Relationship between Economic Growth and Environmental Quality (Pakistan)

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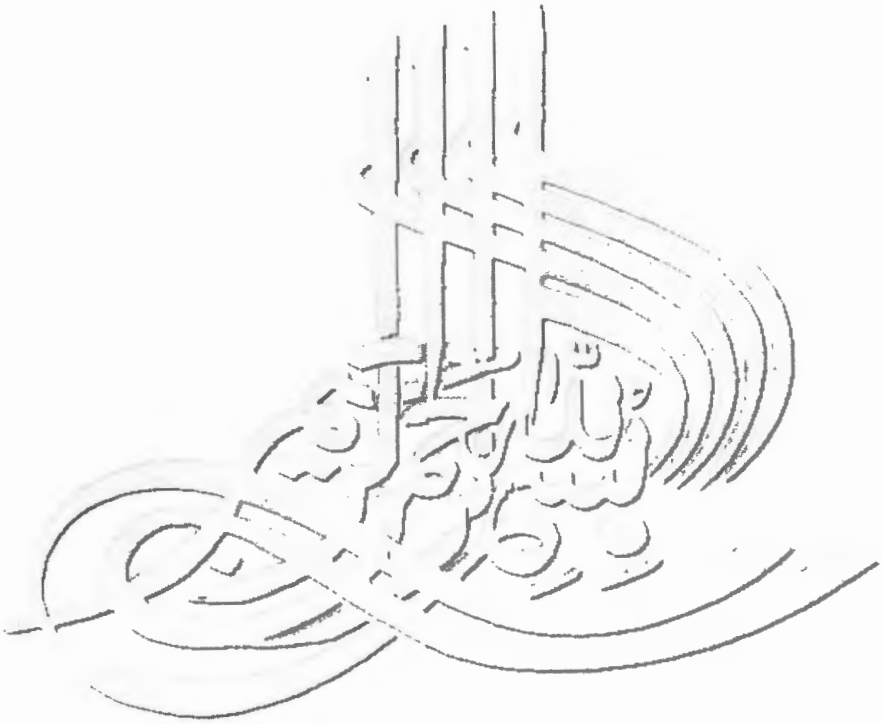

DECLARATION

I hereby declare that this thesis, neither as a whole nor as a part thereof, has been copied out from any source. It is further declare that I have carried out this research by myself and have completed this thesis on the basis of my personal efforts under the guidance and help of my supervisor. If any part is proven to be copied out or earlier submitted, I shall stand by the consequences.

Nazma Zeb

DEDICATION

I dedicate this humble effort to my loving parents, my husband Sarfraz Ahmad and those who always work for the betterment and prosperity of human beings and are a sign of love and happiness in this materialistic world.

ACKNOWLEDGEMENTS

There are no words that can express my deference and regard for **Almighty Allah**, Who bestowed the humankind with knowledge and wisdom and granted His vice regency to them attitudes honorific vocabulary would count to nothing in return for His last and Most beloved **Prophet Muhammad (PBUH)** for enlightening the humankind with the essence of faith in Allah and in guiding the humankind to follow the path of life as desired by Allah the most Merciful and the most kind true path of life.

I feel pleasure to place on record my deep sense of appreciation and indebtedness to my supervisor **Mr. Arshad Ali Bhatti,** for his guidance and effort to improve quality of my work during all stages of my research work his efforts including writing of synopsis, data collection analysis and its presentation.

Nazma Zeb

ABSTRACT

This study finds the threshold effect of per capita GDP on So_2 and Co_2 pollution in Pakistan for the period of 1970-2008 and the nature of this relationship before and after the threshold level of per capita GDP. The study employs instrument variable (IV) threshold regression method suggested by Caner and Hansen (2004). This technique applies asymptotic theory and location and number of thresholds is determined endogenously by the data. The lag value of GDP per capita (PCGDPt-1) is an instrument variable. Energy consumption, trade openness, capital accumulation, and population growth and gross capital formation are some control variables use in this threshold regression method. Sulphur dioxide (So_2) and carbon dioxide (Co_2) gas emission are dependent variables. The results show that for both types of pollution indicators there exists threshold level of real per capita GDP which is significant. For both types of pollution indicators the effect of real per capita GDP is positive and significant before and after threshold level.

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Chapter 1

INTRODUCTION

1.1 BACK GROUND

The issue of relationship between environment quality and economic growth has always remained controversial. Traditional theories of economics suggest that economic development can only be achieved at the cost of environmental quality. But the rapidly expanding works on the theory of Environmental Kuznets Curve (EKC) has proposed a positive association among the environment quality and economic development and hence economic development is a require condition for environmental improvement.

Environmental Kuznets Curve (EKC) is an assumed association among a great variety of indicators of environment deterioration and per capita income. According to the theory in early period of economic growth, environmental deterioration increases, but after some level of per capita income, that is at high income level increase in economic growth causes to improve the environmental quality. This implies that there is an inverted U-Shaped relationship between economic growth and environmental degradation.

Environmental Kuznet Curve (EKC) is a manifestation of Pollution haven hypothesis. Pollution haven hypothesis states that when large developed countries search for setting up offices or factories in foreign countries, they choose the countries

with cheapest labour and natural resources. However, this practice often results in the form of degradation of environmental quality. Developing nations having cheap labour and resources usually have weak environmental policies. On the contrary, countries having strong environmental policies are expensive for foreign companies because of the expenses related to meet these standards. As the result these companies' select to invest in those foreign countries which have the weakest environmental policies or weakest enforcement. Environmental Kuznet Curve (EKC) is a manifestation of Pollution haven hypothesis as one of the causes that tent to increase environmental degradation in pre-industrial economies is an invasion of waste from post-industrial economies. This relocation of polluting industries and firms through foreign investment and trade make possible the decrease in environmental pollution seen in downward-sloping section of the EKC.

The empirical literature about relationship between economic growth and environment shows that there is causality between them. In this regard the concept of decoupling is very important. The term decoupling means utilization of fewer natural resources for each economic output and minimizing the impact on the environment from every economic activity. In 2011 under the supervision of UNEP (United Nations Environmental programme) the concept of decoupling is studied for some developed and developing countries. This study shows that these countries gain some level of success in achieving decoupling.

Environment plays both direct and indirect role in supporting economic activities. Its direct role is the provision of recourses and raw materials such as timber, minerals, water and fossil fuel that are essential inputs for the production of goods and services; and its indirect role is the provision of services such as

sequestration of carbon, purification of water, handling flood threats, and the nutrient cycling. Hence the role of resources of nature is very important for achieving economic growth, for today and for future generations.

On the other hand, economic growth is an important factor in increasing the levels of income and employment, and it also generates the necessary level of investment, infrastructure and technology, both at public and private level. This investment has facilitated the shift to a growth path in which resources are efficiently used. With economic development countries have the opportunity to improve the living standard of their citizens and to cope with the challenges of environmental they have to face. Economic growth plays crucial role in the reduction of poverty level of countries. With the growth of economic activities difference in the distribution of income also reduces and there comes harmony in the states.

Economic growth also improves the educational system and makes the people able of getting better quality education. More and more people avail the opportunity of education. With economic growth quality of education also improve as government have more to spend on hiring highly educated teachers and make available the access to high quality books. Economic growth leads to improve the health and thus life expectancy of the people of a society. With the growth in national income, health care facilities improve and research on the cure of diseases and medical technology also stimulates.

Although economic growth has produced many benefit such as improving the living standard and quality of life all over the world but it has also led to many problems. With economic progression, transformation of the structure of economy also takes place. Generally the economy transforms from agriculture to manufacturing

and then service economy. With this transformation the individual engaged in the older economies are disturbed. But in the long run this transformation proves good for the whole society as with this transformation there is an increase in the income level of individual and production of agriculture and industrial sectors also increases. Another consequence of increase in economic growth is the negative effect on health due to eating too much and consuming energy rich food. This kind of life style produces more sever diseases than diseases produce by malnutrition. Advance countries have to run programmes and campaigns to create awareness about proper diet. Economic growth ultimately results in the form of income inequality. Kuznet for the first time points out that with economic growth income inequality increases in the early period and then it starts decreasing. Pollution is a major setback of economic growth. As with economic development countries pass through the process of industrialization, which ultimately results in the form of land pollution, water pollution and air pollution. Almost all the developed countries in the world have passed through this phase of economic growth. Now developing countries have to face this issue. Infect this issue has grape all the world in its net. Even developed countries cannot escape from its destructed effects. The process of industrialization needs consumption of energy. This energy comes from the burning of fossil fuels like petroleum, oil and coal. The process of burning of fossil fuels results in the form of environmental pollution. Air is most affected by the burning of fossil fuels. Developed countries and developing countries are both engaged in the practice of polluting the air. With the rapid consumption of the fossil fuels the reserves of the nature are also going to decrease. Research shows that if non-renewable sources 0f energy are continued to be consumed in this speed then these reserves will soon be depleted. In developed countries renewable sources of energy are also applied to

