Analysing the Relationship Between Environment, Foreign Investments, Monetary, and Fiscal Policies – The Case of India

Kritika Nagal[a] and Irfan Ali K C[b*]
[a,b]Dr. B.R. Ambedkar School of Economics University, Bengaluru, India

Abstract

This study investigates the complex interplay between foreign direct investment (FDI), fiscal and monetary policies, economic growth, and CO_2 emissions in India using a Structural Vector Autoregression (SVAR) model. The analysis examines short- and long-term dynamics to assess the Pollution Haven Hypothesis (PHH), the Environmental Kuznets Curve (EKC), and broader economic-environment linkages. Given India's challenge of balancing economic growth with environmental sustainability, the study evaluates the impact of FDI inflows, fiscal deficits, money supply, and GDP growth on CO_2 emissions. The findings suggest that while FDI inflows initially lead to higher CO_2 emissions, supporting the PHH, they also contribute to cleaner technologies and sustainable practices over time, aligning with the Pollution Halo Hypothesis (PHL). Economic growth exhibits a dual impact, confirming the EKC, where emissions rise in the early industrialization phase but decline as the economy transitions toward cleaner energy sources. Monetary policy, represented by money supply (M3), has a significant short-term effect on emissions by stimulating industrial activity. However, its impact diminishes over time, highlighting the need for green financing mechanisms to support low-carbon investments. Fiscal policy, particularly fiscal deficits, exacerbates emissions due to increased infrastructure spending and fossil fuel subsidies. To counteract this, policies should emphasize green infrastructure, carbon taxation, and renewable energy investments. The study also examines the effects of the 1991 New Economic Policy (NEP), revealing mixed environmental outcomes. While trade liberalization spurred economic growth and industrialization, it also contributed to resource depletion and pollution. However, long-term improvements in environmental regulations and clean energy adoption suggest a gradual shift toward sustainability.

Keywords: Foreign Direct Investment, CO_2 Emissions, Structural VAR, Monetary Policy, Fiscal Policy, Environmental Kuznets Curve, Pollution Haven Hypothesis, Green Finance, India

1. Introduction

The complex interactions between economic growth, foreign investment, and environmental sustainability in developing economies, particularly India, is a subject of growing concern. In an era of rapid globalization and industrialization, the tension between economic growth, foreign investments, and environmental sustainability has become one of the most pressing challenges, particularly for developing nations like India. As countries strive for economic advancement, they often face trade-offs in the form of environmental degradation. India, with its dynamic growth trajectory, presents a fascinating case study of this complex interplay. While foreign direct investment (FDI) and foreign institutional investment (FII) are hailed as catalysts for development, their environmental consequences cannot be overlooked.

Several studies have explored this complex nexus. Research suggests that globalization and financial development, while boosting economic performance, can negatively impact environmental sustainability (Sethi et al., 2020). FDI and FII play crucial roles in India's economic development, but their environmental implications are significant (Duhan, 2014). Research supports the Environmental Kuznets Curve (EKC) hypothesis, suggesting that as economies grow, they eventually adopt cleaner technologies (Hunjra et al., 2024). However, the relationship between FDI and carbon emissions is generally positive, indicating the need for careful consideration of investment types and regulatory frameworks (Hunjra et al., 2024). Fiscal policy and globalization have been found to increase environmental pollution, with a threshold level of fiscal policy identified at -1.2889 (Kamal et al., 2021).

India's trade liberalization policies since 1991 have significantly impacted its economy and environment. These policies reduced trade barriers and investment restrictions, leading to increased FDI inflows and GDP growth (Tripathi, 2018). With the aim of foreign investment, these policies promoted trade by lowering protective tariffs, encouraging domestic competition and stimulating construction. However, it is not only the economic factors which matter; one also has to bear in mind the consequences of such liberalization on the environment. The FDI and FII inflows policy aims at increasing economic growth but through liberalization it can also lead to higher consumption of resources, pollution and destruction of the environment (Khan, 1999). Despite this growing body of evidence, a comprehensive understanding of the interplay between FDI, fiscal policy, monetary policy, and environmental outcomes in India is still lacking. This research aims to bridge this gap by integrating these aspects into a unified framework.

It is not sufficient to analyse economic issues in silos. There is a need to comprehend the nexus between environmental issues, FDI-FII, monetary policy and fiscal policy so that these components can be bridged in policy formulation for sustainable development in India. How these environmental issues, FDI-FII inflows and economic growth, sustainability depending on these interactions are the major focus questions of this research. Also, the relationship between environmental policies, FDI-FII inflows and macroeconomic policies is investigated to shed theoretical and empirical light on policy and research developments on these topics among policymakers and researchers.

The primary objective of this study is to explore the intricate relationship between environmental outcomes and economic policies, focusing on India as a case study. The study aims to test the Pollution Haven Hypothesis (PHH) by assessing the impact of FDI, fiscal policy, and monetary policy on CO2 emissions. It also investigates the role of the New

Economic Policy of 1991 in shaping these dynamics. By analyzing both short- and long-term interactions, this research seeks to provide policymakers with insights into crafting balanced strategies that promote sustainable economic development while mitigating environmental degradation.

2. Literature Review

The dynamic interplay between environmental sustainability, FDI, and economic policies, particularly monetary and fiscal, has become an increasingly vital area of study. This relationship is particularly pertinent for emerging economies like India, where economic growth is often accompanied by environmental degradation, exacerbated by industrialization, trade liberalization, and rapid urbanization. The literature surrounding this issue often revolves around several key hypotheses, including the PHH, the EKC, and the Pollution Halo Hypothesis (PHL), offering varied perspectives on the impact of FDI, fiscal and monetary policies on environmental outcomes. This review synthesizes existing literature to explore how these factors converge in the Indian context, identifying research gaps, policy implications, and potential avenues for future studies.

The relationship between fiscal and monetary policies and environmental outcomes has been explored from a neoclassical perspective in several studies. Faria (1998) offers an insightful investigation into how fiscal policies, such as public spending, and monetary policies, such as inflation control, affect environmental quality. Faria's model, which extends Sidrauski (1967) framework, incorporates natural resources as a key input in the production process. The study's findings emphasize that while fiscal policy, particularly government spending, has a more direct and persistent impact on the environment, monetary policy influences the environment under specific circumstances, such as when money reduces transaction costs. However, Faria highlights the complexity and indeterminacy of these environmental impacts, calling for further empirical research to draw conclusive results.

The concept of the PHH suggests that developing countries attract polluting industries due to weaker environmental regulations, has been central in the debate over FDI and environmental degradation. Dietzenbacher and Mukhopadhyay (2007) assess the validity of this hypothesis in the Indian context, particularly following trade liberalization. Their study suggests that contrary to PHH predictions, India's exports are relatively "cleaner" than its imports, indicating that the country has not become a pollution haven. Their findings implies that increased trade and exports have, in fact, had a beneficial environmental effect, disproving the traditional interpretation of PHH.

In contrast, Rezza (2014) utilizes a meta-analysis to examine the broader relationship between FDI and environmental regulations. The results shows that countries with weaker environmental regulations tend to attract more FDI, supporting PHH in certain contexts. However, Rezza argues that focusing solely on pollution-intensive industries does not necessarily increase the likelihood of PHH, especially in developing countries where the unique characteristics of FDI flows can counterbalance the advantages of lenient regulations.

EKC hypothesis posits an inverted-U relationship between income and environmental degradation, suggesting that as economies grow, pollution initially rises but eventually declines as income levels reach a certain threshold. Ren et al. (2014) extend the EKC theory by

examining the environmental impact of FDI and international trade, focusing on China. Their study finds that both trade and investment contribute to CO2 emissions, supporting the notion that economic growth driven by trade and FDI can exacerbate environmental degradation. However, they also find an inverted-U relationship between per capita income and CO2 emissions, consistent with the EKC hypothesis, and suggest that policy interventions should focus on promoting green investment and sustainable trade practices.

In the Indian context, Adamu et al. (2019) further explore the relationship between economic growth, FDI, energy consumption, and environmental degradation. They acknowledge the mixed results for developing countries regarding the EKC hypothesis, with FDI showing both positive and negative effects on the environment. Their study also highlights the increasing importance of export variety and energy consumption as key drivers of pollution, suggesting that these factors must be considered in policy design to mitigate environmental harm.

The role of monetary policy in influencing environmental outcomes is less frequently explored but has gained attention in recent years. Campiglio (2016) emphasizes the importance of integrating monetary policies into the broader framework of green finance. He argues that carbon pricing alone is insufficient to stimulate low-carbon investments, given the market failures in credit creation. Central banks can play a pivotal role by adjusting monetary policies, such as differentiated reserve requirements, to encourage banks to prioritize green investments. This perspective is particularly relevant for emerging economies, like India, where monetary policy can influence the flow of credit to environmentally sustainable projects.

