

A QUESTION TO SUSTAINABLE ECONOMIC GROWTH WITH RESPECT TO MODERNISATION: A CASE STUDY OF INDIA

Astha Sharma*

ABSTRACT

The study is focused on the analysis of various sources of carbon equivalent emissions and their cross-relation with India's economy. These sources are mainly the sectors of India's economy that have a significant influence on both economic growth and total emissions creating a paradoxical situation with the existence of inter-dependence among them. Energy and Industrial Sector are identified to be the major source of these emissions and are therefore further analysed in terms of their operations or activities. The impact of CO₂ equivalent emissions is noted on both environment and India's population health.

KEYWORDS: *Urbanisation, CO₂ equivalent Emissions, Economic Growth and Sectorial Trends.*

Introduction

India's current GDP growth rate is 6.7%. A great rise in its economic development has been noticed since past few years. Many factors have been a reason for the development of its economy. India as an emerging industrialized economy has attained a good level of economic development (GDP) and has travelled a long way to modernization. Therefore a large shift in the share of sectors in the economic growth has been noticed. Industrial sector is now a major contributor to the economy both in economic terms as well as in the creation of employability. With the increased use of new technologies, machines and methods of production, more efficient transportation facilities, etc. the standard of living of each individual has also uplifted along with our economic growth. But at the same time there is a great need to do the cost analysis of each of these activities and our day-to-day usage of resources for a better sustainable environment and growth.

According to BP Energy Outlook 2017, growth of 4.2% a year in energy consumption has been predicted for India that would even cross the major economies by 2035. For satisfying the huge demand of India's growing population for energy, a large amount of non-renewable and renewable resources are used. Energy through the usage of non-renewable resources involves burning of fuels, coal, etc. This activity of production is causing an increasing amount of carbon content in the atmosphere. As a result India is already at the 4th position in the ranking of carbon emission globally, leading to the emergence of hazardous impact on the human resource of our economy. Hence it is important to study the environmental aspect of our development too.

These gases absorb the heat of the earth following with the increase in the atmospheric temperature. These are termed as 'Greenhouse Gases'. Anthropogenic activities of humans are declared as the main cause of the evolution of such gases and climate change by the researchers, mainly occurring since 1950. The method of reduction can be used for attaining the below '2 degree Celsius aim relative to pre-industrial level'. But formulation or implementation of these methods raises the new challenges of technology, economy and social aspects for the environment and growth.

* BA Economics (Hons.), Christ University, Bangalore, Karnataka, India.

Climate changes affect the economy, the industrial processes by the way of changes in the temperature leading to the rising demand for energy or through the uncertain demands followed by droughts, floods, etc. As a result of these changes the entire economy can be at a risk under the condition of rising sea level and temperature or on the other side tourism sector and agriculture sector can face benefit in terms of high or low temperature at a certain region. That's how India's economy is facing a trade-off between economic growth and environmental safety. Therefore it has been realised that a method for sustainable development is needed for operating through both the aspects hand-in-hand.

Literature Review

Industrialization, efficient transportation, etc has led to an increase in economic growth. But at the same time it is deteriorating the environmental and societal benefits. Carbon emission is a result of production of energy to be used for various purposes. This could be evaluated by comparing the amount of coal consumption and production, burning of fossil fuels for transportation facilities, household activities, etc. All these increased amount of activities in India's current scenario is leading to greenhouse gas emission, as a result of burning, production and consumption. The dominance of carbon is seen among the greenhouse gas emission in India. Hence to keep an account of it and to analyse the CO₂ emission with respect to the economy is very important for the sustainable development of India's economy.

The impact of climatic change is on every sector in the economy. Tourism sector has a great share or contribution in the economy of India. But with the irregular changes in the weather (effect of anthropogenic activities on environment) it has faced a lot of challenges in relation to the climatic conditions at the tourist destination or during specific seasons. Due to the uncertainty of weather, the supply of various facilities also gets limited along with the infrastructure that again limits the tourism economy (Schenker-Wicki, Inauen, & Olivares, 2010). Many literatures involved studying of Environmental Kuznets Curve (EKC) hypothesis. This involved a base level assumption that emission occurs as a result of rise in income and continues to increase until it reaches a specific threshold level of income, followed with a decline in the emission rate. In contradiction to the same it has been noted that there is not only unidirectional relationship between the two, as emissions can occur as a result of production contributing to rise in income (Dinda and Coondoo, 2006; Akbostanci et al., 2009). This gave a separate view point on the relationship between the environmental pollution and economic growth.