minimise the thread of depletion of non-renewable and to avail the blessing of nature. But developing countries are still using these limited resources in vast quantities to meet the needs of population of the country and also to increase the export to generate foreign revenue. Trade openness is another factor of increasing the air pollution. With trade openness, countries have the opportunities to increase their export so that they can gain revenue to trigger the economic growth. Export can only be increased by increasing the manufacturing process. Developed countries usually shift the more polluting industries to the developing countries. Pollution resulting from this manufacturing process affects the air of the domestic countries as well as the air of the other countries as well. Air pollution is the collection of different gases like carbon dioxide gas (Co_2), sulphur dioxide gas (So_2), nitrogen dioxide gas (No_2), lead and smoke particles. Some gases can cross the border and thus disturb the environment of the other countries .Carbon dioxide is such a gas that has very long life and can cross the boundaries of the countries which are responsible for producing it. While sulphur dioxide and lead are only responsible for the local pollution problems. Developed countries are mostly involved in polluting the global environment either by emitting pollution by themselves or by consuming the products made in other countries for the consumption of these developed countries. Growth in population of a country is perhaps the crucial cause of the pollution. Infect all the other causes of pollution emission emerge from this main cause. With the increase in population demand for more and more production increases which stimulate and then increase the manufacturing process. This causes to increase the consumption of energy and then pollution starts to increase. Behaviour of the individuals of a society also affects the pollution problem. If the individuals have the behaviour to invest in the protection of environmental then the pollution problem is minimised. On the other hand if reverse

occurs then the environment is badly disturbed and also the health of the individual is at risk as pollution shows its effect on the health of the population. On the other hand the second behaviour also badly effect the accumulation of capital and thus saving decreases and production of the country also decreases. Economic growth effects the environment in so many ways. Air pollution is perhaps the type of pollution which effects the population on the global level in the form of global warming. Two types of air pollution emission are widely discussed in this regard which are sulphur dioxide gas (So_2) and carbon dioxide gas (Co_2) emission.

Sulphur dioxide gas (So_2) and carbon dioxide gas (Co_2) emission is a form of air pollution and a cause of environmental degradation. Naturally So_2 discharges from volcanoes, water bodies like oceans, decay of biological substances and forest fires. Almost all fossil fuel contain sulphur. During combustion of these fossil fuels, sulphur releases in the form of So_2. Oil, oil by products and coal contain 0.1% to 4% sulphur and up to 40% sulphur is present in natural gas but before distribution, during the processing of gas, sulphur is removed efficiently. About 50% of annual global emissions of sulphur dioxide are the result of the burning of coal all over the world. On the other hand oil burning accounts for 25 to 30% [Troposphere emission monitoring internet service]. Sulphur dioxide has many environmental and health effects. Countries where coal is abundantly used for the production of energy are now facing the problem of acid rain due to excessive emission of So_2. Acid rain is a mixture of dry and wet deposited material consisting of greater than normal amounts of nitric acid and sulphuric acids. Sulphur dioxide and nitrogen dioxide are the major precursors of acid rain [EPA]. When acid rain falls it causes the acidification of streams, lakes and soils, increase corrosion of buildings and monuments, and also decrease visibility. China is worse affected by acid rain. Sulphur dioxide gas only

produces pollution at the domestic level. So countries where fossil fuels are abundantly consume to generate energy face the problem of pollution by themselves. While carbon dioxide (Co_2) can cross the border of the countries where it is produced so it effect the environment of the other countries.

Carbon dioxide (Co_2) is a very important gas in the atmosphere of the earth accounting for about 0.04% of the atmosphere.Co_2 is an effective greenhouse gas and plays most important role in regulating Earth's surface temperature through greenhouse effect and radioactive forcing. The current phenomenon of global warming is considered as the result of the increasing atmospheric Co_2 concentrations in Earth's atmosphere [Wikipedia]. Since the Industrial Revolution, the worldwide annual concentration of Co_2 in the atmosphere has increased from 280 ppm to 395 ppm as of 2013, anthropogenic sources, particularly the burning of fossil fuels and industrialization are the main causes of this increase. [High stats, Co_2 emission data]. Atmospheric oxygen is decreasing at just about the same rate as the atmospheric CO2 increase, which means that the source of the change is from a release of carbon combining with atmospheric oxygen rather than a natural release of CO2. It is well known that the 30 billion tonnes of CO2 released by human activity must go somewhere, and in fact atmospheric CO2 is only increasing by about 16 billion tonnes per year (the remaining is going into the oceans). CO2 produced from the burning of fossil fuels or burning of forests also has quite a different isotopic composition from CO2 in the atmosphere, because plants have a first choice for the lighter isotopes (12C vs. 13C); thus they have lower 13C/12C ratios. And indeed experimentally it is confirmed that this ratio decline in the atmosphere.

Pakistan's energy consumption has almost tripled in the last 20 years. In 1980 its energy consumption was 0.6 quadrillion British thermal units (Btu) which increase to 1.9 quadrillion Btu in 2001. In 2009-10 Pakistan's total energy consumption increase to 63.1million tons of oil equivalent. Energy consumption is met by mix of gas, petroleum products, coal, electricity etc. Burning of petroleum products and coal is a cause of So_2 and Co_2 emission in the country. Petroleum products are consumed in nearly all sectors of economy, with transport and power generating station as major consumers of oil. In power generating sector oil consumption increased from 23.5% in 2003-04 to 46.1% in 2009-10.While in transport sector oil consumption decreased from 61.5% in 2003-04 to 46.3% in 2009-10 due to the utilization of Gas .Pakistan's trade policy is moving towards more liberalization; low tariff rates and less control. Rapid expansions in industrial production and urbanization have led to environmental pollution. As Co_2 and So_2 pollution can cross the boarders, in spite of very little contribution to the overall Greenhouse Gas (GHG) emissions, Pakistan has been severely affected by the negative effects of climate change. Pakistan has been ranked as the 12th country most exposed to climate change [Climate change and its impact on Pakistan (2010)]

The empirical literature about the association of economic growth and air pollution is termed as EKC. The relationship between air pollution (Co_2 and So_2)and economic growth reveals that economic growth is linked with high level air pollution emission initially and the emission of So_2 (Co_2) tend to decrease as the economy achieves the threshold level of economy. In 1991 Grossman and Krueger estimate EKC for air pollution using data of 32 countries. They found that turning point forSo_2 was at $4,000- $5,000 per capita. According to their studies at the initial phase of

economic development, environment quality degrades but later at certain level of income (turning point) it improves.

Selden and Song in 1994 also estimate EKCs for air pollution. Besides So_2 and suspended particles, they also use some other indicator of air pollution like No_x, and CO. Their estimation shows that turning points are very high as compare to the previous studies because in this study data from urban as well as rural areas is used.

Later different studies include other variables in the model of EKCs and find different results. The association between trade openness and environment is inconclusive. Some studies shows positive effect and other shows negative effect. Infect trade openness damage the environment of the countries having not very strong environmental policy. While the association between energy consumption and environmental quality shows that there is negative impact of energy consumption on the environmental condition that is increase in energy consumption increase the pollution. On the other hand population growth also increases the pollution because the increase in population leads to increase the production and thus energy consumption increases and this leads to increase the pollution. On the other hand study about the effect of gross capital accumulation on the environmental quality shows that if the individual in a generation spend some portion of money for the preservation of environment then environment quality and the whole economy works better and vice versa.

1.2 SIGNIFICANCE OF THE STUDY

In the case of Pakistan different studies estimate EKC hypothesis. Ismail at el (2014)estimate EKC hypothesis to examine the connection among So_2 emission ,

economic growth, trade openness, energy consumption, gross capital formation and population density by using Auto Regressive Distributed lag (ARDL) methodology for the period 1971-2008.Their study shows that inverted U-Shaped relation exist between So_2 pollution and economic growth.

Similarly, Shahbaz at el (2010) determine the relationship between an indicator of air pollution that is CO_2 emission and consumption of energy, economic growth and trade liberalization for Pakistan over the period of 1971 -2009 by applying Auto Regressive Distributed lag (ARDL) methodology model for integration. The results show that EKC hypothesis does exist in this case also.

Similarly, Shahbaz at el (2011) determine the relation among Co_2 emission, economic growth, consumption of energy, growth in population and financial development for Pakistan for the period 1974-2009. This study applies ARDL bounds testing approach and confirms the presence of EKC hypothesis for the country.

Until now, no work has been done to find the threshold level of per capita GDP for the relationship between economic growth and So2 and Co_2 pollution for Pakistan. The aim of the present study is to find the threshold effect of per capita GDP on So2and Co_2 pollution in Pakistan for the period of 1970-2008 and the nature of this relationship before and after the threshold level of per capita GDP.

1.2 RESEARCH OBJECTIVES

- To explore the determinant of So2and Co_2 pollution in Pakistan.
- To explore the threshold effect of per capita GDP on So2and Co_2 pollution in Pakistan.

1.3 TESTABLE HYPOTHESES

Following the above discussion and research objectives, we form our testable hypotheses as follows:

H1: There is a significant impact of per capita GDP, trade openness, population growth, investment, and energy utilization per capita on So2 and Co_2 pollution.

H2: There exists a threshold level of per capita GDP below which the association between per capita GDP and So2 (Co_2) is positive whereas it is negative above it.

Methodologically, we use threshold regression with instrumental variables as suggested by Caner and Hansen (2004) to test the above hypotheses.

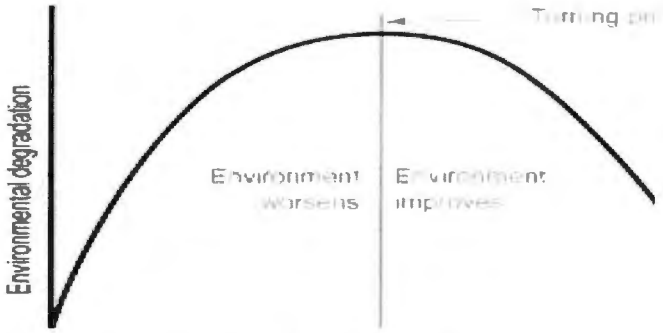
This thesis is organized as follows. In Chapter 2, we discuss some prominent studies from the huge literature of environment Kuznet curve and relationship between So_2 (Co_2) pollution and trade openness, population rate, energy consumption and gross capital formation. Chapter3 discusses data and econometric methodology. Chapter4 explains our empirical results and findings. Chapter 5 provides the concluding remarks. Descriptive statistics, and gauss coding are provided in Appendix A.