Similarly, the study by Jiang et al. (2020) assesses the impact of expansionary and contractionary monetary policies on CO2 emissions in Asian economies. Their findings suggest that expansionary policies tend to increase emissions, while contractionary policies can help mitigate environmental degradation. The study implies that monetary policies can be a useful tool in managing environmental outcomes, particularly when combined with other policy measures.

Fiscal policy is another crucial tool in influencing environmental outcomes. Muhafidin and Didin (2020) explore the intersection between fiscal policy and environmental degradation in Indonesia, highlighting the importance of carbon taxes, subsidies for renewable energy, and stricter industrial emissions regulations. While their study is focused on Indonesia, the findings have important implications for India, where fiscal policies, such as subsidies for green technologies and investments in renewable energy, could help mitigate environmental degradation and promote sustainable growth.

The literature reviewed highlights the complex and multifaceted relationship between FDI, monetary and fiscal policies, and environmental outcomes. While some studies support the Pollution Haven Hypothesis, suggesting that weaker environmental regulations attract more FDI and polluting industries, others, such as Dietzenbacher and Mukhopadhyay (2007), indicate that trade liberalization can actually benefit the environment, contradicting the traditional view of PHH. Similarly, the EKC offers a useful framework for understanding the relationship between income and pollution, though the results are mixed, especially for developing countries like India.

Monetary policies have also emerged as an important tool in influencing environmental outcomes, particularly through the financing of green investments. Campiglio (2016) and Jiang

et al. (2020) suggest that well-designed monetary policies can help mitigate emissions and foster sustainable development. Moreover, fiscal policies, including carbon taxes and renewable energy subsidies, play an important role in shaping environmental outcomes, as demonstrated by studies on Indonesia.

Despite the valuable insights offered by these studies, significant gaps remain in the literature. For instance, there is a need for more nuanced research that distinguishes between the effects of different types of FDI, particularly those originating from developed versus developing countries. Additionally, the integration of green finance into monetary and fiscal policies requires further exploration, particularly in the context of developing economies like India. Future research should aim to build on these gaps, providing more detailed and context-specific insights into how FDI, fiscal and monetary policies can be leveraged to promote environmental sustainability in India.

In conclusion, the relationship between environmental outcomes and economic policies in India is complex and context-dependent. Policymakers must carefully design and implement fiscal, monetary, and trade policies to ensure that economic growth is decoupled from environmental degradation. As the country continues to industrialize and integrate into the global economy, fostering a sustainable growth trajectory will require a holistic approach that considers the roles of FDI, fiscal and monetary policies, and environmental regulations.

3. Theoretical Framework

The theoretical framework of this paper provides the foundation for understanding the intricate relationships between economic growth, policy interventions, and environmental outcomes. At the core of the study lies the interplay between variables such as foreign direct investment (FDI), monetary and fiscal policies, and their impact on CO2 emissions, a key proxy for environmental degradation. By drawing on established theories like the PHH, PHL, EKC, and Porter Hypothesis, this framework explores the pathways through which economic activities and policies influence environmental sustainability.

These concepts collectively illustrate how economic forces—whether through industrialization, technological innovation, or regulatory frameworks—shape the balance between development and environmental health. For instance, while FDI may initially increase emissions in less-regulated environments, it also holds the potential to transfer cleaner technologies. Similarly, fiscal and monetary policies affect emissions indirectly by driving industrial output and energy consumption. The EKC hypothesis adds further depth by suggesting that economic growth and environmental degradation follow a non-linear trajectory, with sustainability achievable as economies mature.

This section introduces these theoretical lenses, setting the stage for analyzing the dynamics between economic drivers and environmental impacts, and providing valuable insights for crafting effective policy solutions.

3.1 Pollution Haven Hypothesis

The relationship between economic activities and environmental outcomes is complex, driven by diverse theoretical concepts. The PHH suggests that multinational firms relocate emission-intensive industries to countries with less stringent environmental regulations. This relocation increases emissions in developing nations, which attract FDI due to lower compliance costs. Conversely, the PHL argues that FDI can reduce emissions by introducing cleaner production technologies and advanced management practices, especially in host countries that encourage sustainable investments. The net environmental impact of FDI depends on the interplay between these hypotheses and the sectoral distribution of investments.

Monetary policy, reflected in changes in money supply (M3), influences emissions indirectly through economic activity. An expansionary monetary policy, which increases liquidity, stimulates industrial production, consumer demand, and energy use, often leading to higher emissions. Conversely, a contractionary policy can reduce emissions by curbing economic activity and energy demand. Monetary policies also shape credit availability, influencing investments in renewable versus fossil-fuel-based energy.

Fiscal policies, including GDP growth, government fiscal deficits, and structural reforms like liberalization, further impact emissions. Economic growth initially drives emissions due to industrialization but may eventually reduce them as cleaner technologies emerge (EKC). Fiscal deficits, if directed toward infrastructure development, typically increase emissions unless investments prioritize green initiatives.

3.2 Pollution Halo Hypothesis

The PHL offers a contrasting perspective to the PHH by suggesting that FDI can lead to environmental improvements in host countries. Multinational corporations, driven by global standards and technological advancements, may introduce cleaner production techniques and environmentally sustainable practices, thereby reducing emissions. This hypothesis aligns with the notion that FDI fosters innovation, enhances energy efficiency, and incentivizes the adoption of green technologies, especially in countries with institutional capacity to enforce environmental safeguards.

These frameworks extend to monetary and fiscal policies, where economic growth and structural reforms interact with emissions. Expansionary monetary policies drive industrial growth and energy demand, while fiscal deficits influence the scale and nature of infrastructure investments. Together, these theories offer a lens to examine how economic policies and global capital flows shape environmental outcomes.

3.3 CO2 Emissions

CO2 emissions serve as a critical proxy for environmental degradation, offering a measurable and globally recognized indicator of anthropogenic impacts on the environment. As the primary greenhouse gas emitted through fossil fuel combustion, deforestation, and industrial processes, CO2 is central to understanding climate change and environmental stress. Theoretical concepts like the EKC help contextualize CO2 emissions within the dynamics of economic growth. According to the EKC, CO2 emissions initially rise with industrialization and economic expansion but eventually decline as economies transition to advanced stages of development

with cleaner technologies, increased energy efficiency, and stronger environmental regulations.

In the Indian context, rapid economic growth post-liberalization has made CO2 emissions a focal point for assessing environmental degradation. While industrialization and urbanization have increased emissions, India's commitments to renewable energy expansion and international climate goals reflect an evolving balance between growth and sustainability. CO2 emissions, therefore, provide a comprehensive lens to explain the environmental implications of policy and economic activity.

3.4 Foreign Direct Investment

FDI plays a dual role in influencing environmental outcomes, as explained by the PHH and the PHL. The PHH suggests that FDI may exacerbate environmental degradation when multinational corporations relocate emission-intensive production to countries with lax environmental regulations. This relocation lowers costs for firms while increasing CO2 emissions and other pollutants in host nations. Conversely, the PHH posits that FDI can reduce emissions by transferring cleaner technologies, management expertise, and environmentally sound practices to host countries. The actual environmental impact of FDI depends on the regulatory environment, sectoral composition, and the type of technologies introduced by foreign investors.

In the Indian context, the liberalization policies of 1991 catalysed significant FDI inflows. While these investments spurred economic growth and industrialization, their environmental impact has been mixed. Some sectors, such as renewable energy, benefited from FDI-driven technological advancements, supporting the PHL. However, industries reliant on fossil fuels or with weak regulatory oversight often aligned with the pollution haven hypothesis, leading to higher emissions. Thus, India's FDI experience underscores the critical role of environmental governance in determining whether FDI becomes a driver of sustainability or degradation.

3.5 Money Supply (M3)

The money supply (M3) plays an important role in shaping macroeconomic and environmental dynamics. M3, the broadest measure of monetary aggregates, reflects the total liquidity available in an economy, including currency, demand deposits, and time deposits. Changes in M3 influence aggregate demand, investment, and production, thereby indirectly impacting energy consumption and CO2 emissions. An expansionary monetary policy, characterized by growth in M3, increases liquidity, stimulates industrial output, and raises consumption levels, often leading to higher energy demand and emissions. Conversely, a contractionary monetary policy reduces liquidity, curbing production and emissions but potentially slowing economic growth.

In the Indian context, post-liberalization growth in M3 has significantly influenced economic expansion, industrialization, and energy consumption. Policies aimed at boosting liquidity have fuelled infrastructure development and energy-intensive activities, often leading to higher emissions. However, recent monetary interventions promoting green financing and renewable

energy investments aim to decouple M3 growth from environmental degradation, reflecting India's evolving approach to balancing economic and environmental objectives.