It has been stated that there would be a rise in the level of carbon emission in India from 212 to 738 million tonnes from 1995 to 2035 respectively. This reflecting a 3.1% of CARG i.e. compound annual rate of growth (ShuklaGhosh and Garg, 2004). This increase of carbon content in the atmosphere can have a very severe impact on the population. Based on the estimates of ADB, 1994 it has been found that an increase in the sea level at this condition with just one meter can displace around 7 million people and destroy the roads, etc. This leads to the emergence of the question on our economic growth (with respect to trade, modernization, technology, production and consumption) that, whether India is really on a path of sustainable development or not. As in India, industrial sector is the major user of energy. Hence this is indirectly creating a huge burden on the resources by generating demand for the energy production. All these industrial activities and their effect on the economy are referred as externality in economic terms. As with the growth of industrial policies, the economy would also grow. But along with it, the externalities would also increase. These externalities are the pollution done by the industry while undertaking its operations without knowing the effect of it on the cost of production and the environment.

Mitigating Instruments and their Discrepancies

Hence policy instruments are important for mitigating these emissions. Therefore Austin, 1999 analysed the two instruments under his study. These are 'Command and Control' (CAC) and 'Economic Incentives' (EI). CAC is a traditional approach that puts a limit on the amount of harmful activities, involving emissions and abatement standards under it. In comparison to this EI is considered efficient as it internalizes the externalities by the way of putting taxes or charge on every count of an effluent released in the production by the industry. In this way it changes the decision of the production unit on the basis of their cost of production and keeps a control. But still some discrepancy is continued in the formulation of these two instruments, causing an improper control on the carbon emission. Introduction of 'Carbon-Tax Rate' is taken as another way for solving this problem by many countries. This tax rate could be used as product charge based on the amount of carbon content, applied on various fossil fuels. The increase in price as a result of this could generate more revenue as most of the developing countries

deals largely in fossil fuels in the case of production. This rise in revenue could be beneficial in fiscal terms, if minimum market distortion is seen. It could be effective for environment benefit, if reduction of emission is possible. But the occurrence of these two together seems contradicting and creates a scope for more study on it. Another problem faced as a result of carbon emission is that with an increase in the price of energy with respect to such taxes on it to control the same, would lead to fall of demand in the short run. Therefore assuming technology as fixed this would lead to decrease in the employment.

Emissions and Economic Growth

It has been found that during the period of 1993-1994 to 2002- 2003, the most urbanised states of India have experienced a rise in their respective growth with a great share, accounting to more than 100% of their net growth. The 2001 Census showed that the India's urban population has increased by around 28%. A 40% further increase of the same has been predicted under the 2001 Census by the year of 2021. The urban development is strongly linked to the adoption and implementation of public services and their respective strategies. As with the urban development, a significant and continuous development in the areas of infrastructure, transportation, power consumption and supply, water supply, etc. are also taken into account. These public strategies or urban economic development contributes in the share of emissions exerted as well as their GDP growth is interlinked to each other. Many studies were done in order to study the relationship among all these factors (urbanisation, industrialisation, economic growth and emissions).

A 'multi region input output' model was used on the sample of 'middle-income' countries for the same purpose of analysing the effect of industrialisation on CO₂ emission by Asane-Otoo (2015). Result of this study showed a positive impact of the former. Another study by Madlener and Sunak (2011) focused on both developing and developed countries separately to study the relationship between urbanisation and energy consumption. A comparison between the results of both is done, as their short run and long run relationship varied a lot. As the economy is developing various new strategies are being adopted for the same. Therefore a structural change or shift is seen from one sector to another in the process of growth. This result of a sectorial movement of the economy from agriculture to manufacturing activities is backed by the study done by Annez and Buckley (2009), representing a strong relationship of this shift with economic growth (GDP).

