

CHAPTER - 1

INTRODUCTION

Greenhouse gas emissions linked with diverse economic activities are key drivers of climate change in the globe. The relationship between environmental pollutants, trade openness and economic growth has received major focus in the past decades as these components play a major role in global warming and climate change. It is so challenging to have a sustainable environment with a rapid economic growth. In the 26 principles, the United Nations Environment Programme put forward the basics of sustainable development paying attention to environmental protection in concurrence with development socially and economically. The principles promote societal development and give the rights of freedom, equality and quality of life, the economic development of developing countries while quoting our responsibility to protect and improve the environment for present and future generations by safeguarding and managing natural resources and wildlife and preventing pollution (Srivastav, 2013).

Historically, growing wealth of countries is linked to increasing industry, energy usage and carbon emissions. Therefore developing countries are not an exception to this view. But this welcome economic growth has risky side effect, the greenhouse gas emissions.

1.1 Greenhouse gas emissions (GHGs)

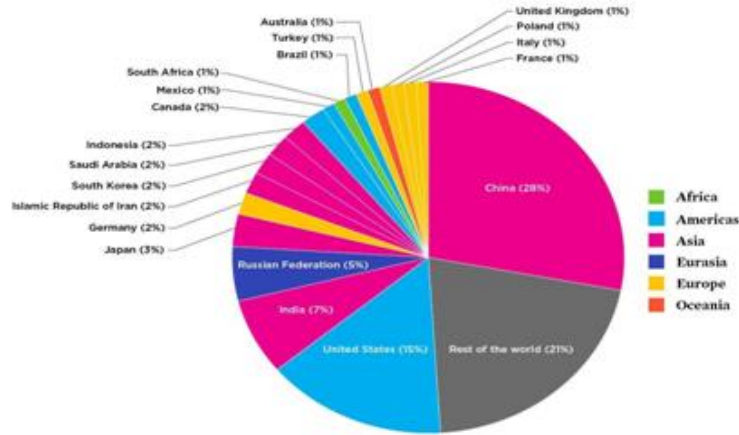
GHGs are greenhouse gases emitted to the Earth's environment due to the activities of humans: the greenhouse effect of 50 billion tons a year causes climate change. Burning of fossil fuels such as coal, oil, and natural gas are the reasons for most of the greenhouse gas emissions. Global warming potential of the greenhouse gases differentiate one from another. Some gases are short lived while other gases may stay in the atmosphere for decades. Some are emitted in large quantities but may not be dangerous. Some may be emitted in trace amounts but are harmful to the atmosphere. The principal greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide and fluorinated gases.

Table 1.1: Key Drivers of Greenhouse Gas Emissions

Type of Gas	Share in GHG	Source Driver
CO ₂	73%	Coal Combustion, Oil Combustion, Natural Gas combustion, Cement Clinker Production
CH ₄	18%	Cattle stock, Rice production, Natural gas production, Oil production, Coal Mining, Land fill: municipal waste, Waste water
N ₂ O	6%	Cattle stock, synthetic fertilisers, Animal manure applied to soils, crops, fossil fuel management, manure management
F-Gases	3%	HFC use, HFC-23, SF ₆ use, PFC use

