Industrial Growth and Environmental Degradation in India: Relevance of the Environmental Kuznets Curve Hypothesis

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CHAPTER SEVEN

CONCLUSION

Overview: The present study highlights the environmental costs of industrialization. The present chapter summarizes the findings of the three objectives undertaken in the study along with policy implications. Sustainable industrial practices play a key role in achieving overall environmental sustainability. In this regard, industrialists, environmentalists and government should take appropriate measures to build a greener and safer economy.

7.1. Trend of carbon emissions in the Indian core industries:

The study found that the carbon emissions by the core industries have been continuously increasing during the period from 2005 to 2021. Among the eight core industries, the electricity industry is the only low-polluting industry, while crude oil is the most polluting of all. The electricity industry in India has been able to achieve this state owing to its increased capacity for renewable energy generation. In India, electricity generation capacity from renewable sources has increased from 8.94% in 2008-09 to 27.51% in 2021-22 (Central Electricity Regulatory Commission, 2023). The crude oil industry is a fossil fuel energy and in India, the consumption of crude oil has been continuously increasing. The Statistical Review of World Energy statistics reveals that in 2021, 55.85 percent of primary energy was generated by the combustion of coal energy. This clearly indicates the consumption of higher fossil fuel and hence, greater emission scale. Fertilizers industry is found to be another high-polluting core industry. It is primarily because of the greater use of synthetic or inorganic fertilizers with the modernization of the agricultural sector in India. In 2021, approximately 89.27 percent of total fertilizer applications were dominated by inorganic fertilizers, demonstrating the polluting traits of the fertilizers industry. An increase in inorganic fertilizers raises environmental risks and degrades soil and water quality. The rest five core industries were found to fall in the category of moderately-polluting industries.

Based on these findings of the study, the following policy and managerial implications are put forward:

a) Greater use of renewable energy is the most fundamental step for ensuring sustainable industrialization of the core industries. This can be possible only with greater investments in renewable energy by the core industries (Kahia *et al.*, 2017; Qayyum *et al.*, 2021). India's renewable energy generation capacity has shown great progress in the last decade. However, its consumption is still considered costly because of which industries choose to opt for high-polluting and cheaper fossil fuel energies (Kahouli, 2018).
b) Renewable energy projects are also known for demanding huge investments and therefore, it is not very convenient for all industrial players to switch to eco-friendly measures. In order to overcome the environmental issues, renewable energy must be made available at cheaper rates so that it can be consumed at larger scales by industries. Financial institutions can facilitate credit and subsidies to help industries shift towards a renewable energy structure. The financial sector should provide greater funding to the core industries for undertaking investment in renewable energy.
c) The financial sector should monitor the utilization of funds to ensure that the funds are channeled in the generation of renewable energy or the adoption of greener technologies.
d) Promotion and utilization of organic fertilizers in place of synthetic fertilizers can help in reducing the emission levels of the fertilizers industry (Birkhofer *et al.*, 2016; De Ponti *et al.*, 2012).
e) The implementation of stricter industrial policies and environmental regulations by the government will be instrumental to monitor and control industrial emissions (Kanjilal and Ghosh, 2013).

7.2. Drivers of carbon emissions in the Indian core industries:

Among the economic factors, economic growth, agricultural production and FDI have led to an increase in emission levels, which is unfavourable for the environment. The Indian economy is still in a developing stage and as per the first phase of the EKC hypothesis, this stage of growth is expected to cause environmental degradation. Similarly, emerging countries like India heavily rely on FDI to achieve faster growth which often overlooks the environmental concerns as described by the pollution haven hypothesis.

Investment in research and development is found to be the only economic factor having a favourable impact on the environment. This is in accordance with the endogenous growth model that emphasizes the need for investment in research and development. Research and development investments lead to innovation in various industrial processes and technologies, which is essential for improving environmental quality.

Among the industrial factors, industrialization and financial credit have helped to reduce emission levels. Although industrialization generally has a positive impact on carbon emission, this study has considered the carbon emission levels of only the core industries which is the possible explanation for the difference in the results obtained. Industrial design and industries' energy consumption are found to have a positive impact on carbon emissions. In India, the adoption of sustainable industrial design is still at a preliminary stage and hence, the favourable impact is yet to be realized. Energy consumed in industries is majorly fossil fuel which is the main source of carbon emission. In the initial growth stages as described by the U-shaped REKC, the higher cost of renewable energy and lack of infrastructure compels industries to rely on fossil fuels which in turn adversely affects the environment.

