Do Sectoral Growth Promote CO$_2$ Emissions in Pakistan? Time Series Analysis in Presence of Structural Break

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ABSTRACT

This study has examined the impact of sectoral growth on CO$_2$ emissions in the case of Pakistan from 1970 to 2019. ADF and PP unit root tests have been applied to check the stationarity of the data series, whereas the Zivot-Andrew structural break unit root test has been applied to check the existence of structural break. The results of the unit root test show there is mixed order of integration among the selected variables, Zivot-Andrew unit root test also highlights the point of a structural break in the data series. The autoregressive distributed lag model has been applied for checking the cointegration among the variables of the model. The results show that industrial growth, population density, and time trend are positively and significantly contributing to CO$_2$ emissions in Pakistan. Whereas services sector growth is responsible for reducing CO$_2$ emissions in Pakistan. The results show that agricultural growth and globalization are reducing CO$_2$ emissions but this relationship is insignificant over the selected time. In the short-run industrial growth, agricultural growth, and service sector growth are reducing the level of CO$_2$ emissions in Pakistan. Likewise, long run, trend time is promoting CO$_2$ emissions in the short run in Pakistan. The government of Pakistan can control CO$_2$ emissions by improvement in industrial production methods, reducing population density, and promoting services sector growth. There must be some dynamic policies are required to control the time trend impact on CO$_2$ emission in Pakistan.

Keywords: CO$_2$ Emissions, Agriculture Growth, Industrial Growth
JEL Classifications: N5, O14, Q01

1. INTRODUCTION

Presently, climate changes and global warming have become a critical issue of discussion among policymakers, social scientists, and economists. The rising level of CO$_2$ emissions and other greenhouse gases are becoming the main inputs of global warming (Rao and Riahi, 2006; Mongelli et al., 2006). The patterns of world energy production and consumption have become major causes of rising CO$_2$ emissions in general and global environmental degradation in specific (Kaika and Zervas, 2013; Balsalobre-Lorente et al., 2018). This change in the environment has significant impacts on human health, wildlife viability, and the smooth functioning of ecosystems. It is a known

fact that economic growth is very necessary for the survival of a country and for attaining the desired level of economic growth, there must be sufficient agriculture and industrialization. Either infant or improved industrialization, there is a specific amount of greenhouse gases are attached to it (Nanda et al., 2016; Stephenson et al., 2010). Considering environmental quality as a basic necessity of human beings, United Nations took serious steps to control the greenhouse gases by introducing binding agreements such as Kyoto Protocol (1997). The Kyoto Protocol forces developing and developed countries to produce a specific amount of greenhouse gases for their targeted level of economic growth. Thus, there must be a reasonable trade-off between greenhouse gasses and economic growth (Tan et al., 2014; Malerba, 2020).

Previously, Millennium Development Goals (MDG's) and recent Sustainable Development Goals (SDG's) of UNDP are trying to force countries to reduce those energy consumptions which are producing enough amount of CO$_2$-emissions and other greenhouse gases to meet their international commitments under the umbrella of the UN. Especially there is greater pressure on China to reduce its domestic CO$_2$ emissions (Xiao et al., 2017). During the last two decades, there is a substantial increase in economic growth, energy consumption, and CO$_2$ emissions is witnessed in China (Wang et al., 2016). The modern world is now divided into different blocks and globalization has the potential impact on the socio-economic well-being of the nations (Gehring, 2013). In these blocks, developed countries favor higher economic growth with less environmental degradation, whereas developing countries prefer economic growth at any cost (Suri and Chapman, 1998; Todaro, 2006). Frankel and Rose (2002) point out that CO$_2$ emissions and their analytical approach have a great deal of international political concern. It is very important to know that CO$_2$ emission is a global externality. The national regulations of developing nations do not favor reducing CO$_2$ emissions (Annunziata et al., 2013; Haggard, 1995; Martínez-Zarzoso and Maruotti, 2011).

Three decades back, Grossman and Krueger (1991) have started the debate of environmental pollution and economic growth. Soon after, investigating the effect of economic growth on environmental quality has become a policy debate all around the world (Shafik and Bandyopadhyay, 1992). Economic growth may have a positive or negative relationship with environmental quality in various aspects (Grossman and Krueger, 1991; McConnell, 1997). The issue of environmental conditions is still unsolved because those parties how to have different points of view about business, unemployment, and international market conditions (Thomas and Tow, 2002). A clean environment is a common benefit to all humans, so a large number of theoretical and empirical research has been conducted on this subject. Grossman and Krueger (1996) have tested the role of economic growth for environmental standards, latter it is known as the environmental Kuznets curve. Selden and Song (1994) point out that in the beginning phases of economic growth a rise in economic growth is associated with rising environmental degradation but after a threshold level the rising economic growth discourages environmental degradation. Many other researchers argue that growth may be helpful for better environmental conditions. If environmental conditions are normal, then an increase in income increases the demand for better environmental conditions. This process forces the governments to increase investment in reducing environmental degradation (Warner et al., 2010).

Pakistan is one of the main important South Asian countries, which is mainly recognized to be an agriculture country, but it has a vulnerable environmental zone with some negative effects of climate change concerned with public health (Malik et al., 2012). Climate change is considered to be a result of air pollution which is increasing day by day in this part of the world (Ramanathan and Feng, 2009). Pakistan is facing many challenges i.e. including a higher rate of population growth, the inefficiency of water availability, soil-degradation, and animal-based diet with climate change (Lal, 2013). According to German Watch, Pakistan has

been ranked in the top ten of the countries most affected by climate change in the past 20 years. The reasons behind this include the impact of back-to-back floods since 2010, the worst drought episode (1998-2002) as well as more recent droughts in Tharparkar and Cholistan, the intense heatwave in Karachi (in Southern Pakistan generally) in July 2015, severe windstorms in Islamabad in June 2016, increased cyclonic activity and increased incidences of landslides and Glacial Lake Outburst Floods (GLOFs) in the northern parts of the country. In line with the commitment to the Paris Agreement under Article 6 facility, Pakistan intends to establish a robust and cohesive carbon market. The carbon market can generate fiscal resources and green jobs to support sustainable recovery from economic regression in the medium term. Ministry of Climate Change with the support of the World Bank conducted Blue Carbon rapid assessment for Pakistan to Figure 1 out how and where to act to protect and bolster blue carbon opportunities. Accordingly, Pakistan envisions gaining value from blue carbon in a plethora of ways that can be beneficial for the climate and the ocean. The assessment concluded that in total, mangrove forests and mapped tidal marshes store approximately 21 million tonnes of organic carbon (Corg)or 76.4 million tonnes CO2e. It is estimated that the Sindh government's Indus Delta Mangroves REDD+ Project, which is being conducted on 350,000 ha, will remove 25 million CO2e by 2030 and 150 million by 2075.

2. LITERATURE REVIEW

Many theoretical and empirical studies examine the relationship between CO$_2$ emissions and economic growth. Here some important has been selected as a review of the literature. Empirical and theoretical literature approve that CO$_2$ emissions are considered one of the main causes of global warming (Cherubini et al., 2011; Beckerman, 1992; Panayotou, 1993; Holtz-Eakin and Selden, 1995; Stern et al., 1996; Carson et al., 1997; Moomaw and Unruh, 1997; McConnell, 1997; Agras and Chapman, 1999; Magnani, 2001; Dijkgraaf and Vollebergh, 2005; Vollebergh and Kemfert, 2005; Richmond and Kaufmann, 2006; Ang, 2007; Apergis and Payne, 2009; Tiwari et al., 2013). The debate over economic growth and negative environmental effects was first started by Grossman and Krueger (1995). Further, Brock and Taylor (2010) mention that the relationship between environmental degradation and economic growth depends on three factors i.e., production technology, production composition, and production volume. Since every country is trying to achieve higher economic growth, thus there is a chance of higher environmental degradation. This inverse relationship becomes more prominent when the economy largely depends on the agricultural sector and the industrial sector is in infant conditions.