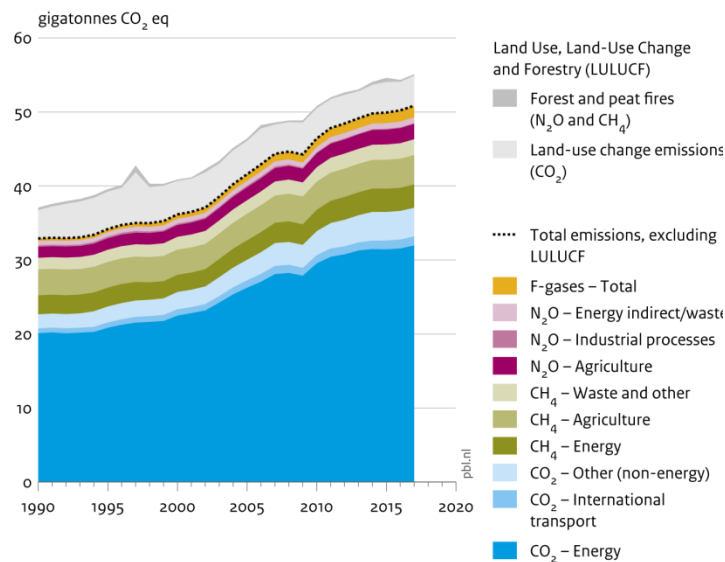
Source: EDGAR,2017

Water as a greenhouse gas stays in the atmosphere and absorbs thermal infra-red energy radiated from Earth and warms the atmosphere. But due to the non-availability of measurements of global water vapour, its effects are uncertain. Carbon dioxide emissions are mostly from human related activities and stay longer for more than a century in the atmosphere. Large emissions of carbon dioxide happen due to generation of electricity, vehicle emissions, cutting down trees and other changes in land use. Though carbon dioxide is important for plant growth, too much of it in the atmosphere is not good. Methane results from natural causes and also from agriculture and farming, though not as abundant as carbon dioxide in the atmosphere, still it absorbs radiation. Decomposition of organic materials by bacteria in wetlands emits methane. Scientists also have come up with alarming causes of methane emissions. Nitrous oxide occurs naturally in atmosphere and also is emitted from human activities. Fluorinated gases though emitted in smaller quantities have the longest life spans and are described as the high global warming potential (GWP) gases. The large emitters are aluminium and semi-conductor manufacturing processes. If the present emission speed continues, then by 2030 the global temperature may increase by 1.5 °C which is the planned limit of the Paris Agreement.



Source: International Energy Agency (IEA) Data, 2018

Figure 1.1: Share of GHG Emissions by Countries in 2020



Source: EDGAR, 2017

Figure 1.2: Greenhouse gas emissions, per type of gas and source

As the pollutants get accumulated in our atmosphere, the greenhouse effect causes warming up of the globe. As the heat of the globe increases, the arctic ice melts in a rapid manner, which raises the sea level (McMichael, et al., 2006). Large numbers of people in India rely upon glacial melt water which is used for day to day activities, agriculture, and hydroelectric power and so the global warming resulting in melting of glaciers would be disastrous to the country.

Even small increase in average global temperatures can have massive effects. The drought which keeps increasing in previously drought affected areas making the areas near the equator unfit for human living is a bad effect of climate change (Dai, 2013). When sea levels rise, the communities living close to the coastal areas get flooded and as most of the highly populated cities are on the coastal area; this will result in movement of large number of people to other places. Such forced migration would cause much impact on the migrants as well the areas they are moving to as climate refugees. Modernisation of agriculture sector also has contributed to the climate change. One such impact is by oil which has contributed to a grave amount of the total energy usage in agricultural sector for a long time in the recent past.

In 2019, China, the United States, India, the EU27+UK, Russia, and Japan were the world's major emitters of carbon dioxide with 62 percent of total global fossil fuel consumption. These countries together have 51percent of the world population. Their share of GDP in world GDP is 62.5 percent (EDGAR Report,2020).

1.2 India and China- The Economic Giants of Asia

India and China are two large Asian countries experiencing speedy growth during recent decades. They are the largest consumers of energy, more open to trade, largest emitters of green house gases and polluters causing health hazards. Since the General Agreement on Tariffs and Trade (GATT) has emerged and the reconstitution of it to the World Trade Organization (WTO) took place, trade between countries has improved significantly, enhancing trade liberalization.

India's average economic growth between the period 1970 and 1980 has been 4.4 percent which rose to 5.4 percent between the decades of 1990s. In 1991, India focused on export-led growth strategy in line with trade liberalisation policies. This was due to a financial crisis and demands from international organizations like the World Bank and International Monetary fund (IMF). There were many reforms announced in the new trade liberalization policy in 1991. The country opted for privatisation, brought down the value of the Indian currency to increase the exports and lessen the unfavourable Balance of Payment (BOP) state. Moreover, share of trade in GDP had been coming down before the 1990s. But, after the 2000s, contribution of trade in GDP showed continuous increase

due to the rapid revamp of tariff and good consequences of trade liberalization measures that kicked off in 1991 to promote export led growth by the Indian government.

