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Analyzing the Dynamics of Energy Consumption, Liberalization, Financial Development, Poverty and Carbon Emissions in Pakistan

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ABSTRACT

Environmental degradation has been a major source of concern for the developing countries of the world especially during last two decades. The environmental quality has become on stake in the process of achieving prime objectives of higher and sustained economic growth, employment generation and poverty alleviation. Extended levels of consumption of fossil fuels coupled with the human induced greenhouse gases have put a heavy toll on the environmental quality that resulted in serious and unprecedented issue of non-renewable natural resource depletion and global warming. Keeping in mind the notion that, in the era of globalized and liberalized world economy, analysis of environment-growth nexus would not clear the picture unless implications of international trade, flows of foreign direct investment, financial development and poverty levels are taken into consideration. So this study is attempt to analyze the impact of energy consumption, economic growth, financial development, economic globalization along with poverty incidence measured by poverty head count ratio on carbon emissions in Pakistan economy. A long run equilibrium association has been found between carbon emissions and regressors in the carbon emission model. Long run and short run causality have been found between the variables.

KEYWORDS: Carbon Emissions, Environmental Kuznets Curve, Energy Consumption, Growth, Trade Liberalization, Foreign Direct Investment, Poverty, Environmental Degradation, Pakistan.

1. INTRODUCTION

It is argued in report of the Intergovernmental Panel on Climate Change (IPCC) that the most unprecedented and challenging problem faced by the inhabitants of our planet is global warming (IPCC, 2007). The IPCC report terms that the “warming of the climate system is unequivocal”. There is a consensus amongst the scientists and experts that carbon emission from burning of fossil fuels along with human-induced greenhouse gases has intensified the situation and caused global warming (IPCC, 2007; World Bank, 2010). The alteration of precipitation patterns, increased intensity of storms, reversal of ocean currents, increase in the sea levels, average increase in air and ocean temperatures, increased frequency of heavy rainfall and floods, and frequent and more intense droughts all indicate that environmental quality has been compromised in the process of industrialization, growth and development of the economies of the globe. The average global temperature has increased by 1^{o} C since the initiation of industrialization era. If the climate change continues at current pace the global average temperature could increase by 5 degree Celsius compared with that of preindustrial times by the end of the 21^{st}century.The best efforts are unlikely to stabilize global temperature even less than 2^{o} C above preindustrial levels of temperatures.

Since developing economies are more exposed and less resilient to environmental and climatic hazards. The consequences of environmental degradation are likely to be disproportionate on developing economies (World Bank, 2010).Increase of global temperature by 2^{o} C from preindustrial times would cause a permanent reduction of 4-5 percent in per capita GDP in African and South Asian economies (Nordhaus & Boyer, 2000; Stern, 2007).South Asian region is characterized with the stressed and largely degraded natural resources. This region has higher levels of poverty and population density (World Bank, 2010). Pakistan economy is second largest economy of the South Asian region with 188 million population and 236 persons/km^2. Air quality in Pakistan is deteriorating rapidly due to significant increase in carbon dioxide (CO_2) and Nitrogen Oxides (NO_x). Changes in environmental quality and climatic conditions have affected almost all sectors of Pakistan economy (PES, 2013-14).Pakistan economy has been facing environmental problems such as environmental pollution, degradation of land, water and air pollution. In Pakistan, estimated annual cost of natural resource and environmental degradation is about 365 billion Rupees (that is about 6 percent of GDP) per year of which about Rs. 112 billion accounts for water supply, sanitation and hygiene, about Rs. 70 billion for agricultural soil degradation, Rs. 67 billion for indoor pollution, Rs. 65 billion for urban air pollution, Rs. 45 billion for lead exposure and Rs. 6 billion for land degradation and deforestation. It is also believed by some experts that the

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costs of environmental degradation have increased up to Rs. 450 billion per year (World Bank, 2006; PES, 2013-14).

The problem of environmental degradation is aggravating day by day. It has its consequences on the majority of the population in developing countries like Pakistan. About one-fourth of the population like other developing economies lives in conditions of poverty. About 70 percent of the population, directly or indirectly, depends on natural resources for their livelihood. There is strong link between environment and poverty in Pakistan. Environmental degradation, in Pakistan, is both cause and consequence of poverty. Since the poor are more vulnerable to disaster and environmental condition so deterioration in environmental quality affects the livelihood and health of the poor (PES, 2011-12; 2013-14). The objective of poverty alleviation cannot be achieved without setting the trajectory of economic growth. Higher economic growth is necessary but not the sufficient condition for poverty alleviation from the economy (World Bank, 2010). There is rich literature, in economic theory, on the relationship between economic growth and environmental quality. This environment-growth relationship is inverted U-shaped and known as Environmental Kuznets Curve (EKC). The EKC hypothesis states that environment is degraded at early stages of development and after a certain income or economic growth it starts improving the environmental quality (Grossman & Krueger, 1995). Economic growth resulting in environmental degradation compromises the natural and social capital available to the generations to come. Environment plays very important role for the existence, betterment and sustainability of life on the planet. The development that ensures the prosperity and welfare of the present without compromising the availability of natural resources would ensure attaining the objective of sustainable development (Brundtland Commission, 1987).

Higher economic growth calls for higher level of energy consumption. Economic growth has a causal effect on energy consumption and carbon emission in long run (Ang, 2007).More consumption of fossil fuels increases the emissions of CO_2, NO_x and lead in the atmosphere. As economy grows with the industrialization of the economy, people move from rural to urban areas. The demand for and use of personal motor vehicles that lead to significant increase in urban transport resulting in increased level carbon emissions (PES, 2013-14). It is not the consumption of more energy that is responsible for higher greenhouse gas emissions but it is the pattern of consumption and production that is a major source of concern (World Bank, 2010). In Pakistan, more than 60 percent of energy (electricity) is being produced from thermal sources. About 41.1 percent of oil/petroleum and 27.5 percent of Gas was used in power sector in 2013 and it increased to 42.8 percent of total oil/petroleum, 26.1 percent of gas consumption in 2014 (PES, 2013-14). Pakistan economy has showed its reliance on thermal sources as it produces 67 percent of electricity from thermal sources and only 33 percent of the electricity is produced from the hydro sources (PES, 2011-12). More reliance on thermal sources has its consequences on environmental quality. Moreover, a significant increase in number of transport vehicles on the road has also increased the consumption of fossil fuels and caused a drastic increase in carbon emissions in Pakistan. Fossil fuel consumption is a major contributor to carbon emission (Lotfalipour, Falahi, & Ashena, 2010).

Another important development during the recent two decades has been economic globalization and liberalization of the economies. Foreign capital flows to the developing and emerging economies especially in terms of foreign direct investment (FDI) increased over time. Pakistan economy like other developing economies of the world has also received huge amounts of foreign direct investment (PES, 2010-11). Foreign direct investment has its implications on environmental quality. One strand about the foreign direct investment is that it worsens the environmental quality by shifting dirty industries to the host countries (Xing & Kolstad, 2002; He, 2006;Levinson & Taylor, 2008; Baek & Koo, 2009; Acharyya, 2009; Jorgenson &Dick,2010; Agarwal, 2012; Hassaballa, 2013; Bukhari,*et al.* 2014). FDI may affect environmental quality through growth channel. FDI inflows stimulate economic growth through introducing modern techniques of management and production. It also makes possible the transfer of technology from the industrialized world to the recipient economies (De Mello, 1997; Marwah & Tavakoli, 2004; Li & Liu,2005;Ahmad,*et al.*, 2012; Agarwal, 2012; Ali, 2013; Ali,*et al.*, 2014, Ali, *et al.,* 2014a). Trade liberalization is another feature of economic globalization. International trade has increase significantly during the last 3 decades. Increased international trade also affects environmental quality directly (Khalil & Inam, 2006; Agarwal, 2012; Boutabba, 2013) and indirectly through the growth channel. Trade increases economic growth (Edwards, 1993; Krueger, 1997; Rodriguez & Rodrick, 1999; Copeland & Taylor, 2003;Makki & Somwaru, 2004; Asghar*et al.*, 2014).