Chapter 2

LITRATURE REVIEW

Kuznet (1955), in his executive address to the American Economic Association , argues that income inequality generally rises in the early stages of economic development as people move from low-productive agriculture to more productive industrial sector as there is little variation in agriculture income while industrialization lead to large differences in income. In the latter stages of development, inequality declines as urban -rural gap reduce and unemployment benefits, old-age pensions and other social benefits are transfer to the people. This inverted U –Shaped association between economic development and income inequality has since been known as Kuznet Curve.

Then in early 1990s, some scholars analyse that inverted U-Shaped relation also exist between economic growth and environmental deterioration. This relationship is called Environmental Kuznet Curve (EKC) on the name of Kuznet curve. EKC hypothesis states that in the early period of economic growth, the environmental pollution is low. But with industrialization, the level of pollution in the environment increases. And, as economic growth reaches its higher stage, pollution level decreases because of the shift of high-polluting industrial economy into service economy or technology- based economy.



Environment Kuznets Curve

The empirical literature about EKC is fuelled by the work of Grossman and Krueger (1991, 1994) and the World Bank (1992). Grossman and Krueger (1991) in a working paper investigate the environmental impacts of North America Free Trade Agreement. According to this study trade liberalization and investment by foreign countries can affect the environmental pollution and the rate of depletion of scarce resources of environment by three separate ways; scale effect, composition effect and technique effect. Scale effect suggests that if trade openness and foreign investment liberalization causes to upgrade the activities of economy but the nature of these economical activities does not change, then the environmental pollution must elevate. While composition effect implies that with trade liberalization, countries gain perfection in those sectors in which they enjoy competitive advantage. And if competitive advantage is due to the variation in regulation of environmental policy, then the composition effect will result in the form of deterioration of environment because each country will be inclined to focus entirely in the economic activities that are not strictly regulated by its government. On the contrary, if the dissimilarities in factor abundance and technology is the cause of comparative advantage then the net effect of this difference on environmental pollution in each country will be based upon the situation that whether pollution-stimulating activities increase or decrease in

the country that has the more strict pollution controls. While, technique effect suggests that by trade openness more modern technologies may transfer to the local economy. Up-to-date technologies are cleaner then old technologies due to global awareness of the importance of environment. Overall effect is that if trade openness generate an increase in income level then demand for cleaner environment also increase. Grossman and Kruger found with the cross section study of 42 countries that with trade liberalization air pollution increase with the increase of income but after reaching a threshold level of income (turning point) it starts decreasing. The turning point So2 is at $4,000- $5,000 per capita. This implies that there is an inverted U-Shape relationship between economic growth and environment degradation. Later on this relationship is term as Environment Kuznet Curve (EKC).

Similarly, Shafik and Bandyopadhyay (1992) investigate the association among economic growth and several environmental quality indicators. This study applies panel regression using data from 149 countries for the period 1960-90. The findings show that an EKC relationship is present for ambient So2 and income with a turning point of about $3,670 per capita. This is consistent with the estimate of this sort done by Grossman and Krueger (1991).

Similarly, Selden and Song (1994) estimate EKCs for four indicators of air pollution (SO2,CO, NOx and SPM,)by using longitudinal data from World Resources (WRI, 1991). Their estimation shows that threshold levels (turning point) are very high as compare to the two previous studies; (in 1990 US dollars). The turning point for SO2 is at $10391, for NOx threshold level is at $13383, for SPM turning point is at $12275; and for CO turning is at level of $7114. Turning points in this study are

very high as compare to earlier studies because data from both urban as well as rural areas are used.

Cole, Rayner, and Bates (1997) investigate the presence of EKC for OECD countries (Organisation for Economic Co-operation and Development. In this study cross-country panel data sets for the period 1970-1992 is applied. Several indicators of environmental pollution are used in this analysis. Some of which are carbon dioxide, carbon monoxide, nitrogen dioxide, sulphur dioxide, municipal waste, energy consumption and traffic volumes. Their study confirms the existence of EKC. Carbon Dioxide has turning point of about $ 22,500 – $ 34,700, Carbon Monoxide has turning point of about 9,900 – 10,100, Sulphur dioxide has turning point of about5,700 – 6,900.

Following them, Friedl and Getzner (2003),Nohman and Antrobus (2005), Dinda and Coondoo (2006) and Coondoo and Dinda (2008) estimate EKC for different indicators of environment degradation. All their work is in favour of inverted U-shaped EKC hypothesis.

Similarly, Phimphanthavong (2013) also test the hypothesis of EKC for Laos. This study applies time series data for the period 1980-2010. Co2 pollution emission is used as an indicator of environmental pollution. The result confirms the hypotheses of EKC. Along with increase in income, industrial expansion, trade openness and becoming full member of ASEAN also aggravate the problem of pollution in the country.

On the other hand Millimet, List, and Stengos (2003) document N-shaped curves .They test EKC for nitrogen oxide and sulphur dioxide pollution by using U.S.

state-level panel data They attribute that as a country develops its pollution level to increases, pollution decreases as the threshold GDP is approached, and then starts to increase again as country's income continues to increase. Such findings can prove significant as they arise the concerning question of whether pollution level begins to decrease in real sense when threshold level is approached or whether the pollution is merely exported to poorer developing countries.

Similarly, some studies show the presence of U-Shaped EKC. The documentation of U-shaped EKC suggest that the developed industrialized countries which have already crossed threshold level an additional increase in their per capita income result in degradation of environment .

On the other hand Yandle at el (2002) argues that increase in per capita income without institutional reform is not enough for the existence of EKC. The upgrading of the environment quality with high level of income is not automatic but it depends on government policies and reforms in the institutions. Actually at higher income level, for betterment in the environmental quality is demanded by public and resources also become accessible for it. Strict government policies, institutional reforms and the perfection and smooth functioning of markets all have to play their role in the improvement of environment quality.

However, Arrow et al (1995) argues EKC would seem to be wrong if pollution level increases once again at the end because o f the increase in income and consumption of the population at large.

Suri and Chapman (1998), on the other hand argue that on global scales there is no net reduction in the pollution. Rich countries have a tendency to export the

activities that produce the most pollution, like manufacturing of furniture and clothing, to underdeveloped or developing countries. This means that when these poor countries will develop, these countries will not be able to export their pollution to anywhere. Thus, this practice of environmental cleaning taking place in association with economic growth cannot be repeated for an indefinite period because there will be nowhere to export waste and pollution.

Roca et al (2010) analysis EKC hypothesis for the country Spain. Their result rejects the most optimistic view that increase in income decrease the pollution. Only in the case of So2 emission, increase in emission accompanied with decrease in emission and in this case it appears clear that coordinated environmental policies among countries play an important role in this regard and these policies have work well in all the countries, regardless of their income level.

Asici (2011), investigate the relationship between economic growth and its impact on environment in the form of pressure from energy consumption, net forest depletion and carbon dioxide pollution. This study is carried out by applying two methods which are fixed effect and fixed effect instrument variable IV by taking data for 213 countries for the period of 1950-2008. The result shows that EKC does not exist in this case. Pressure on environment is low for low income countries but this pressure reaches to its peak in the middle income countries. For high income countries this relation is negative but not significant. In the middle income countries, demand for cleaner environment also arises but does not work to decrease the pressure on the environment. The implementation of advanced technology also does not work in these countries. So it is not right decision to wait for market forces or developing the

institutional structure or use of new and advanced technology to decrease this pressure more far-reaching steps are required .

Similarly, Sappala (2000) and Martın (2004) test EKC and show that EKC does not exist in their case studies. Harbaugh et al and (2002) Harris et al. (2008), also find no prooffor EKC between economic development and environmental quality deterioration.

The environmental Kuznets curve (EKC) suggests that a country's pollution increases with industrialization and development up to a turning point(threshold level), after this point pollution decreases as the country utilize its increased affluence to decrease the environmental pollution, This suggests that environment in the developed countries is cleaner at the cost of a dirtier environment in developing countries. In this sense, the EKC is a manifestation of the Pollution Haven Hypothesis as one of the causes that tent to increase environmental degradation in pre-industrial economies is an invasion of waste from post-industrial economies. This relocation of polluting industries and firms through foreign investment and trade make possible the decrease in environmental pollution seen in downward-sloping section of the EKC.

Temurshoev (2006) empirically examine two contrasting theories of pollution haven hypothesis (PHH) and factor endowment hypothesis (FEH) to investigate the influence of trade openness on the quality of environment. The PHH predicts that countries where environmental policy is not very strict become polluted because they have the tendency to specialize in dirty-goods production. On the other hand, FEH predicts that trade is not effected by pollution policy but instead it is the difference between the factor endowment and technology that effect trade, and asserts that the capital abundant country have the tendency to exports the capital-intensive (dirty)

goods, which increase its production, thus increases the level of pollution in the capital abundant country. By using input-output analysis the study calculate increase or decrease in air pollution (CO_2, SO2 and NOx) in US and China if exports and imports of these two countries increase by the same amount. For this purpose the effects of one million USD (RMB) increase in US (China) trade on emissions are obtained from computing fossil fuels (oil, coal and petroleum) embodied in each commodity under the assumptions of production- and consumption-generated pollution. Then the actual pollutions are computed for different shares of production-generated pollution. This empirical study rejects both theories.