The country witnessed a remarkable average growth of 8.8 percent between 2000 and 2010 due to the major structural changes of globalization of Indian economy. After 2010 till date, India's economic growth is 7.1 percent on an average and this was mostly due to the global economic deceleration post the financial crisis of 2008.

"India's long-term growth has become more steady, stable, diversified and resilient. In the long-run, for higher growth to be sustainable and inclusive, India needs to use the scarce resources such as land and water more productively, make growth more inclusive, and strengthen its public sector to meet the challenges of a fast-growing, globalizing and increasingly middle-class economy", as reported by Ahmad,J, World Bank Country Director in India in 2018. The long-term analysis of India's economic growth shows that the slowdown in the economy is a perceived notion, (Gupta, P. 2018).

The demonetisation and difficulties in the GST implementation resulted in a temporary dip in the growth of Indian Economy during 2016-17 year end and 2017-18 beginning of the year, but stabilized later. India's growth in recent years has been supported by far-sighted macroeconomic policy: a new inflation targeting structure, energy grant reforms, fiscal consolidation, higher quality of public expenditure and a stable balance of payment situation.

The contribution of trade to GDP has increased notably to 50 percent of GDP in the year 2018(World Bank,2018). As a result of such increase in trade openness, carbon emissions also increased in India(Fan & Hossain,2018). Millions have been lifted from poverty due to the increase in the employment opportunities as a consequence of India's strong growth. But this incredible growth record also has its associated problems like degradation of environment and increasing dearth of natural resources. India being a large country by size and diversity, environmental hazards are wide ranging. But there seems to be no choice for a developing country like India which has to grow, at the same time be vigilant of the consequences. To register an impressive growth energy usage is indispensable and India is no exception and uses lots of energy. About 800 million

people in India still subsist on less than 140 Rs. per day. Still a large number of Indians have no access to electricity and cook on traditional stoves. World development index shows India in the 128th position. Improvement in the level of human development is impossible without corresponding increase in energy usage per capita but as a result greenhouse gases are emitted in to the environment

India is presently in the third position among the top emitters of carbon dioxide on the earth and is ranked 140 in the world in emissions per capita. The first two are US and China in the 14th and 48th position respectively. Developed nations like US and China have taken many extreme measures to cut down emissions. But India being a rapidly developing economy with a large requirement of energy, greenhouse gas emissions are set to increase in the coming years. The data shows that emissions were 1.8 percent in 2019 but not as much as it was in 2018 and this must be due to a slowdown in the economy (Carbon Brief,2020).

The reforms in 1978 gave an impetus to the economy of China which expanded multifold. With this the country achieved middle-income status and was successful in pulling out majority of its populace from poverty. Much of the credit for the remarkable growth and economic transformation of Chinese economy goes to the manufacturing sector. China is the leading manufacturer in the world in terms of output replacing Germany, Japan and US and has attained a position as the world's factory after its entry to the World Trade Organization (WTO) in 2001.

Currently, almost 100 million people have jobs in China's manufacturing, which throws light on the importance of industry to China's economy. China's growth has been impressive from a traditional agrarian economy to a manufacturing power house. It accounted for over a 25 percent of total world manufacturing value added in 2016 and is likely to continue rising in the coming years. China's total industry value is USD 4.5 trillion in 2016 which is more than other best performing nations. The industries in China make a variety of goods from textiles and garments to electronic products and transport equipments. China was the source of approximately half of the global supply of crude steel (808 million tonnes), coal (3.5 billion tonnes) and cement (2.4 billion tonnes), and more than a quarter of world's supply of motor vehicles (24.5 million units) in 2015. It is

also the world's leading producer of ships, high-speed trains, robots, chemical fibre, machine tools, cell phones, computers, and a number of metals and home appliances (Linster and Yang, 2018).