A strong finanical sector provides a base in setting robust foundation for sustainable development of the economy (Calderón & Liu, 2003; Ali *et al.*, 2014a). The association between finaicnal development and growth my be causal (Calderón & Liu, 2003). Financial development supports the economic growth by enabling the reallocation of capital and easing the continuous restructuring of the economy. Some of the recent studies such as Talukdar & Mesner (2001), Tamazian *et al.* (2009), Bautabba (2013), Shahbaz *et al.* (2013) etc. focus on the impact of financial development on environment. Financial development may be useful in utilizing environmental friendly techniques of production. It may have its adverse impacts on environmental quality through the channels of growth in income and consumption. Financial development provides easy access of credit facilities to the households. It may result in an increase in more use of personal or private motor vehicles on the road. It may have damaging and harmful impact on environmental quality (PES, 2010-11; 2011-12; 2013-14).

Since the focus of the economic managers and policy makers has been on the sustainable and inclusive growth. But the dream of inclusive and sustainable growth would not come true until or unless environmental issues are not taken care off. Higher growth rates today mean more pressure on natural resources and environmental quality. The environment-growth nexus is not so simple rather it is complex. In the era of open, liberalized and integrated world economy the environmental issues cannot be addressed by merely focusing on environment-growth link but the analysis of implications of international trade, flows of foreign capital especially the FDI, financial development would be helpful in understanding the issue. The assessment of the impact of poverty on environmental quality, along with these variables, would provide a profound insight for the control of environmental degradation. There has been a little attempt, to the best of our knowledge, to analyze the sources of environmental degradation by considering economic growth, energy consumption, liberalization, financial development along with poverty levels in Pakistan. Evidence discloses that higher growth and development schemes sacrifice environment quality in long run for economic benefits and employment generation in short run. Overexploitation of natural resources is harmful for the health of ecosystem and thereby has adverse impact on future growth. Since the rural poor disproportionately rely on natural resources for their livelihood so the environmental degradation has serious poverty dimensions (UNDP, 2010). In Pakistan more than 26 percent of the population on the average is poor and deprived. Higher proportion of population living in poverty and their reliance on natural resources may have adverse impacts on environmental quality. The analysis of the impact of poverty on environmental quality in Pakistan in the framework of an open economy would help to better understand sources of environmental degradation in Pakistan. The present study would be an imperative for economic managers and policy makers to comprehend the sources of environmental degradation (carbon emissions) and would be ready to lend a hand in curbing the carbon emissions in paksitan and ensure preserving long run sustainable growth of the economy.

2. REVIEW OF LITERATURE

2.1. Energy Consumption and CO_2 Emission

The history of higher economic growth and development dates back to the industrial revolution. Since then the economies of the world have established the pyramid of their development by utilizing the nonrenewable natural resources. This race for higher economic development levels compromised the environmental quality. There has been a drastic increase in greenhouse gases emissions especially carbon dioxide during last 3 decades or so. This increase in greenhouse gases has increased the process of ozone depletion and global warming (Conceicao, 2003). Higher economic growth calls for more energy consumption. Higher energy consumption leads to increased carbon emissions. The energy consumption and carbon emissions relationship has been explored in many empirical studies. Yu & Jin (1992) focused on the examination of the causal link between energy consumption, growth and employment for the US economy. They found no causal link between energy consumption and growth. Asafu-Adjaye (2000) explored long run and short run causal association between energy consumption and income for India, Indonesia, Thailand and the Philippines. In short run, the author observed bidirectional causality between energy and income for Thailand and the Philippines but he found unidirectional causality running from energy to income in Indian and Indonesian economy. In long run, the result of the analysis concluded unidirectional causality running from energy to income in India and Indonesia. Moreover, there was bidirectional causality between energy and income in Thailand and Philippines. Furthermore, bidirectional causality between energy and income implied that higher growth called for higher levels of energy demand and vice versa.

Ang (2007), using cointegration and vector error correction econometric techniques, analyzed dynamic causal association between energy consumption, pollutant emissions and economic growth in France. The empirical findings confirmed the existence of a strong long run relationship between the variables. The results supported the argument that economic growth causes energy consumption growth and pollutant emissions growth in long run. There was a unidirectional causality running from energy consumption to economic growth in short run. Apergis & Payne (2009) extended the work of Ang (2007) and examined the causal link between CO_2 emissions, energy consummation and economic growth within a panel for six Central American economies. Panel vector error correction technique was applied to test the relationship for the period 1971-2004. Energy consumption, in long run, showed positive and significant impact on carbon emission. Moreover, the empirical analysis confirmed the inverted-U shape pattern of association between economic growth and carbon emissions in the Central American states. There was bidirectional causality between energy consumption and CO_2 emissions in long run. The study also confirmed unidirectional short run causality running from energy consumption and output, respectively, to carbon emissions. However, the causality between energy consumption and output was bidirectional in short run.

Youssef *et al.* (2012) extending the findings of Ang (2007) and Apergis & Payne (2009) implemented bootstrap panel unit root test and cointegration approach to look into the association between carbon emissions, energy consumption and GDP in Middle East and North African economies. Empirical results confirmed GDP to have positive impact on CO_2 emissions and confirmed EKC hypothesis in most of economies included in the sample. Furthermore, the authors suggested Middle Eastern and North African economies to follow policy of energy conservation rather than CO_2 emissions reduction. Soytas, Sari & Ewing (2007) investigated the impacts of energy consumption and output on CO_2 emission in the US by controlling the energy consumption in the model. The Granger causal link was explored between output, energy consumption, and CO_2 emission, labor force in investment in fixed capital. The results of the analysis failed to confirm environmental Kuznets hypothesis in the US economy. The authors suggested energy consumption to be the major cause of increase in carbon emissions. There was no significant evidence of tradeoff between carbon emission reduction and economic growth in the economy. In another study, Soytas & Sari (2009) attempted to explore long run causality between growth, CO_2 emissions and energy consumption in Turkish economy. The gross fixed capital accumulation and labor were also controlled for. The authors found, interestingly, that carbon emission Granger caused energy consumption. There was no causal link between economic growth and carbon emission implying that Turkish economy would not forgo economic growth while reducing carbon emission levels.

Lotfalipur, Falahi & Ashena (2010) investigated the causal links between carbon emission, consumption of fossil fuels and economic growth by using modern technique of Toda-Yamamoto for the Iranian economy. The authors found unidirectional Granger causality running from GDP, petroleum products and natural gas consumption to carbon emissions but total fossil fuels consumption did not found to Grange cause carbon emissions in long run. Moreover, carbon emissions, consumption of fossil fuels and petroleum products showed no growth stimulating impact on economic growth but gas consumption lead to economic growth in Iran. Alam *et al.* (2011) assessed the dynamic impact of energy consumption, economic growth, labor force and domestic investment measured by gross capital formation on carbon emission Indian economy. Toda-Yamamoto causality test complemented Johansen-Juselius approach was applied for the analysis. The results of the analysis revealed bidirectional causality between energy consumption and carbon emissions in long run. The study concluded no causality running from energy consumption and CO_2 emission to growth. Cole*et al.* (2011) examined four industrial water pollution and four industrial air pollution indicators in Chinese cities to assess the income-pollution link. They found that water pollution and air pollution rises with the increase in economic growth. There is negative impact of financial development on environment in China (Jalil & Feridun, 2009).

Jayantha Kumaran *et al.* (2012) compared China and India by using ARDL approach and tested the relationship between, carbon emissions, economic growth, trade, energy consumption and structural breaks. The CO_2 emission, in Chinese economy, was influenced by income, structural changes and energy consumption. The authors confirmed existence of EKC hypothesis in India but there was no considerable association of structural changes and CO_2emission on economic growth. The authors argued that China and India were two major transitional and developing economies but these economies are different in terms of trade, energy use and structural change in growth. Boutabba (2013), in a multivariate analysis , explored the cointegrating association and causality links between carbon emission, growth , energy consumption, openness of trade and financial sector development in Indian economy. The results of the study confirmed long run and causal relationship between these variables. The existence of EKC hypothesis was also confirmed. The study concluded a unidirectional causality running from real income, energy consumption, and financial development to CO_2emissions. Moreover, the author suggested that financial sector in Indian economy should take into account the environmental aspects during its operations.

Ozturk & Acaravci (2013) found no significant impact of financial development on carbon emission in Turkey but the results of the study confirmed the existence of EKC hypothesis over the sampled period. Carbon emission, initially, increased with the increase in per capita real income up to a stabilization point and then it started declining with the increase in income level. In this study, authors found the evidence of long run relationship between carbon emission, energy consumption, real income, trade openness and financial development. There was a significant impact of trade openness on carbon emission in the long run. Shahbaz *et al.* (2013) explored the relationship between growth, energy consumption, financial development and carbon emissions in Indonesia. The empirical results confirmed long run link between the variables. Economic growth and energy consumption increased carbon emission in long run but financial development and trade openness reduced environmental degradation in the economy in long run. There was bidirectional causality between energy consumption and economic growth in Indonesian. Islam *et al.* (2013) explored long run association between energy consumption, total production, financial development and population in Malaysia.