Transportation, commercial and other household activities involving energy consumption is another factor in the line of greenhouse gas emission with almost one-fourth of its share in it. Therefore a conclusion can be derived from this is that the economic growth rises but along with the rise in greenhouse gases (McCarney 2009). According to Grazi and Waisman (2009) all these are the hidden diseconomies emerging with the urbanisation as an 'agglomeration' aspect of it (Sridhar, 2015). According to the report of 2003 by National Research Council, manufacturing and industrial sector was the major force in the increasing of GDP by almost 86% from 1980 to 1998. This report also stated the extent of dependence of the economies on the path of urbanisation on the continuous extraction of natural resources from the environment turning into degradation process. Hence urbanisation acts as one of the major factor leading to this high amount of emissions (climate change) in the environment.

This can be proofed by the existing theory of urban environmental transition which states that a region can increase its wealth by the way of conducting manufacturing activities on a larger number and scale. This would indirectly increase the pollution due to their resulting industrial processes. This in itself explains the relationship among all these factors together and the presence of inter-linkage among them (Granahan, 2001). Various studies undertaken by York, Rosa, and Dietz (2003) and Dietz and Rosa (1997) showed different results in terms of their extent of dependence. But at the same time the results of their relationship or impact on each other is same.

Objective

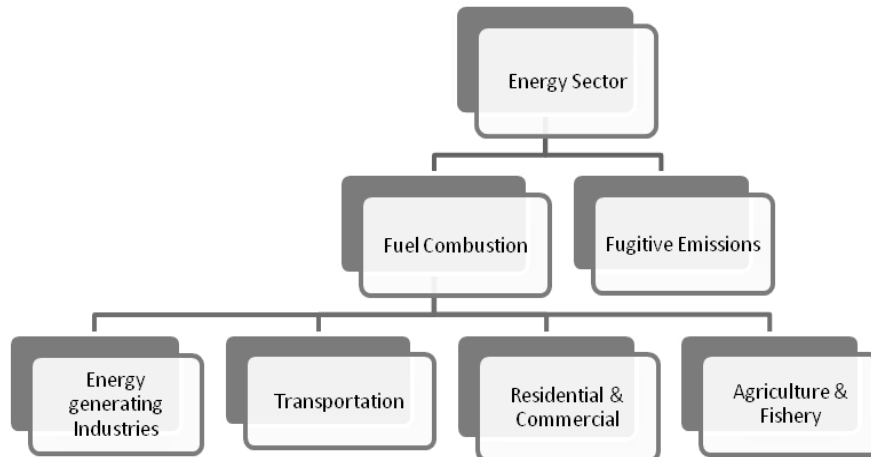
- To identify and analyse the largest emitting sectors in India with respect to their contribution in growth.

Methodology

A pre-existing relationship among the variables urbanisation, industrialisation and economic growth has been noted. This positive relationship among them through their respective contribution in economy's growth is accompanied with a limitation and challenge of increasing the emissions rate with their economic activities.

The reports of 'IPCC' and 'UNFCCC' are used in the selection of these sectors. These sectors are further categorised into sub-parts based on their activities of operation leading to the generation of emissions. Hence the sectors identified are as follows and the further estimations under each of them are done through the submission of their sub activities included under them respectively.

- **Energy Sector:** Total emission from this sector is calculated by taking into account these sub operations and their contribution to it.



- Industrial Processes and Product Use (IPPU): It doesn't include the industries dealing with the energy production. But is mainly focused towards the industries that are more into the production of other goods. This involves identification of various industrial sources contributing to the emissions that are generated "as a by-product" of other goods production.
- Agriculture, Forestry and Other Land Use (AFOLU): The emissions that are formed by this sector are mainly as a result of changes recorded in the carbon stock and natural resources. Therefore all the activities involved in the agricultural sector or related to natural ecology are included in terms of their respective emissions as overall.
- Waste Sector: It is methodologically derived through the analysis of its sub-classification. These includes:
 - Waste treatment under solid waste disposal areas, through the method of anaerobic decomposition of organic waste, etc.
 - Domestic and Industrial wastewater management; mainly in developing countries like India is handled by the way of sewer system.
 - Waste Incineration activities involving burning of waste activities for its further treatment leading to the emissions.