3.6 Gross Fiscal Deficit

Government Fiscal Deficit (GFD) represents the difference between government expenditures and revenue. It is a critical macroeconomic variable influencing economic activities, investment patterns, and environmental outcomes. A high fiscal deficit, often associated with increased government spending, can stimulate economic growth by funding infrastructure projects, social programs, and industrial development. However, this surge in activity often leads to higher energy consumption and CO2 emissions, particularly when investments are directed toward emission-intensive sectors like construction, transportation, and fossil-fuel-based energy generation.

From a theoretical perspective, fiscal deficits can either exacerbate or mitigate environmental degradation depending on the nature of public expenditure. If fiscal policies prioritize green infrastructure and renewable energy projects, they can contribute to reducing emissions. Conversely, deficits that fund traditional energy systems or lack environmental safeguards may intensify emissions.

In the Indian context, GFD has historically played a dual role. Post-liberalization, fiscal policies supported industrial growth and infrastructure development, contributing to higher emissions. However, recent trends reflect a shift toward sustainable public expenditure, with increasing allocations to renewable energy, electric mobility, and environmental conservation programs, demonstrating India's commitment to balancing fiscal expansion with climate objectives.

3.7 Gross Domestic Product

GDP is a central measure of economic activity and a key variable in understanding the relationship between growth and environmental outcomes. Theoretical models often link GDP to CO2 emissions through the lens of production and consumption. Economic growth in its initial stages is typically driven by industrialization and urbanization, leading to increased energy demand and reliance on fossil fuels. This results in higher emissions and environmental degradation. The EKC hypothesis explains this as the upward slope, where economic priorities outweigh environmental considerations.

As economies mature and GDP increases, the composition of economic activity shifts toward less emission-intensive sectors like services and technology. Higher incomes enable greater public and private investments in cleaner technologies, energy efficiency, and environmental protection. This transition is represented by the downward slope of the EKC, where emissions decline despite further GDP growth.

In the Indian context, GDP growth post-1991 economic reforms has been significant, driven by industrial expansion and urbanization. While this has increased emissions in energy and transport sectors, recent efforts to integrate sustainable development into growth policies are evident. India's focus on renewable energy, energy efficiency, and green technology highlights

its transition toward reducing emissions as GDP continues to grow, aligning with the later stages of the EKC framework.

3.8 New Economic Policy of 1991

The New Economic Policy (NEP) of 1991 marked a paradigm shift in India's economic structure, introducing liberalization, privatization, and globalization (LPG) reforms. These structural changes aimed to accelerate economic growth by removing barriers to trade, deregulating industries, and encouraging foreign investments. The NEP significantly impacted environmental outcomes, primarily through its influence on industrialization, urbanization, and FDI. By opening the economy to global markets, the NEP facilitated the growth of emission-intensive sectors, such as manufacturing, construction, and energy, thereby contributing to higher CO2 emissions. This aligns with the PHH, as the increased FDI inflows often targeted less-regulated industries in developing economies.

However, the reforms also provided opportunities for cleaner technologies and sustainable practices, supporting the PHL. Multinational corporations brought advanced technologies and energy-efficient production methods, reducing emissions in some sectors. The overall environmental impact of NEP depends on the balance between industrial growth and the adoption of sustainable practices.

In the Indian context, the NEP significantly increased economic activity, leading to higher energy demand and emissions. Rapid urbanization and infrastructure development further amplified environmental pressures. While the policy's initial phase prioritized growth over sustainability, subsequent efforts incorporated environmental concerns, focusing on renewable energy and climate change mitigation, reflecting a gradual shift toward balancing economic growth with environmental objectives.

3.9 Environmental Kuznets Curve

EKC hypothesis posits a non-linear relationship between economic growth and environmental degradation, typically represented as an inverted U-shaped curve. In its early stages, economic growth leads to increased industrialization, urbanization, and energy consumption, resulting in higher environmental degradation and CO2 emissions. This phase is characterized by the prioritization of economic expansion over environmental concerns, as developing economies rely heavily on resource-intensive and polluting industries for growth.

As economies mature and achieve higher income levels, a turning point emerges where environmental awareness, technological advancements, and regulatory frameworks become prominent. Increased income enables investment in cleaner technologies, renewable energy, and efficient resource use, leading to a decline in environmental degradation. This dynamic reflects a shift from emission-intensive activities to sustainable practices, driven by both market forces and public policies. However, the EKC hypothesis is contingent upon the assumption that institutional and technological progress will align with economic growth.

In the Indian context, rapid industrialization and urbanization have positioned the country on the upward slope of the EKC. While initial phases of economic growth post-liberalization

increased emissions, recent efforts to adopt renewable energy, implement stricter environmental policies, and foster green innovations suggest a gradual movement toward the EKC turning point. These trends highlight India's potential to transition to a sustainable development path.

3.10 Porter Hypothesis

The Porter Hypothesis suggests that well-designed environmental regulations can enhance both environmental performance and economic competitiveness. Contrary to traditional views that such regulations impose a cost burden on firms, the hypothesis argues that these policies can drive innovation, improve efficiency, and open new market opportunities. Firms faced with stringent environmental standards are incentivized to innovate and develop cleaner production technologies, often leading to cost savings and better resource utilization. This innovation-induced productivity can more than offset compliance costs, resulting in a win-win scenario for both the environment and economic growth.

The hypothesis can be expressed in two forms:

1. Weak Version: Environmental regulations drive improvements in environmental outcomes without necessarily harming firm competitiveness.
2. Strong Version: Regulations not only improve environmental performance but also enhance firms' overall profitability and productivity through innovation.

Numerical models illustrate this relationship using cost-benefit analyses where the marginal benefit of innovation exceeds the marginal cost of regulation. For example, firms may reduce emissions and production costs simultaneously through improved energy efficiency.

In the Indian context, environmental policies like renewable energy targets and energy efficiency programs align with the Porter Hypothesis. Industries in India are increasingly adopting green practices, driven by regulatory mandates and competitive pressures, demonstrating the potential for regulations to foster both sustainability and economic growth.

4. Empirical Methodology

This section of research paper explains the detailed methodology used to conduct a time series econometric modelling in order to investigates the relationship between CO2 emissions and key economic indicators, including FDI, gross domestic product (GDP), money supply (M3), and government fiscal deficit (GFD). Additionally, the study considers the role of the National Energy Policy (NEP) of 1991, represented as a dummy variable, to assess its influence on emissions dynamics.

4.1 Data

This study employs yearly data spanning from 1970 to 2023 to examine the relationship between CO2 emissions and key economic variables, including FDI, GDP, money supply (M3), and government fiscal deficit (GFD). The dataset integrates information from

multiple credible sources, ensuring a comprehensive analysis of these relationships. Below is a detailed description of the variables and their sources.

The study examines the relationship between carbon dioxide (CO2) emissions and key macroeconomic variables in India. The dependent variable in this study is per capita CO2 emissions from fossil fuels, measured in metric tons. This variable serves as a critical proxy for the environmental impacts of economic activities and is sourced from Crippa et al. (2023), EDGAR/JRC, European Commission. Given India's rapid industrialization and economic growth, understanding the factors influencing CO2 emissions is essential for formulating sustainable policies.

To analyze the determinants of CO2 emissions, the study considers several independent variables. One of the primary variables is Foreign Direct Investment (FDI), representing the annual inflows of foreign capital into India, measured in US dollars. Sourced from MacroTrends, FDI plays a significant role in shaping industrial growth and energy consumption patterns, thereby influencing emissions. Another key variable is the Government Fiscal Deficit (GFD), which captures the difference between government expenditure and its total revenue receipts, excluding non-debt-creating capital receipts. This variable, sourced from CMI data, reflects the fiscal policies that may impact economic activity and, consequently, emissions levels.

Additionally, the study incorporates Gross Domestic Product (GDP) as an independent variable, measured annually in Indian Rupees. Sourced from India Stat, GDP is a crucial indicator of economic performance and industrialization, both of which are closely linked to energy consumption and carbon emissions. Money Supply (M3), representing the percentage increase in total money supply within the economy, is also included. This variable, sourced from the Reserve Bank of India (RBI), reflects monetary policy influences on economic activity and energy demand.

Finally, the study introduces a policy variable, the New Economic Policy (NEP), modeled as a dummy variable to assess its impact on CO2 emissions. The NEP variable is assigned a value of 1 for years after 1991, marking the introduction of liberalization reforms, and 0 otherwise. This variable captures the structural shifts in the Indian economy and their potential effects on emissions trends.

This dataset provides a solid foundation for analyzing the interplay between economic factors and CO2 emissions, enabling insights into the drivers of environmental impacts in India over time.

