CHAPTER 1

INTRODUCTION

1.1 ECONOMIC GROWTH

India is the seventh-largest country by area, second-most populous country with over 1.38 billion people, and the most populous democracy in the world. While the economy has welcomed international companies with open arms since liberalisation in the 1990s, Indians have been sensible and pre-emptive in adopting global techniques and skills. Indian villagers have proudly taken up farming, advanced agriculture and unique handicrafts as their profession on one hand, while modern industries and professional services sectors are coming up in a big way on the other (Indian economy overview, 2020 updates; ibef.org).

The country is flourished with many global strategic investors owing to the presence of vast range of industries, investment avenues and an evolving business environment. The strongest driver of the economy is its huge youth dominant population.

India is rich in terms of nature with a coastline of 7,517 kilometres and large reserves of coal, manganese, rare earth elements, natural gas, diamonds and arable land. It also has 314,070 sq. kms of water resources.

India has grown many folds over last 65 years. The transition of the Indian economy from an agrarian economy to not so fully industrial economy during the 90's to export led service sector in a short span reflects the structural change. India has overcome many obstacles ranging from wars and BOP crisis to Demonetization and GST, in reaching where it is today, and continuing the battle of attaining high sustainable growth rates. Of the many obstacles that India has faced, one that has been consistent on its list is managing and regulating the environment for sustainable growth.

Environmental degradation is gaining focus of Governments across the globe over again. Till date measures to manage the environmental degradation has been initiated by various authorities. Environmental education and brainstorming takes place time and again to tackle the degradation of one of the important factors of production. This has

resulted in growth and development in India in the last 6 decades. The never-ending needs of a developing country to explore and exploit the natural resource to participate in the growth race doesn't give it an option of conserving and protecting one of the vital resource, making it a luxury good.

The process of economic growth is essentially a steady process by which the productive capacity of the economy is increased over time to persistently and consistently achieve a certain level of National income. Prof. Simon Kuznets, Noble Laureate defines economic growth as "a long term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional & ideological adjustments that it demands" (Kuznets, S. 1973).

Economic growth, therefore, is the capacity of a nation to supply goods and services to its people. This capacity should be based on technological, institutional and ideological adjustments needed in the society. The capacity to supply depends on the ease of availability of resources, which is built overtime, during the growth process. The stage of growth that an economy passes through depicts its state of technological and institutional achievement. The growth path of current developed countries is different from that of developing countries of the world. The catch lies in the adoption of technology and investment in technology and research for further advancements. India in tackling its population explosion couldn't get away with the labour intensive, traditional techniques of production, and is still hesitant in adopting high end technology.

Moreover, the industry cannot absorb the working population and agriculture cannot help anymore, leading to higher dependence on other means of employment. This has resulted in overuse and misuse of environmental resources in the country.

Above discussion provides evidence that the stages of growth of developed nations are far more different than the developing nations today. The transition has been different especially because of the availability of resources. The technique of production is the key to their growth. As a matter of fact, the rate of technological advancement in developed nations has been very fast. This was possible because of availability of capital to these nations. On the other hand the developing nations were and are too

traditional in their approach to production activity. This is also due to availability of labour as a consequence of overpopulation.

Both the developed and developing nations have their share of challenges to overcome to achieve growth targets every year. One common parameter during the course of growth process is that both nations have ignored "environmental degradation" that took place due to their respective production activities. No matter how many worldwide initiatives have been taken, the issue still remains a mystery. This gives an open space for the researchers to work on various aspects of environmental degradation. The competitive environment and the process of globalization in the global markets have created a cheaper market for all goods and services. The economies in the race for achieving good growth rates are allowing free flow of capital as well as goods from foreign countries. This has created a market for lower quality and less durable goods increasing wastage and building inefficiencies, and increasingly greater extraction of natural resources for inputs. The capacity of the environment to assimilate waste generated in the process of growth and development is limited. The cost of damage is never included in the cost of production allowing the firms to create negative externalities.

One school of thought believes that the fastest route to environmental improvement is to generate higher incomes and become rich, as with higher incomes demand for goods and services are less materialistic which improves the environmental quality. But the damage done to environment is irreversible and sometimes the cost of damage is too high to be borne by individuals.

One such researcher and noble laureate Grossman Krueger made an attempt to answer a host of environmental issues. Following him, there have been numerous researches on the relationship between environmental degradation and economic growth, but zeroing down to a unique solution seems impossible. This is due to the very nature of environment itself.

Growth is a process of transformation. Economic growth is thus the process by which an economy transforms its resources and reallocate to make them more valuable. It is an increase in a nation's wealth over a period of time measured in terms of capacity to

produce goods and services. In words of Nobel Prize winner Paul Romer "If economic growth could be achieved only by doing more and more of the same kind of process, we would eventually run out of raw materials and suffer from unacceptable levels of pollution and nuisance. Human history teaches us, however, that economic growth springs from better techniques, not just from more process" Henderson, D. R. (2008).

While some countries have learnt to develop new techniques and are rich, some are just following the same old process and are poor. However, these new techniques produce certain side effects that are harmful in nature. So the process of growth can be uneven and unbalanced. Early economists have developed the stages of growth through which each nation passes in the process of growth. Economists like Colin Clark and W.W. Rostow emphasize the importance of various stages of growth and the dominance of different sectors of economy at each stage.

As economic growth enables increased standard of living, improved tax revenues, better and increased job opportunities, it is one of the most important macroeconomic objective. The three major aspects of economic growth are causes of economic growth, costs and benefits of economic growth and policies to improve economic growth.

Economic growth is caused by two main factors: an increase in the aggregate demand and an increase in the productive capacity of an economy. In the short run, an increase in aggregate demand causes an increase in economic growth. Whereas in the long run change in production capacity of an economy causes economic growth. The balance between aggregate demand and aggregate supply depends on political and economic stability.

Secondly, the benefits of economic growth include higher and sustained incomes, reduced poverty, better health and education, improved economic stability and government finances. Economic growth along with benefits entail costs on economies. These costs are inflation, economic cycles, current account deficits, widening inequality and most importantly environmental costs. As economic growth causes an increase in output and consumption the pollution also increases in an economy. Economic growth can also lead to problems like congestion, depletion of non-renewable resources and health risks.

Lastly, designing and implementation of economic policies to improve economic growth are equally important. Policies that focus on saving and investment rates, fiscal and monetary situations, technological and industrial progress.

For the sake of economic growth natural resources get overlooked and are subject to overexploitation. The amount of economic prosperity gained over the 20th century has been at the cost of exhaustion of non-renewable resources, global warming, climate change and irreversible damages caused to the environment. As claimed in "The Limits to Growth" (Meadows et al. 1972), the Club of Rome report on exponential economic growth, population growth with finite supply of resources, this rate of economic growth is not sustainable as it will lead to failure of production system and halt economic growth. The report also concluded that economic growth trends could be altered to achieve sustainable growth rates in future. Since then the concept of "sustainable growth" has become a part of every discussion.

Two decades later another line of research became popular after a report by *World Development Report 1992* explored the links between economic development and environment. The most important message of the report was the need to incorporate environmental considerations into development of economies. Economic development and sustainable environment are complementary aspects of economic growth. While economic growth is essential for economic development it also causes serious environmental damage. Growth along with sustainable development is a broader goal of economies today. Sustainable development is one that lasts. The future generations should not be worse off if not better off in terms of availability of all resources. But the assessment of current and future situations is a matter of concern. This intergenerational sustainability is the soul of environmental management.