The total greenhouse gas emissions from each of these sectors are calculated in terms of CO₂ equivalent value and are measured in 'Kilo tonnes unit'.

Sources of Data Collection

- Food and Agriculture Organisation of the United Nations (FAOSTAT)
- Intergovernmental Panel on Climate Change
- Ministry of Environment, Forest and Climate Change of India

The entire analysis is based on the period of 1990-2014, focusing majorly on the post – reform period.

Data Analysis

The trend of the identified sectors is analysed both in terms of their respective share in total emissions generated and in India's GDP growth rate. This is done in order to identify the largest emitting sector and further analyse it through the usage of its activity data.

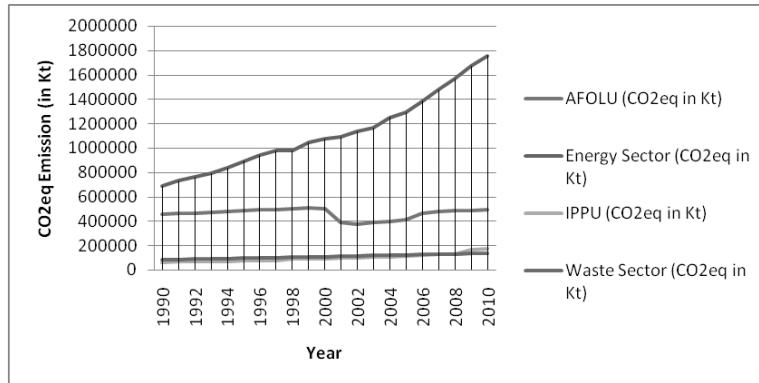


Figure 1: Sector-wise emission

Source: Intergovernmental Panel on Climate Change (IPCC), 2005-14 and FAOSTAT Report 2015

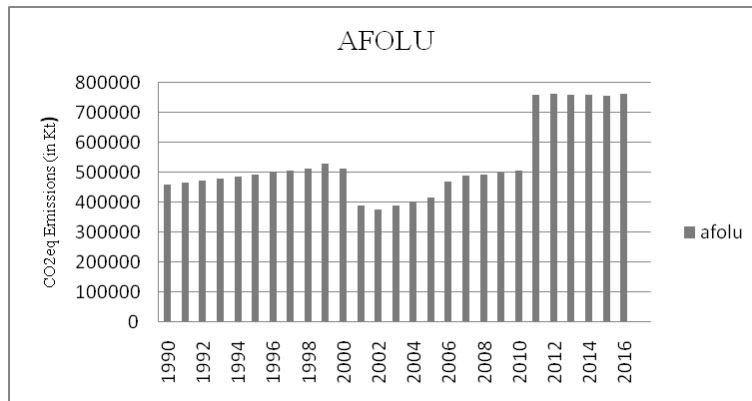


Figure 2: Agriculture, Forest and Other Land Use Sector Trend in CO2eq Emissions

Source: FAOSTAT Report, 1990-2016

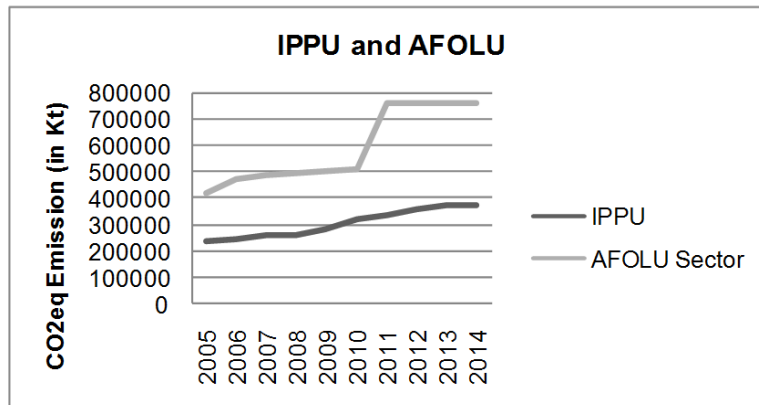


Figure 3: Industrial Processes and Product Use; and Agriculture, Forest and Other Land Use Emission's Trend Source: Intergovernmental Panel on Climate Change (IPCC), 2005-14