Regarding the demographic factors, urbanization and population density are found to increase the emission levels of the core industries, while the effects of education and poverty are non-significant. The positive effect of urbanization on emission levels confirms the ecological modernization theory. India's urbanization is expected to worsen the environmental quality as the country is still in its developing phases. The urban locations are currently more focused on their economic expansion than environmental sustainability. Even the arguments of the urban transition theory assert that urbanization leads to greater energy consumption through higher industrial activities. As India's energy structure is not environmentally effective, such transitions bring more environmental damage. If urban policies are not robust in terms of environmental protection, India's urbanization will continue to reflect its environmental degradation effects. Likewise, population density is found to increase carbon emissions supporting the arguments of the IPAT (Impact, Population, Affluence and Technology) model. The model suggests that a growing population imposes environmental threats through higher demands of limited resources. As a result, the pressure on the environment grows and interferes with the environmental balance of the economy. Energy consumption also takes a hike if the population is concentrated in dense locations, raising the risks of greater emissions.

Among the environmental factors, tree cover loss and water stress have led to greater emission levels. With the rising population, forest areas are being cleared, most commonly for residential, agricultural and industrial set-ups. As mentioned by the World Bank, forest areas remove approximately 16 billion tonnes of carbon emissions annually, which is roughly around 50 percent of the carbon emissions resulting from fossil fuel burning annually (Benschop, 2023). Likewise, the process of water extraction mostly relies on conventional high-polluting fossil fuel energy sources in India.

Focus on environmental technology and CER mechanism document favourable environmental impact. In line with the endogenous growth model, the study confirms that environmental technology has the potential to foster sustainable economic growth, allowing for a win-win situation for both the economy and the environment. The introduction of the CER framework is also expected to lead the Indian economy towards sustainable development. In fact, India was a leading country in generating CERs, holding 46.5 percent of the total global CERs in 2015 as per the reports published by the Ministry of Statistics and Programme Implementation, Government of India. However, that contribution percentage came down to 11.4 percent in 2021.

Based on these findings of the study, the following policy and managerial implications are put forward:

a) In order to mitigate the negative impact on the environment and achieve the second stage of the EKC, sustainable agricultural practices like organic farming, agroforestry, crop rotation, etc. should be adopted in the agricultural sector (Durham and Mizik, 2021).

b) While welcoming FDI, the government should ensure that foreign companies comply with the environmental laws of India so that developed countries cannot take advantage of transferring their pollutive industrial operations to India. India should evaluate the investment quality received from foreign lands so that they do not lead to harmful environmental consequences. Only when such investments promote skill and knowledge sharing between nations, they can help achieve economic welfare that is beneficial in the long run (Hille, 2018; Rana and Sharma, 2019).

c) Funding from the financial sector for the adoption of advanced technologies and resource efficiency will help in achieving sustainable industrialization. This is in line with the Technical Effects of financial development. Industries cannot afford to ignore the benefits of research and development activities while aiming for sustainable industrial growth. Advancement of technologies and resources is a core requirement for enabling sustainability. At present, the innovation of the Carbon Capture, Utilisation, and Storage (CCUS) technology has become a global priority for its potential environmental benefits. It not only helps reduce emission volumes but also promotes recycling and re-usage of carbon components and the removal of carbon pollutants from the atmosphere.

d) Eco-friendly industrial design should be prioritized by the Indian core industries. Industries must be more careful regarding the industrial products' material selection and life cycle assessment to mitigate emissions caused by industrial design. They can ensure that the tangible industrial inputs do not worsen the quality of the environment.

e) India needs better urban policies to extract the benefits of urbanization. The industrial units are usually concentrated in urban places and due to the available facilities, population density is also usually observed to be higher in these locations. In that case, industries in urban places can benefit themselves from economies of scale and reduce their operating costs. Thus, they can potentially provide more attention towards improving their environmental competence through investments in eco-friendly projects. Urban places often facilitate technological advancements, helping industries to achieve both production and environmental targets (Ahmad and Zhao, 2018; Kasman and Duman, 2015).