The figure 1.1 illustrates the linkage between economic activity and environment. With the assumption of given technology, taste and environmental investments, greater economic activity hurts environment. The scale of economic activity is one of the factors that determines environmental quality. Other factors are structure of the economy, efficiency of the production process, ability of the economy to substitute renewable resources in place of non-renewable resources and improved technology.

While economic policy tries to regulate the productivity and composition of output, environmental policy provides incentives to use the natural resources judiciously. Initiatives to invest in environmental technology will directly improve environmental quality.

Together these policies tend to increase the efficiency of the production process and reduce the demand for input resources. Higher incomes lead to demand for better environment. The World Development Report 1972 also presents the improvement in environmental quality in industrialized countries along with continued economic growth. Achievements by OECD countries were in the areas of; access to clean water, adequate sanitation, and reduction in emissions. The possibility of developing economies to improve environmental quality depends on initiatives on efficiency reforms and appropriate pollution abatement measures.   To sum up, the core theme of World Development Report 1992 "Development and the Environment" discusses policies for sustained development as "environment" is an essential part of development. The report pitches on the types of policies that need to be adopted: building positive links and breaking negative links.
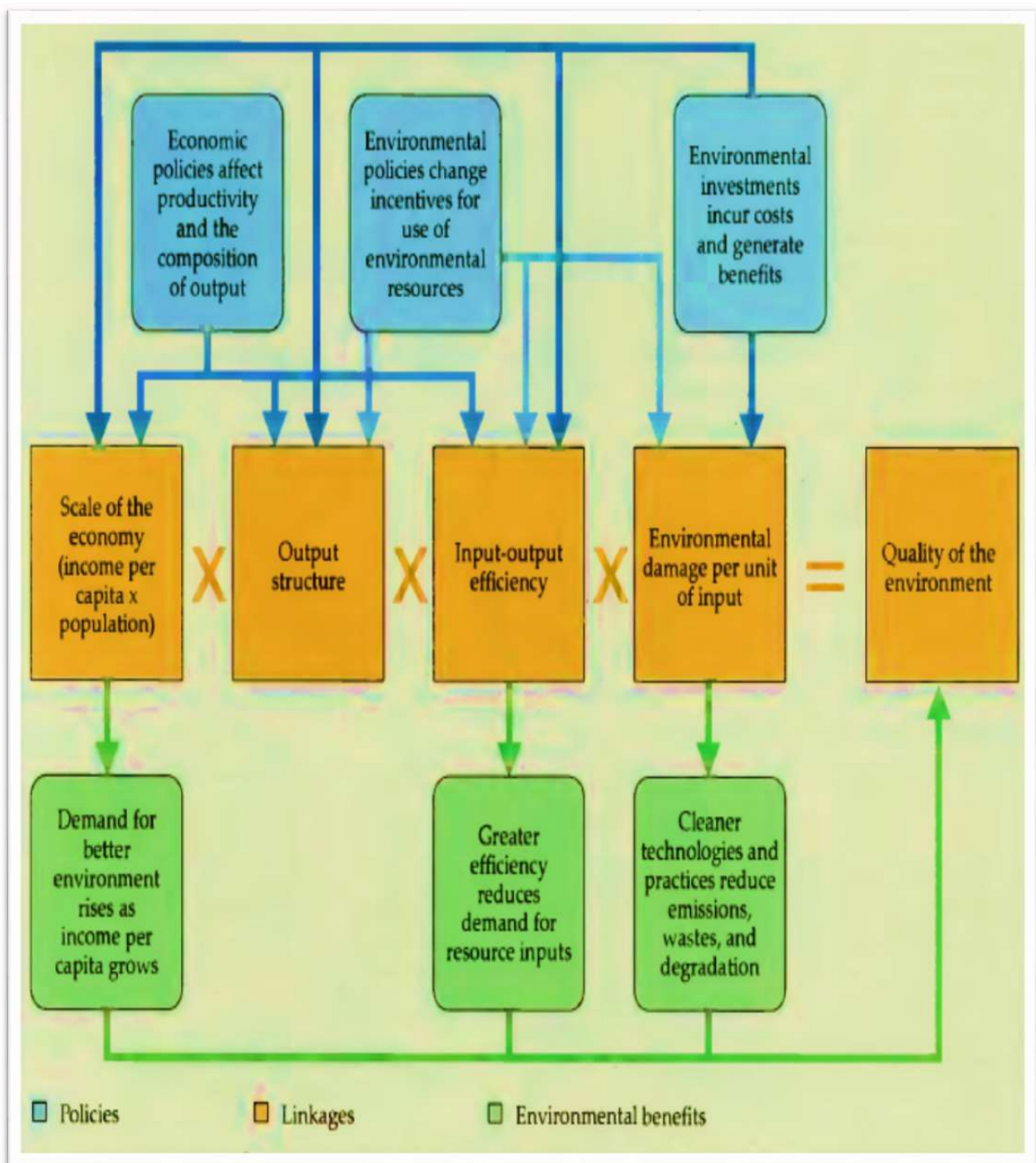
Figure 1.1: Economic activity and the environment
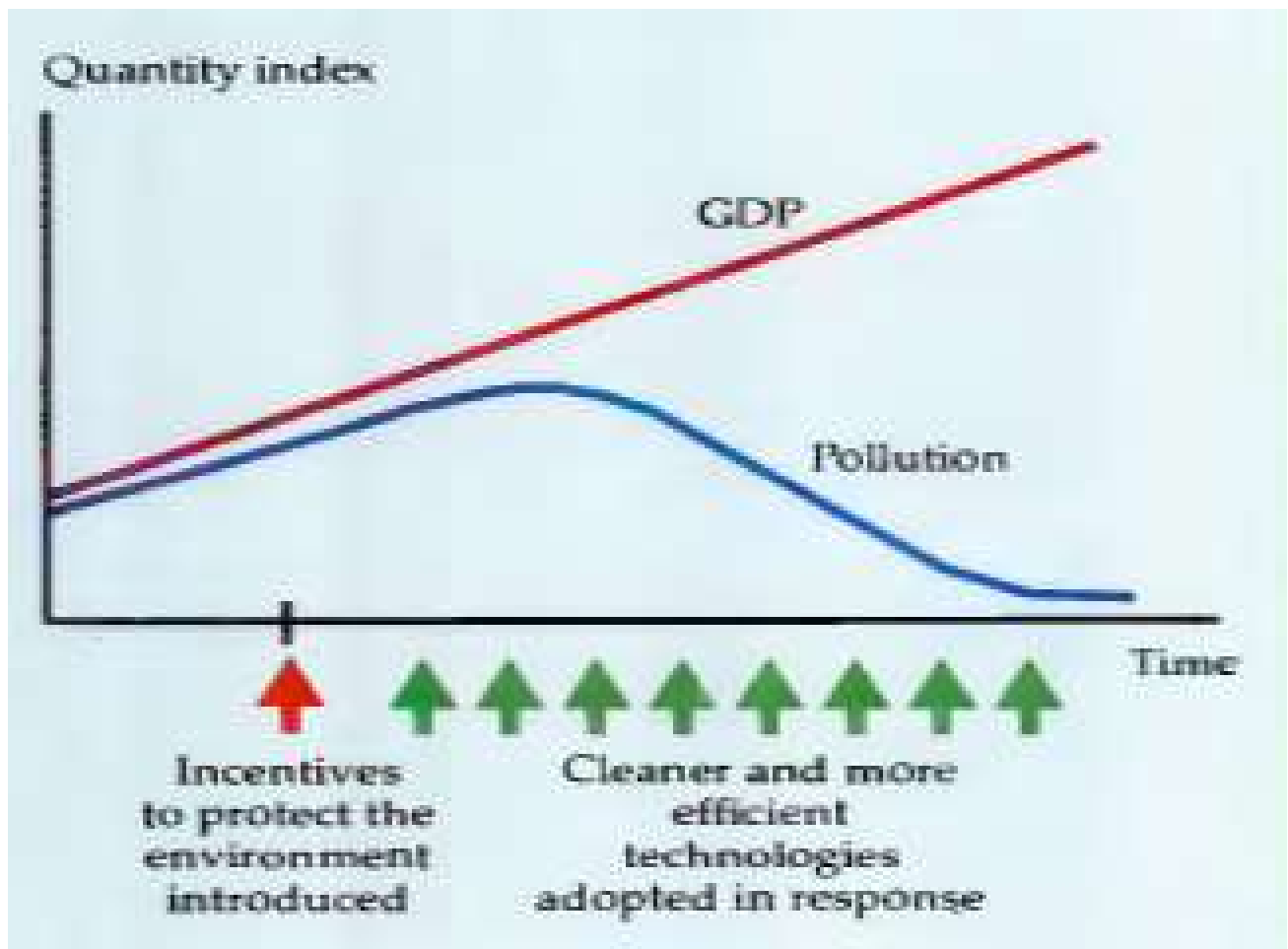*Source: The World Development Report 1992*