There are some empirical studies focusing on the association between energy consumption and carbon emissions in Pakistan. Some of these studies are Alam *et al.* (2011) and Shahbaz *et al.* (2010). Alam *et al.* (2007) assessed the impact of population growth, GDP growth, energy intensity and urbanization on environmental degradation in Pakistan. Moreover, the authors also simultaneously investigated the impact of population growth, energy consumption, urbanization and environmental degradation on sustainable growth in the economy. The empirical results revealed that energy intensity, GDP per capita, population and urbanization has positive and significant on carbon emissions in Pakistan. The conclusion of the study supported the argument that economic growth, urbanization, and population growth increases the demand for energy. The increased energy demand leads to significant increase in CO_2 emissions. Energy consumption and carbon emission were positively related to GDP whereas population and urbanization showed negative impact on growth in Pakistan over the sampled period. Shahbaz *et al.*(2010) investigating the impact of energy consumption, economic growth and trade openness on CO_2 emissions in Pakistan found long run association between the variables included in the model. The results of the study supported the EKC hypothesis for the Pakistan economy. Unidirectional causal relationship from energy consumption to CO_2 emissions was found. Energy consumption affected carbon emission both in short run and long run but trade opens caused CO_2 emissions in long run. Energy consumption Granger causes economic growth in Pakistan (Asghar & Rahat, 2011).Energy consumption adversely affects environmental quality in Pakistan both in long run and short run (Shahbaz *et al.,* 2012).

2.2. FDI and CO_2 Emission

There are two strands in economic literature about the relationship of liberalization and environment. One aspect is that liberalization may worsen environmental conditions in developing countries with similar factor endowment ratios if pollution-intensive industries shift directly to low-income countries having lax environmental regulations. This proposition is known as Pollution Haven Hypothesis (PHH) in economic literature. A little evidence of the PHH has been found in earliest empirical studies. Levinson & Taylor (2008) found a weak association between environmental regulation and trade. Xing & Kolstad (2002) examined the impact of FDI on environment in industrial and developing countries. The study confirmed weak evidence of the PHH that developing economies use lax environmental regulations as incentives for FDI from developed countries with stringent environment regulations. He (2006) concluded that FDI inflows worsen environmental quality in China. In the recent years, manufacturing has shifted to developing economies (Liang, 2006). Liang (2006) examined the link between scales of FDI and air pollution in China by using city level data. The author analyzed the impact of industry composition, FDI, and several socio-economic variables on air pollution. He found favorable impact of FDI on local environment in China.

Jorgenson (2007) explored the extent to which transnational manufacturing organizations affect environmental quality in less-developed economies. Results of the ordinary least squares fixed effects panel data analysis confirmed that foreign direct investment in manufacturing sector increase carbon emissions and foreign investment dependence in manufacturing sector increases organic water pollutants in less-developed economies. Baek & Koo (2009) used cointegration and vector error correction techniques to analyze the relationship between FDI, economic growth and environment in Chinese and Indian economy. FDI, in these economies, was found to play fundamental role in short run and long run growth through capital formation and technical spillovers. But FDI showed detrimental impact on environmental quality in both of the economies. Acharyya (2009) examined the relationship between economic growth, foreign direct investment inflows and carbon emissions in India. The author, firstly, analyzing the growth impact of FDI in the economy found positive but marginal impact of FDI on economic growth in long run. Secondly, FDI-induced growth effect on carbon emissions was explored. The study suggested that FDI inflows have a quite large CO_2 emissions increasing impact through GDP growth. The results of cross-national panel investigation in Jorgenson & Dick (2010) concluded that FDI in manufacturing contributed to carbon emissions as well as carbon emissions per unit of output.

Agarwal (2012) found no support for the PHH in Malaysia. However, economic globalization policies of the Malaysian economy have not adversely affected environmental pollution directly but indirectly through growth channel. Mahmood & Chaudhary (2012) attempted to find out the effects of foreign direct investment on CO_2emissions in Pakistan. Moreover, the impacts of manufacturing output and population density were also controlled for to assess their impact on CO_2 emission. Foreign direct investment, manufacturing valued added and population density were found to have CO_2 emissions increasing impact both in long run and short run in Pakistan economy. Hassaballa (2013) employed a dynamic panel model to examine the impact of FDI inflows on pollution emission such carbon dioxide, energy use and biochemical oxygen demand in developing economies. The results of the study could not confirm FDI-environment relationship. However, the author suggested the analysis of this relationship on individual economy basis. FDI damages environmental quality in Pakistan (Bukhari, Shahzadi, & Ahmad, 2014). In this study, it was also suggested that improvement in capital formation can helpful in the betterment of environment in the economy. FDI, indirectly, may affect the environment through growth channel. Theoretical and empirical literature is enriched with the arguments that FDI stimulates investment and growth in host economies. The studies such as De Mello (1997), Marwah & Tavakoli (2004), Li & Liu (2005), Ahmad, Hayat, Luqman, & Ullah (2012), Agarwal (2012), Ali (2013), Ali *et al.* (2014), Ali *et al.* (2014a) lend support to the argument that FDI has favorable impact on growth in host economies. A time series study by Khalil & Inam (2006) confirmed that trade and foreign direct investment increased carbon emission in Pakistan.

Export-led growth, in economic literature, is considered beneficial for development for the economy. International trade increases the market share of each economy by increasing trade from domestic to international market. It expands the competition and efficiency in resource utilization. With the emergence of globalized and liberalized international trade there has been a magnificent increase in level of international trade. More liberalized trade has its benefits such as stimulated growth rate, generation of new job opportunities, better utilization of resources but it has consequences on environmental quality. But the environmental economists argue oppositely that increase in international has its environmental consequences. Expansion in liberalized trade increases the resource utilization and depletion of resources that adversely affects environmental quality (Khalil & Inam, 2006). There may be direct and indirect impacts of trade on environment (Agarwal, 2012). Trade, directly, may affect environment by increasing emissions in transport sector. Moreover, increase exports means more produced domestically. If there are dirty industries in the economy then increase in domestic production would cause increase in emissions of pollutants. There may be indirect effect of trade on environmental quality through composition, scale and technique channels (Agarwal, 2012). Furthermore, trade may affect environmental quality through the channel of growth. There is a strong relationship between trade liberalization and growth known as trade-growth nexus. Edwards (1993), Krueger (1997), Rodriguez & Rodrick (1999), Copeland & Taylor (2003), Makki & Somwaru (2004), Asghar *et al.*(2014) concluded growth stimulating impact of trade and trade liberalization. Trade libralization, indirectly, has adverse effect on environmental quality through growht channel in Malasiya (Agarwal, 2012). Jayanthakumaran, *et al.* (2012) and Baoutabba (2013) cocluded that trade openness increased carbon emissions in India but the trade openness elasticity of carbon emissions, in Boutabba (2013), was insignificant. Shahbaz *et al.* (2012) found trade liberalization to have favorble impact on environment in Indonesia. Trade openness reduces carobn emission in Pakistan in long run but in the short it has insignificant on carbon emissions (Shahbaz, Lean, & Shabbir, 2012). Trade openness reduces carbon emissions in pakistan through the technique effect provided scale and composition impacts remain constant (Shahbaz, 2013). Internaiton trade an foreign direct investment icnrease carbon emissions in China (Gu, Gao, & Li, 2013). In theis study, the author found bidirectional causality between foreign direct investment and carbon emissions but the causlaity was unidirectional from internaitonal trade dependency to CO_2 emissions. Increase in trade openness causes an increase in carbon emissions in india (Tiwari, Shahbaz, & Hye, 2013).

2.3. Financial Development and Environmental Degradation

In the recent years, finance-environment nexus has been a center of attention for the researchers. Development of the financial sector may be helpful to improve environmental quality. Financial development convalesce environmental conditions by increasing capitalization ad income. Moreover, financial development also assists in utilizing modern environmental techniques of production, exploiting new technology and implementing forcefully the protocols regarding environment. A number of cross-country empirical studies attempted to analyze effect of financial development on environment. Talukdar & Mesner (2001) found positive impact of domestic financial development on environment in 44 developing countries. The empirical results in Tamazian, Chousa & Vadlamannati (2009) revealed that economic and financial development in the economies decrease environmental degradation. The authors used panel data of 24 transitional economies for the analysis from 1993 to 2004. Moreover, the authors suggested more liberalized and developed financial sector to be beneficial for CO_2 emissions reduction. Tamazian *et al.* (2009) stressed that financial liberalization and openness would help to attract research and development related foreign direct investment would be helpful in the reduction of environmental degradation in the economies.