Lee and Roland-Holst (1994) conduct a comparative analysis of dirty industries and environmental risk in the case of developing countries. The empirical results show that a uni-directional relationship has existed from trade liberalization to environmental degradation. The tradeoff between the environment and industrialization shows the comparative cost of pollution. The results highlight the uniform effluent tax that is the important cost effecting tool to control SO2 (Sulphur Dioxide) emissions. The basic instrument like uniform tax resulting from a decrease

Figure 1: Relative Stock of Blue Carbon
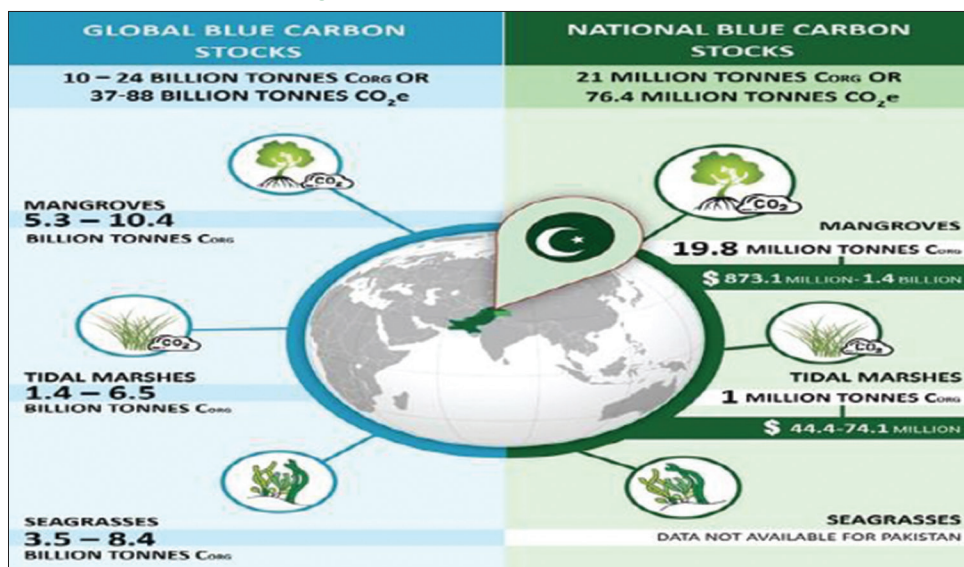
Source: Government of Pakistan, 2021: Economic Survey of Pakistan

in real GDP that is greater than the achieving target significantly using a uniform effluent tax.

Grossman and Krueger (1995) demonstrate the relationship between economic growth and the environment. This study has tested the reduced-form relationship between income per capita and environmental emissions for 1989 to 1990. The main contribution of the present paper is that it employs reliable data and a common methodology to investigate the relationship between the scale of economic activity and environmental quality for a broad set of environmental indicators. Finally, it should be reflected the technological, political, and economic conditions that existed at the time. The low-income countries of today have a unique opportunity to learn from this history and thereby avoid some of the mistakes of earlier growth experiences. With the increased awareness of environmental hazards and the development in recent years of new technologies that are cleaner than ever before, the low-income countries turn their attention to the preservation of the environment at earlier stages of development than has previously been the case.

Copeland and Taylor (1997) examine the effect of trade liberalization on the environment. This study analyzes that if the capital-abundant country trade with the labor-abundant country then free trade reduces the pollution of the world. Trade displaces the production of pollution-intensive industries to the capital-abundant country dislike its strict pollution rules. The study shows that the pollution level grows in the North and falls in the South. The result shows the reversing trend if the North-South gap in income is too larger for, then in this regard, the structure of trade is determined by the income-induced policy changes across different countries. It reveals that world pollution is dependent on the structure of the trade. The study examines that pollution is derived by the demand and supply analyses. The supply of the pollution is derived by the policy of the Government and the pollution demand is derived by the behavior of the producers and consumers. The results of the study reveal that free trade and capital mobility must lead to unchanged world pollution from its autarky point.

Van West and Dean (2000) elaborate the environmental standard that leads to having a comparative advantage in developing countries. According to this study, there are some chances that trade will harm the environmental conditions in developing countries. This research collects the existing literature on trade openness and economic growth and the environmental Kuznets curve (EKC). A simultaneous equation system is derived to determine the effects of the liberalization of trade on environmental status. Pooled data on water pollution in China is used for the estimation. It also suggests that free trade will cover the environmental degradation through better terms of trade. The negotiation of NAFTA and Uruguay Round shows the effects of the liberalization of trade on the environmental status on the part of both the developed and developing countries. In this study, another approach is developed by using a simple Heckscher Ohlin model that shows the endogenous concept of a clean environment. The simulations of this research indicate that per-unit emissions will lead to an increase in all of the provinces. The exchange regime deals with the beneficial effects of the liberalization of trade which may be very important during the period 1992-1995

Kaneko and Managi (2003) investigates the empirical question about free trade whether it is harmful or beneficial for the environment. For this study panel data is used for 63 developing countries and developed countries from the period of 1960-1999. The empirics reveal that the liberalization of trade will increase the emissions that have the elasticity of 0.579. This study shows the whole effects of the liberalization of trade on the environmental condition. It is found that trade has not the beneficial effects on environmental status. The recent research of Cole and Elliott (2003) examines that the estimates are positive but do not examine the overall impacts. In contrary to the small observations of Cole and Elliott (2003) which is used the data of 32 countries, this study that is about 63 countries contributes to the previous literature at two-folds. This is the first research that estimates the whole effects of the liberalization of trade. Second, a beneficial simultaneous model is proved.

McAusland (2005) focuses on consumer-generated-tailpipe-pollution against the vast research of economics on the environmental quality in open economies. It highlights producer-generated-smokestack pollution. This study also examines political opposition to environmental regulations differs from trade regime and indicates the impacts of the movement from the absence of trade to free trade on environmental policy from this study we find that trade openness increases the opposition of industry to smokestack policy and decrease its opposition to the policy of tailpipe. This study focuses on trade and environmental relationships that may depend critically on pollution. It indicates that production-related pollution should re-evaluate before the assumption for the pollution concerned with consumption. The main concern of this paper is to highlight the relation between trade-openness and the environment-politics underlying the assumption that the traditional relation can be rearward. The empirical results indicate that the relationship among trade structure, politics, and environmental regulations can be different in qualitative measures.

Junyi (2006) tries to empirically estimate the relation of EKC and income per capita in the Chinese provinces. The study employs the data for 1993-2002. This research uses the simultaneous equation model (SEM) to empirically examine the relationship between per capita pollutant emissions and income per capita. 2SLS method is used to estimate the SEM in this study. The study uses the Hausman test methodology for examining the homogeneity of income in the model. The findings of the Hausman test reveal that there is simultaneity between pollution emissions and income per capita. The empirics of the study reveal that there is U shape relation between pollution and income, but in the case of poor areas, they need more wealth for better environmental conditions. Rothman (1998) examines the relation of economic development and environmental-degradation in the case of some selected developed countries. The study uses the data of different times. The study concludes that the inverted U shape relation exists between economic-growth environmental-degradation.

Kaygusuz (2007) examines that the energy demand is growing rapidly in Turkey. Energy consumption has been increasing at the rate of 4.3 percent on average since 1990 in Turkey. It is expected that the fast increase in the production and consumption of energy has taken with a broad range of environment-related problems at different levels. The study analyzes that carbon emissions (CO$_2$) in Turkey have raised with the energy-consumption concerned with the global environmental issues. In 2004, CO$_2$ emissions increased by 193 mt. States have performed a very important role in giving protection to the environment by decreasing the emissions of greenhouse gasses (GHGs). On a global scale, state emission is proved to be significant. CO$_2$ emissions and carbon-monoxide (CO) are the major greenhouse gases (GHGs) linked with global warming. At the current level, coal is the main reason for producing CO$_2$ emissions with fossil fuels. Sulfur dioxide (SO2) and NOx have a major contribution to acid pelting. The study concludes that carbon assessment has a major contribution to controlling CO$_2$ emissions while raising revenue.