Figure 1.2: De-linking economic growth and environmental quality

Source: The World Development Report 1992

It also emphasizes on the positive components of policies viz. a) removing subsidies on resources that are being exploited b) common property rights c) encouraging economic activities with positive externalities d) empower and educate communities to be able to take informed decisions. This is an indirect approach to curb future damage. However, certain direct frontal attacks are also needed to be initiated such as: a) to carefully assess the trade-off between income and environmental quality as ignoring irreversible impact on environment could be dangerous b) capabilities of monitoring and enforcement should be kept in mind while designing/se standards and policies c) governments need to build communities to initiate change through curbing vested interest, to increase accountability of institutions and willingness to pay for better environmental quality.

The report also climaxes the solutions in the form of partnership of developed and developing countries in terms of: improved know-how, new technologies, increased

investments, assistance to reduce poverty, limiting population growth, and financing protection of natural habitats etc.

Looking at the severity of environmental problems the report identifies the most serious challenges facing the environment and suggests strategies to overcome them. The table below shows the impact of environmental damage on productivity and health. Each country should assess the severity based on their respective nature and diversity.

The strategies to sustain environmental quality will have to be imbibed in the policies and programs.

Contradictory views of "limits to growth" and "decoupling growth-environment" has reignited the income-pollution debate since early 1990s.

1.2 ENVIRONMENT

Over the last three and a half decades countries have been acting locally and globally to ensure conservation and sustainable use of the environment because environment and natural resources are vital for economic growth. The natural environment serves as direct inputs into the production of many goods and services. The environment provides many other services that enable economic activity. If the composition of output and techniques of production were undisputable then the environmental damage could be linked to the level of global activity. But considerable evidence give rise to structural transformation in production processes across the world.

The significance of the environment in economic growth of a country can be categorized into four categories Bhattacharya, R. (2001). Firstly by providing a biological, chemical, and physical system environment provides a system to set up economic activity in a society. The essential environmental system of air, water, rivers, soil and biodiversity is necessary for existence. The life-support system gets damaged if there is any larger variation in environmental conditions. Secondly, the environment provides basic raw material and energy resources such as minerals, food, cotton, metals for the production of goods and services in the economy. Renewable as well as non-renewable resources must be conserved and preserved for the sustainable use of future generations. Degradation of these resources and their non-availability disrupts economic growth.

Thirdly the environment serves as an assimilator of waste. Absorption of waste originating from production and consumption in the economy generates garbage for collection and disposal. It has its constraints as the assimilative capacity to collect waste and dispose it safely is limited. Human activities like deforestation, waste disposal in rivers and oceans, irresponsible use of natural resources like air, industrialization at large have reduced the assimilative capacity of the environment.

Fourthly, environment also provides amenities and aesthetic services to the society. Though not essential for existence, it is a source of enjoyment and entertainment for the people. The functions of environment may be competitive or complementary in nature.

1.3 INDIA'S ENVIRONMENTAL HISTORY

India possesses a diversified ecosystem including forests, wetlands, islands landscapes, oceans and rich blend of natural greeneries. Many customary practices were evolved by communities to conserve and preserve environment. Traditional practices to preserve and conserve the environment faded away with rapid industrialization, urbanization, deforestation, technological upliftment and exploitation of natural resources.

After independence it was for the first time in 1972 before India's participation in Stockholm Declaration, that environmentalism emerged as an organized movement in India. The National Council for Environmental Policy and Planning was set up in 1972 which later evolved into Ministry of Environment and Forests in 1985.Comprehensive and particular environmental laws were enacted by the Central Government of India. The Wildlife Act, Water Act, Forest Act, Air Act and the Environment Protection Act came into being with the objectives of comprehensively protecting and improving environmental quality in India (Bhattacharya, R., 2001).

Although social and economic development is a national issue, its advancement can be a global concern. Because environment is immune to political boundaries, environmental disasters are not local in their consequences. For instance frequent labour casualties, oil spills and accidents on the coasts of India has drawn attention of international media. Environment and human rights activists intervened to terminate the

functioning of the industry. However, regulatory follow up by the government has streamlined the ship-breaking industry in India.

With the introduction of the concept of sustainable development and awareness to protect environment, international participation by countries in treaties and convention has increased. Basel Convention on Transboundary Movement of Hazardous Wastes, 1989 was ratified by India and certain provisions, were included in The Indian Hazardous Waste Management Rules Act, 1989. UNFCCC (United Nations Framework Convention on Climate Change) aims to regulate greenhouse gas emissions through international cooperation. Even though India was not bound to commitments for mitigation of greenhouse gas emissions, it participated in the multilateral negotiations. India is also a signatory to Agenda 21 and has sought to streamline various parts of development infrastructure such as industry, climate change policy, water, energy, transport etc. One can concluded from the above that environmental awareness is a dynamic concept which has been evolving over time.

1.4 NO SINGLE MEASURE OF ENVIRONMENTAL QUALITY

One of the crucial question regarding environment is measuring environmental degradation. Environment is a complex set of interdependent variables. Using a unique indicator will not suffice. Hence a set of environmental indicators is used to examine its overall state. The categories of environmental indicators is: Land and soil degradation, water pollution, air pollution, atmospheric damage, forest resources and biodiversity.