Most of the empirical studies attempted to assess the impact of financial development in individual economies. Institutional, economic and financial development affects carbon emissions in transitional economies (Tamazian & Rao, 2010). Yuxiang & Chen (2010) concluded improvement in environment with financial development in Chinese economy. In another study, Jalil & Feridun (2011) claimed that financial development had a negative impact on environmental degradation in China. Moreover, the authors suggested that financial development did not take place at the cost of environment. Financial development showed no significant impact on carbon emission in Turkey (Ozturk & Acaravci, 2013). Bautabba (2013) and Shahbaz *et al.* (2013) found financial development has positive and significant impact on CO_2 emissions in long run and there was unidirectional causality from financial development to carbon emission in India and Indonesia, respectively. Financial development helps in reducing environmental degradation by decreasing energy use through energy efficiency (Islam, Shahbaz, Ahmad, & Alam, 2013). There is no significant relationship between financial development and environmental degradation (Ozturk & Acaravci, 2013).

On the other hand, financial development may have its negative impact on environmental quality by providing the easy access to financial sources to the enterprises resulting in increase in investment thereby increasing the economic growth of the economy. Increased investment and growth calls for more energy use. Economic growth and financial development Granger cause energy consumption both in long run and short run (Islam, Shahbaz, Ahmad, & Alam, 2013). Zhang (2011) investigated financial development and carbon emissions nexus for China. He found that financial development contributed an increase in environmental degradation in the economy. Since the enterprises in China have easy access to finance so it makes easy for enterprises to expand their scale of investment. This leads to increase in economic growth and carbon emissions with the expansion of financial sector (Zhang, 2011). Shahbaz (2013) exploring the relationship between financial instability and environmental degradation by using multivariate model found long run relationship between the variables. Financial instability increased environmental degradation in Pakistan.

2.4. Poverty and Carbon Emissions

Poverty, traditionally, is considered as the sources of many problems. In the recent economic literature, poverty has its impact on environmental degradation. It has been argued in Brundtland Commission Report (Brundtland Commission, 1987) that poverty was one of the major causes of the environmental problems and the report suggested poverty alleviation necessary condition for the success of an effective policy to deal with environmental issues. But the relationship between poverty and environment is not simple one. Poverty-environment nexus is complex. There is a two-way association between the environment and poverty. Environment may affect poverty by providing livelihood for the poor, by impacting the poor's health and by affecting vulnerability of the masses living under poverty. On the other side, poverty has its impacts on environment, firstly, by increasing the process of environmental degradation and forcing developing countries to pursue policies for the stimulation of economic growth at the cost of environmental quality(Jehan & Umana, 2003).But Duraiappah(1998) refuted the hypothesis that poverty was a major source of environmental degradation. The powerful and affluent degrade environment in due to institutional and market failures(Duraiappah, 1998). The poor households, in some cases, may cause environmental damage. Poverty works as constraint for the poor and induce them to deplete the natural resources at the rates that are irreconcilable with long run sustainability. This rise in natural resource depletion further reduces the income and natural resources available for the poor (Durning, 1989; Dasgupta & Mäler, 1994; World Commission on Environment & Development, 1987; Pearce & Warford, 1993; Dasgupta, 2003).

Some of the studies concluded that, in many Asian economies, rapid population growth, sluggish growth of production, and environmental degradation were closely related to fast increase in poverty (Jalal, 1993). Satterthwaite (2003) discussed the relationship between urban poverty and environmental degradation in African, Asian, and Latin American economies. The study suggested that consumption pattern of middle and upper-income households affected environmental quality. Moreover, he found failure of government in the implementation of environmental policies to be more responsible for environmental degradation. There was a little evidence of that urban poverty contributed to environmental degradation but environmental degradation was a main contributor to urban poverty in these economies. The link between poverty and environment is causal. Increase in poverty levels may increase the process of environmental degradation and vice versa. The relationship between poverty and environment may be through the channels of economic growth, population, etc. (Khan, Inamullah, & Shams, 2009). Barbier (2010) examined the complexity of association between poverty and degradation of natural resources in developing countries. Barbier argued that most of the poor lived in rural areas. These rural poor depend on natural resources for their livelihood. Moreover, in the absence of labor, capital, land markets, the link between poverty and resource degradation may be influenced by their access to employment opportunities and resource endowments. Alam (2010) suggested that poverty caused environmental degradation in Pakistan. If it persisted, it might slower economic growth of the economy. Zaman, Ikram& Shah (2010) employed cointegration and causality tests to investigate the relationship between rural poverty and agriculture environment in Pakistan. The results of the empirical investigation revealed a significant impact of rural poverty on environmental indices in long run. Moreover, a unidirectional causality from rural poverty to environment was observed.

3. The Model and Data Sources

Since the aim of the present study is to analyze the impact of economic growth, energy consumption, openness of the economic, financial development controlling for the effect of poverty levels on environmental degradation measured by carbon dioxide emissions for the 1972-2011 period. CO_2 is carbon dioxide emissions (metric tons per capita) have been used as a measure of environmental degradation. We have used two variables for energy consumption: electricity production from oil, gas and coal sources, and road sector diesel fuel consumption per capita (kg of oil equivalent). The reason to include these variables as measure of energy consumption is due to the fact that Pakistan economy has been relying heavily in thermal sources of electricity production. More than two third of the electricity in Pakistan has been produced by thermal sources. The use of oil, gas, and coal in the production of electricity may have adverse consequences on environmental quality in Pakistan (PES, 2010-11; 2013-14). Moreover, the number of motor vehicles has increase drastically overtime. The urbanization process has resulted in increased demand for personal motor vehicles. The electricity production from sources of fossil fuels and increase in transport vehicles has increased the consumption of fossil fuels and, as a result, environmental quality has worsened. Openness of the economy may have its environmental consequences too. Increase of FDI flows and volume of international trade affect environment. In the present analysis, we have used FDI and exports as measures of openness of the Pakistan economy. Financial development also has its role in economic growth of the economy. This study also analysis the effect of financial development on environmental degradation. Alam *et al.* (2011) assessed the impact of growth, energy consumption in India butBautabba (2013) assessed the effect of financial development along with the growth and trade in Indian economy. Agarwal (2012) explored the impact of growth, FDI and trade in Malaysia. Other studies such as Acharyya (1999), Cole, Elliott & Zhang (2011), Mahmood & Chaudhary (2012), Hassaballa (2013) and Bukhari, Shahzadi & Ahmad, (2014) included foreign direct investment as explanatory variable in the model. Khalil & Inam (2006) assessed the impact of FDI on carbon emissions in Pakistan. Shahbaz *et al.* (2011) included growth and FDI in the model. Shahbaz (2013) included energy consumption, growth, trade openness and domestic credit to private sector in Pakistan to assess their impact on carbon emissions. In the present analysis, we estimate two models of environmental degradation. In one model, we controlled for the impact of poverty levels on environmental degradation (carbon emissions) along with economic growth, energy consumption measured by road sector diesel fuel consumption and foreign direct investment. In second model, we assess the impact of economic growth, energy consumption measured by electricity production from oil, gas and coal, openness of the economy measured by the ratio of sum of exports and imports of goods and services as ration of GDP, and financial development. Our formulated empirical models are:

$CO_{2t} = f(Y_t, HCR_t, ER_t, FDI_t)$ and $CO_{2t} = f(Y_t, ELP_t, TO_t, F_t)$

The long run models to be estimated are as:

$$CO_{2t} = a_1 Y_{1,t} + a_2 Y_{1,t}^2 + a_3 HCR_t + a_4 ER_t + a_5 FDI_t + u_{1t} \qquad (1)$$

$$CO_{2t} = b_1 Y_{2,t} + b_2 Y_{2,t}^2 + b_3 ELP_t + b_4 TO_t + b_5 F_t + u_{2t} \qquad (2)$$

$\partial CO_2 / \partial Y = a_1, b_1 > 0$ and $\partial CO_2 / \partial Y^2 = a_2, b_2 < 0$