The graphical representation of all the identified sector's emissions together is shown in Fig 1. Energy sector (rising at an average pace of 4.83%) is the largest emitter of GHG and is above all the other sectors in the line. With a sectorial change in the economy, share in the level of emission has also changed. 'AFOLU' still continues to be the second largest emitter among all. But its share is decreasing with subsequent years at an average pace of 0.65% (especially remaining stagnant after 2011 as shown in Fig 2).

With increasing industrial expansion in India, the share of industries in emissions is also increasing at an average pace of 5.6% (Fig 3). IPPU sector crossed the emission level of waste sector in 2010. This rising share of industries in emissions is leading to an emerging threat for the economy with the policy of industrial expansion for achieving the development. Hence, further analysis of 'Energy' and 'IPPU' sector is important for understanding the source of these emissions and their trend in the economy.

Energy Sector

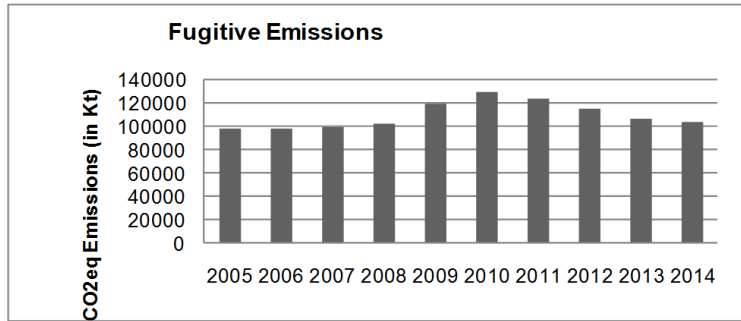


Figure 4 Fugitive Emissions Trend

Source: Intergovernmental Panel on Climate Change (IPCC), 2005-14

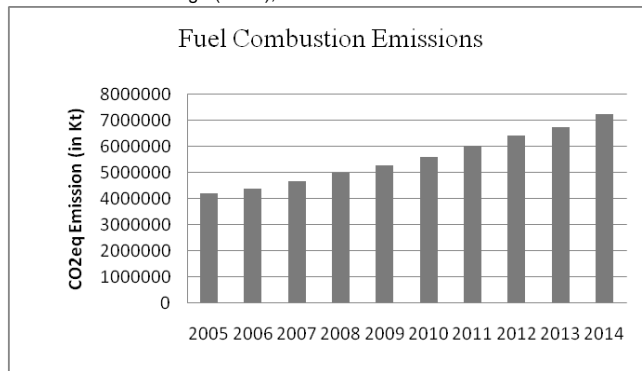


Figure 5 Fuel Combustion Emission Trend

Source: Intergovernmental Panel on Climate Change (IPCC), 2005-14

Under the Energy sector and the source of emission a detailed study is done with respect to fuel combustion operations. As from the above two graphs it is clear that between fuel combustion and fugitive emissions, the former has the greatest share. Therefore in order to identify the major source of creation of emissions the various activities involved under fuel combustion is studied (as in Fig6).

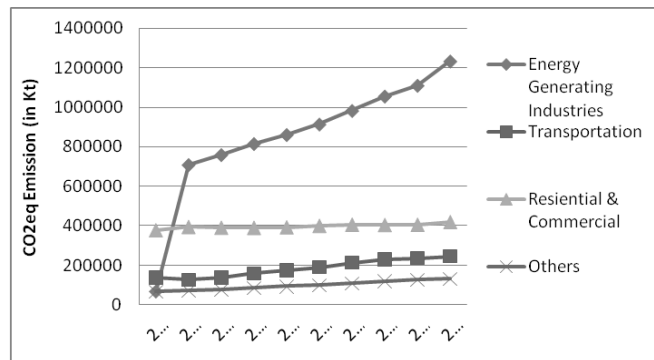


Figure 6 Fuel Combustion Emissions Trend by Classification

Source: Computed by Author

Among all the sectors, energy generating industries emits the most of CO₂eq emission. With the factor of urbanisation, the increasing infrastructure need is causing transportation sector to emit emissions at an increasing rate.