The empirical literature about relationship between economic growth and environment shows that there is causality between them. Panayotou (1997) explores the answer of the question that if the world be able to maintain economic growth for the foreseeable future without the depletion of scares environmental resources or at that level beyond which it is not repairable? In this study effect of economic development on environment in ECE (East central Europe) region is discussed. The ECE region comprises of the highly developed countries and many of the countries are in transition. Although both types of countries have attained some degree of decoupling of environment quality and economic growth by adopting a service-based economy, by adopting production methods in which less energy and material are used, and by applying new policies of economic development and environmental protection. But the continued increase in the municipal waste and CO_2 emissions reveals that in spite of significant development, consumption patterns of these developed nations are unsustainable. Whereas in the transition economies, use of resource and pollution emissions are also increasing but less than proportionately.

Their consumption patterns are similar to that of developed nation but their energy intensity of GDP is greater than that of the highly developed countries.

In 2011 under the supervision of UNEP (United Nations Environmental programme) the concept of decoupling is studied for some developed and developing countries. The term decoupling means utilization of fewer natural resources for each economic output and minimizing the impact on the environment from every economic activity. The purpose of this decoupling is to increase the efficiency of the resources used for the production and to use the material resources in better way and cleanly but it does not means to reduce the use of resources. These material resources include fossil fuels, construction materials and biomass. These materials resources have been used in very huge proportion for gaining economic growth over the world. The material resources pass through a channel of transformation from extraction to transport to the processing unit and then transforming it into commodity and then transferring them to the consumers and consumption and finally the disposal of the waste materials. Every part of this channel requires energy and then finally shows its impact on the environment. So this is a very import issues from the point of view of decoupling. Another important issue with respect to decoupling is trade openness. Large portions of the material resources are traded internationally and contribute its share in the pollution. International trade has been increasing with the passage of time and so it has become a very critical issue with regard to decoupling. The countries studied in this report are Germany, Japan, China and South Africa. Germany is well known as the leading country in making policy for the protection of environment because it has laid the basis for the meaningful reduction of environmental pollution since early 1970. Government of Germany established National Strategy for Sustainable Development (NSSD) in 2002. The NSSD of German has the main goal

of doubling the productivity of both the energy and resources by 2020. Meanwhile the issue of decoupling is also considered as the main goal in the way of progress. For the increased productivity of energy, the Swiss idea of 2000 Watt per capita society is under consideration in the country. 2000 Watt per capita is equal to one third of the present energy consumption of the European countries. This goal can be achieved by complete reforms in the innovation system, by the sustainability in the pattern of consumption and production, by more and efficient use of renewable energy resources and by reducing the loss of energy. The strategy to decrease the raw material by efficiently using the inputs, limiting the waste materials produced and emissions will decrease the cost of production, create new business opportunities, enhance the competitiveness and create new jobs. The empirical studies shows that German economy does experience decoupling for thirteen years from 1994 to 2007 when the productivity of the resources increased by about 35% and GDP increased by 22% and input of resources decreased by about 10%.

On the other hand situation of South Africa economy is not so appreciated. South Africa is newly independent country, gains independence in 1980. South Africa is enriched with natural resources and its economy mainly depends on the export of these resources. So for the period of fourteen years from 1994 to 2008 it gains extraordinary growth due to higher prices of its exports. But this path of growth collapsed in 2008 as the result of financial crisis worldwide in which the prices of the export of South Africa decreased. A second reason of its economic growth has been huge consumption at the domestic level financed by housed debt .On the other hand, the manufacturing sector has not flourished in the country due to the lower rate of tariffs on imports and due to the capital market liberalization . So all these factors lead to sever collapse in the economy of South Africa. The country is enriched with

coal reserves and electricity produced in the country using these coal reserves is cheapest. Coal reserves are used in very inefficient way to meet the needs of domestic energy and energy required for mining and processing the raw materials which result in the form of huge Co2 emission. As South Africa is a developing country, its utilization of huge energy and especially energy generated from coal has made the country highly polluted. The country also imports oil to meet the need of fuels of transport. Oil prices are increasing at the global level. The rigorous energy consuming nature and increasing price of oil is a big challenge for the economy. The country has also experienced decoupling when the use of material resources decreased while the GDP increased in 2000. In 2008 government establishes National Framework for Sustainable Development (NFSD) so that the country use energy and natural resources in most efficient way as the country can no longer run on the same modes of energy consumption, on the same technology principals and on the same system of transport. Now at government level it is decided to diversify the resources of energy and use more and more renewable energy resources, to organized bus and train system and to minimize the use of material resources so that the effect of economic activities on the environment can be minimized.

On the other hand, China is a developing country with huge population and limited natural resources. The economic development of China has undergone four stages. In the first stage agriculture system is organized and developed. In the second stage, non agriculture system gains consideration particularly textile industry and other light industries flourished. Third stage is characterized by the development of heavy chemical industries like infrastructure industry, energy producing industry and household appliances manufacturing industries. After 2000 the fourth stage begins in which heavy chemical industries become the vital part of economic growth. For this

type of manufacturing huge proportion of energy and material resources are consumed and thus this resulted in the form of pollution and environmental degradation . China is the world's largest emitter of Co2 and So2 and at the same time china has also gain wealth. The government is well aware that the country is consuming excessive energy and emits a lot of pollution. So in 2005 government establishes an action plan to limit the consumption of material resources and pollution. The government has also put forward the scheme of ecological civilization. The concept behind ecological civilization is to protect the environment from the bad effects of development and growth. To achieve the goal, government has launched the programs for energy saving and pollution reduction in 2006 and called it Green Development. This type of development includes green consumption, green fiscal policy and green finance. In green consumption people are pursue to consume the products which are environment friendly. Green fiscal policy encourages the investment in the environmental protection technologies, research and development. While in green finance programmed loan are issue for the investment in environment protection production process. Another step is to organize Green Olympics which include more than 150 programs for the protection of environment. China also shows decoupling in some indicators of environment as the result of energy is saving and pollution decreasing programs initiated by government in 2006.

While the economy of Japan is largely depended on the natural resources imported from other countries. These natural resources include food, energy and raw materials. So this country does not extract its raw material and is safe from the ecological effect of extraction. So environment there is not effected from the problem of pollution of extraction, mining and processing of raw materials. But on the other

hand it has a large population and has the problem of increased waste materials as the result of consumption and the diversification of waste materials. As Japan mostly depends on the imported oil so global oil crisis in 1973 and 1979 has very strong effect on the Japanese economy and the economy react this shock by investing to improve the efficiency of energy and to save the energy. This act automatically leads the economy on the way of decoupling. Government of Japan has initiated a Top Runner Program for more efficient use of energy.

On the other hand effect of environmental changes on economic growth is determined by Hsiang et al(2014). They determine the effect of cyclone on the long run economic growth for the period of 1950-2008. In this study growth rate ofeach country is compare to its own growth rate of the years before and after cyclone exposure. The results show that national incomes decrease, as compare to their pre-disaster trend, and do not improve within twenty years. And both poor and rich countries exhibit the same response, and losses are greater in the countries which experience less historical cyclone.

On the other hand both the theoretical and empirical literature on the relation between trade and environment quality is indecisive about the overall effect of trade on environment quality. Antweiler et al (2001) estimate the effect of trade openness on So2 emission. They decompose the determinant of emission (pollution) into scale, composition and technique effect. The scale effect indicates the positive effect of trade on emission; pollution increase with the increase of trade openness. Technique effect indicate the negative impact of trade liberalization on emission intensity; with trade openness modern, less pollution emitting technology transfer to the local economy. And composition effect explains how composition of output effects the

emission. Composition effect is found by the degree of trade openness and comparative advantage of resources. This effect may be positive or negative depending on the resources and the strength of environmental policy. Antweiler found that SO2 concentration increases as GDP increases and decreases as trade openness increases.

Similarly, Cole and Elliot (2003) investigate country level per capita emission of SO2, CO_2, NO and BOD and estimate scale, technique and composition effect. Their finding supported the result of Antweiler in case of So2 emission but suggested that increase in income reduce emission while trade openness increase emission of Co_2 and No.

However, Abdulai et al (2009) analyse the effect of trade openness on economic growth within the contest of the Environmental Kuznets Curve (EKC), by using cross-section data of countries for the period 1990-2003. Separate investigations have been done for groups of low and high-income countries. The empirical results show that no particular relationship is found between trade, economic growth, and the environmental quality across all countries and all the pollutants. Relationship of trade with energy consumption, air pollution and adjusted net saving (ANS) reveals that trade openness may be favourable for rich, but it is harmful for the growth of poor countries. This led to support the pollution haven hypothesis.

However, Frankel and Rose (2005) by using cross section data of 41 countries for the year of 1990 investigate the impact of trade openness on sulphur dioxide pollution. Their result confirms the view that trade openness reduces So2 pollution.

Managi et al (2008) estimate the overall impact of trade liberalization on environmental quality by using the instrumental variables technique. This study analyses the causal impact of trade openness on BOD,SO2 and CO_2 emission by using panel data for both OECD and non-OECD countries. This study reveals that there is difference between OECD and non-OECD countries with respect to So2 and Co_2 pollution emission. Only in OECD countries trade decreases the emissions of these pollutants, both in the short run and long run. Trade openness effects emissions of these pollutants through capital labour effect and the environmental regulation. This study finds that the latter effect is larger than the former effect for all pollutants for OECD countries.