Bartoletto and Rubio (2008) examine the empirical analysis of energy consumption, the passage from organic to fossil energy

carriers, and its impact on CO$_2$ emissions in Italy and Spain. The study uses the data from the period of 1861-2000. This paper also employs new data for analyzing the use of energy from organic roots to the modern roots of energy. The existing studies have revealed that the traditional structure of energy transforms the views about the relation between the energy inputs and the economy. But the recent study of this paper concludes that in the long run, the traditional energy roots must be in the series of pollution intensities of energy consumption, pollution-intensities in the economy, de-carbonization, and other factors to gain a clear picture of the process include. The study also shows the trend of CO$_2$ emissions, which changes significantly with the involved traditional energy carries. It indicates that de-carbonization is not a long-run phenomenon, it prevails since the 1970s in the economy. The study analyses that modification in the placement of energy baskets has an important impact on CO$_2$ emissions in the economy. Because the various energy baskets are the main reasons to emit the CO$_2$ in different degrees.

Akbostancı et al. (2009) empirically examine the relationship between income per capita and the environmental status of Turkey in two scenarios. First, the relation between CO$_2$ emissions and income per capita is studied through the time series data with the help of the co-integration technique and the data is used from the period 1968-2003. Second, the relation between air pollution and income is examined through PM10 and SO2 measurement in Turkey. Panel data is used in this paper. The data is used from the period of 1992-2001 including 58 provinces of Turkey. Panel data analyze the N-shaped relationship for SO2 and PM10 emissions that have no support for the inverted U shape Kuznets curve which is showing the relationship between environmental degradation and income. The long-run relation is existed between income and pollution and finds that these variables are co-integrated. The result shows that the per capita income is less than 2000 in some provinces of Turkey, it also reveals that air pollution increases with the increase in income. The results also show that in those provinces that have income per capita between (2000-6000), air pollution decreases with per capita income. In the provinces with an income of more than 6000, air pollution tends to increase once again. The empirical findings show that the environmental Kuznets curve (EKC) is significant in some provinces during the specific period. This study concludes that the basic need is to control the pollution that will not disappear automatically, no matter what their income level will be.

Poumanyvong and Kaneko (2010) investigate that in recent years, there have been extensive studies on the relations betwixt energy-consumption, urbanization, and CO$_2$ emissions. But there has been little attention towards the distinction in different phases of development or different levels of income. The previous existing literature has assumed that the effect of urbanization is homogeneous for all of the countries. Different questions arise in this assumption that there are many distinctions across countries of various levels of comfort. This study empirically examines the impact of urbanization on energy consumption and CO$_2$ emissions at the different phases of development by using the stochastic impacts of the regression on the population. The affluence and technology model (STIRPAT) is employed by employing the

panel data of 99 countries from 1975 to 2005. The empirical findings of the study recommend that the effect of urbanization on energy use and CO$_2$ emissions differs at the development phases. The results of the study reveal that urbanization reduces energy consumption in low-income countries and grows energy consumption in middle- and high-income countries. The effect of urbanization on CO$_2$ emissions is positive for all the groups of income, but it is strongly marked in the middle-income group than in the other groups of income. These new empirics assist to make advancements in the existing literature, and it can be proved as a special involvement to policymakers.

Nasir and Rehman (2011) analyze the relationship between carbon emissions (CO$_2$), energy consumption, income, and foreign trade in Pakistan. The study uses the data from the period of 1972 to 2008. Johansen's method of co-integration is applied in this study paper. The empirics reveal that there is a quadratic long-run relation between CO$_2$ emissions and income, which confirms the immanence of the inverted U shape hypothesis of Environmental-Kuznets-Curve (EKC) in the case of Pakistan. Furthermore, foreign trade and energy consumption shows positive impacts on CO$_2$ emissions. However, the short-run findings show the immanence of the EKC hypothesis which is unique in the situation that none of the long-run determinants is significant. The empirical findings reveal a different story in the existing literature. The contradiction of the empirics of the short-run and the long-run provide opportunities to the policymakers to make various types of growth policies. The results of the causality test show that the uni-directional relation exists between growth and energy consumption. The study of this paper proposes that the policymakers must not rely on the future energy demand with various growth issues. The policymakers should focus on gaining energy at less cost. Moreover, the empirics highlight that there is no causal relation exists betwixt the CO$_2$ emissions and growth, which suggests that Pakistan can reduce the CO$_2$ emissions without disrupting the economic growth.

Jobert et al. (2012) focus on economic growth, energy consumption, and carbon-dioxide emissions. The study is employing the iterative aspect of the Bayesian Shrinkage method. The Environmental-Kuznets-Curve (EKC) hypothesis is checked by using this procedure for the first time in this study. The obtained empirics suggest that: first, the Environmental-Kuznets-Curve hypothesis is rejected for 49 countries out of 51 countries, considering when heterogeneity in the economies is present, energy-efficiencies across countries and differences in the CO$_2$ emissions are accounted; second, is that categorization of the empirical results in the countries, the growth levels reveal that an inverted U shape curve is because of the matter of fact that the growth in the GDP in the developed or higher-income countries reduces emissions, while, in the developing or lower-income countries it raises emissions. The EKC hypothesis is applied to check the dependency of environmental degradation on the level of economic development. Jobert et al. (2010) examine that during the betterment of the economic structure, these economies decreased their share of the industrial sector in GDP, and hence, they might be qualified as "ecologists despite themselves".

Shahbaz et al. (2013) empirically estimate the relationships among globalization, economic growth, energy intensity, and CO$_2$ emissions. The study implies the data from the period of 1970-2010 for Turkey. Co-integration and unit root tests are used in this paper. VECM Granger-causality method is applied to check the causal relationship among these variables. The empirical estimates indicate that the use of globalization and energy intensity lead to a growth in the CO$_2$-emissions. It also proves the presence of the (EKC) hypothesis in the economy. The findings of the causality test show that the two-way causal relationship exists between CO$_2$ emissions and economic growth. ARDL bounds-testing method of co-integration is applied to check the long-run relations among CO$_2$ emission, globalization, economic growth, and energy intensity. Empirics of this research confirms the existence of co-integration among these variables in the presence of structural break. The findings of this paper reveal that the energy intensity increases the CO$_2$ emissions and globalization reduces the CO$_2$ emissions. This study suggests further research of all the renewable and nonrenewable energy resources of energy that can be integrated with neo-classical production.

Baek and Ali (2016) examine the effect of secondary school education, financial development, energy consumption, economic development, and population density on environmental degradation in the case study of Lebanon. This study uses the data for 1974-2014. The augmented Dickey-Fuller (ADF) unit-root method is used to analyze the stationarity among these selected variables of the model. ARDL bounds testing method is applied to empirically examine the co-integration among the selected variables. The findings analyze that population density, energy consumption, and financial development have positive and significant relation with environmental-degradation in the case of Lebanon. The findings also reveal that economic development has positive and insignificant relation with environmental degradation. The empirics also indicate that there is a negative and significant relation between secondary school education and environmental degradation in Lebanon. The government of Lebanon should increase the efficient methods of energy consumption to reduce environmental degradation, it also increases the educational level to improve the environmental quality in the case of Lebanon.

Dogan and Seker (2016) explore the link among real income, non-renewable and renewable consumption of energy, and openness of trade on pollutant emission. The Environmental Kuznets curve model has been tested for some selected European nations from 1980 to 2012, advanced panel methods have been applied for empirical analysis. The outcomes of the analysis reveal that liberalization of trade and energy production by renewable resources diminish emissions of carbon in the environment, whereas non-renewable energy has a vice-versa impact. The findings of this study show a bidirectional causal relationship between pollutant emission and consumption of renewable and unidirectional causal relationship from real income to pollutant emission, from pollutant emission to nonrenewable energy, and from liberalization trade to pollutant emission.