$\partial CO_2 / \partial HCR = a_3 > 0$

$\partial CO_2 / \partial ER = \alpha_4 > 0$

$\partial CO_2 / \partial FDI = a_5 > 0Ora_5 < 0$

$\partial CO_2 / \partial ELP = b_3 > 0$

$\partial CO_2 / \partial TO = b_4 > 0$ or $b_4 < 0$

$\partial CO_2 / \partial F = b_5 > 0Orb_5 < 0$

Where, CO_2 is carbon dioxide emissions (metric tons per capita), Y is GDP growth rate, HCR is the poverty head count ratio, ER is the road sector diesel fuel consumption per capita (kg of oil equivalent), FDI is ratio of foreign direct investment to GDP, ELP is ratio of electricity produced from oil, gas and coal sources to total electricity produced, TO is trade openness measured by the ratio of the sum of exports and imports of goods and services to the GDP of the economy, F is financial development measured by domestic credit provided by banking sector as percentage of GDP. $u_1$and u_2 indicate time and error respectively. The parameters a_1, a_2, a_3, a_4, a_5, b_1, b_2, b_3, b_4 and b_5 are long run elasticity's of carbon emission. All of the variables are in natural logarithm. The sampled data for these variables was sourced from World Development Indicators (WDI) of the World Bank(World Bank, 2014), the Handbook of Statistics on Pakistan Economy issued by state bank of Pakistan (SBP, 2010), and Pakistan Economic Survey (PES) published by the Ministry of Finance, Government of Pakistan (PES, 1998-99; 2001-02; 2007-08; 2012-13).

4. METHODOLOGY

It has been a common practice, in empirical analyses, to pretest stationary properties of time series variables. A non-stationary time series may be integrated of order *p* it becomes stationary at *p* differences (Engle and Granger, 1987). In that case the time series can be written as $z_t \sim I(p)$. The probable order of integration of the time series can be tested by using Augmented Dickey-Fuller (ADF) (Engle & Granger, 1987) and Phillips-Perron (Phillips & Perron, 1988) unit root tests. The ADF unit root test is considered as a standard test to examine the stationary property of the variables. This test is applicable when the error terms are serially correlated. This unit root test adds lagged differenced terms of the variable. This test examines the null hypothesis of non-stationary variable against the alternative hypothesis of stationary. The ADF test estimates the regression:

$$z_t = \beta_0 + \beta_1 t + \gamma z_{t-1} + \omega_i \sum_{i=1}^{p} \Delta z_{t-i} + \varepsilon_t \qquad (3)$$

Where, Δ and ε_t are difference operator and white noise error term, respectively, and $\Delta z_{t-1} = (z_{t-1} - z_{t-2})$, $\Delta z_{t-2} = (z_{t-2} - z_{t-3})$, and so on.The null hypothesis of the ADF test is $\gamma = 0$. If estimated *t*-value of γ is less than the critical value in table of cumulative distribution of the ADF statistic in (Fuller, 1976) then the time series is concluded to be stationary. The linear combination of I(*p)* variables would also be I(*p)*(Engle & Granger, 1987). Phillips-Perron unit root test is another important test to examine the order of integration of time series variables. In this test, nonparametric statistical methods are used to take care of serial correlation in disturbances without including lagged differenced terms in regression. After finding the variables I(*p)* one can proceed to analyze long run behavior of these variables. Johansen cointegration (Johansen & Juselius, 1990) technique is applied to explore the long run equilibrium association between controlled variable and controlled variables included in the model. The Johansen cointegration using Vector Autoregressive (VAR) model can be expressed as follows:

$$Z_t = \rho_1 Z_{t-1} + \rho_2 Z_{t-2} + \cdots + \rho_k Z_{t-k+t} + \varphi + \epsilon_t \quad (4)$$

Where, Z_t is a vector that contains CO_2 and regressors included in the model. Since, cointegration technique is more sensitive to lag length so optimum lag length is selected on the basis of AIC and SBC criteria. The long run association between the I(p) variables is traced if their linear combination is integrated to any order less than 'p'(Johansen & Juselius, 1990). Maximum likelihood method, in multivariate system, is more appropriate (Johansen & Juselius, 1990). In Johansen cointegration method, cointegrtating vectors (r) are selected on the basis of two statistics; the Trace statistics and max-eigenvalue statistics. The Johansen cointegrtion model can be expressed as:

$$\Delta L_t = b_0 + \pi L_{t-1} + \sum_{i=1}^{k} \sigma_i \Delta L_{t-k} + v_t \quad (5)$$

Where, L_t is a column vector of q endogenous variables. π and σ are $q \times q$matrix of parameters to be estimated. v is Gaussian disturbance term. The matrix π is divided in two $q \times r$ matrices M and N. The reduced rank $r < q$ is hypothesized as H_0: $\pi = -MN^T$. The vectors of N signifying the 'r' linear combinations of $N^T L_t$are stationary. Here, M contains the error correction parameters. Trace statics tests the null hypothesis to examine at most r cointegrating vectors and max-eigen statistics assesses the null of r cointegrations against the alternative hypothesis of 'r + 1' cointegrating vectors. Trace statistics is more suitable statistic to determine the number of cointegrating vectors because it is more robust to skewness and kurtosis. So trace statistics was used to assess the number of cointegrating vectors in the present study. If the variables are cointegrated the relationship between the variables can be explained as error correction representation (Granger, 1988). The error correction models for CO_2 can be expressed as:

$$\Delta CO2_{1,t} = \sum_{i=1}^{p} \theta_{11i} \Delta CO2_{1,t-i} + \sum_{i=1}^{p} \theta_{12i} \Delta Y_{1,t-i} + \sum_{i=1}^{p} \theta_{13i} \Delta Y_{1,t-1}^2 + \sum_{i=1}^{p} \theta_{14i} \Delta HCR_{t-i} + \sum_{i=1}^{p} \theta_{15i} \Delta ER_{t-i} + \sum_{i=1}^{p} \theta_{16i} \Delta FDI_{t-i} + \delta_1 ECT_{1,t-1} + e_{1,t} \quad (6)$$

$$\Delta CO2_{2,t} = \sum_{i=1}^{p} \theta_{21i} \Delta CO2_{2,t-i} + \sum_{i=1}^{p} \theta_{22i} \Delta Y_{2,t-i} + \sum_{i=1}^{p} \theta_{23i} \Delta Y_{2,t-1}^2 + \sum_{i=1}^{p} \theta_{24i} \Delta HCR_{t-i} + \sum_{i=1}^{p} \theta_{25i} \Delta ER_{t-i} + \sum_{i=1}^{p} \theta_{26i} \Delta FDI_{t-i} + \delta_2 ECT_{2,t-1} + e_{2,t} \quad (7)$$

In the above equation, δ's and ECT's indicate the speed of adjustment to restore equilibrium after shock(s) to the long run equilibrium and one time lagged value of residuals obtained from the long run equation. Diagnostic tests are also applied to gauge the adequacy of the model (6)-(7). These tests analyze the normality, serial correlation, homoscedasticity of the error term and stability of the estimated parameters. Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests are used to examine the stability of the coefficients . The coefficients of the estimated regression are concluded to be stable if the graphical plots of the CUSUM and CUSUMSQ values remain within the critical bounds of at 5 percent significance level.

5. RESULTS AND DISCUSSION

5.1. The Stationary Test Results

It is very important to pretest the order of integration of the time series before the application of cointegration technique to explore the long run linkage between the variables. For this purpose the ADF test and Phillips-Perron were applied with the assumption of without constant and no trend, with constant and no trend, and with constant and deterministic trend at level and first difference of each of the time series variable. The results of the unit root tests applied on first difference of the time series are reported in the Table 1. The results of the unit root test are evident that each of the variables (CO_2, Y, HCR, ER, FDI, ELP, TO and F) was I(0) at its first difference.

Table 1: Stationarity Test (First Difference)

Variable	ADF-Statistics			Phillips-Perron Statistics		
	none	c	ct	none	c	ct
ΔCO_{2t}	-1.5476	-7.8588*	-7.9976*	-4.8151*	-7.7561*	-7.8956*
ΔY_t	-6.1794*	-6.0899*	-6.1468*	-24.6246*	-25.8851*	-27.4832*
ΔHCR_t	-2.7853*	-2.9244	-2.9174	-3.6382*	-3.8968*	-4.0028**
ΔER_t	-1.7387	-1.5927	-3.9907**	-4.2407*	-5.0259*	-6.4052*
ΔFDI_t	-7.2488*	-7.2449	-7.2569*	-7.2488*	-7.3628*	-7.4328*
ΔELP_t	-2.6419*	-10.3317*	-10.2305*	-9.6987*	-10.1333*	-10.0728*
ΔTO_t	-6.1328*	-6.0412*	-6.1481*	-6.5059*	-6.3603*	-7.0422*
ΔF_t	-4.2916*	-4.2329*	-4.1454**	-4.1217*	-4.0496*	-3.9258**
			Critical Values			
1%	-2.6272	-3.6156	-4.2627	-2.6272	-3.6156	-4.2191
5%	-1.9504	-2.9411	-3.5331	-1.9499	-2.9411	-3.5331

Source: Author s' estimates.