Similarly Nguyen (2006) investigates the effects of trade openness on the environmental quality for six East Asian countries (Malaysia, Indonesia, China, Philippines, Vietnamand Thailand). The choice of these six countries is based on the fact that these are industrialized and fast developing countries and utilizing huge amount of energy and thus producing huge pollution. This study uses carbon dioxide pollution emission and energy consumption as indicator of environmental pollution. In this study a variety of tests are applied and the result shows that carbon dioxide pollution emission and energy consumption both move linearly with trade openness. This means that trade openness causes to deteriorate the environment. Although, trade openness brings new technology and causes to increase the efficiency but environmental externalities leads to degrade the quality of environment. There is no support for EKC from this literature. However PHH is supported by this study because trade openness has causes to shift the dirty industries in these fast growing countries with not very strong environmental policies.

On the other hand Azhar et al (2007) examine the effect of trade intensity, scale effect, composition effect and technique effect on environment pollution in the case study of Pakistan. This study applies Johanson-Juseliusco integration technique to investigate long run relationship among the variables and error correction model to find out the short run relationship by using the time series data over the period of 1972-2001. The results show that in long run trade openness lead to increase air and water pollution. The finding supports that trade openness effects negatively on environmental indicators. Greenhouse gases especially carbon dioxide emission is increasing with alarming rate. According to this study even if the composition effect is ignored, due to trade liberalization the scale effect causes an increase in output and also increases total industrial pollution. So in order to have a check on scale effect, there must be transfer of cleaner technology from developed countries to decrease the pollution intensity of industrial activity.

On the other hand empirical literature on air pollution and energy consumption shows different findings. Shahbaz et al (2009) investigate the short run and long run relation between Co_2 emission, trade openness, economic growth and consumption of energy for Pakistan, over the period of 1971-2009. They employ ARDL model for co integration and Granger causality test. The empirical result shows that energy consumption causes to increase the Co_2 emission in the country. It is revealed that there is 0.6percent increase in Co_2 pollution emission with one percent increase in energy consumption.

Similarly, Acaravci et al (2010) examine the causal relation between Co_2 emission, energy consumption and economic growth by using ARDL bound testing

approach of co integration for nineteen European countries. In this case also Co_2 emission increase with the increase in energy consumption.

Similarly, Sabooriet al (2013) examine the relationship among energy consumption, carbon dioxide pollution emission and economic growth in the case study of Malaysia by applying Environment Kuznet Curve hypothesis for the period 1980-2009.This study uses aggregate data for energy consumption which include all the sources of energy jointly. And disaggregated energy consumption data that include separate data for each energy source like coal, gas, petroleum and electricity. The logic behind using disaggregated data is that each energy source has different effect on environmental quality. To determine the relationship of cointegration, Autoregressive Distributed Lag (ARDL) methodology is applied. While, Granger causality test is applied to test the causal relation among the variables. The findings show that Environment Kuznet Curve does not exist for short run analysis for both aggregated data and disaggregated data. While in the long run study Environment Kuznet Curve again does not exist for aggregate data however, for disaggregated data Environment Kuznet Curve does hold. Finding of Granger test shows that there is causality between consumption of energy and carbon dioxide pollution emission. This means that increase in energy consumption leads to increase the pollution. Meanwhile there is also causality between economic growth and carbon dioxide pollution emission which is in two ways. This means that increase in economic growth accelerate the pollution and vice versa. These finding leads to conclude that if energy consumption is minimize then economic growth also slow down along with carbon dioxide pollution emission. So other sources of energy should be explored.

H Iwata et al (2009) investigate the presence of Environment Kuznet Curve for the country France. The objective of this study is to explore the effect of use of the nuclear energy for the generation of electricity and thus on the emission of Co2 pollution. This work is done by applying 'autoregressive distributed lag (ARDL) model and Angle Granger causality technique'. This investigation shows that Environment Kuznet Curve works for France. France is one of the developed countries and the ratio of using nuclear energy for the generation of electricity is highest in the world. The causality test shows that there is single directional relation among economic growth, energy consumption and Co2 pollution emission. Energy consumption has negative impact on the generation of carbon dioxide pollution. So carbon dioxide pollution does not increase with the use of nuclear energy.

H Iwata et al (2010) investigate the causes of Co2 pollution emission and the presence of Environment Kuznet Curve for some selected countries of OECD. Trade, nuclear energy and overall energy consumption are taken as independent variables. 'Autoregressive distributed lag (ARDL) model and Angle Granger causality technique' are applied to carry out this work. The research findings show that trade does not play role in increasing Co2 pollution while energy consumption plays major role in this regard. On the other hand result about the role of nuclear energy consumption and Co2 pollution is mix. Only for Japan, Finland, Spain and Korea nuclear energy plays its role in reducing Co2 pollution. Only in the case of Finland EKC is supported.

Mahmood et al (2007) use an ARDL technique to find long run nexus between energy, environment and economy for Pakistan. They find that elasticity of gross

capital formation shows that due to negative by product of energy use, the production function shows decreasing return to scale.

On the other hand Varvarigos (2009) construct an overlapping generation model to provide an alternative explanation to environment Kuznet Curve. This explanation shows that there is an active role of the environmental quality as a contributing factor to growth and capital accumulation. Environment Kuznet curve is explained in term of transition dynamics of economy. In this dynamics there is a permanent structural change, from an original equilibrium below the threshold level to a new equilibrium above this threshold level. During this transition, in the initial stage capital accumulation causes to increase the output growth which leads to increase the pollution emission. After the threshold level is touched, pollution emission falls and approaches to a new dynamic equilibrium. After this point, reduction in the pollution is responsible for the output growth to approach to a new equilibrium. At this new equilibrium the improved environmental quality causes to decreases the rate of premature death and promotes the capital accumulation.

Similarly, G Vernasca (2005) also generates an overlapping generation model to study the relation between environmental externalities and capital accumulation. In this study it is considered that there are two agents who are alive at a time. One type of agent only take care of its own consumption level while other agent take care of its own consumption level and also cares about the environmental quality. People of young age of both categories put their investment in productive capital so that they are able to consume it when they will be old. People of second category also invest in the protection of environment. Production in the preceding period has negative effects on the environment quality in every period. Environmental effects capital accumulation

and if environmental quality is not properly maintained then capital accumulation process is disturbed, as bad environmental quality effects badly on the health of each generation and decrease the saving of the agents. On the other hand if agent take more care of environment and invest more for it and the investment in the production process is reduced then it will also affect the quality of environment in the next period as capital accumulation decrease and this will decrease the proportion of saving to invest in the maintenance of the environmental quality. The presence of equilibrium in which there is high environmental quality and high capital accumulation reflects the situation that developing and under developed countries have worse environmental quality then developed countries. This lead to support the existence of Environment Kuznet Curve in which at first stage the condition of environment is not good but at high level capital accumulation environmental quality becomes better.

M Fodhay (2011) also study the impact of capital accumulation on environment in the background of 'overlapping generation model la Diamond'. In this study impact of taxation and public debt for environment preservation on the environmental quality and capital accumulation is analysed. The study shows that if the initial level of accumulated capital is high then this policy is successful as people are willing to pay for better environment for their health and in the case of debt emission for environment preservation is also a better way as for future generation have to pay the cost for their good environmental quality. On the other hand if the initial level of accumulated capital is low then the above mentioned policy lead to poverty trap as this lead to decrease the public saving and hence capital accumulation. Therefore countries should very carefully analyse the economic conditions before implementation of any policy otherwise there is thread of poverty trap.

Empirical literature about the relationship between population growth and So2 emission shows different results. Yu Benjamin et al (2014) examine the impact of population growth on the shape of EKC in the case of china .They use an overlapping generations (OLG) model to study the EKC. OLG model findings show that the representative agent is altruistic toward her children, and must balance her household consumption with investments in pollution abatement technology. The investment increases monotonically as the economy becomes rich. Population growth has two effects of opposite directions on the EKC. First effect is that more children in the household mean more consumption, and thus production, which generates more pollution. On the other hand, agents may have more incentive to reduce the level of pollution emission, since pollution negatively affects their children's welfare and thus their utility. Thus properties of both production and abatement technologies are the joint determinants that shape the growth-pollution path. By using ten-year panel data from China, they examine the pollution paths of sulphur dioxide, waste water, and industrial waste gas in six regions of China. Empirical evidence from China support the EKC hypothesis and provide partial support for the predictions of their model that higher population growth rate shifts the EKC curve upwards and faster rising EKCs can be observed at low income levels with higher population growth rate in some regions.

Cole et al (2004) estimate the association between growth in population and environmental quality by investigating the effects of demographic factors on So2 pollution. This study employs a modified version of EKC framework. They use longitudinal data set for 54 nations for the time period between 1970 and 1990. This study shows that there is U-shaped EKC relationship between sulphur dioxide pollution emission and population with turning point at around 5.4 million people.

rapidly growing vehicular pollution and industrialization due to increase in population. Industrial pollution emissions, vehicular pollution emission and the burning of fossil fuels causes death of thousands of people and many more suffer from respiratory, heart and lung diseases.