Irfan and Shaw (2017) analyze the relationship between environmental pollution and energy consumption in South Asian

countries. The study uses a panel dataset for three countries (India, Pakistan, and Bangladesh) from 1978 to 2011. The relationship is explored by employing a nonparametric additive model with country and time-specific fixed effects. The data for the analysis are collected by the world bank. The result of the study shows that the relationship between carbon dioxide emissions and energy consumption is nonlinear in nature and energy consumption has a positive impact on carbon dioxide emissions in the panel of countries. The study also expresses that the level of urbanization is inverted U-shaped relationship with carbon dioxide emissions.

Shahzad et al. (2017) study the cointegrating relationship between carbon emissions, energy consumption, trade openness, and financial development in Pakistan. The study uses environmental degradation as a dependent variable and energy consumption, trade openness, and financial development as independent variables. The study has been used the ARDL bounds test for the cointegration procedure. In this study annual time series data is used for the period 1971 to 2011. The data is collected from the world bank. Results, the long-run results show that a one percent increase in trade openness and financial development will increase carbon emission by 0.247% and 0.165%, separately. The short-run elasticities are 0.122% and 0.087% for trade openness and financial development, individually. The Granger causality results show a unidirectional causality from energy consumption, trade openness, and financial development to carbon emission; and a bi-directional causality between energy consumption and financial development.

Bakirtas and Akpolat (2018) explore the relationship between energy consumption, economic growth, and urbanization in the case of new emerging market countries. The study has been used the Dumitrescu-Hurlin panel Granger causality test from 1971 to 2014 in new emerging-market Countries. The data is collected from the world bank. In the trivariate analysis, there is panel Granger causality from energy consumption and urbanization to economic growth, from economic growth and urbanization to energy consumption, and from energy consumption and economic growth to urbanization. The result shows a negative and significant relationship.

Haseeb et al. (2018) explore the dynamics of environmental degradation: the world evidence. The study investigates the linkages among corruption, democracy, tourism, and CO₂ emissions for selected disaggregates. The study uses aggregate panel data over the period 1995-2015. The data is collected from the world bank. The FMOLS results indicate that corruption and tourism at disaggregate and aggregate levels are substantial contributors to CO₂ emissions. These empirical results also reveal that corruption and tourism in low-income countries have a higher impact on CO₂ emissions compared to high-income countries. Besides, democracy in all panels except low-income countries has helped to reduce CO₂ emissions. Some results are found to be illogical.

Adams and Nsiah (2019) analyze the relationship between renewable energy and carbon emission. The study uses carbon emission as a dependent variable and economic growth or urbanization as an independent variable. The study has been

used the panel cointegration technique for 28 Sub-Sahara African countries spanning the period of 1980 to 2014. The data is collected from the world bank. The result shows that the percentage of nonrenewable energy consumption leads to an increase of 1.07% and 1.9% to the carbon emission for the short and long run respectively. The results also show that less democratic states are more likely to pollute the environment than more democratic states. Further, there is no statistically significant effect of non-renewable energy in the short run for more democratic nations.

Zandi and Haseeb (2019) explore the impact of democracy and environmental degradation evidence of Asian countries. The study examines the relationship between corruption, democracy, military expenditure, and environmental degradation in a panel of six Asian countries. The data were collected from 1995 to 2017. The data is collected from the world bank. The study uses fully modified ordinary least square (FMOLS) and dynamic ordinary least square (DOLS) to examine the results. The result shows a significant impact among the variables. Military and corruption show positive impact and democracy shows negative impact. The results suggest that ASEAN countries need environmental performance and good governance systems that are also free from corruption when they are cooperating. The results further confirm that as corruption and military spending increase, carbon dioxide emissions will be emitted in these Asian countries.

Koengkan et al. (2020) examine the indicators of environmental degradation. The study uses CO₂ emissions as a dependent variable and renewable, non-renewable energy consumption, economic growth, and urbanization as independent variables. The study has been used a panel vector autoregressive model. The study collects the data from Southern Common Market, over thirty-five years 1980 to 2014. The data is collected from the world bank. The experimental analysis pointed to the presence of bi-directional causality between the consumption of fossil fuels, economic growth, consumption of renewable energy, and carbon dioxide emissions; and a unidirectional relationship between the consumption of renewable energy and urbanization. This research also thought that the countries from Southern Common Market are dependent on fossil fuels consumption and that the urbanization process is highly linked with the consumption of this type of energy. The results of preliminary tests pointed to the presence of cross-sectional dependence and unit roots in the variables included in this investigation, as well as a low degree of multicollinearity between them. The preliminary tests also pointed to the presence of fixed effects in the model and to the need to use one lag length in the PVAR estimation.

Ozcan et al. (2020) explore the determinants of environmental degradation in OECD countries. The study uses environmental degradation as a dependent variable while energy consumption, economic growth as independent variables. The study uses a sample of 35 OECD countries from 2000 to 2014. The data for the analysis were collected from the world bank. The study analyzes the dynamic causal relationships between energy consumption, economic growth, and CO₂ emissions and two environmental indices (EF and EPI). The result shows a significant positive effect of GDP and energy consumption on all environmental quality

indicators (EF, CO_2 emissions, and EPI). Overall, the results of the study reveal the adjustment of the OECD economies to a compromising relationship between the environment and their economic development paths. OECD countries have started to harmonize their economic growth and energy consumption patterns with their environmental policies.

Ali et al. (2021) analysis the impact of renewable energy consumption and natural resource depletion on environmental degradation in the case of developed and developing countries from 1990 to 2014. An insignificant relation has been found between natural resource depletion and environmental degradation in the case of complete sample analysis and developing country analysis, but vice-versa in developed countries. Fossil fuel energy consumption has a positive and significant impact on environmental degradation in developing countries. Renewable energy consumption harms environmental degradation in the case of complete sample analysis and developed country analysis, but visa-versa in developing countries. Economic growth positively and significantly affects environmental degradation in all three cases, this means for higher economic growth we have to bear some environmental degradation. But it is the need of the hour that we should find some threshold between economic growth and pollutant emissions so that a healthy environment can be safe for coming generations. So, for a healthy environment, fossil fuel consumption should be reduced and consumption of renewable energy with merchandised trade and urbanization can be encouraged.

Sawyer (2021) demonstrates that strategies of environmental degradation. The study discusses the nature of the present era of financialization, outlining the changes in the financial sector and its relations with the real sector which are particularly relevant for the climate emergency. The nature of the study is a primary study. The processes of financialization have involved the growth of the financial sector and its institutions, which from several perspectives have become too large (individually and collectively). The climate emergency, environmental damage, and loss of biodiversity will require, inter alia, a major re-structure of economic activity and much lower rates of its growth. The study is focused on short-term shareholder value maximization that runs into conflict with a longer-term perspective of research and development and investment directed towards sustainability. Funding arrangements are also required which are capable of supporting activities and promoting de-commodification of the environment.

3. THE MODEL

Environmental changes have become one of the main confronting issues among policymakers throughout the world. Different researchers e.g. Beckerman (1992), Panayotou (1993), Holtz-Eakin and Selden (1995), Stern et al. (1996), Carson et al. (1997), Moomaw and Unruh (1997), McConnell (1997), Agras and Chapman (1999), Magnani (2001), Dijkgraaf and Vollebergh and Kemfert (2005), Vollebergh and Kemfert (2005), Richmond and Kaufmann (2006), Ang (2007), Apergis and Payne (2009), Tiwari et al. (2013), Kanjilal and Ghosh (2013), Baek and Kim (2013), Solarin and Ozturk

(2015), Ali and Rehman (2015), Liu et al. (2015), Ali (2015), Dogan et al. (2015), Ali and Baek (2016), Baek and Ali (2017), Zhang et al. (2017), Pal and Mitra (2017), Audi and Ali (2018), Audi et al. (2020), and Ali et al. (2021) have presented different determinants of greenhouse gasess. Following the methodologies of Ali and Audi (2016), Audi and Ali (2017), Zhang et al. (2017), Pal and Mitra (2017), Audi and Ali (2018), Audi et al. (2020), and Ali et al. (2021), the model of this study become as:

$$CO_{2t}=f(IND_t, AGR_t, SER_t PD_t, GLOB_t) \tag{1}$$

where,
CO_2 = CO_2 emissions
IND = industrial sector growth
AGR = agriculture sector growth
SER = services sector growth
PD = population density
$GLOB$ = globalization KOF index
t = time period (1970-2019)

The main objective of this study is to explore the effect of industrial growth, agricultural growth, services sector growth, population density, and globalization in the case of Pakistan from 1970 to 2019. Data for these selected indicators has been obtained from the World Development Indicators (WDI) databases maintained by the World Bank and various issues of the Pakistan Economic Survey.