Table 1. Variables Description

Variable	Description	Source
CO2 Emissions	Per capita CO2 emissions (metric tons)	Crippa et al. (2023), EDGAR/JRC; European Commission
Foreign Direct Investment (FDI)	Foreign direct investment (US dollars)	Macrotrends
Government Fiscal Deficit (GFD)	the difference between a government's total Expenditure and its total revenue receipts and non-debt creating capital receipts	CMI data sources
Gross Domestic Product (GDP) – Growth rate	Growth Rate in Percentage	Indiastat
Money Supply (M3)		
New Economic Policy (NEP)	Dummy variable for New Economic Policy	Derived from policy documents

4.2 Variables Description and Relationships

As nations strive for sustainable development, understanding the factors driving CO2 emissions is critical for shaping effective environmental and economic policies. FDI, for instance, can serve as both a catalyst for economic growth and a source of increased emissions, depending on the sectors it targets and the technologies it brings. Similarly, GDP growth may initially drive emissions during industrialization phases but could later reduce them as economies transition to greener technologies. Meanwhile, variables like money supply and fiscal deficit reflect broader macroeconomic conditions that could indirectly influence energy consumption and emissions. Lastly, the NEP is expected to provide valuable insights into how policy measures can shape emission patterns.

4.3.1 Foreign Direct Investment (FDI)

FDI often acts as a conduit for industrial development and globalization, which can directly increase CO2 emissions. Investment in manufacturing, construction, or energy-intensive industries typically leads to higher energy demand and fossil fuel consumption, contributing to environmental degradation. This phenomenon is referred to as the PHH, where countries with less stringent environmental regulations attract emission-intensive investments; see, Figure 1.

Conversely, FDI can facilitate the transfer of advanced, environmentally friendly technologies and production methods to host countries. This aligns with the PHL, suggesting that multinational corporations may bring cleaner and more efficient technologies, potentially reducing emissions. The net effect of FDI on CO2 emissions

depends on the balance between these opposing forces and the sectors receiving the investment.

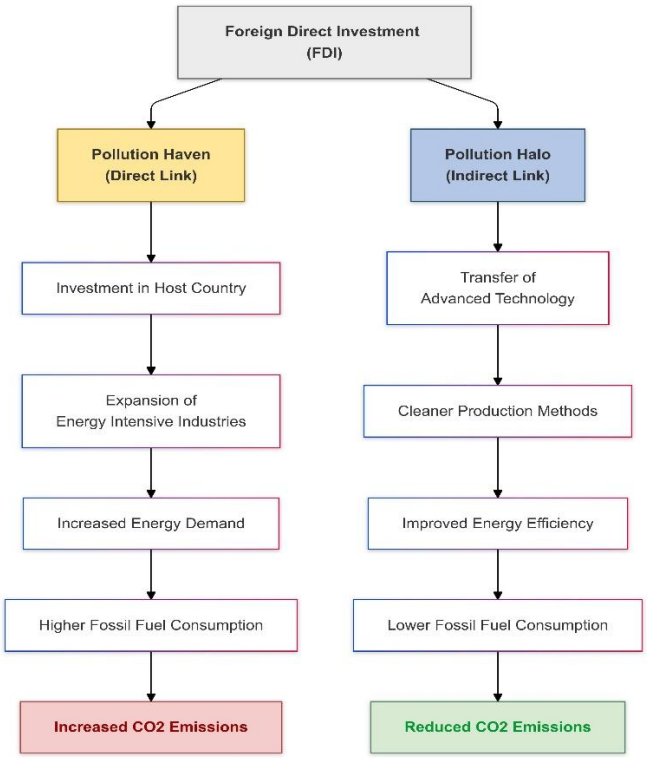


Figure 1. FDI impact framework

4.3.2 Monetary Policy

Monetary policy influences the money supply (M3), which directly impacts aggregate demand and, consequently, energy consumption. An increase in M3 raises liquidity (expansionary monetary policy), spurring economic activities like manufacturing and consumption. This rise in economic activity often correlates with higher energy use and emissions. At the same time, a contractionary policy reduces economic activity, which may directly lower energy consumption and emissions as industrial output and consumption decline; see, Figure 2.

Monetary policy can indirectly affect CO2 emissions through its influence on investment in energy infrastructure. For instance, expansionary policies may increase investments in renewable energy sources due to greater availability of credit. Conversely, if credit expansion focuses on traditional fossil-fuel-based industries, emissions might rise.



Figure 2. M3 impact framework

4.3.3 Fiscal Policy

Fiscal policy, which includes changes in GDP, government fiscal deficit (GFD), and broader reforms like the New Economic Policy (NEP) of 1991, affects CO2 emissions through both direct and indirect mechanisms:

4.3.3.1. GDP Growth

GDP growth is closely linked to energy demand. As economies expand, higher industrial production, transportation, and household consumption typically lead to increased energy usage and emissions. This relationship reflects the EKC hypothesis, which posits that emissions initially rise with GDP growth but eventually decline as economies transition to cleaner technologies. Indirectly, GDP growth may foster innovation and investment in renewable energy sources, leading to emissions reductions over time. It also enables governments to allocate more resources to environmental protection; see, Figure 3.

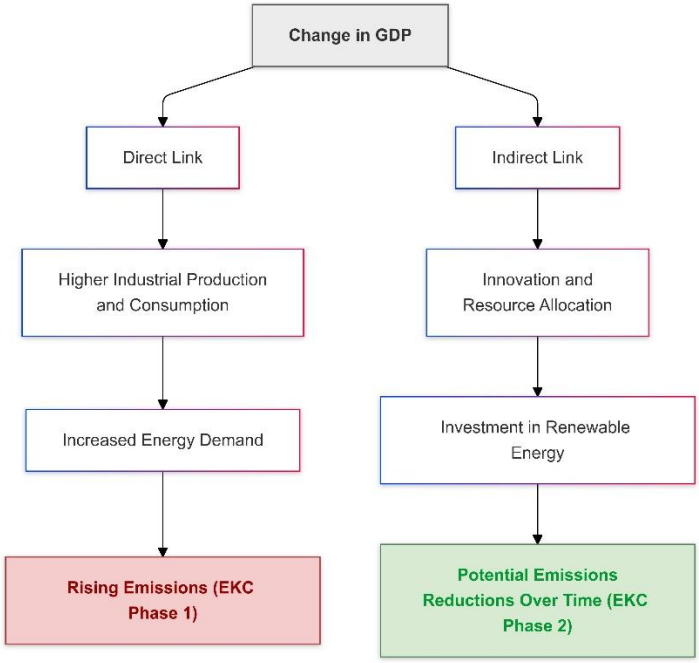


Figure 3. GDP impact framework

4.3.3.2.Government Fiscal Deficit (GFD)

A rising fiscal deficit, often associated with increased government spending, can directly boost economic activities such as infrastructure development. This, in turn, increases energy demand and emissions, particularly if spending targets emission-intensive sectors. Indirectly, government deficits may crowd out private investments in green energy sectors if public borrowing dominates credit markets. Conversely, targeted government spending on green infrastructure, such as public transport or renewable energy projects, could mitigate emissions.

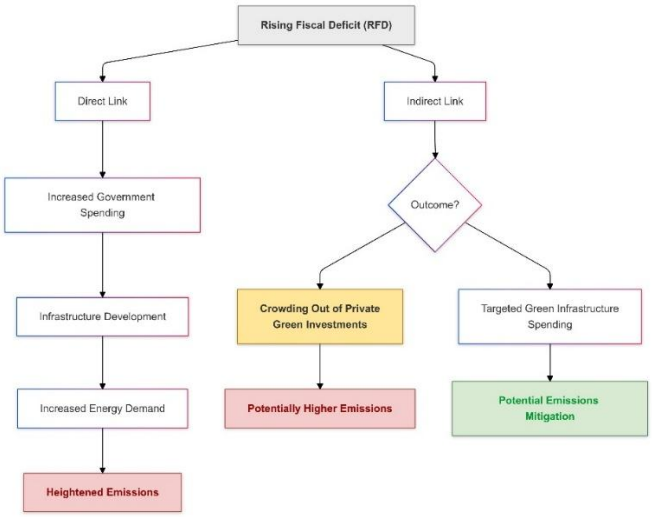


Figure 4. GFD impact framework

4.3.4. New Economic Policy (NEP) of 1991

The NEP, characterized by liberalization, privatization, and globalization, significantly influenced India's economic structure. Increased industrialization and foreign trade following the NEP led to higher energy demands, often fulfilled by fossil fuels, thus raising emissions. Indirectly, the NEP also opened avenues for technological transfer and investments in modern, energy-efficient industries. These reforms allowed the entry of multinational corporations that could introduce cleaner technologies. Additionally, the policy's long-term impact on trade and industrial practices could influence emissions through structural economic changes.