Table 1: Percentage Share of each Sector in Total Emissions

% Share in Total CO ₂ eq Emissions	Energy Generating Industries	Transportation Sector	Residential & Commercial Sector	Other Sectors
2005	10.25341	21.32392	58.03716	10.38551
2006	54.41533	9.808398	30.28088	5.495396
2007	55.61762	10.09632	28.62142	5.664646
2008	56.29231	10.94373	26.94135	5.822612
2009	56.52173	11.55602	25.78908	6.1133168
2010	56.99779	11.89789	24.94345	6.160872
2011	57.4418	12.50417	23.70351	6.350517
2012	58.3207	12.73625	22.30575	6.63729
2013	59.02517	12.63008	21.53698	6.807774
2014	60.77848	12.11618	20.60984	6.495493

Hence 'energy generating industries' including public electricity generation and industrial self-producing power plants is the largest emitter indulged into electricity production activity and other sectors involves energy use for final consumption. Increased emissions from energy sector can be validated by its increased share from 10.25% (2005) to 54.41% (2006), further continuing to increase.

Industrial Processes and Product Use (IPPU)

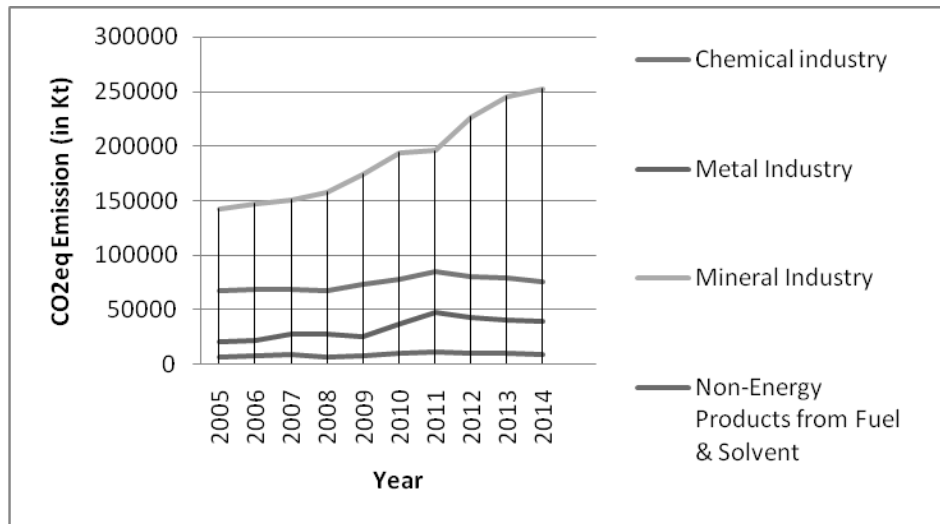


Figure 7 Industry-Wise Emission Classification

Source: Computed by Author

The largest emitter in "Industrial Process and Product Use" is mineral industry. High increase in the level of emission by this industry is been recorded in the subsequent years. In 2005, mineral industry accounted for 60.15% of total emissions along with chemical industry being the second most emitter with a contribution of 28.66%. Chemical, metal and other industries started cutting down their emissions by 2%, 3% and 1% respectively from 2011. But mineral industry still continues to be the largest among all, due to its increased demand and production. Hence it itself accounted for almost 67% of the total emissions in 2015, which is further continued to increase.