4. ECONOMETRIC METHODOLOGY

In time series studies, the time trends make the estimated results biased (Nelson and Plosser, 1982; Brooks and Harris 2014). The existence of time trend makes the time series data non-stationarity, there are number of procedures available which check the unit root issue in the data. For checking stationarity of our time series data, the present study uses Augmented Dickey -Fuller (ADF) (1981) and Philips Perrron (1988).

4.1. Augmented Dickey-Fuller (ADF)
The functional form of ADF becomes as:

$$\Delta X_t = \delta X_{t-1} + \sum_{j=1}^{q}\phi_j\Delta X_{t-j} + e_t \tag{2}$$

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{j=1}^{q}\phi_j\Delta X_{t-j} + e_t \tag{3}$$

$$\Delta X_t = \alpha + \beta t + \delta X_{t-1} + \sum_{j=1}^{q}\phi_j\Delta X_{t-j} + e_{3t} \tag{4}$$

Here X_t; variable having time series data is used for checking unit roots issue, t ; explains the existence of time trend in the series and e_t; white noise error term. The simple DF can be useful if $j = 0$. While testing the unit root issue in the series ADF test can include, until white noise error can be achieved. The simple LM test can be used for analyzing error terms serial correlation. Now we can develop, the null and alternative hypotheses of ADF unit root;

$H_0 : \delta = 0$ non-stationary time series; and series have unit root issue

$H_a : \delta < 0$ stationary time series

4.2. Phillips and Perron (PP) Unit Root Test

Phillips and Perron (1988) present unit root and PP test is viewed as DF test that made robust to serial correlation with the help of Newey and West (1987) heteroskedasticity and autocorrelation consistent covariance matrix estimator. The null hypothesis of PP and ADF have the same normalized bias statistics and asymptotic distributions. PP has two main advantages over ADF. The first PP test has strong power to predict the heteroskedasticity and serial correlation in the error term. Second, the user does not need to specify the lag length of the test regression. The PP test has the following procedure:

$$y_i = \alpha + \beta y_{i-1} + \iota \qquad (5)$$

where we include the time trend and exclude the constant term. In this way Z_p and $Z_{\square}$ are two statistics calculated as:

$$Z_\rho = n(\hat{\rho}_n - 1) - \frac{1}{2}\frac{n^2 \hat{\sigma}^2}{s_n^2}\left(\hat{\lambda}^2 - \hat{\gamma}_{0,n}\right) \qquad (6)$$

$$Z_\tau = \sqrt{\frac{\hat{\gamma}_{0,n}}{\hat{\lambda}^2}}\frac{\hat{\rho}_n - 1}{\hat{\sigma}} - \frac{1}{2}\left(\hat{\lambda}^2 - \hat{\gamma}_{0,n}\right)\frac{1}{\hat{\lambda}_n}\frac{n\hat{\sigma}}{s_n} \qquad (7)$$

$$\hat{\gamma}_\rho = \frac{1}{n}\sum_{i=j+1}^{n}\hat{\varepsilon}_i\,\hat{\varepsilon}_{i-j} \qquad (8)$$

$$\hat{\gamma}_n^2 = \hat{\gamma}_{0,n} + 2\sum_{j=1}^{q}\left(1 - \frac{j}{q+1}\right)\hat{\gamma}_{j,n} \qquad (9)$$

$$s_n^2 = \frac{1}{n-k}\sum_{i=1}^{n}\hat{\varepsilon}_i^2 \qquad (10)$$

where $\square_i$ error term of OLS, k represents the number of covariates, q represents the number of lags, $\hat{\gamma}_n^2$ and $\hat{\sigma}$ is the standard error of $\hat{\rho}$. In eq. (9) when $j = 0$ this represents the variance of the error terms and when $j > 0$ this represents covariance lies between two error terms. In eq. (10) when covariances are zero or –ve the auto correlation between the residuals $\hat{\gamma}_{i,n}$ is zero $j > 0$. Then the second term of the eq. (10) disappears and $\hat{\gamma}_n^2 = \hat{\gamma}_{0,n}$ they can be replaced with each other.

If $\hat{\gamma}_n^2 - \hat{\gamma}_{0,n} = 0$ the in the second term of the eq. (8) disappear.

$$Z_\tau = \sqrt{\frac{\hat{\gamma}_{0,n}}{\hat{\lambda}^2}}\frac{\hat{\rho}_n - 1}{\hat{\sigma}}$$

and $\frac{\hat{\gamma}_{0,n}}{\hat{\lambda}^2} = 1$ then its reduce form is as

$$Z_\tau = \frac{\hat{\rho}_n - 1}{\hat{\sigma}} \qquad (11)$$

Hence there is no autocorrelation or unit root problem between the error terms. In this way by applying this procedure to all variables, we can easily find their respective orders of integration of all variables.

4.3. Zivot and Andrew Structural Breaks Unit Root Test

The problem with PP and ADF is that these tests don't highlight the existence or non-existence of structural breaks in the data. Zivot and Andrews (2002) propose a unit root test to solve this issue.

$$\Delta y = c + \alpha y_{t-1} + \beta t + \gamma DU_t + \sum_{j=1}^{k}d_j\Delta y_{t-j} + \varepsilon_t \qquad (12)$$

$$\Delta y = c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{j=1}^{k}d_j\Delta y_{t-j} + \varepsilon_t \qquad (13)$$

$$\Delta y = c + \alpha y_{t-1} + \beta t + \theta DT_t + \gamma DU_t + \sum_{j=1}^{k}d_j\Delta y_{t-j} + \varepsilon_t \qquad (14)$$

where DU_t is an indicator dummy variable for a mean shift occurring at each possible break-date (TB) while DT_t is the corresponding trend shift variable. Formally,

$$DU_t = \{^{1------if\ t>TB}_{0-------otherwise} \text{ and } DT_t = \{^{t-TB------if\ t>TB}_{0-------otherwise}$$

$\alpha=0$ is the null hypothesis for the above three equations, this reveals the series contains a unit root with a drift that excludes any structural break, while the alternative hypothesis $\alpha<0$ implies that the series is a trend-stationary process with a one-time break occurring at an unknown point in time. The Zivot and Andrews test consider every point as a potential break-date (TB) and runs a regression for every possible break-date sequentially.