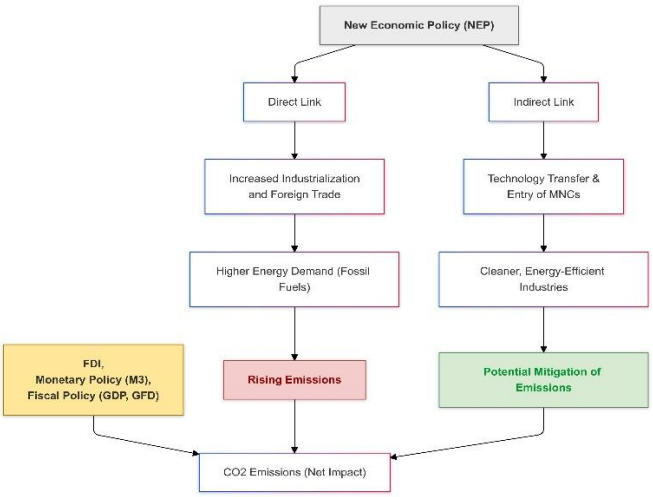


Figure 1. NEP impact framework

The relationships between CO2 emissions and the independent variables—FDI, monetary policy (M3), and fiscal policy (GDP, GFD, and NEP)—are multifaceted. While economic activities and policies often contribute to increased emissions through energy demand, they also hold potential for promoting sustainable practices and green technologies. Understanding these direct and indirect links provides a comprehensive framework for analyzing the factors driving emissions and identifying potential levers for environmental policy interventions.

4.4 Econometric Models

Econometric modeling forms the backbone of this research, providing a quantitative framework to analyze the relationship between CO_2 emissions and economic variables such as FDI, M3, GFD, and GDP. Given the complex interdependencies and potential endogeneity among these variables, the study employs a Structural Vector Autoregression (SVAR) model, which allows for the identification of structural shocks and their dynamic effects over time. The SVAR approach is particularly well-suited for capturing both short-term interactions and long-run transmission mechanisms without imposing restrictive assumptions about exogeneity.

To identify the structural shocks, the model imposes theoretically motivated restrictions, either through Cholesky decomposition or long-run constraints, ensuring meaningful economic interpretations. The study further examines Impulse Response Functions (IRFs) to trace the

effects of shocks on CO_2 emissions and Variance Decomposition (VD) to quantify the relative importance of each variable in explaining forecast error variance. To ensure robustness, the model undergoes diagnostic tests, including checks for autocorrelation, heteroscedasticity, and stability. This empirical strategy provides a comprehensive understanding of the dynamic linkages between FDI, macroeconomic policies, and environmental outcomes.

4.4.1. Stationarity Test

Stationarity is a fundamental requirement in time-series econometrics, ensuring that the statistical properties of a variable (mean, variance, autocovariance) do not change over time. For this study, stationarity is tested using the Augmented Dickey-Fuller (ADF) test, expressed as:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta \Delta Y_{t-1} + \varepsilon_t$$

where, Y_t is the variable being tested, ΔY_t is the first difference of Y_t, α is the drift term, βt is the Deterministic trend, γY_{t-1} is the lagged value to test for unit root, and finally, ε_t is the error term.

4.4.2 Johansen Cointegration Test

The Cointegration is used to determine the existence of a long-term relationship between variables in a model, typically examined using the Johansen Cointegration Test, which is designed for multivariate systems and does not rely on a predefined dependent variable.

Econometrically, cointegration implies that although individual variables may be non-stationary (I(1)), a linear combination of these variables is stationary (I(0)), indicating a stable long-run equilibrium. If cointegration is detected, the VAR model must be adjusted to a Vector Error Correction Model (VECM) to incorporate the long-run equilibrium relationship.

To determine the presence of cointegration, the Johansen method employs two key test statistics:
Trace Test tests the null hypothesis that there are at most rrr cointegrating equations. The test statistic is computed as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} ln\,(1 - \lambda_i)$$

f the test statistic exceeds the critical value, we reject the null and conclude that there are more than r cointegrating relationships.

Maximum Eigenvalue Test tests whether the rank of the cointegration matrix is r versus r + 1. The test statistic is given by:

$$\lambda_{max}(r, r+1) = -T\, ln(1 - \lambda_{r+1})$$

A significant test statistic indicates the presence of an additional cointegrating vector.

The Johansen test equation is used to determine whether a system of variables exhibits cointegration. If cointegration exists, the system is represented as a Vector Error Correction Model (VECM), given by the equation:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + u_t$$

where, Y_t is an (n×1) vector of variables (CO_2 emissions, FDI, M3, GFD, GDP). ΔY_t denotes the first-differenced form of ΔY_t. Π is the cointegration matrix, which contains information about the long-run relationships. Γ_i represents short-term dynamics. u_t is the error term.

- If rank(Π) = 0, there is no cointegration, and a standard VAR in first differences is used.
- If rank(Π) = n, all variables are stationary at levels, and a VAR in levels is appropriate.
- If 0 < rank(Π) < n, there exist r cointegrating relationships, and a VECM is required.

If no cointegration is found, a SVAR model in first differences (DVAR) is estimated to avoid spurious regressions. If cointegration is found, the VECM is estimated, which integrates long-term equilibrium and short-term adjustments.

If the trace statistic or maximum eigenvalue statistic suggests at least one cointegrating equation, this implies the existence of a stable long-run relationship among CO_2 emissions, FDI, monetary aggregates, fiscal policy, and economic growth. In the case of cointegration, the error correction term (ECT) in the VECM captures the speed of adjustment towards equilibrium. If no cointegration is found, a SVAR model in first differences is estimated, and long-run effects cannot be directly inferred.

4.5 Structural Vector Error Correction Model:

In the Structural Vector Autoregression (SVAR) framework, when cointegration is present, the model must account for both long-run equilibrium relationships and short-term dynamics. Structural VAR model to incorporate a single error correction term, the SVAR-based ECM (commonly referred to as a Vector Error Correction Model (VECM)) extends this concept to a multivariate system, allowing all variables to adjust dynamically.

The SVAR model can be written as follows:

$$A_0 X_t = A(L) X_{t-1} + e_t$$

where, Xt is the vector of endogenous variables. $A0$ imposes restrictions on contemporaneous reactions. $A(L)$ and A_0 are coefficient matrices where L is the lag operator. e_t is the structured shocks. The number of restrictions to be imposed on a vector of n endogenous variables is $\frac{n(n-1)}{2}$.

4.6 Impulse Response Functions (IRFs)

Impulse Response Functions (IRFs) are used to trace the time path of a variable's response to an exogenous structural shock in another variable within the system. This is crucial in understanding the transmission mechanisms of economic shocks on CO_2 emissions and other macroeconomic indicators. Specifically, IRFs in this study help assess: The extent to which FDI shocks influence CO_2 emissions over time, how monetary and fiscal policy shocks impact environmental outcomes, the persistence and duration of macroeconomic shocks on the system.

By analyzing the IRFs, we can determine whether these relationships exhibit short-term fluctuations or longer-term stability, thus guiding policy recommendations for sustainable economic growth.

4.7 Variance Decomposition Analysis (VD)

Variance Decomposition (VD) complements IRF analysis by quantifying the proportion of forecast error variance in each variable that is attributable to different structural shocks. This analysis provides insights into the relative importance of FDI, monetary policy, fiscal policy, and GDP fluctuations in explaining variations in CO_2 emissions. Key takeaways from variance decomposition include identifying the dominant macroeconomic driver of CO_2 emissions fluctuations, understanding whether environmental outcomes are more influenced by domestic policy shocks or external investment flows, assessing the time-dependent significance of various economic factors in shaping environmental policies.

By combining SVAR, IRFs, and VD analysis, this study provides a comprehensive empirical framework to understand how macroeconomic policies and international capital flows affect environmental sustainability in the context of economic development.

5. Results and Discussions

5.1 Empirical Results

The empirical analysis begins with descriptive statistics to provide an overview of the central tendencies, dispersion, and range of the dataset variables. This step is crucial as it allows for a preliminary understanding of the data structure, variability, and possible anomalies. The key variables in this study include CO2, Ln_FDI, GDP, GFD, and Money Supply (M3). Their mean, standard deviation, and maximum and minimum values offer a snapshot of their distribution over the sample period.

5.1.1 Descriptive Statistics

The The descriptive statistics provide an overview of the key variables in the study. The mean value of CO_2 emissions is approximately 0.98, with a standard deviation of 0.52. The data ranges from a minimum of 0.37 to a maximum of 2.07, indicating limited variability in emissions levels over the study period.