Emission Trends in Mineral Industry

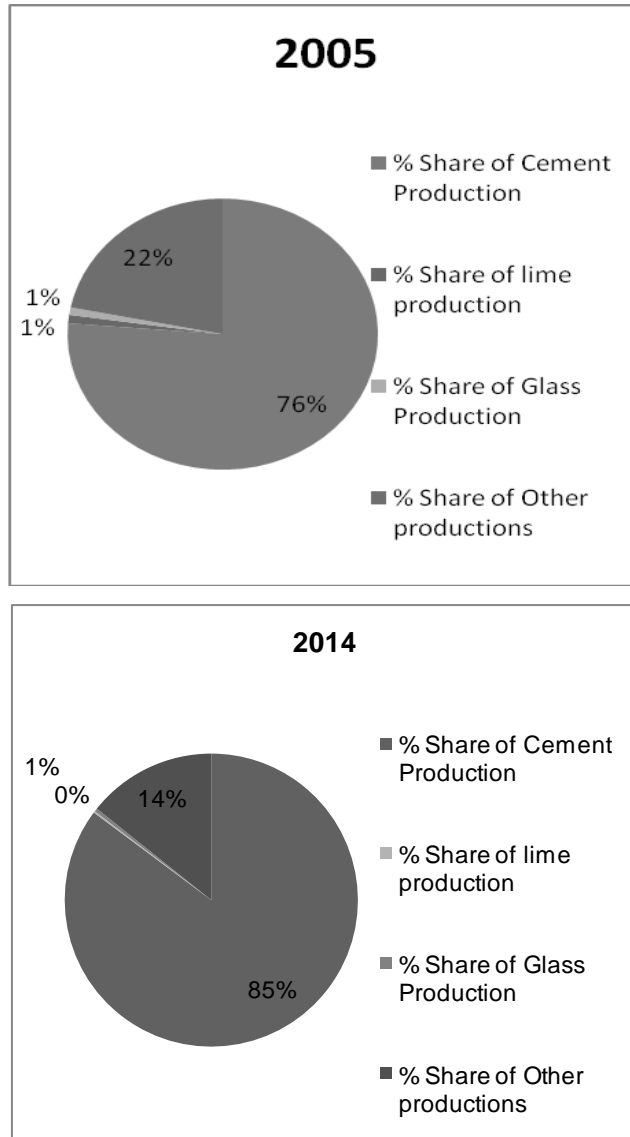


Figure 8 Changing Share of Emissions by Mineral Industry's Production activity

Source: Indian Bureau of Mines, Government of India and World Bank Data

Mineral industry involves cement, glass, lime production and other process use of carbonates. Each of these production activities is contributing to the emissions. But among all, the largest share is maintained by cement industries, increasing from 76% (2005) to 85% (2014). However its share has decreased from 2005 to 2014, it still emits 14% of total emissions. Hence majority of the market of mineral industry is dominated by cement production or demand, and its respectively emerging emissions (directly proportional to production).

Sectorial Emissions vs. Economic Growth

As mentioned before the amount of emissions are directly proportional to the level of production and demand, which contributes to the economic growth. Therefore it is important to do a cost and benefit analysis of the operations of these sectors, connecting with the amount of India's economy dependence on them.

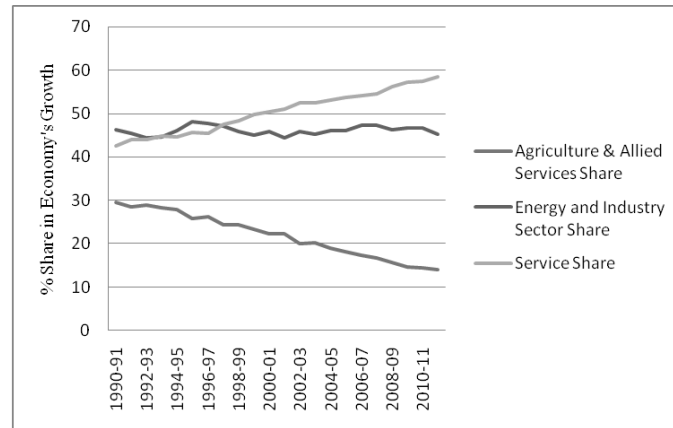


Figure 9: Sectorial Share in India's Economic Growth

Source: World Bank Data

Based on Fig 9 trend, it has been found that during the pre-reform period (before 1990's); agriculture sector was the main driving force of India's economy. After the emergence of new economic reforms, the share in economy's growth shifted from agriculture to service and industrial sector. Currently, in 2019-20 service sector is the largest contributing sector in the India's GDP with 54.15%. Industrial sector and agriculture sector contributing 31.46% and 14.39% respectively. According to the past studies; economic growth, industrialisation/ urbanisation and emissions maintains a positive relationship. But for attaining high growth level and development, absorbing the increasing threat to environment is a question to the sustainable development or growth of India's economy. There is a trade-off that exists between these two.