f) When forest locations are cleared for the purpose of industrial setups and agricultural activities, the restoration of the tree cover should be given more prioritization. The tree cover loss in one location should be compensated by industries by organizing plantation drives in other locations. A 'cut and paste' framework should be suggested to industries so that the overall tree cover percentage is maintained in the nation. Trees are the natural and the cheapest mechanism to remove and store harmful carbon components from the atmosphere and industries should make sure to use its benefits for building a healthier economy.

g) The Emission Trading Scheme (ETS) has caught a lot of attention from policymakers and industrialists in recent times due to its potential mechanism to

curtail carbon emission levels across countries. Certified emission reductions (CERs) provide an opportunity for firms and industries to reduce their emissions levels and gain financial benefits from the process of setting off emissions. These environmental policies are expected to create a win-win situation for the environment and the industries, creating new ways to benefit the ecological balance without causing any financial loss to the firms. Usually, firms are reluctant to volunteer for environmental commitments as they demand additional resources to be invested. It leads to additional challenges for firm managers to balance their environmental performance and market competitiveness simultaneously. However, the introduction of modern environmental policies like ETS gives new encouragement to industries to adopt environmental practices without absorbing any financial shocks (Kukah *et al.*, 2024; Rajput *et al.*, 2015).

7.3. Industrial growth and environmental degradation in the Indian core industries:

The present study finds validity of the inverted U-shaped IEKC hypothesis in the Indian core industries. The inverted U-shaped IEKC indicates the non-linear impact of industrial growth on the environment. While industrial growth harms the environment in the initial phases of growth, they go hand in hand after industries cross the threshold point of growth. The turning point analysis of the IEKC hypothesis reveals that the Indian core industries have not yet reached the threshold point of industrial growth.

Further, the study found negative moderating roles of sectoral policy stringency and industrial structure improvement in the relationship between the core industries' growth and carbon emission levels. The empirical results establish a favourable role of environmental policy stringency, demonstrating that if stringent environmental regulations are implemented for the industries, it can help attain the threshold point of the IEKC at an early stage of industrial growth. The turning point analysis in the study has also confirmed that the threshold point is reached at a lower level of industrial growth when the moderating effect of environmental policy stringency is considered. When environmental policies are strictly maintained and monitored, they promote sustainable practices among industries, assisting the government to control industrial emissions through effective regulatory settings. Likewise, we found a favourable role of industrial structure improvement in strengthening the inverse relationship between industrial growth and emission levels. Moreover, when the moderating effect of industrial structure improvement is present, the

turning point of the IEKC is attained at an earlier stage of industrial growth. The findings suggest that concentrating on the growth of the tertiary sector can help curb the emission levels of the core industries. The tertiary sector consumes less energy and emits fewer pollutants than the primary or secondary sectors. Additionally, the sector offers the necessary support and facilities to the core industries to shelter innovation and technological upgrades and improve their overall environmental management traits.

By analysing the N-shaped IEKC in India's core industries, the study finds the existence of an N-shaped IEKC. It indicates the possible reoccurrence of environmental threats from the core industries' growth in the future. As and when industrial production increases, the technologies and resources become obsolete, making them unable to cater to the environmental demand and expectations for a balanced harmony. Thus, industrial growth loses the advantageous ecological position attained in the second phase of the IEKC hypothesis.

Based on these findings of the study, the following policy and managerial implications are put forward:

a) Environmental sustainability necessitates the early attainment of the threshold level of industrial growth. In this regard, the government of a country can play a critical role in ensuring sustainable industrial operations. Two such key areas for the government to work on are (i) environmental policy stringency and (ii) industrial structure improvement. Policies and regulations can be one of the most effective measures to compel industries to adopt sustainable practices. Such policies should limit industries to emit less pollutants and penalize them if the limit is not followed. It can also reward those who significantly improve their environmental competence and emit less than allowed. When policies are robust and strict, industries are cautious about breaking the law as it invites unwanted legal proceedings and negative attention from the stakeholders. It leads to an inferior market reputation and takes a toll on their revenue generation. Another benefit of regulation is that it brings environmental awareness among the general public. When policymakers introduce regulatory measures for industries, it signals in the market the importance of environmental protection measures to be undertaken by industries. The expectations of the public force industries to take environmental actions so as to maintain the confidence of the public in them.

b) The government should prioritize greater development of the tertiary or the service sector as it can lead to environmental improvement of the core industries as well. The presence of an efficient tertiary sector is necessary for any nation to attain industrial sustainability. The arguments of the Composition Effect also describe the need for tertiary sector's growth in order to promote sustainable economic growth. In 2005, India's tertiary sector contributed 44.4 percent to the nation's GDP, and 47.8 percent in 2021, with a mere growth of 3.4 percent in the study period of 17 years.