Table 1.1: Matrix of Environmental Indicators

Issues	Pressure	State	Response
Land degradation	Depletion of soil nutrients, urban sprawl		Policy measures
Soil degradation	Land use changes	Top soil loss	Rehabilitation/ protection
Water resources	Use intensity, water disposal	Availability of fresh water sources	Reduce, reuse and recycle
Forest resources	Use intensity	Deforestation, soil erosion	Sustainable logging, afforestation
Air resources	GHG emissions	Emissions & concentrations	Energy intensity, environmental measures
Biodiversity	Land conversion; land fragmentation	Species abundance comp. to virgin area	Protected area
Oceans/Coastal Zones	Emissions; oil spills; depositions	Water quality	Coastal zone management; ocean protection
Urban Environmental Quality	Emissions (Sulphur oxide, Nitrogen oxide)	Concentrations	Policy measures

(Source: Hammond, A., & World Resources Institute, 1995)

The above table depicts various environmental indicators. To keep indicators as simple as possible, a single measure is usually selected for each major environmental issue. Emissions of greenhouse gases can be combined to create a composite index. Various organizations like World Development Indicators, World Bank and OECD monitor

these indicators to simplify information for policymakers. Hence environmental degradation does not have a single indicator.

THE ENVIRONMENT – INCOME RELATIONSHIP

The state of natural resources and environment in the economy depends on five main factors (Panayotou, T., 1993) - the level of economic activity, structure of the economy, the choice of technology, the demand of environmental quality and the policy initiatives towards environmental degradation. The larger the size of the economy rapid will be the depletion of natural resources and higher levels of pollution in the economy. The nature of resource depletion depends on the extent of natural resources needed as input in the industrial sector of the economy. That is, sectoral structure creates an impact on the kind of natural resources that are being extracted from the nature. Economies that depend on agriculture and primary industries suffer from high depletion rates such as deforestation, ground water contamination, soil erosion etc. The process of extraction is accomplished using the technology available in the economy which itself is a matter of concern. Traditional techniques of processing and manufacturing are highly pollution intensive. New high end technology have lesser harmful effects on the environment.

There is a dynamic relationship between demand for high environmental quality and income level in the economy. Low income countries predominant in agriculture and core industries are in a state to conserve environment. As economic growth occurs, middle income levels have the highest share of growth from heavy industries further increasing pollution levels. Industrial development stabilizes and shifts towards sophisticated technology in higher income countries. At this stage of economic growth countries can allocate higher expenditures towards environmental conservation and protection through policy expenditures.

The level of industrial emissions is determined by the structure of input pricing, use of energy in the production process and the level of capital stock of the economy. Subsidizing the use of energy, electricity, water and natural resource raw material will induce higher levels of pollution and environmental damage. Weaker environmental regulations related to industrial waste disposal discourages input-minimizing

technology. Along with industrial structure, the level of capital stock and production technology determine the extent of environmental degradation in the economy.

Over time as the economy grows people can afford stringent policy initiatives because environment becomes a necessity. Market distorting subsidies are withdrawn and high prices of energy inputs reduce environment damage. Hence environment-income tend to share a closely knitted relationship. Figure 1.3 depicts the growth stages of an economy and its environmental degradation levels.
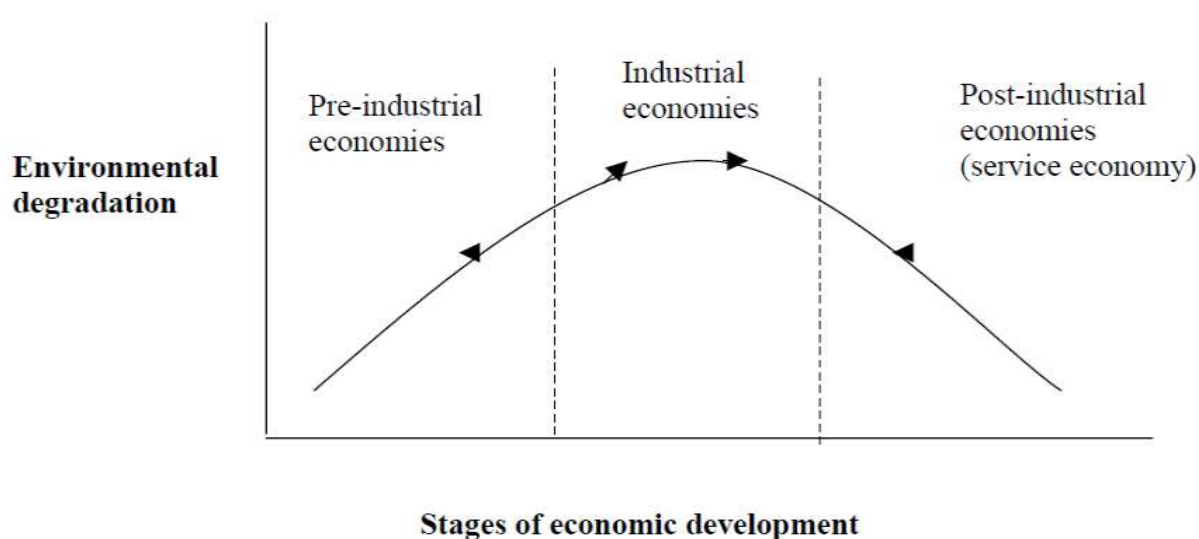

Figure 1.3: Environment – Income relationship
Source: Panayotou, T. (2003)

1.5 THEORETICAL FRAMEWORK

Several decades ago, Simon Kuznets (1965-66) advanced the intriguing inverted-U shaped hypothesis between income inequality and income per capita. The hypothesis examines that in the course of economic development income disparities rise at first and then begin to fall. The idea that things worsen before they get better appears to have general applicability. For instance, causal observation suggests that environmental degradation also rises at first and then falls in the course of economic development. Taking a glance at the history of megacities of the world it can be observed that Mexico, Delhi, Bamenda are far more polluted than they were two decades ago. While cities in Australia, Canada, Japan and Sweden are cleaner today than they were two decades ago.

If this is to be believed then the aforementioned causal observation suggests that environmental degradation is a temporary phenomenon associated with the stage of growth of the economy. The concept of the Environmental Kuznets Curve (EKC) emerged from the path breaking study by Grossman and Krueger on the potential impacts of the North American Free Trade Agreement (NAFTA). The background study for the World Development Report 1992 supported also the relationship of economic growth with environment degradation. Panayotou (1993) offered the most detailed explanation of the EKC in an analysis conducted for World Employment Program of the International Labor Office in 1992.

The situation of natural resources and environment in a country depends on: a) the level of economic activity b) the structure of the economy c) technology d) demand for environmental amenities and e) environmental expenditure.

The structure of economy in terms of a sector's contribution in generating employment and income plays a significant role in natural resource depletion. If a larger proportion of rural population depends on the unsustainable sector of the economy, higher will be the natural resource depletion. Larger the size of the economy as measured by Gross domestic product (GDP) higher will be the resource depletion. The share of industry in GDP of a country is closely related to the level of development. Low income countries general have lower share of industry in GDP as compared to higher income countries. In low income countries the industrial sector is mainly associated with agro-processing units whereas in the middle income countries the industry is dominated by paper, cement, steel etc. In higher income countries electricals and electronics have higher share in the industry which are less polluting in nature. This process is depicted in Figure 1.4.

It is possible that economies with the same industrial structure have different emission intensity. The role of technology is what makes them different. Obsolete, highly inefficient and outdated technology is less energy efficient than sophisticated high-end technology. An economy's technological techniques and input material is highly dependent on environmental regulatory framework and energy input prices. Countries

subsidizing energy, water, raw material and electricity bound to have high pollution levels than those promoting clean technology at relatively reasonable prices.