Note: Here none, c and ct stand for with no drift and trend, with drift but no trend, and with drift and deterministic trend respectively.

***(**) shows significance at 1%(5%) level respectively.**

5.2. Long Run Analysis

After finding the all of the variables I (1), VAR model was used to explore cointegrating vectors between the outcome and covariates. Since the cointegration technique is sensitive to lag length so the AIC and SBC criterion were used for the specification of optimum lag length of 3 and 2 for model (1) and (2) respectively. Then the Johansen's cointegration test was applied to find out any cointegrating vector. The results of the cointegration test are shown in the Table 2. The results of unrestricted cointegration rank test (trace) confirm the existence of 5 and 4 coinetgrating vectors for model (1) and (2), respectively, at 5 percent level of significance. It implies that there exists a long run equilibrium association among CO_2 emission, economic growth, poverty, road sector diesel consumption, and foreign direct investment, in model (1), and economic growth, electricity production, trade openness, and financial development, in model (2).

After establishing the long run relationship between the variables, we proceed further to the normalized coefficients (reported in the Table 3). The coefficient of all the covariates, in model (1), has the positive sign except Y^2 and FDI. The normalized cointegration coefficients reported in the Table 3 reveal that economic growth, poverty, road sector diesel fuel consumption cause carbon dioxide emissions in the long run. The squared Y and FDI have negative impact on CO_2 emissions. In model (2), economic growth, electricity production from oil, gas and coal, and financial development has positive association with CO_2 emissions whereas Y^2 and trade openness has environment friendly impact in the economy. One percent increase in GDP growth, in Pakistan, significantly increases the CO_2 emission by 3.32 and 1.12 percent in model (1) and (2) respectively. The coefficient of the squared Y, in both of the models has negative sign. This result is in agreement with the economic theory and empirical studies that at early stages of development environment conditions worsens and after a certain level of economic growth the process of environmental degradation slows down and helps in improving environmental quality (Kuznets, 1955: Grossman & Kruger, 1995; Khalil & Inam (2006); Jayanthakumaran, Verma, & Liu (2012); Boutabba, 2013). Our results confirm environmental Kuznets curve in Pakistan.

Poverty is an important variable to affect environment. Poverty elasticity of carbon emission is positive and statistically significant at 0.01 level. The elasticity is 0.5815 showing that one percent increase in poverty head count ratio leads to 0.58 percent increase in carbon emissions. Higher poverty levels cause a significant increase in environmental degradation measured by carbon emissions. As the masses step into the bracket of poverty they more rely on natural resources. The poor has insufficient income for their survival so they overuse the natural resources available to them. They cut trees for timber, art craft and firewood. They indulge in the easy economic activity of cutting and selling the trees to earn income. The cutting of trees exposes the soil to erosion resulting in degradation of natural resources and their quality as well. Moreover, the poor has no enough resources to access to opportunities of income and education that might enable them utilize electricity or gas. Most often they even have no facility of electric or gas heaters to warm themselves in the winter. The poor cannot use the natural resources in sustainable manner due to lack of knowledge and basic education. Poverty, in Pakistan, has adverse impact on environment. It, significantly, affects the environmental conditions in Pakistan. Pakistan in the economy characterized with a large proportion of population living under the absolute poverty. Majority of the poor live in rural areas as 27 percent of the rural population were living in poverty (PES, 2007-08) in Pakistan. In the rural and far off areas, burning of fuel-wood and biomass to fulfill energy requirements of the people is a major cause of indoor air pollution (PES, 2006-7, 2007-08). Poverty may have its impacts through the channel of increase in population in Pakistan. Poor households are more likely to have large family size. Pakistan economy has higher growth rate in Asia. The population growth rate is 2.05 percent which is very much higher than the population growth of 0.9 percent in Asia. Moreover, Pakistan economy has population growth in South Asia (PES, 2011-12). Since, the poor earn their livelihood directly from the natural resources so large population puts extra pressure on the natural resources by over-exploitation of land and increase in deforestation (Khan, Inamullah, & Shams, 2009). The poor households have limited access to social services. They have insufficient knowledge about environment and its protection. Limited access to sanitary facilities also has environmental consequences. The results are in agreement with that of Alam (2010) and Zaman, *et al.* (2010). Though poverty is found to affect environment quality adversely yet the poor are not sole responsible for environmental degradation. Affluent and more powerful households are also responsible for environmental degradation (Duraiappah, 1998; Satterthwaite, 2003; Jehan & Umana, 2003). Environmental institutions failed to comprehensively monitor and regulate resource use and pollution in Pakistan (Faruqee, 1996). It was also argued that regulatory and monitoring structure failed because of lack of monitoring and implementation capability.

The FDI elasticity of carbon emission (in model 1) is negative showing that one percent increase in foreign direct investment to GDP ratio decreases the carbon emission by 0.81 percent. The FDI elasticity is statistically significant at 1 percent level. Results are in contrast to the results in Acharyya (2009) for Indian economy, Khalil & Inam (2006) and Mahmood & Chaudhary (2012) for Pakistan, and Gu, *et al.* (2013) in China. The measure of international trade openness also has carbon emission decreasing impact as one percent increase in trade openness causes an increase of 4.88 percent in carbon dioxide. In contrast to Jalil and Mahmud

(2009), openness elasticity of the CO_2 is statistically significant. The result of the present analysis, in agreement to Alam (2010), is in contrast to the results in Khalil & Inam (2006), Jayanthakumaran, Verma, & Liu (2012), Boutabba (2013) and Gu, *et al.* (2013). These studies confirm a positive impact of international trade and openness on carbon emissions.

Table 2: Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Model 1: $CO_{2t} = a_1Y_{rt} + a_2Y_{rt}^2 + a_3HCR_2 + a_4ER_t + a_5FDI_t + u_{1t}$					
H_{00}: $r \leq 0$	Ha_0: $r > 0$	0.9758	339.4552*	117.7082	0.0000
H_{01}: $r \leq 1$	Ha_1: $r > 1$	0.9178	205.4257*	88.8038	0.0000
H_{02}: $r \leq 2$	Ha_2: $r > 2$	0.7516	115.4601*	63.8761	0.0000
H_{03}: $r \leq 3$	Ha_2: $r > 3$	0.5988	65.3273*	42.9153	0.0001
H_{04}: $r \leq 4$	Ha_4: $r > 4$	0.4359	32.4451*	25.8721	0.0066
H_{05}: $r \leq 5$	Ha_5: $r > 5$	0.2801	11.8325	12.5180	0.0649
Model 2: $CO_{2t} = b_1Y_t + b_2Y_t^2 + b_3ELP_t + b_4TO_t + b_5F_t + u_{2t}$					
H_{00}: $r \leq 0$	Ha_0: $r > 0$	0.7656	165.5323*	95.7537	0.0000
H_{01}: $r \leq 1$	Ha_1: $r > 1$	0.7215	111.8585*	69.8189	0.0000
H_{02}: $r \leq 2$	Ha_2: $r > 2$	0.5959	64.5619*	47.8561	0.0007
H_{03}: $r \leq 3$	Ha_2: $r > 3$	0.4977	31.0382*	29.7971	0.0358
H_{04}: $r \leq 4$	Ha_4: $r > 4$	0.1337	5.5594**	15.4947	0.7469
H_{05}: $r \leq 5$	Ha_5: $r > 5$	0.0067	0.2478	3.8415	0.6186

The Trace test statistics of Model 1 and 2 indicates5 and 4 cointegrating equations at the 0.05 level respectively.
**** denotes rejection of the hypothesis at the 0.05 level.***
*****MacKinnon-Haug-Michelis (1999) p-values***