4.4. Autoregressive Distributive Lag Model to Co-Integration

Pesaran (1997), Pesaran and Shin (1998), Pesaran et al. (1999) have developed a cointegration model which is known as the Autoregressive Distributive Lag model (ARDL). ARDL procedure can be applied as follows:

$$\Delta \ln Y_t = \beta_1 + \beta_2 t + \beta_3 \ln Y_{t-1} + \beta_4 \ln X_{t-1} + \beta_5 \ln Z_{t-1} + ...$$

$$+ \sum_{h=1}^{p}\beta_h\Delta \ln Y_{t-h} + \sum_{j=0}^{p}\gamma_j\Delta \ln X_{t-j} + \sum_{k=0}^{p}\phi_k\Delta \ln Z_{t-k} + ... + u_{it} \qquad (15)$$

Here the dependent variable is $\ln Y_t$; time is presented with t; the lag of the dependent variable can be presented with $\ln Y_{t-1}$; first independent variable is presented by $\ln X_t$; the second independent variable is presented by $\ln Z_t$ and so on. The rate of change can be measured with the help of Δ. First, we will examine the relationship direction for the variables in the case of Pakistan with the help of the F test. F-statistic decide the order of integration for the variables, here we can use either time trend or intercept for the analysis procedure. F-Statistic is used for the comparison of tabulated values of Pesaran (1997) or Pesaran et al. (2001) which

was further revised by Narayan (2005). In case the calculated F-test statistic is higher than the upper bound value, we can reject the null hypothesis and conclude that there is cointegration among the variables of the model and vice-versa for the other case. The procedure to write null and alternative hypothesis of the ARDL bound test is as follow:

$H_0 : \beta_3 = \beta_4 = \beta_5 = 0$ (no co-integration among the variables)

$H_A : \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (co-integration among variables)

Vector error correction model is used for examining the short-run relationship among the variables. Its procedure can be explained as:

$$\Delta \ln Y_{it} = \beta_1 + \beta_2 t + \sum_{h=1}^{p} \beta_h \Delta \ln Y_{it-h} +$$

$$\sum_{j=0}^{p} \gamma_j \Delta \ln X_{t-j} + \sum_{k=0}^{p} \phi_k \Delta \ln Z_{it-k} + \omega \, ECT_{t-1} + u_t \qquad (16)$$

Lagged error correction can be presented by ECT_{t-1}; all the other variables that have been explained in the earlier equation. The results of the error correction term explain the speed of adjustment from short tun towards the long run.

5. RESULTS AND DISCUSSIONS

The descriptive statistics provide us with the intertemporal properties of the selected data series. The results of descriptive statistics have been given in Table 1. The estimated results present mean, median, maximum, minimum, std. dev. Skewness and Kurtosis values of the data series. Based on estimated results, it is found that all series have theoretically correct intertemporal properties. The results of Jarque-Bera show that all the selected variables have normally distributed data series, which are also necessary for the white noise error term in any type of regression analysis.

The results of the correlation have been given in Table 2. The results explain that CO$_2$ emissions have a significant correlation with most of the selected variables. Moreover, selected explanatory variables i.e. industrial growth, agricultural growth, services sector growth, population density, and globalization have not very high correlation to create the issue of multicollinearity among the select explanatory variables. Thus, our model meets one of the necessary conditions of variable selection for regression analysis.

For checking the unit root issue of the selected data series, we have applied ADF and PP unit root tests. The estimated results have been given in Table 3, the results show that CO$_2$ emission, population density, and globalization are not stationary at level, whereas industrial growth, agricultural growth, and services growth are stationary at level. The results show that CO$_2$ emission, population density, and globalization are stationary at first difference. In the presence of time trend, some of the selected variables are stationary at the level and some are stationary at first difference. Both ADF and PP outcomes show that there is mixed order of integration among selected variables without and with a time trend. These results recommend applying the autoregressive distributed lag model for examining the long-run and short coefficients of the selected model.

One of the big problems with ADF and PP i.e. these tests do not give the presence of a structural break in the data series, as most of the time-series data have structural break issues. DeJong et al. (1992) and Baum (2004) mention that in the presence of structural break, the estimated results are biased and inconsistent. The appropriate information about the structural break enables the policymakers to design comprehensive socioeconomic policies to achieve policy targets. To test the structural break in the data

Table 1: Descriptive Statistics

	CO$_2$	IND	AGR	SER	PD	GLOB
Mean	11.10258	5.646511	3.272988	5.551787	2.683832	42.84000
Median	11.22504	5.157286	3.175550	5.171768	2.759534	42.50000
Maximum	12.24707	17.37416	11.72315	10.50643	3.363952	55.00000
Minimum	9.848453	−5.206873	−5.286028	1.331493	2.022967	30.00000
Std. Dev.	0.726804	4.002646	3.416279	2.193636	0.423963	8.821032
Skewness	−0.255242	0.130784	−0.003140	0.351581	−0.062231	0.129161
Kurtosis	1.748384	4.351646	3.842325	2.759039	1.727408	1.440866
Jarque-Bera	3.806535	3.948677	1.478230	1.151040	3.406211	5.203396
Probability	0.149081	0.138853	0.477536	0.562412	0.182117	0.074148
Sum	555.1289	282.3256	163.6494	277.5894	134.1916	2142.000
Sum Sq. Dev.	25.88395	785.0375	571.8770	235.7899	8.807502	3812.720s
Observations	50	50	50	50	50	50

Table 2: Correlation Matrix

Variables	CO$_2$	IND	AGR	SER	PD	GLOB
CO$_2$	1.000000					
IND	−0.354910**	1.000000				
AGR	−0.081314	0.218704	1.000000			
SER	−0.349507**	0.492734***	0.074164	1.000000		
PD	−0.791372***	0.335543**	0.197556	0.287791**	1.000000	
GLOB	0.950828***	−0.370807***	−0.128446	−0.298745**	−0.884573***	1.000000

***,**,* present significance level 1%, 5% and 10% respectively

series we have applied Zivot-Andrew structural break unit root test. The estimated results of the Zivot-Andrew unit root test have been given in Table 4. The results show that CO_2 emissions, population density, and globalization are not stationary levels without time trends in presence of structural break 1997, 1987, and globalization respectively. The results show that industrial growth, agricultural growth, and services growth are stationary at without time trend in presence of structural break 2008, 2000, and 1988 respectively. At first difference without time trend, all the selected variables of the model are stationary with different structural breaks. In presence of time trends at level CO_2 emissions, industrial growth, agricultural growth, and population density are stationary with structural breaks 1995, 2008, 1993, and 1997 respectively. Whereas, services growth with structural break 1986 and globalization with structural break 2004 are non-stationary at the level in the presence of a time trend. All the selected variables are stationary at first difference with different structural breaks. This shows that there is mixed order of integration in the presence of structural breaks with is a very suitable condition to apply the autoregressive distributed lag model.

Table 5 gives us information about the lag order selection criterions. Normally, Hannan-Quinn information criterion, Akaike

information criterion, Final prediction error, sequential modified LR test-statistic, and Schwarz criterions are used optimal selection. For the selection of lag order, the searcher should keep in mind the number of variables and number of observations (i.e. degree of freedom). The findings indicate that most of the criterions refer to the optimal-lag length as 4. Hence, following the Hannan-Quinn information criterion, Akaike information criterion, Final prediction error, sequential modified LR test-statistic, and Schwarz criterion maximum 4 lag length is employed in this study.

Table 6 provides the empirical findings of ARDL co-integration among CO_2 emissions, industrial growth, agricultural growth, services growth, population density, and globalization. F-statistic has been used to test the null hypothesis of no cointegration against the alterative hypothesis. The calculated F-statistics (7.522391) is greater as compared to the upper bound at 1 percent given by Pesaran et al. (2001). So, the null hypothesis of no cointegration has been rejected. This confirms that CO_2 emissions, agricultural growth, services growth, population density, and globalization have cointegrated in the case of Pakistan over the selected period.