The logic of the EKC relationship is spread across three phases. At very low income levels when the economy is dominated by agricultural sector and very light industry the economic activity is at a subsistence level that barely affects environmental conditions. As the economy develops and industrialization dominates, environmental degradation increases due to increased use of natural resources as inputs into production processes. Due to higher significance associated with increased output at this stage the environmental consequences are disregarded. Lower level of technological progress and inefficient techniques of production lead to high emission of pollutants.
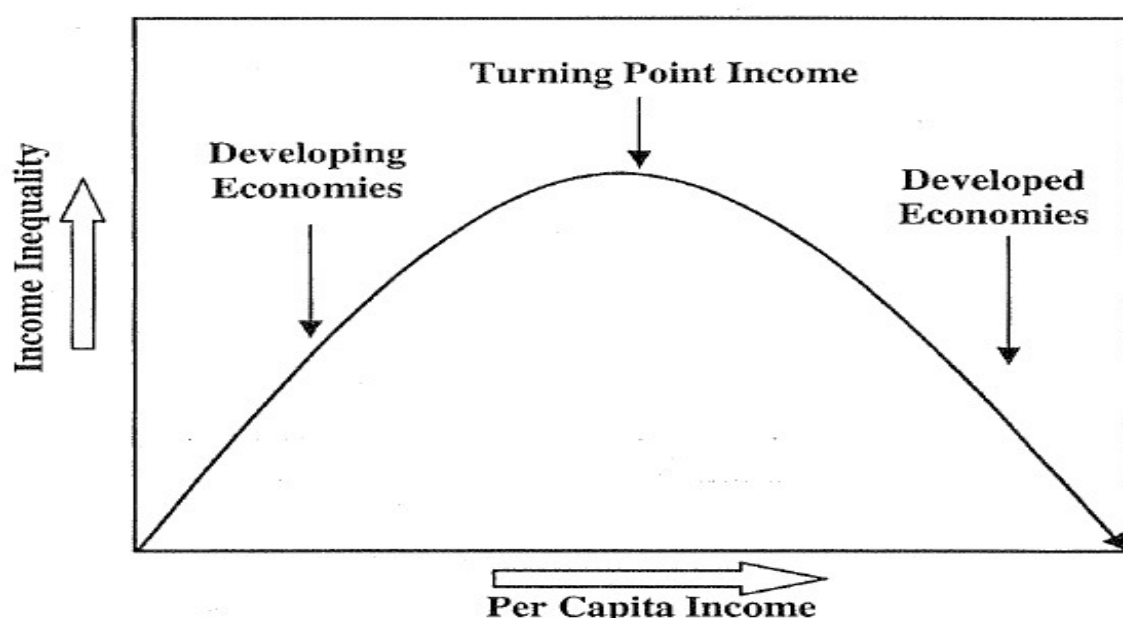

Figure 1.4: The Environmental Kuznets curve
Source Yandle, B., Vijayaraghavan, M., & Bhattarai, M. (2002)

With realization of economic growth, environmental degradation increases. However as economic growth continues and standard of living increases, people demand better environmental amenities. In the later stage there is a shift in industrialization towards information technology and communication so that environmental quality improves.

This highlights a turning point beyond which environmental degradation begin to fall. Economies need to achieve this turning point in order to improve environmental quality.

A general notion regarding this transitional relationship between economic growth and environmental degradation is that it is automatic. So one of the main issues regarding EKC is whether it occurs automatically in the course of economic growth or whether environmental policy plays a crucial role in improving environmental quality after the turning points.

1.6 POSSIBLE CAUSES OF THE ENVIRONMENTAL KUZNETS CURVE

The theoretical framework of Environmental Kuznets Curve hypothesis predicts an inverted U-shape curve. Several theoretical models and arguments have commented on the underlying causes of the downturn of the EKC. The possible causes of the Environmental Kuznets Curve are as follows:

The first most prominent cause of the downturn of the EKC is *income elasticity and demand for environmental quality* (Khanna, N., 2002). The results of EKC analysis can be interpreted in a way that pollution is inversely related to income elasticity. The demand for improved environmental quality at higher income levels is partly due to regulations and partly due to necessary technology upgradation. After a certain income level the willingness to pay for clean environmental quality rises by a greater proportion than income. The value of the elasticity coefficient is greater than one when environmental quality is a luxury good. As the income level rises environmental quality becomes a necessity good changing the value of elasticity coefficient to less than one. Hence the defensive expenditure increases with an increase in income levels.

Another imperative cause of EKC hypothesis is *structural change (Syrquin 1988, Panayotou 1995)* in the economy. People living at subsistence level in an agrarian economy produce low level of pollution. However as industrialization takes place and agriculture intensifies the pollution levels rise in the economy. Furthermore when the economy reaches a state where major source of income is the service sector and industrial sector takes a back seat, pollution levels fall. The structural change within the industrial sector can explain the rise and fall of EKC. Initially the industrial sector

is dominated by heavy highly polluting industries such as minerals, metals etc. At higher income levels the industrial sector shifts toward high-end technologies which are comparatively less polluting industries.

Similarly, structural change caused by change in environmental policy can also explain the EKC hypothesis for an economy. At the outset the dirty industry is larger than the clean industry. A higher tax on the dirty industries would reduce pollution levels in the economy. With higher taxes in the dirty industry the clean industry becomes sufficiently large.

International trade (Grossman & Krueger 1991) is also considered as one of the important causes of EKC hypothesis. Higher scale of economic activities increases the volume of international trade. This leads to higher pollution levels in the economy. Especially the non-restricted trade zones will have larger trade activities than usual. Free trade also encourages compositional or technological change in trade activities allowing migration of pollution intensive industries from one country to another. Countries following stringent environmental regulations would allow the dirty industries (polluting industries) to displace from their countries and countries allowing free trade would not restrict the establishment of dirty industries (Cole 2000). This is known as Pollution haven hypothesis in the literature on EKC hypothesis. Developed countries with higher income levels have higher demand for environmental quality pressurizing the authorities to tighten environmental regulations. Hence there is movement of dirty industries to developing economies with weaker environmental regulations.

The next cause of downturn of the EKC is the *demand for environmental quality (Shafik 1994)*. Environmental quality is considered as a normal good and when income increases the demand for environmental quality increases. With increased incomes of the economy environmental awareness increases, environmental health hazards decrease and demand for good quality environment increases making it a normal good. Some studies do argue that environmental quality is a luxury good because income elasticity of demand for environmental quality is greater than one. However, empirical evidence proves that though positive it is less than one. Though less than one, the change

in income positively affects environmental quality hence rejecting the luxury good argument.

Since reducing environmental degradation is an important responsibility of the government, the governments must ensure the demand for environmental quality is met. With rising incomes people support strong environmental policies, democracies sign international agreements and treaties with regard to environment and an organized movement on environment improves environmental quality.

There is no abatement at lower income levels as the focus is on growth of output. At higher income levels as the demand for environmental quality increases abatement expenditures become positive. As income grows the policy maker attempts to *internalize the external effects* (Selden and Song 1995) of pollution. Environmental effects are not sufficiently integrated into the market leading to market failure. Environmental goods market is inclined to inefficient market equilibrium. The "internalization" of external effects intend to restore efficiency and reestablish the equilibrium. The government raises the price of pollution by implementing taxes on environmental good as input in production process. A given price increase can lead to reduction of polluting input and substitution away from such inputs.