One percent increase in road sector diesel fuel consumption ration (in Model 1) and electricity production from oil, gas and coal (in model 2) increases the CO_2emission by 1.77 and 2.64 percent respectively. The electricity production ratios' elasticity is statistically significant at 1 percent significance level. The carbon emission increasing effect of electricity ratio may be due to the fact that 35.1 and 27.3 percent electricity is produced from the oil and gas sources. Only 33.6 percent electricity is being produced by hydal sources in Pakistan. More than 64 percent electricity in Pakistan is produced by thermal sources. As about two-third electricity is produced by thermal source so thermal power generation requires oil and gas. More utilization of oil and gas in the production of electricity results in increase in greenhouse gas emissions (PES, 2010-11; 2011-12). Road sector diesel consumption per capita, another measure of energy consumption, causes 0.10 percent increase in CO_2 emissions. The positive relationship between the road sector diesel consumption and carbon emissions may be due to the fact that number of motor vehicles on the road has increased drastically in Pakistan. The number of registered motor vehicles in Pakistan has shown a significant increase over the years. The total number of motor vehicles increased form 2712837 in 1990 to 4701596 and 9080437 in 2000 and 2011, respectively (PES, 2011). Total number of motor vehicles registered, in Pakistan, increased by 93.14 percent in 2000 and 234.72 percent in 2011 when compared with the year 1990. Composition of motor vehicles in Pakistan has also changed over the years. Motor cars, jeeps and station wagons were more than 25 percent of the total registered vehicles in 1990 but declined to 20.11 percent of the total in 2011. The buses, trucks and motor cycles were 3.10, 3.88, and 46.10 percent of the total vehicles in 1990 respectively. The proportion of motor cycles has increased to 58.60 percent in 2011. Though the proportion of the motor cars, jeeps and station wagons to the total vehicles has declined over the years but their number has shown a magnificent increase of 167.51 percent in 2011 when compared with the numbers in 1990. During the same period, motor cabs/taxis, buses, trucks, motor cycles (with two wheels) and motor cycles (with 3 wheels) increased by 282.14, 139.44, 112.03, 325.43 and 370.20 percent respectively. Motorcycles and rickshaws are most inefficient in fuel consummation. These vehicles contribute most to the carbon emissions (PES, 2010-11; 2011-12). A fast growth in transport sector and unplanned infrastructural development caused environment quality to decline. Moreover, a dramatic increase in number of vehicles, on the road, combined with the use inefficient automotive technology, use of low-quality fuel, routine of burning of waste and garbage, and discharges of brick kilns caused increase in air pollution in Pakistan (PES, 2007-08; 2009-10). Lack of public transports facility also increased the demand for privately owned vehicles (PES, 2006-07; 2009-10) that increased the oil and gas consumption and has its environmental consequences. The finding of the present analysis that energy consumption causes increase in carbon emission is consistent with empirical evidence of Shahbaz, Lean & Shabbir (2010, 2012) for Pakistan, Asafu-Adjaye (2000)for India, Indonesia, Thailand and the Philippines, Jayanthakumaran, Verma, & Liu, (2012) and Boutabba (2013) for India. Some other studies such as Soytas, Sari & Ewing (2007), Ang (2007), Soytas & Sari (2009), Alam, Fatima & Butt, Asghar & Rahat (2011), Shahbaz, *et al.* (2010) also concluded a positive impact of energy consumption on carbon emissions.

Table 3: Long Run Regression Coefficients

Normalized Cointegrating Coefficients
Dependent Variable: Carbon Emission (CO_{2t})

Variables	Model 1	Model 2
	Coefficient(t-value)	Coefficient(t-value)
Y_t	3.3229*(8.6275)	1.1151**(2.5778)
Y_t^2	-0.9901*(-6.5675)	-0.3565**(-2.0909)
HCR_t	0.5815*(3.6763)	-
ELP_t	-	2.6429*(11.9687)
ER_t	1.7660*(8.5988)	-
TO_t	-	-4.8808*(-6.8938)
FDI_t	-0.8084*(-8.6911)	-
F_t	-	3.3311*(6.6465)
Time	(0.0561)*(4.5167)	-

Source: Author Estimations
****(**) significant at 0.01(0.05) level.***

Financial development causes an increase in carbon emission over the long run period. One percent increase in bank credit as percentage of GDP significantly causes 3.33 percent increase in CO_2 emission in Pakistan. The financial development elasticities of CO_2 emission are statistically significant at 99 percent confidence level. It implies that improvement the financial development increases environmental degradation in Pakistan. This may be due to the fact that financial sector may not pursue the environmental friendly policies. Moreover, it may be due to the fact that financial sector development provides easy access to finance that may have stimulating impact on investment and consumption in the economy. Investment in the economy increases the income and output. Increased growth warrants higher levels of energy consumption leading to increase in carbon emissions. Financial development increases energy demand in the economy (Sadorsky, 2010).Banking sector, from the recent past, has increased the advances of loans to consumers and households that may have increased the consumption. There has been a significant increase in auto-loans resulting in significant increase in personal transport vehicles. So it may have caused increase in fossil fuel consumption and improved environmental degradation. Our conclusion differs with Talukdar & Mesner (2001), Tamazian *et al.* (2009), Jalil & Feridun (2011), Islam *et al.* (2013), and Shahbaz *et al.* (2013) that financial development reduces environmental degradation but lends support to arguments of Zhang (2011) for China and Boutabba (2013) for India.

5.3. Short Run Analysis

The existence of long run equilibrium relationship between carbon emissions, economic growth, foreign direct investment, and electricity production, road sector diesel consumption, trade openness, poverty and financial development implies that there must be at least unidirectional causality between the variables.The corresponding vector error correction estimates of model (1)-(2) were obtained with 5 and 4 cointegrating vectors respectively. Diagnostic tests, on each error correction equation, were applied to find out error term of the error correction regression to be multivariate normal, serially uncorrelated and homoscedastic. Furthermore, CUSUM and CUSUMSQ statistics were confirmed to lie within the critical limits. After finding the after the confirmation of stability of the coefficients of error correction models, we applied Granger causality test based on the block exogeneity Wald tests.

The results of the regressions are reported in the Table 4. The coefficient of the error correction term in the error correction model of CO_2, in model (1)-(2), have correct sign and are statistically significant at 1 percent and 5 percent, respectively, showing that 97.66 percent and 0.06 percent disturbances are corrected in the next period if there is any disturbance in the systems. Significance of the error correction term in D(CO_2) equation confirms the long run causality from economic growth, poverty, road sector oil consumption, and foreign direct investment in error correction model (6) and causality from growth, electricity production for oil, gas and coal, trade openness and financial development (in Model 7) to carbon emissions in Pakistan. The causality is unidirectional from D(Y) and D (Y^2) to D(CO_2) in ECM model (6) and it is statistically significant at 0.05 level. But, in ECM model (7), confirms reverse causality and it is significant at 0.01 level. The bidirectional causality, in short run, between carbon emissions and economic growth implies that adaptation of policies for reduction in carbon emissions would restraint economic growth in Pakistan. The causality results confirm a tradeoff between carbon emission and economic growth in Pakistan. Shahbaz *et al.* (2010) also confirmed the existence of short run environmental Kuznets curve in Pakistan.