The long-run results of the study have been given in Table 7. The results show that there is a positive and significant relationship

Table 3: Unit Root Analysis

Variables	At Level without trend	At First Difference without trend	At Level trend	At First Difference with trend
Augmented Dickey-Fuller Test				
CO_2	0.250779	−5.131523***	−2.023921	−5.089897***
IND	−6.104426***	-	−6.571368***	-
AGR	−9.722486***	-	−9.667097***	-
SER	−4.731066***	-	−5.008044***	-
PD	−0.523089	−4.832824***	−3.275790*	−5.789907***
GLOB	−0.849685	−4.794825***	−1.329221	−6.338258***
Phillips-Perron Test				
CO_2	0.114136	−5.098812***	−2.352458	−5.071919***
IND	−6.138791***	-	−6.567494***	-
AGR	−9.671595***	-	−9.716695***	-
SER	−4.677230***	-	−4.715144***	-
PD	−0.188693	−2.050421**	−2.494701	−2.050421***
GLOB	−0.733070	−6.366606***	−1.329221	−6.333982***

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

Table 4: Zivot-Andrews Structural Break Unit Root Test

Variables	At Level without trend		At First Difference without trend		At Level trend		At First Difference with trend	
	T-Statistic	Time Break	T-Statistic	Time Break	T-Statistic	Time Break	T-Statistic	Time Break
CO_2	1.273008	1997	−5.173376***	2008	−5.684998**	1995	−6.053869***	1987
IND	−7.113871**	2008	−9.308260***	2005	−6.994745**	2008	−9.265465***	2005
AGR	−4.061953*	2000	−5.281451***	1993	−7.071922**	1993	−5.458055***	1992
SER	−5.343588**	1988	−8.036633***	2006	−5.357183	1986	−8.096322**	2009
PD	−1.791295	1987	−5.338886***	1987	−6.045833**	1997	−7.237669***	1980
GLOB	1.221071	2008	−6.946416	2008	−2.311140	2004	−6.935191**	2004

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

Table 5: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
1	−211.2266	NA	0.001894	10.74898	12.18010*	11.28509
2	−148.9735	92.02637	0.000645	9.607544	12.46977	10.67975
3	−84.81954	78.10049*	0.000230	8.383458	12.67679	9.991766
4	−34.23732	48.38299	0.000185*	7.749449*	13.47389	9.893859*

* indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

between industrial growth and CO$_2$ emission. Industrial growth is vital to attain higher economic development (Ranis and Fei, 1961; Prebisch, 1962; Amin, 1999; Chen and Sivakumar, 2021). While the impacts of industrial activities on the natural environment are a major concern in developed countries, much less is known about these impacts in developing countries. Our results explain that a 1 percent increase in industrial growth brings (0.029972) percent rise in CO$_2$ emissions in the case of Pakistan. The developing world is often seen as having a high percentage of heavily polluting activities within its industrial sector. But the sound industrialization policies are of paramount importance in developing countries' economic development and call for the management of natural resources and the adoption of low-waste or environmentally clean technologies (Freeman et al., 1992; North, 1997; Ahuti, 2015; Shugurov, 2018). In industrialized countries, environmental regulation and new technologies are reducing the environmental impact per unit produced, but industrial activities and growing demand are still putting pressure on the environment and the natural resource base (Ehrlich et al., 1999; Munasinghe, 1999). In developing countries, a double environmental effect is occurring: old environmental problems, such as deforestation and soil degradation, remain largely unsolved. At the same time, new problems linked to industrialization are emerging, such as rising greenhouse gas emissions, air, and water pollution, growing volumes of waste,

Table 6: ARDL Bounds Test

Test Statistic	Value	K
F-statistic	7.522391	5
Critical Value Bounds		
Significance	Lower Bound	Upper Bound
10%	2.75	3.79
5%	3.12	4.25
2.5%	3.49	4.67
1%	3.93	5.23

Table 7: Long Run Coefficients

Variables	Coefficients	Std. Error	t-Statistic	Prob.
	Dependent Variable: CO$_2$			
IND	0.029972	0.010528	2.846794	0.0074
AGR	−0.001980	0.004743	−0.417509	0.6789
SER	−0.021752	0.009109	−2.387954	0.0226
PD	0.509724	0.121561	4.193169	0.0002
GLOB	−0.001495	0.009746	−0.153389	0.8790
C	8.098723	0.623834	12.982182	0.0000
@TREND	0.067118	0.004889	13.729092	0.0000
R-squared	0.998130	Mean dependent var	11.16802	
Adjusted R-squared	0.997470	S.D. dependent var	0.699806	
S.E. of regression	0.035200	Akaike info criterion	−3.626156	
Sum squared resid	0.042127	Schwarz criterion	−3.114413	
Log likelihood	98.21467	Hannan-Quinn criter.	−3.433584	
F-statistic	1512.315	Durbin-Watson stat	2.025665	
Prob (F-statistic)	0.000000			

desertification, and chemical pollution (Ahuti, 2015; Carley and Christie, 2017; Hasnat et al., 2018; Bekabil, 2020).

The estimated results show that agricultural growth has a negative and insignificant impact on CO$_2$ emissions. There is an extensive amount of literature that examines the relationship between agricultural growth and CO$_2$ emissions (Jebli and Youssef, 2017; Chebbi, 2010; Hertel et al., 2014; Gokmenoglu and Taspinar, 2018). Though economic development in the modern age is substantially dependent on industrialization as well as the use of modern technology. The role of the traditional agriculture sector is still significant since it provides a base for the development of an agro-based industry and is a major source of food. Further, the agriculture sector has the potential to assist in protecting the environment from pollution (Parry, 1998; Mahmood et al., 2019). Almost half of the world's population live in rural areas to attain their livelihood in agriculture where the contribution of this sector in the global gross domestic product (GDP) is near to 30% (FAO, 2011). But due to the negative climatic change, agriculture-driven GDP growth for the reduction of poverty, ensuring the security of food, biodiversity, etc. are now under various challenges (Torrellas et al., 2012; Lloyd, 2017).

The estimated results show that service sector growth has a negative and significant impact on CO$_2$ emissions in Pakistan. McEwen (2013) mentions that services sector growth can protect the ecosystem, improve environmental quality, reduce deforestation, and improve environmental practices and freshwater supply. Since then, services sector growth could be a solution to numerous environmental and social problems (Wheeler and Ben-Shlomo, 2005; Senge et al., 2007; Hall et al., 2010). The results show that indicate that a 1 percent increase in service sector growth brings (-0.021752) percent decrease in CO$_2$ emissions in the case of Pakistan over the selected period. Over the last few decades, environmental concerns have been considered in the design of the economic policy. Natural capital is considered to be an indispensable production input, and also a determinant of societal wellbeing (Costantini and Monni, 2008). Moreover, concern about whether the social-ecological processes which allow human wellbeing to be sustained suggests that sustainable development should be a broad social goal. The role of services sector growth in achieving such a goal is emerging as a subject of some debate. It is considered as the most important channel toward the production of sustainable products and services and the implementation of new projects to address many environmental and social concerns (Kemp and Rotmans, 2005; Garetti and Taisch, 2012).

The estimated results show that population density has a positive and significant impact on CO$_2$ emissions in the case of Pakistan. From the last few decades, the policymakers highlight that the rapid population growth is a serious global crisis. One of the primary causes of environmental degradation in a country could be attributed to the rapid growth of population, which adversely affects the natural resources and environment (Nagdeve, 2007; Ray and Ray, 2011; Chopra, 2016). Population impacts on the environment primarily through the use of natural resources and production of wastes and are associated with environmental stresses like loss of biodiversity, air, and water pollution, and increased

pressure on arable land. The rapidly growing population and economic development are leading to several environmental issues in Pakistan because of the uncontrolled growth of urbanization and industrialization, expansion and massive intensification of agriculture, and the destruction of forests. Major environmental issues are forest and agricultural degradation of land, resource depletion (water, mineral, forest, sand, rocks, etc.), environmental degradation, public health, loss of biodiversity, loss of resilience in ecosystems, livelihood security for the poor. Our results show that a 1 percent increase in population density brings (0.509724) percent increase in CO$_2$ emissions in the case of Pakistan over the selected period. The uprising population and the environmental deterioration face the challenge of sustainable development. The existence or the absence of favorable natural resources can facilitate or retard the process of socio-economic development. The three basic demographic factors of births (natality), deaths (mortality) and human migration (migration) and immigration (population moving into a country produces higher population) produce changes in population size, composition, distribution, and these changes raise several important questions of cause and effect. Population growth is contributing to many serious environmental calamities in Pakistan.

The estimated results show that globalization has a negative and insignificant impact on CO$_2$ emissions in the case of Pakistan over the selected period. The effect of globalization on the environment has been explored in the previous literature (Laws, 1994, Goudie and Viles, 1997). Globalization produces a technical effect due to improvements and new technologies that facilitate the reduction of CO$_2$ emissions (Tisdell, 2001). Globalization has a positive impact on economic efficiency (technique effect), which improves environmental quality (Cavlovic et al., 2000). List and Co (2000) conclude that globalization helps promote energy efficiency and reduces CO$_2$ emissions, while Tamazian et al. (2009) found that globalization through foreign direct investment (FDI) encourages technological innovation and the adoption of new technologies that develop more energy-efficient processes and promote sustainable economic growth.