Internalization is possible when property rights of environmental goods are assigned to establish artificial markets thereby eliminating the inefficiency of the market system.

The downturn of EKC can be also caused due to *substitution between pollutants (Devlin and Grafton 1994)*. Developing economies attempt to abate pollutants that are local in nature and have lower cost of abatement. If the government regulates only the flow pollutants then some pollutants go unnoticed. Firms may substitute regulated pollutants for unregulated ones. The reason can be changes in technological progress. In this process the firms are emitting more of unregulated pollutants. The firms might be unaware of the magnitudes of the emitted pollutant. This entirely shifts the burden on to the future generation. Hence decline in pollution levels for some pollutants turns the EKC downward temporarily. Lieb (2001) in his discussion paper substantiates the claim of substitution between pollutants with the help of an example. Figure 1.4 graphically represent the cyclic effect of substitution between pollutants. Abatement of pollutant 1

with the help of new technology exposes the environment to a new pollutant 2. This reduces the pollution levels of pollutant 1 in the environment but increases the pollution levels of pollutant 2. For instance in developed countries end-of-pipe technologies have been crucial in reducing SO_2 pollution levels. Energy needed to operate end-of-pipe technology uses fossil fuels causing higher carbon dioxide emissions.
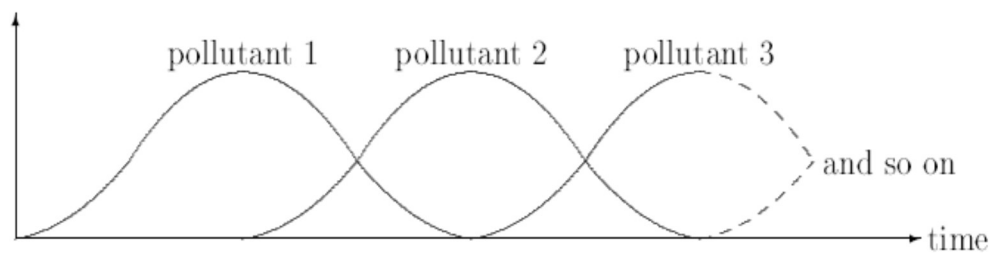

Figure 1.5: Pollutant cycles due to substitution and technological change Source: Smulders, S., & Bretschger, L. (2000)

Further, *technological progress (Lopez 1992)* also plays an important role in reducing pollution levels. Change in capital stock of the economy increases production of capital goods. Investment in production technology leads to higher output and economic growth. Investment is oriented towards saving factors of production and not environment. Economic growth leads to higher pollution. With environmental policy in place pollution levels gradually fall orienting investment towards environmental/ energy saving technologies. Clean technology should be affordable and accessible to the economy. As can be clearly seen in figure 1.5 use of new technologies can expose the environment to new and unknown pollutants. New technology can bring along with them newer pollutants into the system which will increase the pollution levels in the economy. Consequently there can be a cyclic effect of the clean technology oriented environmental policy.

Finally *irreversibility,* which is an irreversible damage to environment, might have occurred. Fall in emission levels or concentrations doesn't seem to imply that environmental quality is improving when the damage is irreversible. The assimilative capacity of nature is limited. If emissions in the economy exceed the assimilative capacity concentrations increase. With rising income only when emissions fall below the assimilative capacity the concentrations may reduce. Mounting concentrations may

reduce the assimilative capacity of nature. Hence falling concentrations may not guarantee that there will be an improvement in environmental quality.

1.7 DECOMPOSITION ANALYSIS

As per literature review EKC hypothesis can be decomposed into three mechanisms: scale effect, composition effect and technique effect. If liberalization causes expansion of economic activity foreign investment can also affect environmental quality. If the nature of the activity remains same larger scale of economic activity causes higher levels of pollution in the economy. Expansion of economic activity give rise to higher energy demand increasing the output of harmful pollutants. Composition effect results from the change in the structure of the activities. Competitive advantage in trade supports the production process of activities that are not regulated by the government. Negligible regulation encourages trade activities that leads to movement of dirty industries from one country to another, since the cost of abatement is relatively high.

Due to liberalization of trade and foreign investment output can produced using different methods. Change in the technique of production is known as technique effect. But pollution per unit of output will rise or fall depending on the availability of technology. If foreign investment transfers modern technology to developing countries then pollution per unit of output will fall. Higher income levels in the economy post liberalization might raise the demand for better environment quality. Thus, stricter environmental regulation might shift the production methods towards cleaner techniques. Figure 1.5 depicts the three effects where scale effect can be seen positively impacting pollution and composition and technique effect helps in downturn of EKC.
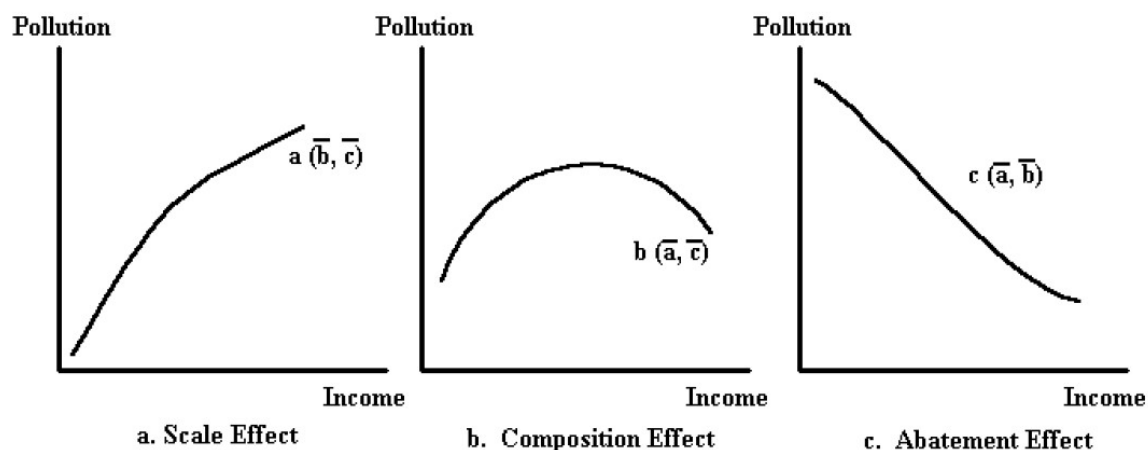
Figure 1.6: Decomposition effect

Source: Islam, Vincent and Panayotou (1999)

Researchers have found evidence which is not in line with the decomposition effect. This is due to contradictory evidences from various researches. This study decomposes the EKC into: Economic factors, Demographic factors, Governance factors and Environmental factors with respect to India.

1.8 VARIANTS OF EKC

Researchers have attempted to examine the empirical evidence of EKC and shared their results that depict alternative shapes of EKC. The traditional approach of EKC hypothesis is an inverted-U shape curve where the environmental degradation initially increases and higher incomes in the economy brings about the downturn. Attempts have been made to expand the hypothesis to include various policy initiatives that can achieve a downturn of EKC preferably before it reaches turning point through automatic mechanism.

