995) discovered that industrialized countries buy fewer products which have polluted goods and export pollution-intensive goods to countries with less rigorous environmental regulations. It may have a negative impact in some underdeveloped and developed countries. Because industrialized countries' dirty industries manufacture polluting-intensive commodities in poor nations, in developing countries, trade openness has a generally favorable association with CO2 emissions. Chaka Borty and Mukherjee (2013) discovered that trade openness harms the environment and increases CO2 emissions. Many other research, particularly those focusing on emerging economies, have established a positive association between trade openness and CO2 emissions. Another intriguing fact is that trade openness is linked to the effect of economies of scale. Developing countries have a comparative advantage in polluting intensive goods because of the positive association between Carbon Emissions and Trade. Technological advancement improves the trade openness ratio, and as a result, companies acquire new technology to cut production costs. Urbanization linkage with CO2 emissions is positive. CO2 emissions increase due to urbanization. Mostly energy consumption is in urban areas is high relatively rural areas. When we are discussing Pakistan, there is 40% approximately population is live in the urban areas and 60% approximately population is live in the rural areas. Mostly consumption of energy in urban areas is greater

improves environmental circumstances. When a country

$$CO2_t = \beta_1 + \beta_2 EC_t + \beta_3 FDI_t + \beta_4 GDP_t + \beta_5 UP_t + \beta_6 TO_t + \varepsilon_t \ldots\ldots\ldots Eq(1)$$

CO2t = CO2 emissions per capita
EC = Energy Consumption
FDI = Foreign Direct Investment
GDP = Gross Domestic Product
UP = Urban Population Percentage
TO = Trade Openness Ratio

In this model we are using CO2 per capita is as Dependent variable and Energy used per capita, Foreign Direct Investment, GDP current US dollar, Urbanization Population actual and Trade Openness Ratio. To investigate the how these independent variables are affecting the Environment.

Econometric Methodology

We are using time series data into this model. Taken data from WDI and SBP from 1976-2018. There is a trend into the variables and variables are holding the non-stationary series. Using the unit root test to check stationary and the ADF test to check series is stationary or not (Granger, 1987), non-stationary time series are defined as integrated of order d if they become stationary after being differentiated d times. The ADF test follows the same approach as the Dickey Fuller Test, but applies to Fuller's (1976) model with constant β1 and temporal trend coefficient β2.

$$\Delta Yt = \beta 1 + \beta 2t + \delta Yt\text{-}1 + \alpha i \; \Sigma \; \Delta Yt\text{-}i + \varepsilon t \quad \text{----------(ii)}$$

ADF test is providing results about series are stationary on which level. εt is error term in this model of ADF test δ is equal to zero in this test. Fuller (1976) showed a cumulative distribution of ADF statistics. If the estimated t ratio of the coefficient δ is smaller than the critical value from Fuller's table, Yt is deemed stationary. It is an empirical reality that many major macroeconomic variables appear to be integrated of order (d) or I (d) in Engle and Granger's (1987) terminology, implying that their combination will be I (d). If series is stationary at level, we write in this way I (0), if series is stationary at first difference I (1), if series is stationary at second difference, we assumed that I (2) and so on.

ARDL Bound Test

M.H. Pesaran and Y. Shin introduced the ARDL bound test, a novel method for detecting cointegration (Pesaran et al. 2001) (Pesaran, 2012). The ARDL bound test was utilized in this study instead of Engle and Granger's (1987) and Johansen and Juselius's (2010) co-integration tests due to its multiple advantages. The ARDL test is more reliable for small data sets than typical co-integration tests, which are only applicable to large sample sizes. The ARDL technique is more adaptable than standard tests, which require all variables to be in the same order of cointegration. It can be performed with variables in either I (0) or I (1) order, broadening its reach. The ARDL model determines the error-correcting model's dynamic using linear transformation. The error correction model confirms the causal link between variables (Granger, 1988). Individual lagged-term coefficients can be used to compute short-term dynamics, but the Error Correction Term (ECT) contains long-term dynamics. The lagged explanatory variable's significance level indicates short-run causality, whereas ECT significance and negative value imply long-run causality. In this research work see the association of variables which is describe in the model and used ARDL technique to find the relationship among the variables.