Table 4: Results of VEC Granger Causality/Block Exogeneity Wald Tests

Model 1: (CO_2/Y, Y^2, HCR, ER, FDI)						
Ind. Variables	**Dependent Variables**					
	D(CO_{2t})	**D(Y_t)**	**D(Yt^2)**	**D(HCRt)**	**D(ER_t)**	**D(FDI_t)**
	χ^2-Values [df = 3]					
D(CO_{2t})	-	3.6043 [0.3075]	4.1929 [0.2414]	1.2428 [0.7428]	13.7365* [0.0033]	4.3890 [0.2224]
D(Y_t)	8.4589** [0.0374]	-	1.9722 [0.5782]	6.1966 [0.1024]	3.3831 [0.3362]	16.7475* [0.0008]
D(Yt^2)	9.1486** [0.0274]	3.8162 [0.2820]	-	4.5558 [0.2074]	3.5892 [0.3094]	11.2894** [0.0103]
D(HCR_t)	18.0670* [0.0004]	6.7059*** [0.0819]	9.9927* [0.0186]	-	5.0485 [0.1683]	10.3610** [0.0157]
D(ER_t)	15.2943* [0.0016]	0.9933 [0.8029]	1.3358 [0.7207]	1.3682 [0.7130]	-	4.3134 [0.2296]
D(FDI_t)	13.5635* [0.0036]	10.0282** [0.0183]	7.1116*** [0.0684]	4.5737 [0.2058]	8.5134** [0.0365]	-
$\sum\chi^2$[df = 15]	82.8044* [0.0000]	45.6192* [0.0001]	44.7686* [0.0001]	18.0529 [0.2599]	27.0649** [0.0282]	30.0742** [0.0117]
ECT_{t-1}	-0.9766* (-4.1695)	0.0022** (0.0276)	0.03164 (1.0036)	-0.1479** (-2.6984)	0.2616* (4.7968)	-
R^2	0.9365	0.8813	0.8778	0.7853	0.8842	0.8550
Model 2: (CO_2/Y, Y^2, ELP, TO, F)						
Ind. Variables	D(CO_{2t})	D(Y_t)	D(Yt^2)	D(ELP_t)	D(TO_t)	D(F_t)
	χ^2-Values [df = 2]					
D(CO_{2t})	-	17.8763* [0.0001]	18.0179* [0.0001]	1.0996 [0.5771]	6.7017** [0.0351]	0.6615 [0.7184]
D(Y_t)	0.6812 [0.7114]	-	1.5163 [0.4685]	0.3607 [0.8350]	1.7711 [0.4125]	1.7846 [0.4033]
D(Yt^2)	1.9302 [0.3809]	1.5680 [0.4566]	-	0.4210 [0.8102]	0.0955 [0.9534]	1.8159 [0.4033]
D(ELP_t)	6.3163** [0.0425]	13.0141* [0.0015]	16.8329* [0.0002]	-	10.7428* [0.0046]	0.5265 [0.7686]
D(TO_t)	7.1276** [0.0283]	3.4149 [0.1813]	5.9665*** [0.0506]	2.2404 [0.3262]	-	5.2969 [0.4373]
D(F_t)	0.2219 [0.8950]	3.8668 [0.1447]	4.8746*** [0.0874]	9.1166** [0.0105]	6.1841** [0.0454]	-
$\sum\chi^2$[df = 10]	33.0804* [0.0003]	34.7654* [0.0001]	45.4607* [0.0000]	34.1455* [0.0002]	23.3101** [0.0097]	10.0364 [0.4373]
ECT_{t-1}	-0.0630** (-2.2248)	-0.0208 (-0.2734)	0.0334 (1.1380)	0.1992** (2.4369)	-	-
R^2	0.6912	0.8121	0.8348	0.8091	0.6715	0.6537

Source: Author Estimations

Note: The values in [ ] & ( ) are p-values and t-values respectively.

The measures of energy consumption measured by road sector diesel consumption and Electricity production from oil, gas and coal Granger cause CO_2 emission in Pakistan without feedback effect. The causality from energy consumption in both of the models is significant at 5 percent level of significance. The causality form energy production to CO_2 emissions implies that increase in consumption would lead to degradation in environmental quality. This implies that best option for the reduction in CO_2 emissions would be decline in energy consumption. But the decline in energy consumption would lead to decline in economic growth as, in our causality results, energy production Granger causes GDP per capita. Our results are in strong agreement with that of Shahbaz *et al.* (2010). In this study, authors found energy consumption to increase CO_2 emissions in Pakistan in short run. The feedback association between energy consumption and carbon emission was also confirmed in Shahbaz *et al.* (2013). Poverty levels in Pakistan significantly Granger cause carbon emissions in short run. There is a unidirectional causality from poverty levels to carbon emission in Pakistan. Zaman, *et al.* (2010) also found unidirectional causality running from poverty to environmental degradation in Pakistan. In contrast to our conclusion Khan *et al.* (2009) confirmed bidirectional causality from poverty to environment degradation. Financial development measured by ratio of bank credit does not Granger cause CO_2 emissions. But in the long run it financial development adversely affects environmental quality. This may be due to the fact that financial sector, in Pakistan, provides credit facilities to the firms who invest in projects that are not environmental friendly. Moreover, credit money may be used, by consumers, to purchase carbon-intensive products such as houses, heating and cooling systems and cars, etc. These causality results are comparable to the results in Boutabba (2013) for India, Shahbaz (2013) for Pakistan, Shahbaz *et al.* (2013) for Indonesia.

6. Conclusion

The present study is an attempt to explore the long run and short run relationship between economic growth, energy consumption, economic globalization and liberalization, financial development, poverty and carbon emissions in Pakistan for the period of 1972-2011. Two separate models have been estimated to assess the impacts of these variables on CO_2 emissions. After finding the all of the variables integrated of order one by the augmented Dickey-Fuller test and Phillips-Perron unit root tests, Johansen cointegration test was applied to explore the long run association amongst the variables. The Trace statistic confirmed long run association between the variables. Economic growth, poverty, electricity production form oil, gas, and coal sources, road sector diesel consumption, and financial development are found to significantly increase carbon emissions in Pakistan in the long run. The results of the both of the estimated models confirm the existence of the Environmental Kuznets Curve hypothesis in Pakistan economy for the sampled period. Moreover, the FDI has been found to have negative impact on carbon emissions in Pakistan for the sampled period. The study found no evidence of Pollution-Heaven-Hypothesis in the economy. Significance of error correction term having negative sign confirmed long run causality from explanatory variables to carbon emissions for both of the models. The study concluded Granger causality from economic growth and electricity consumption to carbon emission with feedback effect. There is unidirectional causality from poverty to environmental degradation.

The results of the present study reveal that boost of competitiveness in environment friendly investment projects have become very essential. Pakistan economy, over the years, has been successful in attracting huge amounts of foreign direct investment. A pragmatic and profound eco-friendly FDI policy ensuring the investments in high-tech projects that make sure efficient use of natural resources and energy would help in obtaining objectives of less carbon emissions. Furthermore, the conclusions of the empirical analysis also cry out for suitable and environment friendly industrial policies. A sound industrial policy coupled with governance intended for regulation of strict laws for environment protection and promotion of sustainable growth in the economy would be helpful. A stringent environmental policy to reduce pollutant from transport vehicles is required. A more stringent policy ensuring the proper maintenance of vehicles and use of emission control systems would only reduce the harmful carbon dioxide, nitrogen oxides and hydrocarbons but also would improve the efficiency and performance of the vehicles. Moreover, there is a dire need to utilize zero-emission transport vehicles such as batter-electric vehicles, hydrogen fuel-cell-electric vehicles and plug-in hybrid-electric vehicles would be helpful in protecting environment and making it sustainable for future.

There is a dire need of decline of the reliance on the economy on thermal sources. Thermal source of energy has shown serious consequences on balance of payment of Pakistan economy. Pakistan economy should utilized hydro, wind and solar energy to produce electricity in the economy. Hydro energy is very cheaper source of energy. Development of hydro energy projects not only enables the economy to save huge financial resources spent on oil and uranium but it is also helpful in obtaining the objectives of lower levels of carbon emissions. The objectives to control energy crises and lowering the carbon emission can be achieved by developing small and large dams on the rivers and streams in the country. Pakistan has large coastline area from Karachi to Gwader. The utilization of the wind energy would massively helpful in generating electricity. Hydro and Solar energy would be the best and cheaper sources of energy in Pakistan. The land of Pakistan is characterized with the large sunny belts couple with higher levels of insolation. Solar energy is abundantly available and widely distributed in Pakistan. Utilization of the solar energy sources would contribute to economic growth, development of socio-economic conditions and poverty alleviation in the economy. Solar energy, in recent times, has been recognized as new, cheaper and environment friendly source of energy. Reliance on solar energy source would lead to low-carbon future and would be helpful in controlling climatic catastrophe on the planet. Government should actively promote the utilization of the solar energy on priority basis. Since the solar installations are expensive and are out of reach of majority, the financial sector can play its vital and supportive role by increasing the financing for this energy source.

The findings of our analysis reveal that financial development has adverse impact on environmental quality both in long run and short run. Environmental aspects should be taken into account in the current functioning of financial sector. Financial sector can play its role in environmental protection by encouraging environmental friendly and energy efficient investment projects in Pakistan. The offer of interest discounts and carbon related conditions while advancing loans for business, investment and real estate credits would be beneficial in curbing carbon emissions. Moreover, a more efficient and strong financial sector would help in facilitating the investment process and helps to stimulate economic growth. The generated economic growth helps in poverty alleviation. Development of efficient financial sector can help in poverty alleviation through enabling easy access to microfinance to the poor segments of population. Moreover, more developed financial sector would help in the establishment and progress of industrial and manufacturing sector in the economy. Growth of the industrial sector improves entrepreneurship, stimulates business investment, introduces dynamism and up-gradation in technology, improvement in human skills and generates job opportunities and help in poverty alleviation. Furthermore, development of the industrial and manufacturing sector would help in laying the foundation for the expansion of agriculture and service sector.

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