After the official entry into WTO in 2001, China competed heavily in the International arena. No doubt trade liberalisation is one of the important reasons behind China's economic development. Merchandise exports from China were USD 2263.3 billion and imports were USD 1843.7 billion in 2017(UN Statistics division). This remarkable progress had its negative side with wider range of CO₂ emissions due to energy usage for export production which happened at the cost of a safe environment.

Among the OECD and BRICS economies, China consumes more energy per unit of GDP and is also the world's largest emitter of CO₂ emissions since 2006. China pollutes the environment with 80 percent of the residues from Industry production, CO₂ and SO₂ emissions. Even with strong environmental legislations, weak enforcement of them has made the impacts more severe. The excess capacity of the energy efficient industries also adds to its pollution issues.

As per the Paris Agreement, the National Determined Contribution (NDC) targets for China was to reduce the carbon dioxide intensity per unit of GDP by 60 -65 percent compared to 2005 and to increase non fossil energy consumption to 20 percent of total primary energy consumption by 2030. But the country was not able to achieve it as the drop of carbon dioxide intensity was only to 45 percent and rate of decline averaged to 4.9 percent (China Statistical Yearbook, 2018).

Due to the large scale production, the energy demand in China would be a quarter percent of the world's total energy demand by 2035 and is expected to increase as much as 38.5 percent (World Energy China Outlook (2013–2014) forecast). The increase in energy use due to the faster growth of the economy will also lead to the rise in emissions. Emissions also affect the human health and the environment. These impacts pose a serious threat to the economy which has to bear considerable costs thereby reducing the possible sustainability.

By 2030, the two countries will account for 34 percent of the world's population, 30 percent of the global economy and 32 percent of its primary energy demand. China and India are already making noteworthy progress towards their climate goals (World Resource Institute, 2018). India has the largest number of

cities in the world's 20 most polluted list replacing China (The Hindu,2019). With the acceleration wind and solar installations, India will be able to achieve its targets of shifting to renewable energy resources. Both India and China have kept up good annual economic growth of 6.8 percent and 7.1 percent respectively. Thus India and China have a significant role to play in reducing greenhouse gas emissions without compromising economic progress.

1.3 Environmental agreements

An international environmental agreement has the purpose of laying down some procedures to be followed so that the objective of protecting the environment is fulfilled. All economic activities of human have its impact on the environment. The environmental agreements aim at measuring the impacts, devising procedure to assess the effects and then create policies and integrate them into the development process. In other words, it is an intergovernmental document intended as legally binding with a primary stated purpose of preventing or managing human impacts on natural resources. To manage the whole process of measuring the impacts, drafting regulations and ensuring enforcements, an organization is needed at the international level. The organization should call for treaties which are signed by all concerned as the harmful effects on the environment is a common problem to all and will impact the earth in so many ways. Such an effort is the Multilateral Environmental Agreements (MEAs) that creates procedures and rules to be followed by all its International signatory members and to maintain cooperation in the matters discussed.

Montreal Protocol (1987)

This is a landmark multilateral environmental agreement that regulates the production and consumption of ozone depleting substances (ODS) which damage the stratospheric ozone layer that protects the Earth from harmful levels of ultraviolet radiation from the sun. The protocol eliminated nearly 99 percent of these ozone-depleting substances. In 2016 through the Kigali Amendment, the members agreed to reduce their production of hydro fluorocarbons (HFCs), powerful greenhouse gases that contribute to climate change.

To phase out of the different groups of ODS, the treaty gives specific responsibilities to the parties such as to control ODS trade, submission of data

annually and licensing systems within the country to control ODS trade. Developing and developed countries have measurable commitments.