M Cropper et al (1994) investigate the relation between population growth, deforestation and per capita income for Latin America, Africa and Asia. Deforestation is the result of clearing the land for cultivation of crops, using wood for fuel and cutting the trees for getting logs. All these causes are emerging from population growth because increase in population leads to increase the demand for more food, houses and fuel. The association between population growth and the rate of deforestation is influenced by the application of modern technology in agriculture and by industrialization as industrialization leads to attract more labour to it and hence labour force in agriculture decreases. On the other hand income level has an impact on logging because as income level increases the capacity of processing the log also increase. Similarly, the use of wood for fuel is also affected by income as income increases the use of fire wood decrease and other sources of energy are used. The result for Latin America and Africa shows that there is inverted U-Shaped relation between income and deforestation. This means deforestation increases with increase in income level and then decreases. While in the case of Asia the relation is insignificant, the possible reason may be that deforestation is more or less substituted by plantation in this area. This study also shows that only the decrease in the population growth is not sufficient for controlling deforestation but market failure is also a reason for deforestation in developing countries.

While in the case of Pakistan Azhar et al (2005) study the interrelationship between population and environmental quality. According to this study land of Pakistan has been becoming barren due to over use of fertilizer and water to fulfil the needs of growing population. On the other hand air and water quality is also becoming worse due to the rapid growth in industrialization. This study investigates the impact of growth in population on air quality (carbon dioxide pollution emission) and on the quality of arable land for the period 1972-2001. They apply Engle and Granger co-integration technique and error-correction model. The result shows that population growth increase Carbon dioxide pollution and also increases the area of cultivation and thus making the land quality poor.

On the other hand, in Asia cross-border pollution has become increasingly common because the agro-forestry projects and factories are growing and clustering in the manufacturing and resource-intensive regions of China, India, Indonesia and other countries of ASEAN region. In Asia two main sources of cross-border pollution are carbon emissions from fossil fuel burning for energy production and heavy industry and trans boundary haze from the burning of forests to fulfil the needs of agricultural demands. China is the largest emitter of carbon dioxide pollution from fuel combustion. Pakistan has very little contribution in greenhouse gas emission but remain severely affected by climatic changes due to global warming.

On the other hand, J Lina et al (2013) investigate the effects of pollution emitted by China due to production for its export, on the world's atmosphere especially on United States. The study is carried out by using 'atmospheric chemical transport model' and by 'economical emission' analysis. China is engaged in huge manufacturing process to fulfil the needs of other developed and developing

countries. On the other hand there is no strict environmental policy. So both these situations lead to huge amount of pollution in the country especially Co2, So2 and Co2. As Co2 is long lasting gas and can cross the border so countries like America and Canada are trying to find out the way to decrease the pollution emission from China. There is another discussion among countries that country that avails from production manufactured in other countries should also bear some share of pollution. The pollution in the western America is very poor because of the transfer pollution mission from China. While the pollution in east America is low due to the production of its consumables in the other countries.

Overall the above literature shows that EKC does exist in most of the studies. So pollution does rise with the increase in the GDP of the country. While some studies shows U- shaped EKC which means that advanced countries have passed the threshold level and now increase in income level is damaging the environment as their consumption continued to increase and thus waste materials and air pollution also continued to increase. However, some studies show EKC does not exist. According to this view, the decrease in the pollution at the higher level of income is may be due to the export of high pollution producing industries to poor countries. Another view is that increase in the GDP is not an essential condition for the decreasing of pollution; it may be decreased by the implementation of environmental policies coordinated with other developed countries. The relationship between economic growth and environment shows that there is causality between them. The study of ECE(east central Europe) countries shows that although these countries have gain some degree of decoupling between economic growth and environment quality but the continuously increasing municipal waste and Co2 pollution shows that these countries still have unsustainable consumption pattern. While environment changes also does

show their impact on economic growth. The impact of cyclone on the economic growth shows that cyclones cause to decrease the process of growth and this impact continue till many years after the cyclones and the countries that have frequent cyclones are less affected by them as compare to the countries where these are not very common.

While the impact of trade openness on the environment within the framework of EKC is also studied in a lot of literature. And this is not very clear. Infect trade effect is derived from scale effect, composition effect and technique effect. Generally scale effect causes to raise the pollution level. While technique effect causes to decrease the pollution level as new less polluting technologies are applied for the production process. On the other hand impact of composition effect is depended on the resources available in a country and the strength of implementation of environment protection policy. Similarly, the impact of gross capital formation on the pollution emission depends on the behaviour of the individuals of a generation. If the individuals have the behaviour of preserving the environment and spend a portion of saving on the protection of environment and spend the rest of the saving in investment then the both environment and economy move smoothly. But if the individuals do not spend on the protection of environment and invest all the saving in production process then bad environmental condition effect badly on the health of the population and saving begin to decrease and thus production also decreases. While the effect of population growth on the environment within the contest of EKC shows that it is negative. Growth in population increases pollution as with the increase in population, production increases and the number of vehicles also increases. So the consumption of energy increases which leads to increase the air pollution. Increased population make difficult the implementation of laws made for the protection of environment. On

the other hand decrease in population does not automatically decrease the pollution, proper implementation of environment protection policies is necessary for it. Cross-border pollution is another cause of increase in the pollution of the countries .This problem is common in Asia. China is emitting Co2 gas in huge proportion. As Co2 can cross border it pollutes the environment of the other countries. Pakistan produces very small proportion of this gas but is badly affected by problem of global warming and Co2 is the main part of this gas.

For the case of Pakistan different studies shows that the hypothesis of EKC is confirmed. But no work has been done to find out the threshold effect. The present study aims to find the threshold effect of per capita GDP on So2and Co_2 pollution emission in Pakistan. We investigate whether or not Pakistan income level is reached at the point beyond which So2 pollution tend to increase less or decreases as developed countries experienced.

Chapter 3

DATA AND MATHODOLOGY

3.1 DATA

This study uses data from Pakistan for the period of 1971-2008 .We have selected this data on the basis of availability of data on So2 pollution emission. For pollution emission, we use two measures of pollution emission that may capture the pollution situation in the country, that is sulphur dioxide (So2) pollution emission and carbon dioxide (Co_2) pollution emission. These two variables are mostly used in the existing literature, like Grossman and Krueger (1991), Cole and Elliot (2003) and Acaravci et al (2010). To capture the effect of economic development, we use per capita GDP. We use this variable because this variable is used in almost all the existing literature on EKC.

The summary statistic of data and correlation matrix is presented in Table A1 and A2 in the Appendix. The findings of correlation matrix show that the relationship between the indicator of economic development and pollution emission variables is positive and significant.

We use some control variables in our estimated regression. For example, energy consumption, trade openness, capital accumulation, and population growth and gross capital formation.So2and Co_2 emission data is taken from Emission Database for Global Atmospheric Research (EDGAR), release version 4.2. Data for trade

openness, energy consumption, and real per capita GDP and population growth rate and gross capital formation is taken from Pakistan Statistical Bureau.

3.2 ESTIMATION METHODOLOGY

3.2.1Threshold models

In economics threshold models (sample splitting models) have wide application. Existing estimation methods are limited to regression models, in which all right-hand-side variables are exogenous. In this study instrument variable (IV) regression method suggested by Caner and Hansen (2004) is applied with endogenous variables but an exogenous threshold variable. This method develops a two- stage least squares estimator of the threshold parameter and a generalized method of moments estimator of the slope parameters. In this model it is shown that these estimators are consistent, and the asymptotic distribution of the estimators is derived. The threshold estimate has the same distribution as for the regression case, with a different scale. The slope parameter estimates are asymptotically normal with conventional covariance matrices. The significant advantages of the instrument variable threshold regression technique over the traditional approach are as follows:

1. It does not employ any specified functional form of nonlinearity, and the location and number of thresholds are determined endogenously by the data; and

2. Asymptotic theory applies, which can be used to generate proper confidence intervals. A bootstrap method to assess the statistical significance of the threshold effect is also available in order to test the null hypothesis of a linear formulation against a threshold alternative.

By using the following model we determine the threshold effect of economic growth on So_2andCo_2 pollution;

$$Y_{i,t} = \alpha_1 + \alpha_2 RPCGDP_{i,t} + \alpha_3' CV + e_{i,t} \quad (3.1)$$

Where $Y_{i,t}$ is the indicator of pollution emission(So2 and Co_2),real per capita GDP(RPCGDP) is indicator of economic development and is our threshold variable, CV is the vector of control variables that includes trade openness, energy consumption, population growth and capital accumulation and *e* is white noise error.