Earlier attempts discussed the flattening of the curves by assumption of the existence of an inverted –U shape. Panayotou (1993, 1995, and 1997) presented different scenarios that flatten shape of the EKC. Figure 1.7 depicts the flattening of EKC when policy initiatives are in place. Environmental policy initiatives should be directed towards removal of harmful subsidies from the system to increase the price of input thereby

conserving natural resources. People tend to exploit natural resources beyond threshold limits when property rights are ill-defined. Increasing public responsibility and defining property rights by internalizing the externalities flattens the EKC. However it could entail huge costs if irreversible damage has been done.
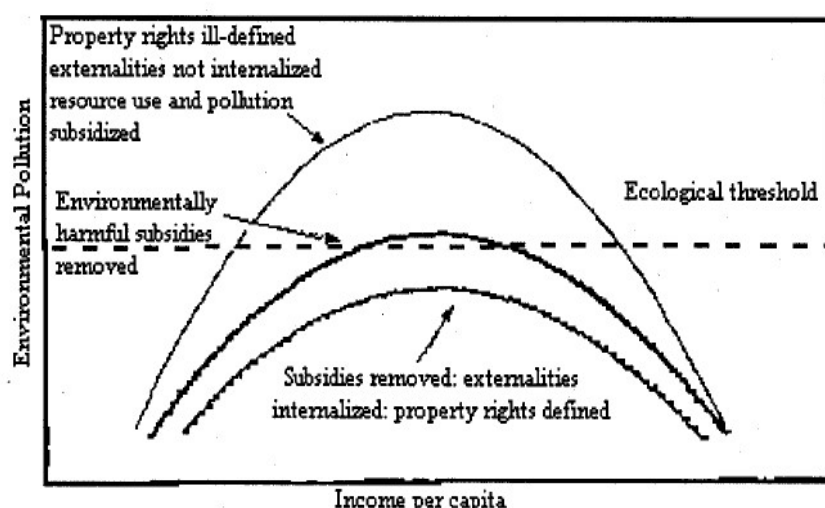

Figure 1.7: Flatter EKC under various policy initiatives
Source: Panayotou (1997).

In 1993 Panayotou underlined the fact that EKC cannot be considered optimal. If the assimilative capacity of the environment has already been traversed even policy initiatives cannot not flatten the curve. In the presence of a complementary relationship between environmental degradation and economic growth the depletion could be high enough to be irreversible. In this case instead of a flatter EKC there could be a presence of deep inverted-U shaped EKC. Figure 1.8 (a) depicts an EKC over threshold limits and figure 1.8 (b) depicts a deep inverted U EKC when complementarities exist.

EKC has been interpreted in several ways. It is believed that developing countries are "too poor to be green" and cannot adopt policy initiatives in the early stages of development. While development takes place, pollution intensive industries are relocated from developed economies to developing economies nullifying the overall impact of policy regulation in developed economies. This view point was criticized by many (Dasgupta et al. 2002). The counter argument states that with increased

environmental awareness even developing economies have not only identified pollution problems but are also being remedied. Such stylized facts on EKC hypothesis have given rise to variants of EKC. Figure 1.9 portrays possible variants of EKC. Mostly all environmental indicators show a monotonically rising relationship with income per capita. But researchers suggest that the overall shape of the EKC is a combination of two scenarios (Dasgupta et al. 2002). On the one hand there can exist new toxics that will increase emissions in the economy. On the other, over time this can lead to a downturn of the EKC which will actually shift the conventional EKC downward, – "revised EKC".
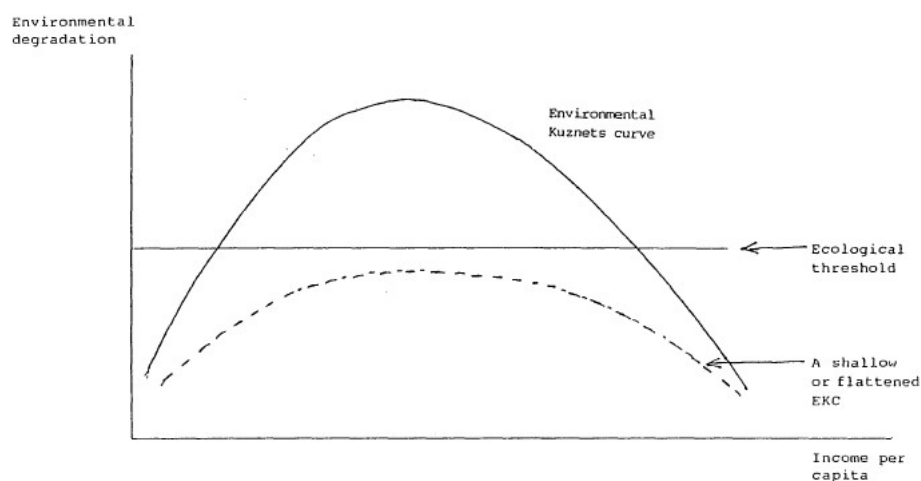

Figure 1.8 (a) EKC beyond threshold limits
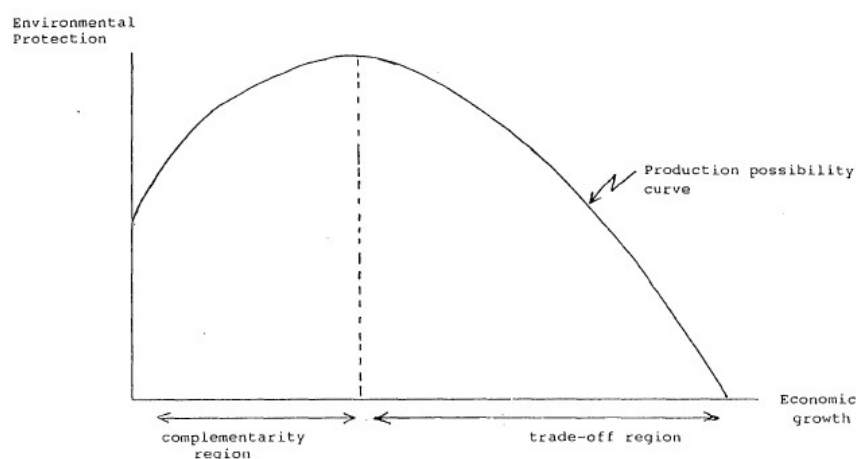*Source: Panayotou 1993*

Figure 1.8 (b) Deep Inverted U EKC when economic growth and environment complement each other
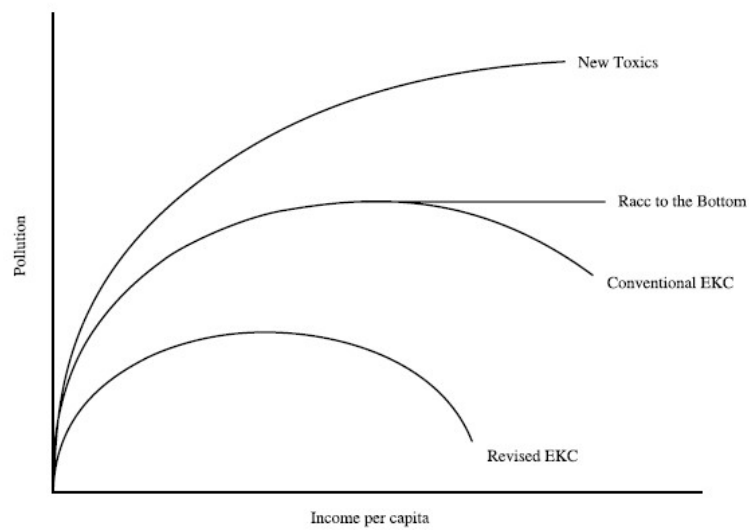*Source: Panayotou 1993*

Figure 1.9: Variant of EKC
Source: Dasgupta et al. 2002

It is observed through various empirical evidence that there is nothing automatic about the EKC. Economies need to be aware of their environmental state and initiate action at the right time to avoid irreversibility and higher abatement costs. Success ratio of such initiatives will rely on the effectiveness of policy.