The natural logarithm of Foreign Direct Investment (Ln_FDI) has a mean value of 6.97 and a standard deviation of 1.48, reflecting moderate variability. The range extends from -0.72 to 8.52, suggesting significant fluctuations in FDI inflows, which may be influenced by global investment trends and domestic economic conditions. The GDP growth rate has a mean of 5.41, with a standard deviation of 3.16, indicating considerable variability in economic performance. The GDP growth rate ranges from a contraction of -5.78 to a peak of 9.69, reflecting periods of both economic downturn and strong expansion. The gross fiscal deficit (GFD) exhibits substantial variation, with a mean value of 345,669.20 and a standard deviation of 493,002.60. The fiscal deficit ranges from a minimum of 8,299 to a maximum of 1,818,291, indicating significant fiscal imbalances over the period, likely influenced by changes in government borrowing, expenditures, and revenue collection. The money supply (M3) has a mean of 15.67 and a standard deviation of 3.92, showing moderate variability. The range extends from 6.90 to 23.58, reflecting shifts in monetary policy and liquidity conditions within the economy. These fluctuations may have influenced inflation, interest rates, and overall economic activity during the study period.

Table 2. Descriptive statistics

Variables	Mean	SD	Max	Max
CO2	0.979074	0.523011	0.37	2.07
Ln_FDI	6.972778	1.480581	-0.72	8.52
GDP	5.409815	3.161536	-5.78	9.69
GFD	345669.2	493002.6	8299	1818291
M3	15.6671	3.922792	6.9	23.58096

5.1.2 ADF Test

The ADF test is used to determine whether a time series variable is stationary or contains a unit root. Stationarity is critical in time series analysis as it ensures meaningful relationships between variables and avoids spurious regression results. Here, the null hypothesis of the ADF test states that the series contains a unit root (i.e., it is non-stationary). If the test statistic is less than the critical value at a given significance level, the null hypothesis is rejected, indicating stationarity.

The results reveal a mix of stationary and non-stationary variables. The log of Foreign Direct Investment (ln_FDI) has a Dickey-Fuller statistic of -3.322, which is less than the 5% critical value, and a p-value of 0.0139, indicating that it becomes stationary at the first difference and

is thus integrated of order one (I(1)). Similarly, CO2 emissions (CO2), with a statistic of 2.155 and a p-value of 0.9988, are non-stationary at levels but stationary at the first difference, making it I(1). The gross fiscal deficit (GFD), with a statistic of 1.026 and a p-value of 0.9945, also follows the same pattern and is I(1). The money supply (M3), with a Dickey-Fuller statistic of -3.589 and a p-value of 0.006, becomes stationary at first difference and is I(1).

In contrast, the GDP growth rate (GDP) has a Dickey-Fuller statistic of -7.107, which is less than all critical values, and a p-value of 0, confirming stationarity at levels and making it integrated of order zero (I(0)).

Table 3. ADF Test

Variable	*Dickey-Fuller Statistic*	*1% Critical Value*	*5% Critical Value*	*10% Critical Value*	*P-Value*	*At First Difference*	*Stationarity*
ln_fdi	-3.322	-3.576	-2.928	-2.599	0.0139	0	I(1)
co2	2.155	-3.576	-2.928	-2.599	0.9988	0	I(1)
gdp	-7.107	-3.576	-2.928	-2.599	0		I(0)
gfd	1.026	-3.628	-2.95	-2.608	0.9945	0	I(1)
m3	-3.589	-3.576	-2.928	-2.599	0.006	0	I(1)

5.1.3 Structural VAR

The R-squared value for CO_2 emissions is 0.9936, indicating that the independent variables (GDP, LN_GFD1, M3, and LNFDI) explain 99.36% of the variation in CO_2 emissions. The Adjusted R-squared (0.9918) remains high, confirming a strong model fit with minimal overfitting. The F-statistic (563.98) is highly significant, suggesting that the overall model is robust in explaining CO_2 emissions. The Sum of squared residuals (0.0882) and Standard Error of the Equation (0.04695) are relatively low, indicating a good model fit with minimal unexplained variation. The Akaike Information Criterion (AIC) (-3.08) and Schwarz Criterion (SC) (-2.63) suggest model efficiency, with lower values indicating a better balance between model fit and complexity. The Mean of CO_2 emissions (1.002) and its Standard Deviation (0.52) highlight the distribution of the dependent variable. Overall, the model exhibits a strong explanatory power for CO_2 emissions, suggesting that economic factors such as GDP, fiscal policy (LN_GFD1), money supply (M3), and FDI (LNFDI) play a significant role in determining CO_2 levels.

Explanation of the SVAR Results

The regression results reveal several important dynamics regarding the determinants of CO_2 emissions. Notably, the lagged values of GDP, specifically GDP(-1) and GDP(-2), exhibit statistically significant negative coefficients of -0.000502 ($p = 0.00263$) and -0.002272 ($p = 0.00229$) respectively. This suggests that higher levels of GDP in the previous periods are

associated with a decrease in current CO_2 emissions. One possible interpretation is that, over time, economic growth may be linked with investments in cleaner technologies or more efficient production processes, thereby reducing emissions in subsequent periods.

The variables representing the logarithm of gross fiscal deficit (LN_GFD1) at lags one and two yield positive coefficients of 0.096028 (p = 0.09291) and 0.016342 (p = 0.09842). Although these p-values are slightly above the conventional 5% significance level, they are borderline significant and hint at a positive relationship, implying that increased fiscal deficit in previous periods might be contributing to higher CO_2 emissions.

Similarly, the money supply variable (M3) shows mixed results. M3 lagged by one period has a positive and statistically significant coefficient of 0.001598 (p = 0.00246), whereas the lag two coefficient is slightly negative at -0.000158 (p = 0.00245). The significant p-values indicate that changes in the money supply have an immediate and measurable impact on CO_2 emissions, although the small magnitude of these coefficients suggests that the effect size is relatively modest. The differing signs between the lags might indicate a short-term stimulative effect on emissions that is counterbalanced by longer-term adjustments.

The results for foreign direct investment (LNFDI) also demonstrate statistically significant relationships. The coefficient for LNFDI lagged by one period is 0.003458 (p = 0.00753), indicating that an increase in FDI is associated with higher CO_2 emissions in the subsequent period. Conversely, LNFDI lagged by two periods has a negative coefficient of -0.001231 (p = 0.00735), suggesting that the impact of foreign direct investment on emissions might reverse over a longer period. This dual effect could reflect initial environmental costs due to industrial expansion funded by FDI, which are later offset by technological improvements or efficiency gains as investments mature.

In contrast, the autoregressive components of CO_2—$CO_2(-1)$ and $CO_2(-2)$—do not show statistically significant coefficients, with values of 1.078295 (p = 0.19020) and -0.18782 (p = 0.19504) respectively. This lack of significance may indicate that the past levels of CO_2 emissions do not strongly predict current emissions when controlling for the other variables in the model.

The constant term (C) is negative (-0.412778) but not statistically significant (p = 0.16357), suggesting that in the absence of the other explanatory variables, there is no strong baseline effect on CO_2 emissions. However, the dummy variable (NEP) is negative and significant (-0.03691, p = 0.02922), indicating that the new economic policy exerts a modest but statistically significant dampening effect on CO_2 emissions.

Overall, these findings suggest a nuanced and dynamic relationship between economic activity, financial variables, and CO_2 emissions. The significant negative association with lagged GDP implies potential long-term benefits of economic growth on environmental performance, possibly through the adoption of cleaner technologies. Meanwhile, the mixed effects of financial funding, money supply, and foreign direct investment underscore the complexity of their impacts on environmental outcomes. These results highlight the importance of considering temporal dynamics and lagged effects when analyzing the interplay between economic policy, investment flows, and environmental performance.

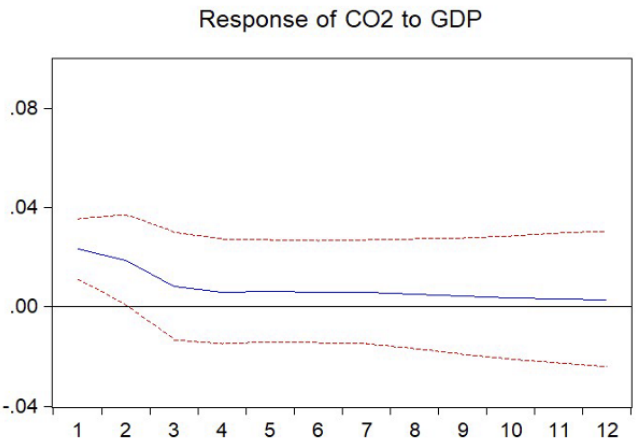
Table 4. Results of SVAR

	CO2	P-Values
GDP(-1)	-0.000502	(0.00263)
GDP(-2)	-0.002272	(0.00229)
LN_GFD1(-1)	0.096028	(0.09291)
LN_GFD1(-2)	0.016342	(0.09842)
M3(-1)	0.001598	(0.00246)
M3(-2)	-0.000158	(0.00245)
LNFDI(-1)	0.003458	(0.00753)
LNFDI(-2)	-0.001231	(0.00735)
CO2(-1)	1.078295	(0.19020)
CO2(-2)	-0.18782	(0.19504)
C	-0.412778	(0.16357)
DUMMY1	-0.03691	(0.02922)

5.1.4 Impulse Response Analysis: The Impact of Macroeconomic Shocks on CO_2 Emissions

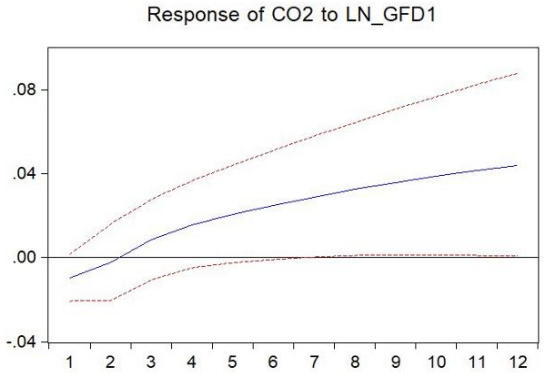
Impulse response functions (IRFs) help in understanding the dynamic effects of a one-standard deviation shock in different macroeconomic variables on CO_2 emissions over time. The responses depicted in the IRF graphs provide valuable insights into the relationship between economic activities, fiscal and monetary policies, foreign direct investment (FDI), and environmental outcomes. The following section provides a detailed interpretation of each response.