To determine the threshold effect of RPCGDP on So2 and Co_2 pollution emission we apply instrument variable (IV) regression method suggested by Caner and Hansen (2004). The general form of this method is given below:

$$Yi = \theta'_1 Z1.\, I.\, (q_i \leq \gamma) + \theta'_2 Z1\, .I.\, (qi > \gamma) + \varepsilon \quad (3.2)$$

Where θ_i and θ_2 are vectors of regression parameters before threshold level of So2 (Co_2) emission and after it respectively. Z1 represent the vector of all independent variables. I (.) Represent indicator function that takes the value of unity when the expression in parenthesis is satisfied. q_i is the threshold variable. Γ is the threshold parameter, where Γ is a strict subset of support of q_i. The slope parameters θ_1 and θ_2 may differ depending on the value of qi. The difference between these parameters $(\theta_2 - \theta_1)$ is the magnitude of the threshold effect. The above model can be specifically, written as

For So2

$$So2_{i,t}=[\alpha_{11}+\alpha_{21}.RPCGDP_{i,t1}+\alpha_{31}.EUPCi_{i,t}+\alpha_{41}.TRt_{i,t}+\alpha_{51}.POPN_{i,t}+\alpha_{61}.GCF_{i,t}].I.(RPCGDPi\leq \gamma)$$

$$+[\alpha_{11}+\alpha_{21}RPCGDP_{i,t}.+\alpha_{31}.ENC_{i,t}+\alpha_{41}.TRt_{i,t}+\alpha_{51}.POPR_{i,t}\alpha_{62}GCF_{,t}].I.(RPCGDPi>\gamma)+vi,t \quad (3.3)$$

$$RPCGDP_t=[\alpha_{11}+\alpha_{21}.RPCGDP_{t-1}$$

$$+\alpha_{31}.EUPCi_t+\alpha_{41}.TRt_t+\alpha_{51}.POPN_t+\alpha_{61}.GCF_t].I.(RPCGDPt\leq\gamma)+[\alpha_{11}+\alpha_{21}RPCGDP_{t1}+\alpha_{31}$$

$$.EUPC_t+\alpha_{41}.TRt+\alpha_{51}.POPN_t+\alpha_{62}GCF_t].I.(RPCGDPt>\gamma)+vt \quad (3.4)$$

For Co_2

$$Co_{2i,t}=[\alpha_{11}+\alpha_{21}.RPCGDP_{i,t1}+\alpha_{31}.EUPCi_{i,t}+\alpha_{41}.TRt_{i,t}+\alpha_{51}.POPN_{i,t}+\alpha_{61}.GCF_{i,t}].I.(RPCGDPi\leq\gamma)$$

$$+[\alpha_{11}+\alpha_{21}RPCGDP_{i,t}.+\alpha_{31}.EUPCi_{,t}+\alpha_{41}.TRt_{i,t}+\alpha_{51}.POPN_{i,t}\alpha_{62}GCF_{,t}].I.(RPCGDPi>\gamma)+vi,t \quad (3.5)$$

$$RPCGDP_t = [\alpha_{11}+\alpha_{21}.RPCGDP_{t-1}$$

$$+\alpha_{31}.EUPCi_t+\alpha_{41}.TRt_t+\alpha_{51}.POPN_t+\alpha_{61}.GCF_t].I.(RPCGDPt\leq\gamma)+[\alpha_{11}+\alpha_{21}RPCGDP_{t1}+\alpha_{31}$$

$$EUPC_t+\alpha_{41}.TRt+\alpha_{51}.POPN_t+\alpha_{62}GCF_t].I.(RPCGDPt>\gamma)+vt \quad (3.6)$$

Where RPCGDP is real per capita GDP, EUPC is energy utilization per capita, TR is trade openness, POPN is population growth rate, and GCF is gross capital formation.

We can estimate equations (3.3) and (3.4)using threshold regression with instruments method as suggested by Caner and Hansen (2004) and in the same way the equation (3.5) & (3.6) can also estimate.We use the lag value of GDP per capita (PCGDPt-1)as an instrument of GDP per capita (PCGDPt). In this method the threshold value γ is estimated by minimizing the concentrated sum of squared errors (SSE). The procedure explores for the possible value of γ that minimize the SSE

function. We can estimate the regression coefficient and variables, once the estimate of γ (γ ^) is establish,

According to Caner and Hansen (2004), the parameters in equations (3.3) and (3.4) are estimated by sequential way. First of all, we estimate equation (3.3) and (3.4) using OLS equation and take the fitted values of our endogenous variables. Secondly, by substituting the fitted values back in equation (4.3) we obtain threshold parameter γ using OLS through concentration method as discussed above. Third thing is that, on the bases of threshold estimate we split the whole sample into two sub-samples and employ the generalized method of movements (GMM) or 2SLS on split sub-samples to find the regression estimates of equation(3). We apply the above estimation procedure using a modified GUASS program as used by Caner and Hansen (2004).

Chapter 4

ESTIMATION AND RESULTS

In this chapter, we discuss the results obtained from our estimation of threshold regression model explained in Chapter 3.

4.1 RESULTS AND DISCUSSION

We use time series data from Pakistan for the threshold analysis of economic growth and pollution emission. We select this data on the basis of availability of data on So_2 pollution emission for the period 1971-2008.Our estimation results are presented in Tables 4.1 and 4.2. Table 4.1 represent the effects of economic growth, trade openness, energy consumption, gross capital formation and population growth rate on sulphur dioxide pollution emission. While table 4.2 represent the effects of economic growth, trade openness, energy consumption, gross capital formation and population growth rate on carbon dioxide pollution emission.

Table 4.1: **Threshold effect of per capita GDP on So2 pollution emission, using PCGDP as an indicator of economic development**

	Model (1)		Model (2)		Model (3)		Model (4)		Model (5)	
Threshold Estimate	**5.8832*** (0.0000)**		**6.1047* (0.0899)**		**5.8832*** (0.0000)**		**6.1993*** (0.0004)**		**5.8832*** (0.0000)**	
PCGDP	0.7264*** (0.0003)	1.0259*** (0.0000)	-0.2803** (0.0166)	1.4746 (0.1388)	0.6702*** (0.0003)	0.9615*** (0.0000)	-0.6926*** (0.0000)	2.8700*** (0.0001)	0.8830*** (0.0000)	0.2511 (0.2925)
C	0.8155 (0.3472)	-0.0077 (0.9950)	-26.3613*** (0.0000)	28.0158 (0.1471)	-0.2111 (0.8501)	4.1161 (0.1103)	-8.5340*** (0.0000)	48.6436*** (0.0000)	5.4619*** (0.0001)	-0.4987 (0.150)
EUPC			5.6911*** (0.0000)	-5.0337 (0.2193)						
TR					0.3864 (0.1778)	-1.0514* (0.0727)				
POPN							3.9304*** (0.0000)	-12.0426*** (0.0001)		
GCF									-2.2143*** (0.0012)	1.9613*** (0.0016)

Notes: The p-values are reported in the brackets. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. Dependent variables are Sulfur dioxide pollution (So2) and Carbon dioxide pollution (Co_2).Threshold variable is log of real per capita GDP growth. All variables are taken in log form.

Table 4.2 **Threshold effect of per capita GDP on Co_2 pollution emission, using PCGDP as an indicator of economic development**

	Model (1)		Model (2)		Model (3)		Model (4)		Model (5)	
Threshold Estimate	5.8832*** (0.0000)		6.1709* (0.0427)		5.8832*** (0.0000)		6.1170* (0.0122)		5.8832*** (0.0000)	
PCGDP	0.7605*** (0.0000)	1.0272*** (0.0000)	0.2219*** (0.0003)	0.2944*** (0.0000)	0.6940*** (0.0000)	0.2944*** (0.0000)	0.0060 (0.9485)	0.3305*** (0.0001)	0.8409*** (0.0000)	0.8025*** (0.0000)
C	6.1119*** (0.0000)	5.0266*** (0.0000)	-7.6866*** (0.0000)	-1.5733 (0.7615)	-7.6866*** (0.0000)	-1.5733 (0.7615)	1.7269** (0.0126)	2.2044*** (0.0000)	8.4948*** (0.0000)	4.8843*** (0.0000)
EUPC			2.9162*** (0.0000)	1.8535* (0.0981)						
TR					0.4583*** (0.0037)	-0.8259*** (0.0981)				
POPN							1.9550*** (0.0000)	1.4673*** (0.0000)		
GCF									-1.1356*** (0.0034)	0.5686** (0.0499)

Notes: The p-values are reported in the brackets. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. Dependent variables are Sulfur dioxide pollution (So2) and Carbon dioxide pollution (Co2).Threshold variable is log of real per capita GDP (RPCGDP). All variables are taken in log form.

Tables 4.1, uses So2 as indicator of pollution emission whereas Table 4.2 uses another measure of carbon dioxide (Co_2).In both the tables we use log of per capita GDP as threshold variable. Threshold estimates are significant for all the models of both tables. In Table 4.1, model (1) shows that there exists a threshold level of real per capita GDP (PCGDP) which is significant at 1% level. The effect of PCGDP on So2 pollution emission is significant and positive before the threshold level of PCGDP and also after threshold level. Its means that this type of pollution increases with the increase in the economic growth and then there comes a turning point after which it again starts to increase. In Table 4.1 model (2)shows there exists a threshold level of real per capita GDP (PCGDP) which is significant and the effect of energy utilization per capita on So2 pollution emission is significant and positive before the threshold level of PCGDP, whereas insignificant and negative after it. Similarly, in Table 4.1, model (3) there exists a threshold level of real per capita GDP (PCGDP) which is significant at 1% level the findings shows that the effect of trade openness on So2 pollution emission is insignificant but positive before the threshold level, whereas significant and negative after it. While in Table 4.1,model (4) threshold estimate is again significant at 1% and the effect of population growth rate on So2 pollution emission is significant at 1%and is positive before the threshold level and is significant and negative after it as shown in Table 4.1, model (4) While in case of relation between gross capital formation and So2 pollution emission, threshold estimate is significant at 1% and the effect of gross capital formation on So2 pollution emission is significant and negative before threshold level and is significant and positive after it as shown in table 4.1, model (5)

On the other hand, in Table 4.2, model (1) shows that there exists a threshold level of real per capita GDP which is significant at 1% level. The effect of economic

growth on Co_2 pollution emission is positive and significant before the threshold level of PCGDP and also after threshold level. Its means that this type of pollution increases with the increase in the economic growth and then there comes a turning point after which it again start to increase. In Table 4.2, model (2) shows that there exists a threshold level of real per capita GDP (PCGDP) which is significant, the effect of energy utilization per capita on Co_2 pollution emission is positive and significant at 1% before the threshold level of PCGDP and similarly, positive and significant at 10% after it. On the other hand Table 4.1, model (3) shows that the threshold estimate is significant in this case and the effect of trade openness on Co_2 pollution emission is significant and positive before the threshold level, whereas significant and negative after it. While in the case of model 4 of Table 4.2 the threshold estimate is significant at 10% and the effect of population growth rate on Co_2 pollution emission is significant at 1% and is positive before the threshold level and is again significant and positive after it as shown in Table 4.2, model (4).While in case of relation between gross capital formation and Co2 pollution emission, threshold estimate is significant again and the effect of gross capital formation on So2 pollution emission is significant and negative before threshold level and is significant and positive after it as shown in table 4.2, model (5).