$$\Delta CO2 = \beta 1 + \beta 2 \sum_{(i=I)}^{D} \Delta CO2t + \beta 3 \sum_{(i=0)}^{I1} \Delta TO + \beta 4 \sum_{(i=0)}^{I1} \Delta UP + \beta 5 \sum_{(i=0)}^{I1} \Delta FDI + \beta 6 \sum_{(i=0)}^{I2} \Delta GDP + \beta 7 \sum_{(i=0)}^{I2} \Delta EC + \lambda 1 \Delta CO2t\text{-}1 + \lambda 2 \Delta ECt\text{-}1 + \lambda 3 \Delta GDPt\text{-}1 + \lambda 4 \Delta FDIt\text{-}1 + \lambda 5 \Delta UPt\text{-}1 + \lambda 6 \Delta TOt \quad \text{eq (iii)}$$

The Unrestricted Error Correction Model for the ARDL test is shown in the preceding equation. CO2 emissions, trade openness, urban population, foreign direct investment, gross domestic product, and energy consumption are indicated by the variables ΔCO2, ΔTO, ΔUP, ΔFDI, ΔGDP, and ΔEC. The symbols β1, β2, β3, and β 4 stand for short-term dynamics, while λ1, λ2, λ3, and λ4 stand for long-term dynamics. The symbols d and I represent the corresponding lag times. Co-integration was examined using the F-statistic in the bound test. H0, which states that there is no co-integration, is the null hypothesis. H1 is the alternative hypothesis for co-integration and reads as

follows: λ1 6¼ λ2 6¼ λ3 6¼ λ4 6¼ λ5 6¼ λ6 6¼ 0. If the bound test F-statistic value is less than the lower bound, we can accept the null hypothesis that there is no cointegration. If the F-statistics value exceeds the upper bound, we may validate co-integration between model variables, implying long-run equilibrium and rejecting the null hypothesis of no co-integration. If the F-value falls between the lower and upper bounds, the model has no co-integration.

Error Correction Model

The error correction model verifies that the variables are causally related (Granger, 1988). While long-term dynamics are contained in the Error Correction Term (ECT), short-term dynamics can be calculated utilizing the individual coefficients of lag-terms. Short-run causality is indicated by the significant level of the lagged explanatory variable, but long-run causality is indicated by the ECT significance and negative value.

ΔCO2= β0+ ∑_I^D▒€i ΔCO2t-1+ ∑_f^E▒£f ΔTOt-f+ ∑_h^G▒Ωh ΔUPt-h+ ∑_k^J▒πk ΔFDIt-k+ ∑_n^M▒¥n ΔGDPt-n+ ∑_p^O▒λp ΔECt-p+ δecmt-1+ €t….eq(iv)

After establishing the long-run equilibrium, the short- and long-term elasticity were examined using the ARDL Cointegration Equation and the error correction model.

To forecast the effect of experimental factors on Pakistan's carbon dioxide emissions, we employ the Equation of ARDL Cointegration. The speed at which corrections are made towards long-run equilibrium is indicated by δ ecm in the error correction model. This implies that the system will eventually return to equilibrium if it deviates from equilibrium in one direction.

A test for autocorrelation in regression model mistakes is the Breusch–Godfrey test. A test statistic is obtained from the residuals from the model under consideration in a regression study. There is no serial correlation of any order up to p, according to the null hypothesis. Use the LM test for serial correlation in this model to verify serial correlation.

We have applied Cumulative Sum of Recursive Residua (CUSUM) and Cumulative Sum of Recursive Residua of Squares (CUSUM of Squares) (R. L. Brown, 1975) Tests.