1. The Impact of CO_2 Emissions on GDP



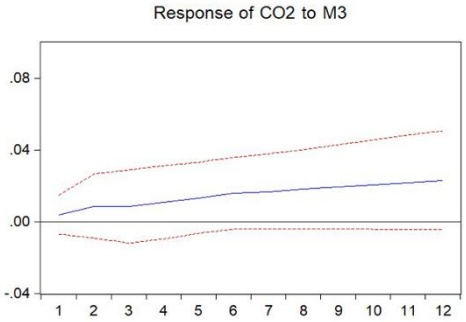
The response of CO_2 emissions to a shock in GDP appears to be slightly positive in the initial periods but gradually stabilizes around zero. This suggests that an increase in economic activity, measured by GDP, initially contributes to higher carbon emissions. This outcome aligns with the Environmental Kuznets Curve (EKC) hypothesis, which suggests that during the early stages of economic growth, environmental degradation intensifies due to increased industrialization and energy consumption. However, as the economy matures, investments in cleaner technology, stringent environmental policies, and shifts towards a service-based economy help stabilize and eventually reduce emissions. The insignificance of the long-term response indicates that economic growth alone may not be a major determinant of sustained changes in CO_2 emissions without complementary policies promoting green energy and sustainability.

2. The Impact of CO_2 Emissions on Fiscal Deficit (LN_GFD1)



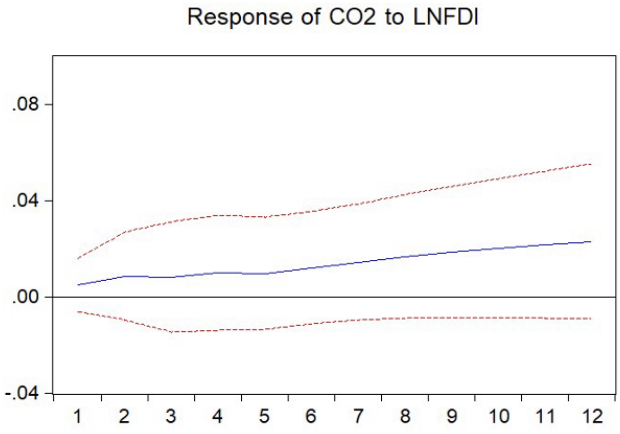
A shock to the fiscal deficit (LN_GFD1) leads to a persistent and increasing rise in CO_2 emissions. This indicates that expansionary fiscal policies, characterized by higher government spending and borrowing, tend to have long-term adverse environmental consequences. The likely explanation is that increased government expenditure, especially in infrastructure, manufacturing, and energy-intensive industries, drives up carbon emissions. Additionally, fiscal stimulus measures, such as subsidies for fossil fuel consumption or investment in carbon-intensive industries, could further exacerbate environmental degradation. The steady increase in emissions over time suggests that without targeted green fiscal policies, rising fiscal deficits could have a long-term negative impact on the environment.

3. The Impact of CO_2 Emissions on Money Supply (M3)



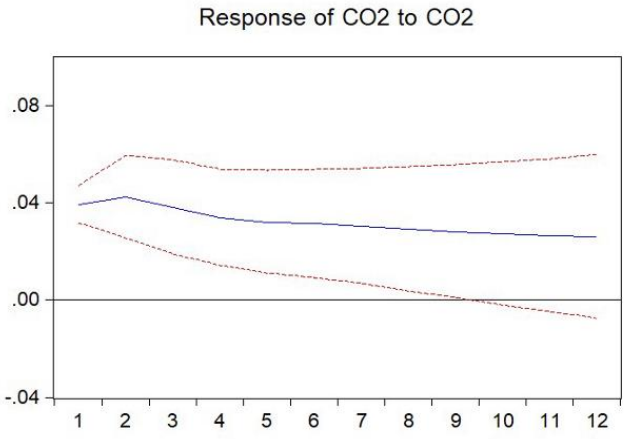
The response of CO_2 emissions to a monetary expansion (M3) follows an upward trend, implying that an increase in money supply contributes to higher emissions over time. This could be due to the fact that an expansionary monetary policy reduces interest rates, encouraging borrowing and investment. As a result, firms and industries increase production, leading to higher energy consumption and CO_2 emissions. The sustained increase suggests that monetary policies, if not aligned with environmental objectives, may lead to long-term ecological challenges. Policymakers should consider incorporating environmental sustainability into monetary policy frameworks, for instance, by incentivizing green investments and discouraging credit expansion towards carbon-intensive industries.

4. The Impact of CO_2 Emissions on Foreign Direct Investment (LNFDI)



A positive shock to FDI (LNFDI) leads to a gradual but steady increase in CO_2 emissions over time. This suggests that foreign investments, while contributing to economic growth, may also be associated with increased industrial activity and resource exploitation. This finding supports the Pollution Haven Hypothesis (PHH), which argues that multinational corporations tend to invest in countries with less stringent environmental regulations, leading to higher pollution levels. However, the effect of FDI on emissions appears to be moderate compared to other variables, implying that while foreign investments do contribute to environmental degradation, their impact depends on the nature of investment inflows. If FDI is directed towards clean energy, technology transfer, and sustainable infrastructure, its negative effects on emissions could be mitigated.

5. The Persistence of CO_2 Emissions (Response of CO_2 to Its Own Shock)



The response of CO_2 emissions to its own past values is significantly positive and persistent over time. This indicates a high degree of path dependency, meaning that once emissions increase, they tend to remain elevated for a prolonged period. This could be attributed to structural factors such as long-term investments in fossil fuel-based energy, reliance on carbon-intensive industries, and delays in adopting green technologies. The persistence of CO_2 emissions highlights the importance of long-term policy interventions aimed at reducing reliance on fossil fuels, improving energy efficiency, and enforcing environmental regulations. Without such measures, CO_2 levels may continue to rise even if economic growth slows down.

5.1.5 Variance Decomposition

The data suggests that the economy is undergoing significant structural changes over the observed periods. Notably, while domestic production—as measured by GDP—declines markedly from 24.49 to 4.02, financial indicators such as the money supply (M3) and foreign direct investment (LNFDI) exhibit robust growth. This divergence indicates a potential shift from a traditional production-based economy to one that increasingly relies on financial markets and foreign investment. The expansion of the money supply may be indicative of monetary policies designed to inject liquidity into an economy experiencing contraction, possibly as an effort to stabilize or stimulate economic activity despite the downturn in domestic output.

In parallel with these financial shifts, the data reveals interesting trends in government or financial funding, as captured by LN_GFD1. Initially, this variable shows variability but then embarks on a strong upward trajectory, suggesting that there may have been a strategic policy shift or an increasing reliance on external or governmental funding over time. This growing infusion of funding could be instrumental in sustaining the financial health of the economy during periods of declining domestic production, although it also underscores the need for a closer examination of policy impacts on economic dynamics.

Environmental indicators further enrich this analysis. The pattern of CO2 emissions, which peak early and then decline steadily, hints at a reduction in carbon intensity, possibly due to a shift in the industrial structure or the effective implementation of environmental policies. The decrease in CO2 emissions is particularly notable when considered alongside the contraction

in GDP, suggesting that the reduction in emissions may not solely be a consequence of reduced economic activity, but also of deliberate measures to mitigate environmental impact.

Overall, the results indicate a complex interplay between declining traditional economic output and the expansion of financial and investment activities. The contrasting trends underscore the need for further investigation into the underlying drivers of these changes, including potential shifts in economic policy, the influence of external investment, and the implications of environmental regulation. These findings not only highlight the transformative nature of the economic landscape but also point to important considerations for policymakers aiming to balance growth, investment, and environmental sustainability.