Our estimated results show that for both types of pollution indicators there exists threshold level of real per capita GDP which is significant. For both types of pollution indicators the effect of real per capita GDP on both types of pollution indicators is positive and significant before and after threshold level so in our study inverted U-shaped EKC is not observed.

Chapter 5

CONCLUSION

Scholars have conducted a lot of researches in order to better describe the impact of economic growth on environmental pollution, in which the most important one is the hypothesis of Environment Kuznet Curve (EKC). According to this theory an inverted U- shaped relation is present between economic growth and environmental pollution. That is in the early period of economic growth, the environmental pollution is low. But with industrialization, the level of pollution in the environment increases. And, as economic growth reaches its higher stage, pollution level decreases because of the shift of high-polluting industrial economy into service economy or technology- based economy. (Grossman and Krueger, 1991). Later Selden and Song(1994) and Grossman and Kruger (1995) produce more refined estimate by using higher quality data and confirm the existence of inverted U- shaped relationship between per capita GDP and pollution. After them a lot of theoretical and empirical work done on EKC shows that inverted U- shaped relation does exist between per capita income and pollution [(Cole, Rayner, and Bates (1997) Friedl and Getzner (2003),Nohman and Antrobus (2005), Dinda and Coondoo (2006)]. On the other hand Millimet, List, and Stengos (2003) document N-shaped curves. They attribute that as a country develops its pollution level increases, pollution decreases as the threshold GDP is approached, and then starts to increase again as country's income continues to increase. Such findings could prove significant as they arise the

concerning question that whether pollution level begins to decrease in real sense when threshold level is approached or whether the pollution is merely exported to poorer developing countries..Similarly, some studies show the presence of U-Shaped EKC. The documentation of U-shaped EKC suggest that the developed industrialized countries which have already crossed threshold level, an additional increase in their per capita income result in degradation of environment. Similarly some studies rejects EKC hypothesis [(Suri and Chapman (1998), Sappala (2000)]. According to this view although there is decrease in the pollution level of the most advanced countries but at the global level there is no reduction in the pollution level. This may be perhaps due to the transfer of highly polluting industries to the poor countries.

In the case of Pakistan different studies estimate EKC hypothesis. Shahbaz at el (2010) and Ismail at el (2014) estimate EKC hypothesis to examine the connection between economic growth and pollution. But until now, no work has been done to find the threshold level of per capita GDP for the relationship between economic growth and pollution for Pakistan. The present study is an effort to find the threshold effect of per capita GDP on air pollution in Pakistan for the period of 1971-2008 and the nature of this relationship before and after the threshold level of per capita GDP. For this purpose, we employ threshold regression method with instrument variable as suggested by Caner and Hansen (2004). Our findings show that there exists a threshold level of real per capita GDP which is significant at 1% level. The effect of economic growth on So2 pollution emission is significant and positive before the threshold level of PCGDP and also after threshold level. This means increase in economic growth causes to increase the sulphur dioxide pollution then there comes a turning point and after threshold level So2 pollution again increase with the increase in PCGDP. Similarly in case of Co_2 there exists a threshold level of real per capita

GDP which is highly significant. The effect of economic growth on Co_2 pollution emission is positive and significant before the threshold level of PCGDP and also after threshold level. So we can say that inverted U-shaped relation does not exist in the case of Pakistan.

Different studies also examine the impact of trade openness on the environment within the framework of EKC. The impact of trade on the environmental quality is not very obvious. Infect effect of trade is derived from scale effect, composition effect and technique effect. Generally scale effect causes to raise the pollution level. While technique effect causes to decrease the pollution level as new less polluting technologies are applied for the production process. Composition effect is found by the degree of trade openness and comparative advantage of resources. This effect may be positive or negative depending on the resources and the strength of environmental policy. The result of studies shows that trade openness is favourable for the rich countries where there are strong environmental policies but it is harmful for the poor and developing countries where environmental laws are not very strong or are not well implemented (Abdulai et al (2009). This finding again supports EKC and PHH. In our study the effect of trade openness on So_2 pollution emission is positive but not worth mentioning before the threshold level, whereas it is significant and negative after it. And in the case of Co_2 pollution emission, the result show that trade openness does play a major part to increase Co_2 pollution emission before the threshold level, whereas Co_2 pollution emission decreases with the increase in trade openness. So we can say that in the case of carbon dioxide pollution EKC hypothesis is supported.

The association between energy consumption and environmental quality shows that there is causality. Energy consumption derived from fossil fuel causes to increase the Co2 and So2 pollution and thus deteriorate the environmental quality. The decrease in the use of energy consumption leads to slow down economic growth --(Sabooriet al (2013).So other sources of energy should be applied in large scale both in developed countries and developing countries so that problem pollution at the global level might be minimized. In France nuclear energy has been used for the generation of electricity which has proved well in increasing economic growth and decreasing pollution (Iwata et al (2009). In our study, in the case of So2 pollution emission, the effect of energy utilization per capita on So2 pollution emission is significant and positive before the threshold level of PCGDP. Its mean that with the increase in energy consumption So2 pollution also increases. Whereas after threshold level its effect becomes negative but negative effect is not worth mentioning. While the effect of energy utilization per capita on Co_2 pollution emission is positive and highly significant before the threshold level of PCGDP and similarly, positive and significant at 10% after it. Its means that Co_2 pollution increase with the increase in energy consumption then there comes a turning point and after it, it again start to increase with the increase in energy consumption. So in this case EKC is not confirmed.

On the other hand the impact of gross capital formation on the environment depends on the behaviour of the individuals of a generation. If the individuals have the behaviour to invest their savings in both for the improvement of environment quality and for the production process then environment quality is well maintained but the production process will be slow down as a portion of saving is utilized for the protection of environment. On the other hand if the individuals invest all the saving in

the production process then health of the individual is badly affected due to poor environmental quality, so investment in the next period is decreased. So for equilibrium high initial level of capital accumulation is required so that individuals are willing to pay for better environment which affect well on their health so that they are able to invest in the production process. (Vernasca (2005) and Fodhay(2011). In our study the effect of gross capital formation on So_2 and Co_2 pollution emission is negative and significant before threshold level and is positive and significant after it. While the studies about the relation between population growth and environmental quality shows that growth in population rate leads to increase the pollution. There are different reasons of this causality. Growth in population rate needs more production. So more energy is consumed for this process. This consumption of energy leads to increase all kinds of pollution; air pollution, water pollution and land pollution. Co2 and So2 pollution emissions are main parts of the air pollution. Large population limits the implementation of environmental protection policies. It is very hard to successfully implement the protection policies in crowded areas. On the other hand, to increase the food production, fertilizers are used in huge quantities which ultimately make the land barren. Numbers of vehicles on the road also increase and thus the air pollution increases. Deforestation also increases to meet the needs of shelter and food of growing population. On the other hand decrease in the population is not the only solution for decreasing pollution. To decrease the pollution, well functioning of market and the implementation of laws about the environment protection are essential. In our study the results show that the effect of population growth rate on So_2 pollution emission is positive and highly significant before the threshold level and is negative and significant after it. Its means that pollution of sulphur dioxide gas increases with the increase in population growth while after turning point it pollution decreases with

the increase in population growth. While the effect of population growth rate on Co_2 pollution emission is positive and significant at 1% before the threshold level and is again positive and significant after it. Its mean that carbon dioxide pollution continue to increase with the increase in population growth. This finding is in similar to the findings of the most of the literature. So we can say that there is partial fulfilment of our hypotheses.

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APPENDIX

Table A-1: Summary Statistics

	eupc	Popn	So2	gcf	Co_2	pcgdp	trade
eupc	1.0000						
popn	0.9934	1.0000					
So2	0.9474	0.9422	1.0000				
gcf	0.8435	0.8510	0.8567	1.0000			
Co_2	0.9685	0.9685	0.9659	0.9193	1.0000		
pcgdp	0.9113	0.9044	0.8499	0.8377	0.9455	1.0000	
trade	0.3420	0.3087	0.2299	0.1712	0.2387	0.2992	1.0000

Table A-2: Correlation Matrix

Variable	Obs	Mean	Std. Dev.	Min	Max
Eupc	41	387.9371	73.15289	279.73	509.6
Popn	42	113.879	36.75884	59.2	176.17
So2	39	400.566	305.6979	83.35437	975.2465
Gcf	42	0.1378889	0.0224313	0.1020514	0.18688
co_2	42	72430.36	47031.62	18431	159878
Pcgdp	42	450.0569	267.1866	98.37	1212.42
Trade	42	33.02439	3.93048	19.93229	38.9095