1.9 RATIONALE OF THE STUDY

The Environmental Kuznets Curve illustrates a relationship between environmental quality in an economy and income per capita. It is a concept developed during 1990s by Grossman and Krueger. They attempted to study the potential impact of the North American Free Trade Agreement (NAFTA) on environmental quality of Mexico. The study came to limelight after it became a part of the World Development Report 1992 with a view that large scale economic activity inevitably hurts environment. Since then it has remained the most debated theme for environmentalists with controversial theoretical and empirical evidences.

The theoretical framework for EKC is in its early stages. Using various theoretical models, studies lay emphasis that EKC exists. For instance, *Munasinghe (1999)* used marginal cost-benefit analysis to examine EKC. He suggested that because in the early

stages of economic development the marginal benefits of environmental protection are way beyond realization environmental protection is weak in these early development stages.

Vernon Ruttan in 1971 in his presidential address termed environmental quality as a "luxury" good. Using the elasticity concept he elaborated the EKC behavior over different income levels. In early growth stages where income elasticity of demand for environmental quality is high, environmental quality is considered as a luxury good. At high income levels the demand for environmental quality is income inelastic hence environment becomes a necessity good.

Researchers also created hypothetical markets for environmental goods and assigned prices. In the initial stages of the economy when the price of environmental goods is low more is being demanded and hence exploited. Over later stages of the economy as environmental goods become scarce prices rise. Attempts have been made to create utility functions for environmental goods along with presence of externalities to examine environment-income relationship.

However the theoretical framework on EKC has not yet fully provided evidence of existence of the EKC.

Empirical studies on EKC range from simple quadratic functions to Dynamic error correction models with time series and panel data analysis. Environmental indicators chosen for the studies depend on data availability. In the plethora of research studies on EKC only few find supportive evidence. Many studies find other shapes for the relationship and have justified their viewpoints. To be precise, the results of empirical analysis differ on the basis of; chosen environmental indicator, choice of time period, countries selected for comparison, estimation functions and methods of analysis.

The choice of environmental indicator depends on the availability of data. EKC studies have always been limited by the availability of environmental data for all indicators over time. Hence most of the studies are based on panel data where countries chosen for analysis differ in every parameter. Developed country estimates cannot be used as a benchmark for developing countries. The economies differ in terms of capital stock,

technology, population, etc. Demographic and Economic growth paths are poles apart. Technical drawbacks of the models reflect the inefficiency of the estimated results.

EKC analysis has turned out to be a "black box" (Panayotou, 1999) for researchers. To solve this conundrum researchers are relying on better empirical evidences and sophisticated statistical tools which only complicates it further. The empirical evidences only state the shape of the EKC that exists with one or the other environmental indicator. The underlying process of an inverted-U shape of EKC is missing. What impacts the environmental quality the most? Which effect influences the EKC and brings a downturn to it? What kind of policy initiative will help in flattening the EKC curve? And above all whether an EKC exists for an economy in particular?

The study makes an attempt to address the research gap by investigating the answers to the above questions. The significance of a sustainable approach is not unknown. It is important understand the nature of environmental quality and accordingly increasing research presents greater insight into the available information for apt decision making.

1.10 CENTRAL THEME OF THE STUDY

The concept of sustainability is significant than ever before. Sustainability is a profound concept as it includes concepts such as resource use, production techniques, waste management, resource allocation and consumption. Each country has policies in place to management environment in their own way. Before the countries design environmental policies, insightful knowledge of their respective countries is imperative. Focused and effectives measures can eliminate bottlenecks to achieve sustainable economic growth.

As per the EKC literature and evidence from OECD countries, if a country can successfully decouple economic growth and environmental quality, growth path can be sustainable. The study makes an attempt to understand the state of environment in India (specifically in terms of carbon dioxide emissions). The relationship of carbon dioxide with important economic variables and its impact on them. The underlying structure environmental quality and economic growth relationship in India is one of the important objectives of this research.

Investigating the presence of the Environmental Kuznets Curve in India and examining its status along with its structure is the central theme of this study. The study in its initial stage examines traditional approach to the EKC analysis. Using regression and curve estimation techniques the EKC is plotted for India. To take it further EKC is decomposed with the help of economic effect, demographic effect, environmental effect and governance effect. These effects are individually tested against carbon dioxide emissions in India. The result and analysis is presented in following chapters. Finally the structure of Environmental Kuznets curve is analyzed with the help of Structural Equation Models.

The analysis include following variables, which has been selected on the basis of theoretical background and their relevance to economic growth and environmental quality in India.

Gross Domestic Product per capita, Electricity production from coal sources as a percentage total electricity production from all sources, Trade openness as a percentage of GDP, Industry (including construction), value added as a percentage of GDP, Foreign direct investment, net outflows and inflows as a percentage of GDP, Fossil fuel energy consumption as a percentage of total, Population density per sq. km., Population ages between 15-64 as a percentage of total population, Urban population as a percentage of total population, Literacy rate, as a percentage of total population, Poverty rate rural and urban as a percentage of total rural and urban population respectively, Alternative and nuclear energy as a percentage of total energy use, Access to clean fuels and technologies for cooking as a percentage of population, Access to electricity as a percentage of population, People practicing open defecation as a percentage of population, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory quality, Rule of Law, Control of Corruption,

Carbon dioxide emissions is selected as the indicator of environmental quality in India. According to a report by Union of Concerned Scientists (UCS) climate change is primarily a problem of too much carbon dioxide. "CO_2" sticks around. It remains in the atmosphere more than any other heat trapping gases emitted as a result of human activities. As per the announcement of Global Carbon Project energy use from fossil

fuel is still outpacing low-carbon sources. Total carbon dioxide emissions from fossil fuels and industry rose by 1.7 percent in 2019 to 36.2 gigatonnes CO_2 (iea.org, Global Energy & CO2 Status Report 2019).

The data utilized is extracted from World Development Indicators (latest edition), World Governance Index and Handbook of Statistics of India 2019. Earlier research works had non-availability of data as their major limitations. The availability of data set for India since 1960 is one of the major benefit of the study, as it helps in comprehend the evolving structure of economic growth and environmental quality.

1.11 SUMMARY OF ALL CHAPTERS

The structure of the study is as follows. Chapter 2 presents a comprehensive literature review under general EKC studies, studies emphasizing role of economic variables in EKC, studies stressing the importance of governance factors in examining EKC and studies using demographic variables in explaining the shape of EKC. This chapter also presents literature review on empirical evidences available for the EKC hypothesis and studies using Structural Equation Models for analysis.

The chapter on Research methodology defines research design of the study. It also includes the definition of variables used and its sources. Part A attempts to investigate a traditional EKC for India. Part B uses non-traditional structural equation models (SEM) to analyze the decomposition of EKC. Part C attempts to identify the structure of environment – income relationship with respect to the Indian economy. Data analysis and interpretation chapter presents the statistical techniques used in the study for modelling EKC. The final chapter of the study presents the observation of the researcher concluding remarks and recommendations.

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