Time trend is playing an important role in the quantity enlargement of CO$_2$ emissions in Pakistan. The estimated coefficient shows that a one-year time brings (0.067118) percent rise in CO$_2$ emissions in the case of Pakistan over the selected period. The constant coefficient also strengthens the time trend involvement in rising CO$_2$ emissions, as Pakistan has huge industrial production economies in its neighbors i.e. India and China. Thus, if Pakistan carries on with the existed industrial, agricultural, and services sector growth, then (8.098723) percent rise in CO$_2$ emissions will occur every year.

The estimated short-run outcomes have been given in Table 8. The results show that industrial growth and services sector growth has a negative and significant short-run impact on CO$_2$ emissions in Pakistan. The results show that agricultural growth has a negative but insignificant short-run impact on CO$_2$ emissions in Pakistan. The estimated short-run results reveal that population density and globalization have a positive and significant impact on CO$_2$ emissions in the case of Pakistan.

In long run, the time trend is one of the main contributors to CO$_2$ emissions in Pakistan. The value of ECT is theoretically correct, i.e. negative and significant, the results show that 36.61 percent variation in the dependent variable is corrected very next year. The results show that the short-run needs two years and 7 months to complete convergence in the long run. Overall, short-run results show that most of the explanatory variables are contributing to CO$_2$ emissions in the long run and short run too.

The estimated diagnostic tests outcomes have been given in Table 9. The results show that there is no issue of heteroskedasticity, serial correlation, and omitted variable biasedness. From Table 1, Jarque-Bera values also explain that the data of selected variables are normally distributed. The outcomes of diagnostic tests show that our estimated results are unbiased and consistent for the policy purpose.

The stability of the model enables us to see either the estimated model shift or not over the selected period. Hansen (1996) mentions that misspecification of the model may provide biased results that influence the explanatory power of the results. The Cumulative Sum (CUSUM) and the Cumulative Sum of the Squares (CUSUM sq) tests are used for examining the stability of short-run and long-run coefficients of the model (Brown, Durbin, and Evans, 1975). The results of Cumulative Sum (CUSUM) and the Cumulative Sum of the Squares (CUSUM sq) tests are reported in Figures 2 and 3. The figures show that Cumulative Sum (CUSUM) and the Cumulative Sum of the Squares (CUSUM sq) are between the two critical lines and do not go outside the critical boundaries. The figures of Cumulative Sum (CUSUM) and the Cumulative Sum of the Squares (CUSUM sq) confirm that our model is correctly specified.

Table 8: Short Run Coefficients

Dependent Variable: CO$_2$				
Variables	**Coefficients**	**Std. Error**	**t-Statistic**	**Prob.**
D (IND)	−0.002976	0.001578	−1.885958	0.0679
D (AGR)	−0.000725	0.001730	−0.419158	0.6777
D (SER)	−0.007964	0.003491	−2.281216	0.0289
D (PD)	0.186632	0.044143	4.227899	0.0002
D (GLOB)	0.014803	0.006492	2.280221	0.0290
D(@TREND)	0.024575	0.004507	5.452213	0.0000
ECT	−0.366143	0.069922	−5.236481	0.0000

Table 9: Diagnostic Tests

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.784839	Prob. F (9,39)	0.1026
Obs*R-squared	14.29465	Prob. Chi-Square (9)	0.1122
Scaled explained SS	9.812373	Prob. Chi-Square (9)	0.3659
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.471199	Prob. F (2,37)	0.2428
Obs*R-squared	3.609636	Prob. Chi-Square (2)	0.1645
Ramsey RESET Test: Omitted Variables			
	Value	**Df**	**Probability**
t-statistic	1.194345	38	0.2397
F-statistic	1.426460	(1, 38)	0.2397

Figure 2: Cumulative Sum (CUSUM)
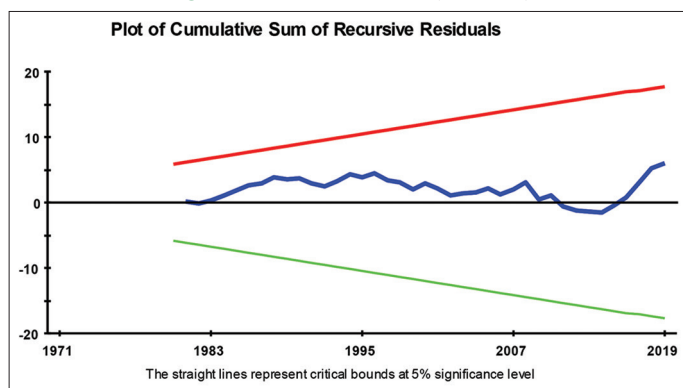
Figure 3: Cumulative Sum of the Squares (CUSUM sq)
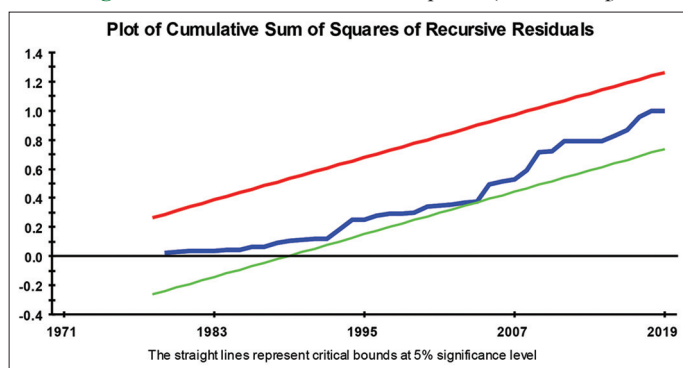
6. CONCLUSIONS

This study has examined the impact of sectoral growth on CO$_2$ emissions in the case of Pakistan from 1970 to 2019. Industrial growth, agricultural growth, services sector growth, population density, and globalization have been selected as explanatory variables. Unit root issues of data series have been checked with the help of ADF and PP unit root tests, whereas the Zivot-Andrew structural break unit root test has been applied to check the existence of structural break. The autoregressive distributed lag model has been applied for checking the cointegration among the variables of the model. ADF, PP unit root tests find mixed order of integration among the selected variables of the model. The results of the Zivot-Andrew unit root test approve the existence of different structural breaks selected data series with mixed order of integration as well. The long-run results show that industrial growth, population density, and time trend are positively and significantly contributing to CO$_2$ emissions in Pakistan. In the long run services sector growth is responsible for reducing CO$_2$ emissions in Pakistan. The results show that agricultural growth and globalization are reducing CO$_2$ emissions but this relationship is insignificant over the selected period. In the short-run industrial growth, agricultural growth, and service sector growth are reducing the level of CO$_2$ emissions in Pakistan. Likewise long run, trend time is promoting CO$_2$ emissions in the short run in Pakistan. In the short-run population density and globalization have a positive impact on CO$_2$ emissions in Pakistan.

Overall results conclude that sectoral growth is responsible for promoting CO$_2$ emissions in Pakistan but it has a reverse kind of relationship in the long run and short run. On the basis above conclusions, there are some policy suggestions for Pakistan to reduce the level of CO$_2$ emissions. Government must control industrial sector pollution which is the major cause of environment-related problems. Preventive measures including encouraging the use of cleaner fuels and diesel with lower sulfur content should be encouraged in Pakistan. The old petrol-based engine should be converted into new engines to control the air pollution. The system of sanitation should be improved to control the urban population. The government of Pakistan must positively increase agricultural growth to reduce environmental degradation. There should be a policy to protect environmental quality with non-polluted agricultural growth. The Government must also increase industrial growth inefficient manner to control environmental degradation in Pakistan. There should be proper control on the energy consumption, negative impacts of globalization, and population density to overcome the environmental degradation in Pakistan. In the end, considering a long-run phenomenon, Pakistan must treat environmental issues as the primary issue for its coming generations.

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