Data Sources

Using World Development Indicators' time series data from 1976-2018, we can calculate CO2 emissions per capita, foreign direct investment inflows in current US dollars, trade openness ratio, GDP per capita, urban population percentage (percentage of total population), and energy consumption in Pakistan.

Empirical Analysis

The preliminary stage in our study is to determine the degree of integration of each variable. We used the well-known augmented Dickey-Fuller test (ADF) to determine if there was a unit root in the level and first difference of each variable in our sample. ADF test statistics examine the stationary of the series. The result presented in property is found in the first difference of the variables. Showing results below that our series is non stationary at level, first difference and second difference of all variables.

Table 1

Variables	Level (Constant) (P Value)	Level (Constant and trend) (P Value)	First Difference (Constant)	First Difference (Constant & Trend)
CO_{2t}	.2735	.9842	.000	.000
EC	.1354	.9999	.0005	.0002
GDP	1	.9999	.0032	.0000
FDI	.1676	.3660	.0015	.0086
TO	.8650	.7978	.0001	.0006
UP	.9999	.9975	.1056	.0353

When series is non stationary of all variables on different level, we use ARDL technique. Basically, through the ARDL bound test to check long run relationship among the variables. F value is showing that the long run relationship is existing among the variables.

Table 2

F-Bounds Test	Null Hypothesis: No levels relationship
	Asymptotic: n=1000

Table 3

Test Statistics	Value	Significance	I(0)	I(1)
F-statistics	7.465704	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

The upper critical bound values of 3 at 10%, 3.38 at 5%, 3.73 at 2.5%, and 4.15 at 1% level of significance are all bigger than the F-statistics value of 7.465704. These numbers demonstrate that the variables have a long-term relationship.

Table Long Run Coefficients.

Table 4

Variable	Coefficient	SE	t-statistics
EC	0.002161	0.000384	5.628994
GDP	4.350001	2.480013	1.755086
FDI	1.200011	4.760012	2.519387
UP	0.006377	0.012988	0.490996
TO	-1.950012	2.620012	-0.741735

The table long rung coefficients report the long run outcomes. Energy use in Pakistan has a substantial and positive link with carbon emissions, as does urban population in this model. On the other hand, GDP and FDI have a positive and insignificant link with carbon emissions, whereas TO has a negative and insignificant influence.

Table Short Run Coefficients.

Table 5

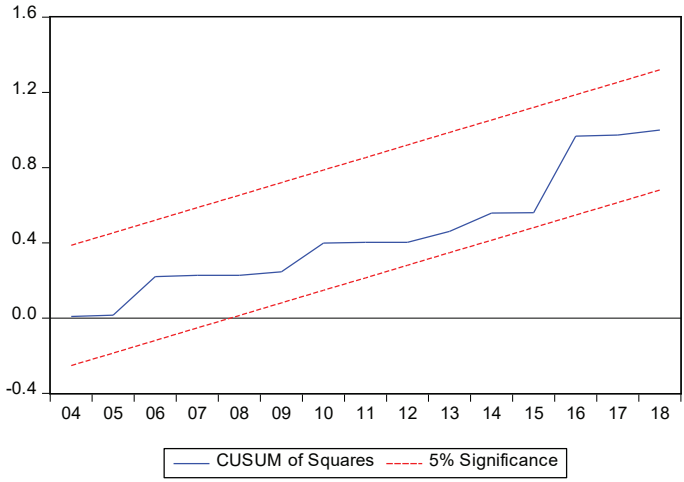
Variable	Coefficient	SE	t-statistics
EC	0.002001	0.000254	7.872215
GDP	1.080013	2.450013	0.439153
FDI	4.580012	2.980012	1.533217
UP	0.197234	0.055193	3.573553
TO	1.200012	1.750012	-0.683519