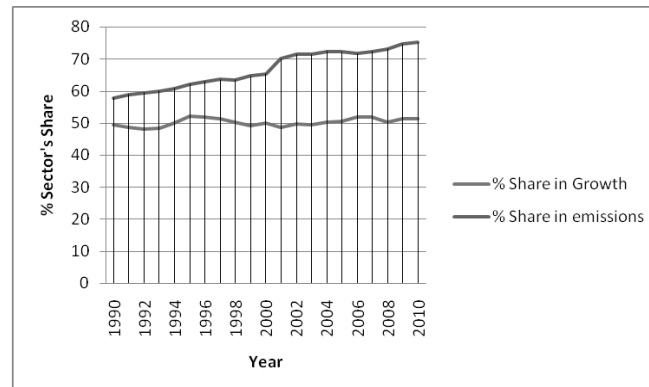


Figure 11 Cost-Benefit Analysis of Sector's Share in Economic Growth and CO2eq Emissions

Source: Computed by Author

In this graph the share of only energy and industry sector is analysed in both GDP contribution and total emission. These two sectors were selected for cross analysis as they are the most emitting sectors and are equally significant for the economic growth. The share of emission included emission from energy sector, industries and transportation. Similarly in the calculation of share of these selected sectors to total GDP are included. Therefore their equal representation shows an emerging and continuously diverging gap with respect to time in the contribution of all these economic sectors to the GDP and total emission. However the diverging trend shown by the sector's share in emissions and a stagnant growth in their respective share in overall GDP, is leading to an increasing growing threat on India's sustainable development. Hence this is creating a "paradoxical" situation where the economy's growth is dependent on these sectors, which are at the same time emitting the most and are affecting the environment and society as a whole. The gases emitted by each of these sectors are greater in amount than the economy produced by them respectively. Hence this portrays the increasing risk or cost of environment with respect to the economic growth in India.

Conclusion

The study was mainly focused towards the analysis of variations experienced by the Indian economy, environment and the society as a whole with respect to time and adoption of new developmental goals. Therefore the analysis or interpretation of time variant data in regard to the economic growth operations and its effect on the environment is studied. The result of the study shows that after liberalisation (1990) or with the introduction of new economic reforms, the Indian economy has grown. This is majorly with respect to increased installation of industrial or manufacturing units in India. The new-economic reforms gave a new direction to the India's developmental goals. As with respect to de-licensing system and other policies, the economy became freer and a new phase of industrialisation started. Based on the result of analysis undertaken, it has been proved that after 1990 a sectorial shift has been recorded from agriculture sector to energy/power generating sectors or industries. However, it is recorded that agriculture sector's share in GDP growth rate has decreased over years. But at the same time it still continues to be a stagnant emitter in the long run with comparatively reduced level. Energy or power generating sector turned out to be the largest emitter of CO₂ equivalent emissions. This is further followed by industrial sector including manufacturing and construction activities to be an emerging emitter in the race. Hence the cross analysis of these two sectors in terms of their share in both India's total emissions and GDP growth rate is analysed showing a result of emerging threat to the environment due to increasing pace of emissions in comparison to stagnant share in GDP.

This industrial expansion in India is proved to be one of the major reasons of increasing concentration of emissions and global warming. But specifically according to the derived results among all the classified industries, 'cement industries' found to be the most generating these emissions. Therefore as a conclusion of the largest emitting sectors in India, energy or power generating sector (including industries for the same purpose) and other manufacturing industries are accounted for this rising trend. Within this, mineral industries are the major driving force behind this, particularly by cement industries and their respective operations. These identified sources of emissions have created a contradicting situation for India as the major contributors in the growth are equally contributing to the generation of emissions. Hence this sectorial change has proved to be effective for the development, but along the same line is creating a threat for the economy. As cutting down of these emissions, will lead to cutting down of growth oriented activities and hence a loss in overall GDP. Therefore very strong mitigating policies are needed for sustainable development.

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