c) The core industries should improve upon their management attributes and contribute to waste-free industrialization. Industries should facilitate the recycling of their wastes and undergo proper procedures to neutralize their harmful environmental impact. Modern industrial production processes should ensure durability, recyclability and reduced waste to efficiently manage the limited resources of the earth. From raw material extraction to product disposal, environmental harmful effects should be attempted to minimize at each step of the product life-cycle.

d) Innovation is a fundamental action to achieve sustainability in industries. Innovation is a costly process that requires the sacrifice of a considerable amount of resources, with the opportunity cost of production increase. Therefore, developed countries and international authorities like the International Monetary Fund, World Bank, etc. should play a responsible role in assisting developing nations towards sustainable industrialization with financial and non-financial support.

e) The government should urge the core industries to furnish sustainability reports in order to disclose them to the concerned stakeholders. Such reports should reveal information regarding their carbon emissions. These practices help maintain transparency and accountability, investors' confidence and compliance with regulations for the industries.

f) The core industries, being the leading players in the Indian industrial sector, are expected to pave the path for other industries towards sustainable industrialization. They should play a pioneering role in adopting environmental protection measures to limit the harmful effects of industrial emissions on the environment.

7.4. Progress so far:

In India, the Ministry of Environment, Forest and Climate Change (MoEFCC), formerly known as the Ministry of Environment and Forest (MoEF), is the principal authority that administers the country's environmental and forestry regulations on behalf of the Central Government of India. MoEF was responsible for the preparation, promotion, harmonization, and supervision of the country's overall ecological health through regulatory compulsion to the industries. MoEF had implemented the following regulations that have helped to build India's environmental regulatory foundation:

- Environment (Protection) Act, 1986, amended in 1991
- Forest (Conservation) Act, 1980, amended in 1988
- Wildlife (Protection) Act, 1972
- Water (Prevention and Control of Pollution) Act, 1974, amended in 1988
- Air (Prevention and Control of Pollution) Act, 1981, amended in 1987

These acts have helped India protect ecosystems and biodiversity, control pollution, mitigate climate change outcomes, safeguard public health and promote the overall sustainable development of the nation.

In April 2015, as per the resolution of the 57th Conference of the Chairmen & Member Secretaries of the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs), the government formed a 'Working Group' to classify the Indian industries based on their pollution levels. Thus, the industries in India were classified into four groups: (1) red, (2) orange, (3) green, and (4) white, with red industries indicating the most pollutive industries and white reflecting the least pollutive or cleanest among all other industries (CPCB, 2016). As per the government's direction, the red, orange, and green industries must be inspected at least once every six months, one year and two years of intervals, respectively. This categorization has helped targeted monitoring and regulation, efficient environmental impact management, faster clearances for low-risk industries, incentives for environmentally friendly operations, enhanced public health and safety and so on.

The E-Waste Management Rules of 2016 and the Plastic Waste Management Amendment Rules of 2021 are two notable recently introduced regulations. These two regulations are instituted to encourage environmental technological advancements. This has helped achieve resource conservation, reduction of hazardous industrial substances, formalization

of the e-waste recycling sector, eco-friendly product design, promotion of alternatives to plastic, encouragement of plastic recycling and so on.

7.5. Future scope of the study:

Despite the best efforts of the researcher to present a comprehensive environmental assessment of industrial growth in India, there remains certain scope that can be explored by future studies. They are:

- The present study is focused on investigating the sustainable dimensions of the Indian core industries. Cross-sectional studies including other emerging nations would be useful to provide a comparative picture regarding the environmental performance of industries.
- Researchers can conduct studies on similar lines to assess the environmental dimensions of other industries in India.
- Considering additional measures for environmental degradation other than carbon dioxide is possible to understand a more comprehensive view of the industries' polluting attributes.
- Assessing the impact of new/amended regulations implemented by MoEF/MoEFCC on the environmental impact of industrial growth in India will add more novelty to the existing literature.

"Sustainable development - development that does not destroy or undermine the ecological, economic, or social basis on which continued development depends - is the only viable pathway to a more secure and hopeful future for rich and poor alike."

- *Maurice Strong, Opening Statement to the Rio Summit, 1992.*