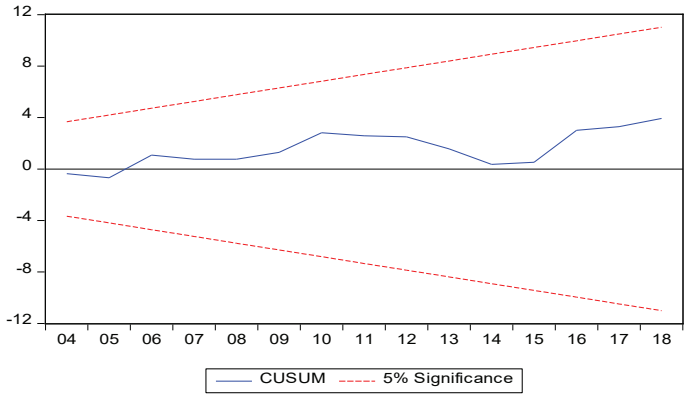
Table 6

F stat.	Prob F (2,13)
0.145910	0.8656
Obs *R-squared	Prob. Chi Square
0.856239	0.6517

The stability of our model is critical to the effectiveness of the policy. The stability test determines whether or not commerce has an influence on the environment across the time period covered by the study's sample. Stability of the model is proved through the CUSUM and CUSUM of Square test, which is describe below through the figures. The blue lines are inside critical boundaries and statistically significant at 5%, showing that the model is extremely stable across the data period.

Figure 2 and 3





Conclusions and Policy Implications

The world has changed rapidly in the previous 50 years. This indicates that if we do not organize our aims and objectives with these obstacles, the upcoming time will be extremely perilous for our country. Firstly, we are discussing on global warming. Pakistan is the country who are very effected from the global warming but there is CO2 emissions is less with respect to developed countries like China and other countries. Another thing is that with respect to CO2 emissions Greenhouse gases. Greenhouse gases is the creation mostly co2 emissions in the world who is affected the atmosphere through radiation and it is main cause of global warming. So, government makes policies regarding CO2 emissions to preserve the climate and atmosphere of the country. If we are not thinking about environment today, in future the problems will increase more and more and it's on day by day. Due to this Pakistan agriculture is most affected because we are as an Agriculture economy, it is based on 80% on natural rain system, if global warming increased it is affected the natural rain system firstly and increasing the temperature of the country. Promote plantation around the country and investing in to increase plantation in all over the country. Because plants and trees is preventing from global warming. Provide awareness to the nation and banned on cutting plant and trees, determine punishment on it. Another variable is Energy consumption is affecting the environment due to

inefficient allocation of resources. If we are seeing towards developed country's they have efficient use of energy consumption. In the context of Pakistan, government of Pakistan should be making policies regarding efficient allocation of resources in energy consuming goods. It is many benefits for the nation. Due to this we are able to produce low-cost energy, due to low-cost energy production increasing and GDP is increasing. When we see EKC hypothesis firstly CO2 emission increasing but when economy is in the condition of efficient allocation of resources, CO2 automatically decline, due to EKC curve is inverted U shaped. When we are talking about efficient allocations of resources, government should be a power to implementation on it and politically showing maturity to rectify this problem. Bring all political parties on board and show his seriousness. Solar energy and wind energy is more effective, in this regard only government invest in these plants and establishing plants, which is producing efficient energy. Provide facilities to investors who are investing in this manner. If government is in succeed to increasing investing opportunities, our energy shortage problem will be solved. Efficient energy and CO2 emissions have negative relation.

Government is established institutions regarding making policies about Environmental. Issues and strict laws and rules regarding disturbed the environment, if we are talking about Pakistan first time in `1997 legislation about environment protection. There is need of proper legislation on environmental policy and apply these policies in a good manner. Implementation is the issue of these policies, because if implementation of these policies in the country legislation is useless. Our economy spends more than Rs. 365 billion per year on environmental degradation which is not a good sign for the economy and for the resident of the nation. Other environmentalists say that the cost of environmental destruction must exceed Rs. 450 billion.

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