Table 5. Variance Decomposition

Period	S.E.	GDP	LN_GFD1	M3	LNFDI	CO2
1	2.820177	24.48759	4.144007	0.632748	1.011678	69.72398
2	2.903918	19.82245	2.158633	1.865492	2.060051	74.09337
3	3.297035	15.40239	2.741703	2.463366	2.492787	76.89975
4	3.385977	12.67275	5.350629	3.383579	3.192348	75.40069
5	3.456509	10.75418	8.824988	4.557663	3.555781	72.30739
6	3.486401	9.190247	12.61467	5.861276	4.155374	68.17843
7	3.494947	7.941327	16.59548	6.896627	4.938845	63.62772
8	3.506957	6.881079	20.47645	7.809143	5.828693	59.00463
9	3.516775	5.967909	24.19281	8.616429	6.757996	54.46486
10	3.522987	5.202286	27.64138	9.314851	7.625543	50.21594
11	3.528527	4.56059	30.74308	9.936161	8.415154	46.34502
12	3.532106	4.021851	33.50808	10.4734	9.132783	42.86389

6. Conclusion

This study has provided an in-depth analysis of the intricate relationships between foreign direct investment (FDI), fiscal and monetary policies, economic growth, and CO_2 emissions in India, utilizing a Structural Vector Autoregression (SVAR) model. By assessing the short-term and long-term impacts of economic policies and investment patterns on environmental sustainability, the research offers crucial insights into the validity of the Pollution Haven Hypothesis (PHH), the Environmental Kuznets Curve (EKC), and the broader economic-environment nexus. The empirical findings suggest that while economic growth and FDI inflows contribute to CO_2 emissions, their effects are dynamic and vary over time, contingent on the nature of investments, regulatory frameworks, and policy responses.

One of the key findings of the study is the significant role of FDI in influencing CO_2 emissions. The results indicate that FDI inflows initially lead to an increase in CO_2 emissions, supporting the Pollution Haven Hypothesis (PHH), which posits that countries with relatively lax environmental regulations attract pollution-intensive industries. However, the long-term dynamics reveal a more nuanced picture—as investments mature, they bring in cleaner technologies and more efficient production processes, aligning with the Pollution Halo

Hypothesis (PHL). This suggests that the environmental impact of FDI is highly sector-dependent—investments in manufacturing and heavy industries contribute to emissions, while investments in renewable energy, technology-driven sectors, and sustainable infrastructure can mitigate environmental degradation.

The study also finds a dual effect of GDP growth on CO_2 emissions, consistent with the Environmental Kuznets Curve (EKC) hypothesis. Initially, as GDP grows, emissions increase due to industrialization and higher energy consumption. However, as economies move beyond a certain threshold, structural transformations occur, shifting towards cleaner production methods, energy efficiency improvements, and stricter environmental regulations, ultimately leading to a decline in emissions. This reinforces the need for sustainable economic policies that accelerate the transition from the early stages of industrialization to a more sustainable, low-carbon growth trajectory.

Monetary policy, as measured by money supply growth (M3), is found to have a significant positive impact on CO_2 emissions in the short run. Expansionary monetary policies, which increase liquidity and boost industrial activity, lead to higher energy consumption and emissions. However, this effect diminishes over time, suggesting that monetary interventions alone are insufficient for long-term environmental sustainability. Instead, monetary policy should be aligned with green financing initiatives, directing credit towards renewable energy projects, energy-efficient infrastructure, and sustainable businesses.

Fiscal policy, particularly government fiscal deficit (GFD), has a persistent impact on CO_2 emissions. The results indicate that increased government spending often translates into higher emissions, particularly when public investments are directed towards infrastructure development, energy-intensive projects, or subsidies for fossil fuel consumption. This highlights the importance of green fiscal policies—government spending should be strategically reallocated to support renewable energy adoption, sustainable transportation systems, and environmental protection programs. Carbon taxation, removal of fossil fuel subsidies, and fiscal incentives for clean energy can help in mitigating the negative environmental effects of expansionary fiscal policies.

The findings on the New Economic Policy (NEP) of 1991 suggest that trade liberalization and globalization have had mixed effects on India's environmental outcomes. On the one hand, the inflow of capital and technology has accelerated economic growth, enhancing industrial productivity and infrastructure. On the other hand, unregulated industrial expansion and increased resource exploitation have led to rising emissions. However, the long-term effects of NEP indicate a shift towards more sustainable economic structures, as India has gradually embraced environmental regulations, international climate commitments, and renewable energy investments.

The Impulse Response Functions (IRFs) and Variance Decomposition (VD) further highlight the dynamic relationships between economic activities and environmental sustainability. The IRFs show that a shock to FDI, GDP growth, and fiscal expansion leads to a short-term increase in CO_2 emissions, while monetary shocks exhibit persistent yet moderate effects. The variance decomposition results indicate that GDP and FDI account for a substantial proportion of CO_2 fluctuations, reinforcing their dominant role in shaping environmental outcomes. These findings underscore the importance of policy coherence, ensuring that economic growth strategies are synchronized with environmental objectives.

Policy Implications

The empirical findings underscore the urgent need for integrated policy interventions that balance economic growth, investment flows, and environmental sustainability. Based on the results, the following policy recommendations emerge:

India should implement sector-specific FDI policies that encourage investments in green technologies, renewable energy, and sustainable industries. While FDI inflows contribute to economic expansion, they should be directed towards sectors that enhance energy efficiency and reduce emissions, rather than those that perpetuate fossil fuel dependency. Regulatory frameworks must be strengthened to ensure that multinational corporations adhere to strict environmental standards, preventing the relocation of pollution-intensive industries to India.

Monetary policy must be aligned with environmental objectives, promoting green financing mechanisms. The Reserve Bank of India (RBI) should develop incentive structures for banks to prioritize lending to renewable energy projects, electric mobility, and clean technology sectors. A differentiated reserve requirement policy could be introduced, where banks holding a higher proportion of green loans receive favourable reserve treatments, encouraging sustainable investment practices.

Fiscal policy should prioritize sustainable public investment by reallocating expenditures toward low-carbon infrastructure, clean energy projects, and environmental conservation programs. The elimination of fossil fuel subsidies and the introduction of carbon taxation should be considered to internalize the environmental costs of industrial activity. Furthermore, targeted fiscal incentives—such as tax breaks for renewable energy adoption and subsidies for energy-efficient industries—can drive a transition towards a low-emission economy.

Given the dual effect of GDP growth on emissions, policymakers should accelerate the transition towards the downward phase of the Environmental Kuznets Curve by investing in cleaner industrial practices, technological advancements, and stringent environmental regulations. India should strengthen its environmental governance, ensuring strict enforcement of pollution control measures while encouraging innovation in low-carbon production technologies.

Trade policies should incorporate environmental sustainability clauses that prevent India from becoming a pollution haven. Future trade agreements should include carbon footprint assessments and environmental standards, ensuring that liberalization efforts do not come at the expense of environmental degradation. Additionally, environmental tariffs could be introduced on imported goods with high carbon footprints, incentivizing domestic industries to adopt cleaner production technologies.

The results on the long-term impact of monetary and fiscal policies suggest that macroeconomic stability and environmental sustainability must be pursued together. Policymakers should avoid trade-offs where economic expansion comes at the cost of environmental degradation. Instead, a balanced macroeconomic framework should be developed where fiscal and monetary policies support economic resilience while advancing climate objectives.

Finally, India must strengthen its commitment to international climate agreements, leveraging global financial mechanisms such as the Green Climate Fund (GCF), carbon trading schemes,

and climate adaptation funds to finance its transition to a sustainable economy. Engaging with multilateral organizations, foreign investors, and domestic industries to promote climate-resilient growth models will be crucial in ensuring sustainable economic development in the long run.

Conclusion

This research contributes to the existing literature by providing empirical evidence on the relationship between economic growth, FDI, fiscal and monetary policies, and environmental outcomes in India. By employing a Structural VAR model, the study captures both short-run and long-run interactions, offering valuable insights for policymakers aiming to achieve a sustainable balance between economic expansion and environmental preservation.

The results indicate that India's path to sustainable development requires a strategic combination of policy interventions—where economic growth, investment flows, and fiscal and monetary policies are harmonized with environmental goals. As India continues to integrate into the global economy, green finance mechanisms, sustainable trade policies, and environmentally conscious fiscal strategies must be prioritized to curb emissions and foster long-term economic resilience.

By redirecting investments, reforming fiscal incentives, and leveraging monetary tools, India can mitigate the negative environmental effects of economic expansion while maximizing the benefits of technological innovation and green infrastructure. This will enable the country to transition towards a low-carbon economy, ensuring prosperity without compromising environmental integrity.

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