The Multilateral Fund for the Implementation of the Montreal Protocol established in 1991 provides financial and technical assistance to developing country whose annual per capita consumption and production of ODS is less than 0.3 kg. The Fund's activities are implemented by four international agencies – UN Environment Programme (UNEP), UN Development Programme (UNDP), UN Industrial Development Organisation (UNIDO) and the World Bank as well as bilateral agencies of non-Article 5 countries

Hydrochlorofluorocarbons (HCFCs) used in refrigeration, air-conditioning and foam applications are phased out under the Montreal Protocol as they are nearly 2,000 times more potent than carbon dioxide in terms of its global warming potential (GWP)

Overall HFC emissions are growing at a rate of 8 percent per year and annual emissions are projected to rise to 19 percent of global CO₂ emissions by 2050. If not controlled HFC emissions will be disastrous to the environment. Therefore all parties to the Montreal Protocol reached agreement in Kigali, Rwanda to phase-down HFCs. Countries agreed to add HFCs to the list of controlled substances, and approved a timeline for their gradual reduction by 80-85 per cent by the late 2040s. Developing countries are advised to freeze HFCs consumption levels by 2024. With the all these efforts, the ozone layer is projected to recover by the middle of this century.

United Nations Framework Convention on Climate Change (UNFCCC) 1992

UNFCC aims to stabilize greenhouse gas concentrations at a level with a time frame enough to allow adaptability by the eco system. Industrialised nations have to provide financial support for action on climate change, share technology with the developing nations and also have to submit reports on their climate change policies. They are required to reduce emissions to 1990 levels. Understanding that economic development is vital to the world's poorer countries, the convention helps such countries to limit emissions without hindering their economic progress

Kyoto Protocol (1997)

The Kyoto Protocol with 192 parties was originally adopted on 11 December 1997 but came into force on 16 February 2005. Kyoto Protocol implements the United Nations Framework Convention on Climate Change by advising industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions agreed by them as individual targets and also to adopt policies and measures on alleviation and to report periodically. Kyoto Protocol had compulsory emission reduction targets during the first commitment period, 2008-2012 for 37 industrialized countries and economies in transition and the European Union which add up to an average 5 per cent emission reduction compared to 1990 levels. The Doha Amendment to the Kyoto Protocol was adopted for a second commitment period with an emissions reduction target of 18 percent below 1990 levels in the eight-year period from 2013 to 2020. Flexible market mechanisms permitting trade of emission permits is an important element of the Kyoto Protocol. Under the Protocol, countries must devise national measures to meet their targets. The protocol ensures transparency with rigorous monitoring, compliance, review and verification system.

Copenhagen agreement (2009)

Climate change policy gained political status at the Copenhagen Climate Change Conference which was attended by nearly 115 world leaders. The conference threw light on the infrastructure needed for effective global climate change cooperation. The Copenhagen Accord contained several important elements like limiting the maximum global average temperature increase to 2 degrees Celsius. It also had the developed countries promise to provide US\$30 billion for the period 2010-2012 to reduce greenhouse gas emissions and to adapt to the unavoidable effects of climate change in developing countries and also to mobilize long-term finance of a further US\$100 billion a year by 2020 from a variety of sources. There was an agreement on the measurement, reporting and verification of developing country actions.

Paris Agreement (2015)

The Paris Agreement was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and came into force on 4 November 2016 with a goal to limit global warming preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Economic and social transformation is must to implement the Paris Agreement. By 2020, countries were to submit their plans for climate action known as nationally determined contributions (NDCs) where they will take measures to reduce their greenhouse gas emissions and build flexibility to adapt to the impacts of rising temperatures in order to reach the objectives of the Paris Agreement. To plan the long term goal better, the Paris Agreement invited countries to devise and submit long-term low greenhouse gas emission development strategies (LT-LEDS) by 2020. The Agreement also provided a structure for financial, technical and capacity building support to those countries that need it. With the Paris Agreement, countries established an enhanced transparency framework (ETF) to report on actions taken and the progress in climate change mitigation and to set more ambitious plans in the next round. Though much more has to be done to achieve the goals, since the agreement there have been low carbon solutions. Zero-carbon solutions are becoming competitive across economic sectors representing 25 percent of emissions.

1.4 Research Gap

The following are the important research gaps identified in the earlier studies.

1. In analyzing the greenhouse gas emissions, only carbon dioxide was taken into account in the earlier studies. But this study includes methane, nitrous oxide and four F gases along with carbon dioxide under greenhouse gas emissions as these gases also contribute to global warming.
2. Very limited studies had compared the relationship among greenhouse gas emissions, trade openness and economic growth between India and China for the period 1970-2018.
3. Impact of economic growth on greenhouse emissions has been studied vastly but the influence of greenhouse gas emissions on economic growth was assessed by very few earlier studies (Azam et al., 2016).

4. The decoupling classifications for India and China for 49 years were attempted in this study which was found in very few earlier studies.

In this backdrop the current study to find Relationship between Greenhouse Gas Emissions per capita, Trade openness and Gross Domestic Product per capita in India and China was conducted with the following objectives

1.5 Objectives of the study

The present study is an attempt to investigate the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita in India and China, the world's fastest growing economies. To understand the linkages, the study was carried out with the following objectives.

1. To analyse the trend and growth of greenhouse gas emissions per capita, trade openness and gross domestic product per capita in India and China.
2. To assess the decoupling status of greenhouse gas emissions per capita and gross domestic product per capita, greenhouse gas emissions per capita and energy consumption per capita, greenhouse gas emissions per capita and trade openness.
3. To test the stationarity of greenhouse gas emissions per capita, gross domestic product per capita, trade openness and their determinants.
4. To study the cointegrating relationship among greenhouse gas emissions per capita, gross domestic product per capita, trade openness and their determinants.
5. To test the causal relationship among the greenhouse gas emissions per capita, gross domestic product per capita and trade openness

1.6 Hypotheses of the study

1. The variables chosen in the study are stationary
2. There exists long run relationship between gross domestic product per capita and its determinants
3. There exists long run relationship between trade openness and its determinants

4. There exists long run relationship among the greenhouse gas emissions per capita and its determinants
5. Decoupling effects exist between greenhouse gas emissions per capita and gross domestic product per capita, greenhouse gas emissions per capita and energy consumption per capita, greenhouse gas emissions per capita and trade openness

1.7 Scope of the study

The study would contribute to existing literature in numerous ways. It attempts to find the linkage between greenhouse gas emissions per capita, trade openness and gross domestic product per capita. The period for the study is from 1970 to 2018. In analysing the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita, CO₂ emissions alone were considered as greenhouse gases in most of the earlier studies. Emissions of non-CO₂ gases such as Methane, NO₂, F gases are also expected to increase rapidly in response to urbanization, consumer preferences and end-user behavior in both India and China. It is important to reduce short-lived climate pollutants (including non-CO₂ gases) along with CO₂ emissions to help to achieve the overall goal of limiting global temperature rise to less than 2°C.

Reducing short-lived climate pollutants could help to avoid 0.6 °C in temperature increase by 2050 and halve the rate of global warming (Shindell et al. 2012 and Xu et al., 2013). Despite the importance of short-lived climate pollutants, Ross et al (2018) found that actions to lessen those pollutants are often underrepresented in the Nationally Determined Contributions (NDCs) submitted in support of the Paris Agreement. In the present study CO₂ and non CO₂ pollutants are included in the GHG emissions. The study would also discuss on the Environment Kuznets Curve theory.

1.8 Scheme of the study

The study is organized into five chapters. Besides the current introductory chapter which discusses on selected research area, the concepts, international agreements, statement of the research problem, objectives, hypotheses, scope of the study, there are other 4 chapters.

The second chapter on review of literature is streamered in four areas. The first discussion is on the theories related to the study. The second area of

research review focuses on studies based on Environment Kuznets Curve hypothesis with set of studies on carbon emissions and economic growth, few available studies on carbon emissions as explanatory variable, studies on relationship between carbon emissions, economic growth and number of other influencing variables. The third area of research review focuses on other related studies.

The chapter on methodology defines the framework and data used for empirical analysis of the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita. The chapter also outlines the model specification for India and China during the study period and defines the variables used in the study. The source of secondary data is also highlighted. The chapter discusses in detail the pre-estimation tests used in time series analysis through the unit root and the cointegration tests and brings out the estimation modeling techniques. The stability tests through the CUSUM and CUSUM square tests are also briefly explained in the chapter.

The fourth chapter is devoted to discussions and interpretations of the results of the analysis performed to test the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita. The last chapter provides the summary of findings, conclusion and suggestions of the study.